UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/01**

Paper 1 Multiple Choice **May/June 2008**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft Clean Eraser
Soft pencil (type B or HB is recommended)
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do **not** use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 In the Basic Oxygen steel-making process the P_4O_{10} impurity is removed by reacting it with calcium oxide. The only product of this reaction is the salt calcium phosphate, $Ca_3(PO_4)_2$.

In this reaction, how many moles of calcium oxide react with one mole of P_4O_{10}?

A 1 **B** 1.5 **C** 3 **D** 6

2 *Use of the Data Booklet is relevant to this question.*

A typical solid fertiliser for use with household plants and shrubs contains the elements N, P, and K in the ratio of 15 g : 30 g : 15 g per 100 g of fertiliser. The recommended usage of fertiliser is 14 g of fertiliser per 5 dm^3 of water.

What is the concentration of nitrogen atoms in this solution?

A 0.03 mol dm^{-3}

B 0.05 mol dm^{-3}

C 0.42 mol dm^{-3}

D 0.75 mol dm^{-3}

3 Skin cancer can be treated using a radioactive isotope of phosphorus, $^{32}_{15}P$. A compound containing the phosphide ion $^{32}_{15}P^{3-}$, wrapped in a plastic sheet, is strapped to the affected area.

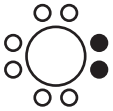
What is the composition of the phosphide ion, $^{32}_{15}P^{3-}$?

	protons	neutrons	electrons
A	15	17	18
B	15	17	32
C	17	15	17
D	32	17	15

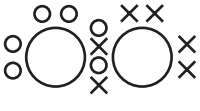
4 When barium metal burns in oxygen, the ionic compound barium peroxide, BaO_2, is formed.

Which dot-and-cross diagram represents the electronic structure of the peroxide anion in BaO_2?

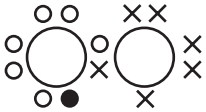
A



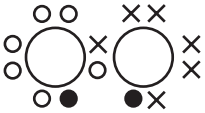
B



C



D



key

○ electron from first oxygen atom

× electron from second oxygen atom

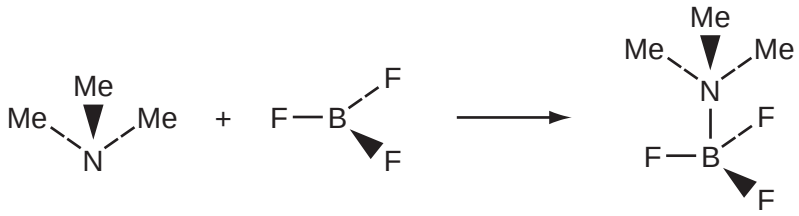
● electron from barium atom

5 In this question, the methyl group, CH_3, is represented by Me.

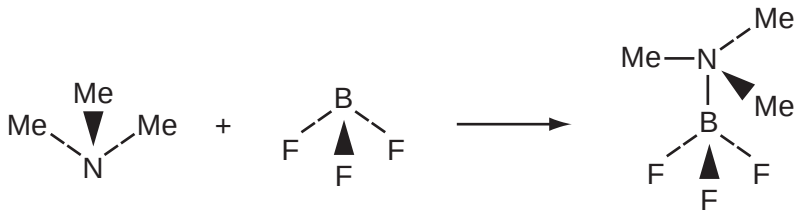
Trimethylamine, Me_3N, reacts with boron trifluoride, BF_3, to form a compound of formula $Me_3N.BF_3$.

How may this reaction be written in terms of the shapes of the reactants and products?

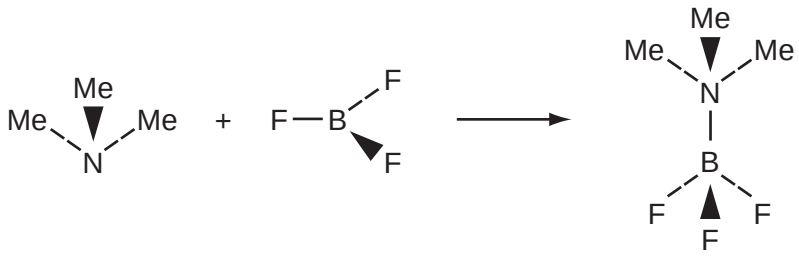
A



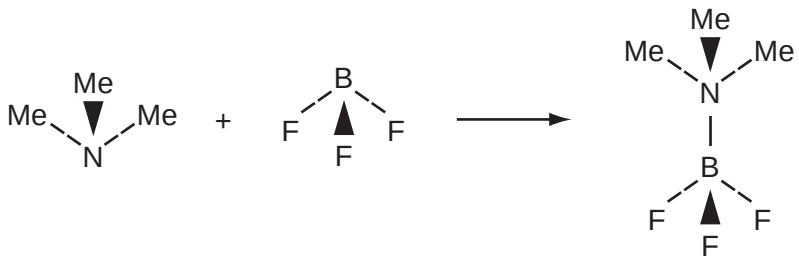
B



C



D



6 The density of ice is 1.00 g cm ^{3}.

What is the volume of steam produced when 1.00 cm^3 of ice is heated to 323 °C (596 K) at a pressure of one atmosphere (101 kPa)?

[1 mol of a gas occupies 24.0 dm^3 at 25 °C (298 K) and one atmosphere.]

A 0.267 dm^3 **B** 1.33 dm^3 **C** 2.67 dm^3 **D** 48.0 dm^3

7 Which pair of elements have bonds of the same type between their atoms in the solid state?

A aluminium and phosphorus

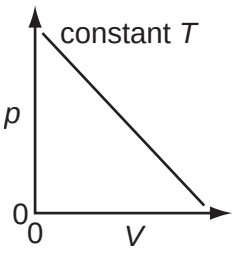
B chlorine and argon

C magnesium and silicon

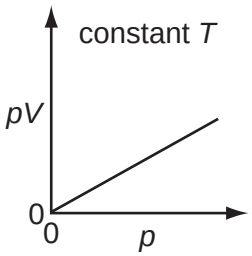
D sulphur and chlorine

8 Which diagram correctly describes the behaviour of a fixed mass of an ideal gas? (*T* is measured in K.)

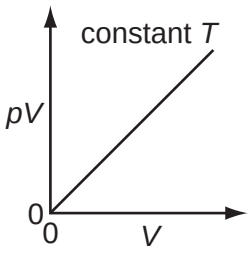
A



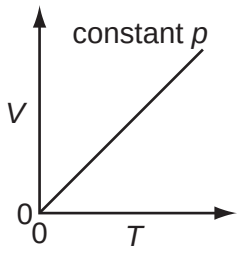
B



C



D



9 For which equation does the enthalpy change correspond to the enthalpy change of atomisation of iodine?

A $\frac{1}{2}I_2(s) \rightarrow I(s)$

B $\frac{1}{2}I_2(s) \rightarrow I(g)$

C $I_2(g) \rightarrow 2I(g)$

D $I_2(s) \rightarrow 2I(g)$

10 Titanium occurs naturally as the mineral rutile, TiO_2. One possible method of extraction of titanium is to reduce the rutile by heating with carbon.

$$TiO_2(s) + 2C(s) \rightarrow Ti(s) + 2CO(g)$$

The standard enthalpy changes of formation of $TiO_2(s)$ and $CO(g)$ are –940 kJ mol ^{1} and –110 kJ mol ^{1} respectively.

What is the standard enthalpy change of this reaction?

A –830 kJ mol ^{1}

B –720 kJ mol ^{1}

C +720 kJ mol ^{1}

D +830 kJ mol ^{1}

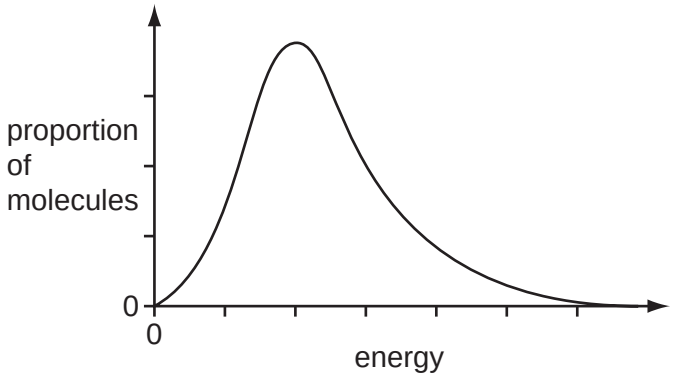
11 For the reaction

$$W(aq) + 2X(aq) \rightleftharpoons 2Y(aq) + 3Z(aq)$$

what are the correct units for the equilibrium constant K_c?

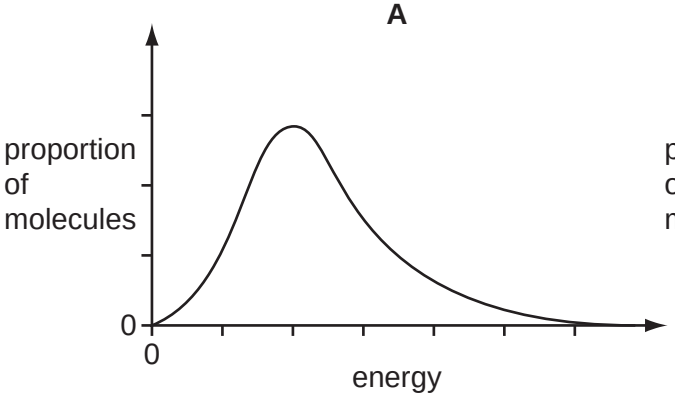
A mol dm ^{3} **B** mol^{2} dm ^{6} **C** mol ^{1} dm^{3} **D** mol ^{2} dm^{6}

12 The molecular energy distribution curve represents the variation in energy of the molecules of a gas at room temperature.

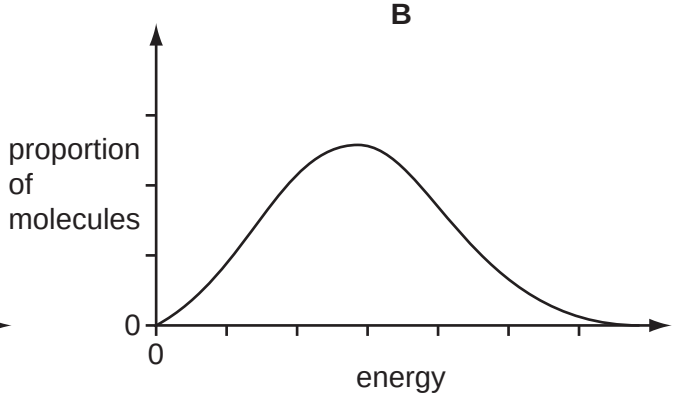


Which curve applies for the same gas at a lower temperature?

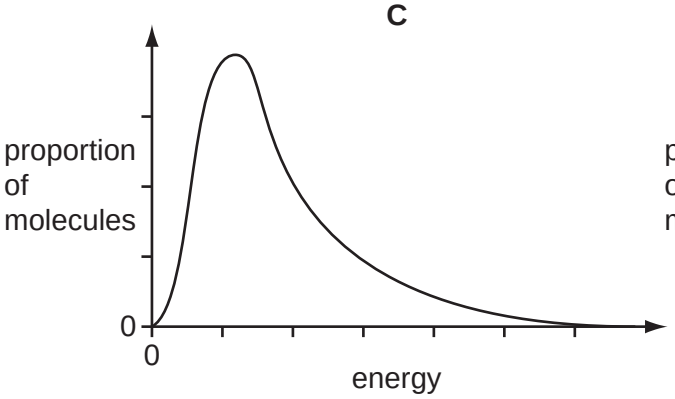
A



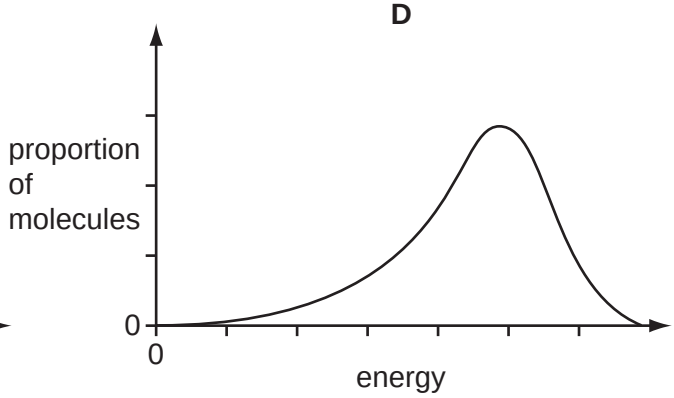
B



C



D



13 In an experiment, 0.1 g samples of Na_2O, MgO, P_4O_{10} and SO_2 are added to separate 100 cm^3 volumes of water.

For which oxide is the resulting mixture most alkaline?

A Na_2O **B** MgO **C** P_4O_{10} **D** SO_2

14 Which element is expected to show the greatest tendency to form some covalent compounds?

A aluminium

B calcium

C magnesium

D sodium

15 *Use of the Data Booklet is relevant to this question.*

The combustion of fossil fuels is a major source of increasing atmospheric carbon dioxide, with a consequential rise in global warming. Another significant contribution to carbon dioxide levels comes from the thermal decomposition of limestone, in the manufacture of cement and of lime for agricultural purposes.

Cement works roast 1000 million tonnes of limestone per year and a further 200 million tonnes is roasted in kilns to make lime.

What is the total annual mass output of carbon dioxide (in million tonnes) from these two processes?

A 440 **B** 527 **C** 660 **D** 880

16 Properties of chlorine, iodine and their compounds are compared.

Property **Q** for chlorine is smaller than for iodine.

What is property **Q**?

A oxidising ability of the element

B solubility of the silver halide in $NH_3(aq)$

C strength of van der Waals' forces between the molecules of the element

D thermal stability of the hydrogen halide

17 Which reagent, when mixed and heated with ammonium sulphate, liberates ammonia?

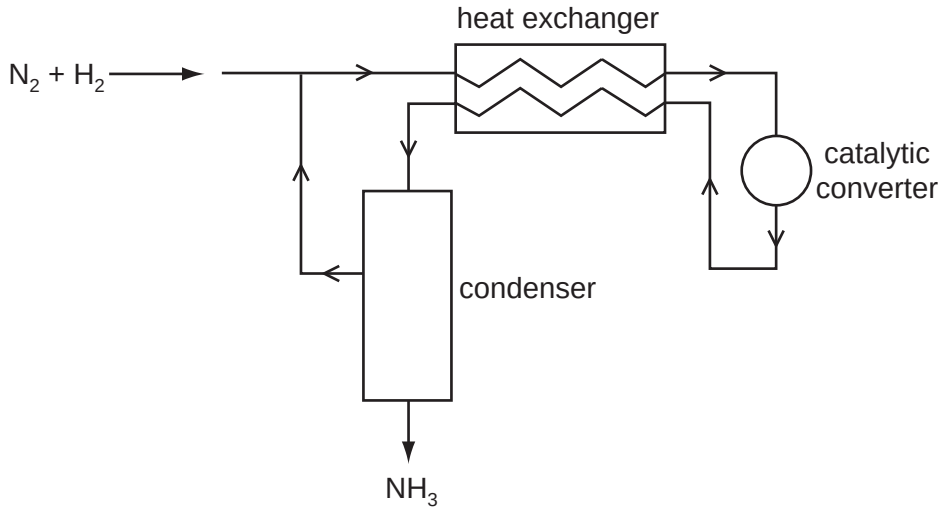
A aqueous bromine

B dilute hydrochloric acid

C limewater

D acidified potassium dichromate(VI)

18 The diagram represents the Haber process for the manufacture of ammonia from nitrogen and hydrogen.



What is the purpose of the heat exchanger?

A to cool the incoming gas mixture to avoid overheating the catalyst

B to cool the reaction products and separate the NH_3 from unused N_2 and H_2

C to warm the incoming gas mixture and shift the equilibrium to give more NH_3

D to warm the incoming gas mixture and speed up the reaction

19 Total elimination of the pollutant sulphur dioxide, SO_2, is difficult, both for economic and technical reasons. Its emission can be reduced in furnace chimneys using desulphurisation plants, where the gases are scrubbed (washed) with calcium hydroxide to remove the SO_2.

What is the main product formed initially?

A CaO **B** $Ca(OH)_2$ **C** $CaSO_3$ **D** $CaSO_4$

20 Which pair of reaction types is illustrated by the reaction sequence below?

$$CH_3CH{=}CHCH_3 \xrightarrow{HI \text{ in } CH_3CO_2H} CH_3CH_2CHICH_3 \xrightarrow{NaOH(aq)} CH_3CH_2CH(OH)CH_3$$

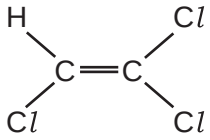
A electrophilic addition and electrophilic substitution

B electrophilic addition and nucleophilic substitution

C nucleophilic addition and electrophilic substitution

D nucleophilic addition and nucleophilic substitution

21 Trichloroethene is widely used as a dry-cleaning agent.



With which of the following does trichloroethene react to give a chiral product?

A Br_2 **B** HCl **C** NaCN(aq) **D** NaOH(aq)

22 Chloroethene, CH_2=$CHCl$, is the monomer of PVC.

What are the C C C bond angles along the polymeric chain in PVC?

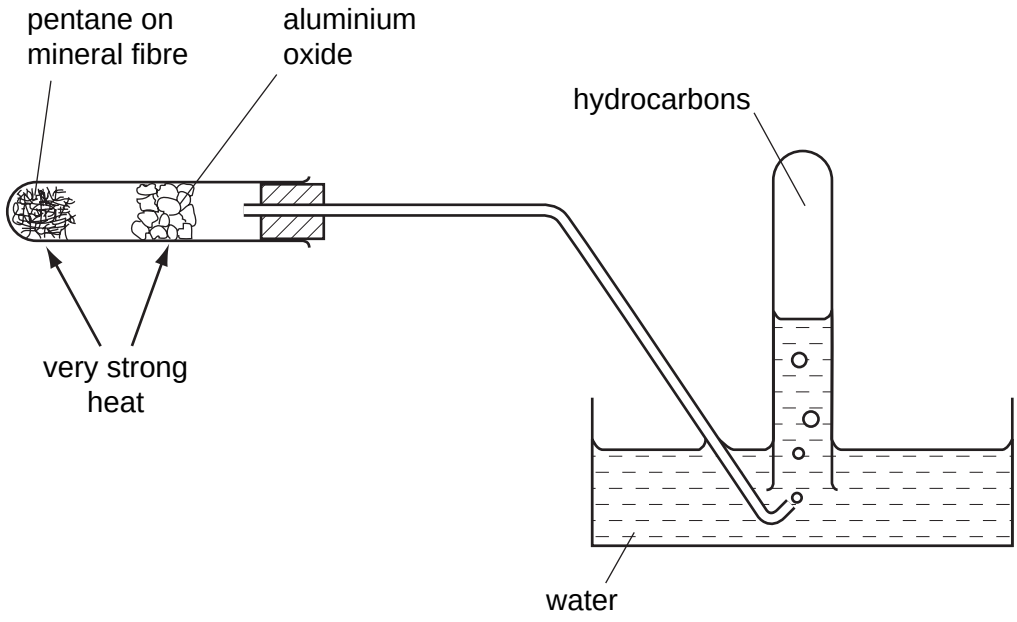
A They are all 109.5°.

B Half are 109.5° and half are 120°.

C They are all 120°.

D They are all 180°.

23 Which hydrocarbon would **not** be collected in the inverted tube by heating pentane, $CH_3(CH_2)_3CH_3$, in the apparatus shown?



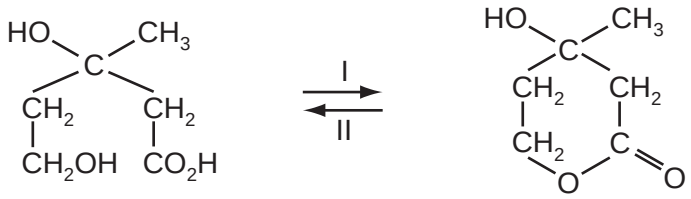
A CH_4

B CH_3CH_3

C $CH_3CH_2CH=CH_2$

D $CH_3(CH_2)_8CH_3$

24 Mevalonic acid, 3,5-dihydroxy-3-methylpentanoic acid, is involved in cholesterol formation in the body. It is an oil that occurs as a mixture of the two interchanging molecules shown in the diagram.



What names are used to describe the pair of interchanging reactions I and II?

A condensation and addition

B dehydrogenation and hydrogenation

C esterification and hydrolysis

D neutralisation and acidification

25 Halogenoalkanes are important molecules in organic synthetic reactions. In particular they undergo a range of nucleophilic reactions.

Which reaction proceeds **only** by an S_N1 mechanism?

A $CH_3CH_2Br + NH_3$

B $CH_3CH_2CH_2I + OH$

C $CH_3CHBrCH_3 + NH_3$

D $(CH_3)_3CI + OH$

26 An alcohol of molecular formula $C_4H_{10}O_2$ contains two OH groups and has an unbranched carbon atom chain.

On reaction with an excess of hot MnO_4 / H^+ this alcohol is converted into a compound of molecular formula $C_4H_6O_4$.

To which two carbon atoms in the chain of the alcohol are the two OH groups attached?

A 1st and 2nd

B 1st and 3rd

C 1st and 4th

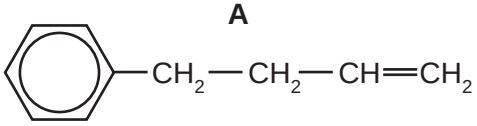
D 2nd and 3rd

27 Compound **X**

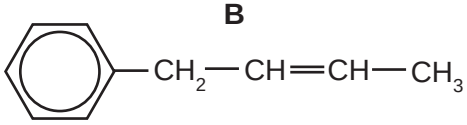
- has the molecular formula $C_{10}H_{14}O$;
- is unreactive towards mild oxidising agents.

What is the structure of the compound formed by dehydration of **X**?

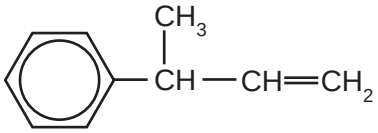
A



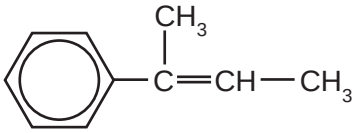
B



C



D



28 Ethanal, CH_3CHO, can be reduced using an aqueous methanolic solution of $NaBH_4$ as the reducing agent.

This is a nucleophilic addition reaction.

What could be the first step of this mechanism?

A attack of an H^+ ion at the carbon atom of the carbonyl group

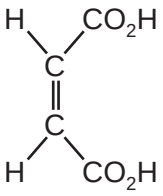
B attack of an H^+ ion at the oxygen atom of the carbonyl group

C attack of an H ion at the carbon atom of the carbonyl group

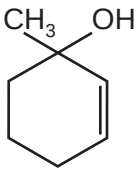
D attack of an H ion at the oxygen atom of the carbonyl group

29 Which compound is both chiral and acidic?

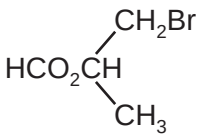
A



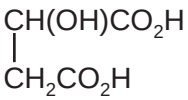
B



C



D



30 Compound **X**, $C_6H_{12}O$, is oxidised by acidified sodium dichromate(VI) to compound **Y**.

Compound **Y** reacts with ethanol in the presence of a little concentrated sulphuric acid to give liquid **Z**.

What is the formula of **Z**?

A $CH_3(CH_2)_2CH{=}CHCO_2H$

B $CH_3(CH_2)_4CH_2COCH_2CH_3$

C $CH_3(CH_2)_4CO_2CH_2CH_3$

D $CH_3CH_2CO_2(CH_2)_4CH_3$

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 For complete combustion, 1 mol of an organic compound **X** was found to require 2.5 mol of molecular oxygen.

Which compounds could be **X**?

1 C_2H_5OH

2 C_2H_2

3 CH_3CHO

32 Catalysts are used in many reversible reactions in the chemical industry. Vanadium(V) oxide is used in this way in the Contact process for the formation of SO_3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

What effect does vanadium(V) oxide have on this equilibrium?

1 It speeds up the forward reaction.

2 It increases the value of K_p.

3 It increases the value of E_a for the reverse reaction.

33 Which statements about the properties of a catalyst are correct?

1 A catalyst increases the average kinetic energy of the reacting particles.

2 A catalyst increases the rate of the reverse reaction.

3 A catalyst has no effect on the enthalpy change of the reaction.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

34 Water is added to anhydrous aluminium chloride to make a 0.1 mol dm^3 solution.

Which observations are correct?

1 The reaction is endothermic.

2 The solution is acidic.

3 The solution contains the ion $[Al(H_2O)_6]^{3+}$.

35 The electronic structure of the outer shell of the element radium is $7s^2$.

Which statements will be correct for radium within its group?

1 The element will decompose water, liberating hydrogen.

2 The element will show an oxidation number of +2 in all its compounds.

3 Radium has the highest first ionisation energy.

36 When the yellow liquid NCl_3 is stirred into aqueous sodium hydroxide, the reaction that occurs can be represented by the following equation.

$$2NCl_3(l) + 6NaOH(aq) \rightarrow N_2(g) + 3NaCl(aq) + 3NaOCl(aq) + 3H_2O(l)$$

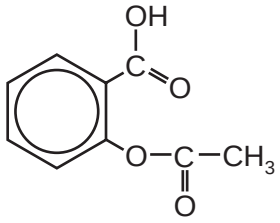
What will be the result of this reaction?

1 The nitrogen is oxidised.

2 A bleaching solution remains after the reaction.

3 The final solution gives a precipitate with acidified silver nitrate.

37 Aspirin is a widely-available pain-killer, whose properties have been known for centuries. The structure of aspirin is shown.



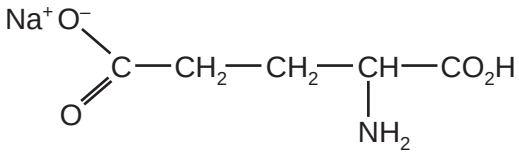
Which functional groups are present in aspirin?

1 alcohol

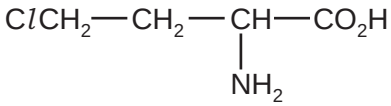
2 carboxylic acid

3 ester

38 The structure of monosodium glutamate, a flavour enhancer, is shown.



It may be prepared starting from the following compound.



Which set of reagents and reaction conditions could be used to prepare monosodium glutamate?

1 Heat under reflux with ethanolic KCN followed by hydrolysis with NaOH(aq).

2 Heat with sodium methanoate, $HCO_2^- Na^+$.

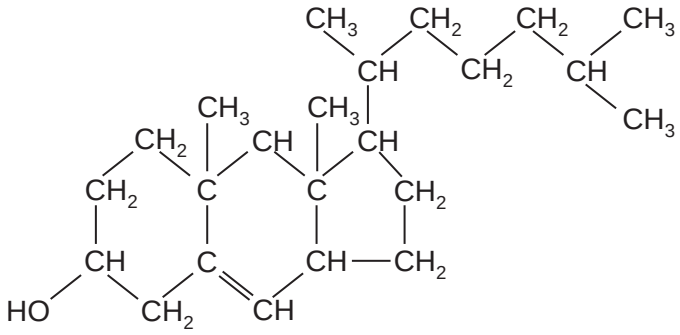
3 Heat under reflux with NaOH(aq).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

39 The compound cholesterol has the following structure.



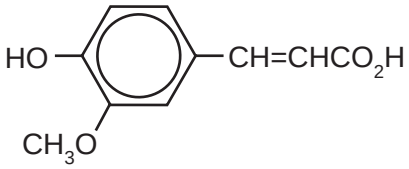
Which statements are correct?

1 Cholesterol reacts with a mixture of ethanoic acid and concentrated sulphuric acid.

2 Cholesterol reacts with bromine to form a compound which has two new chiral centres.

3 Cholesterol is oxidised by acidified sodium dichromate(VI) to form an aldehyde.

40 Ferulic acid is an antioxidant that occurs widely in plants.



ferulic acid

Which reagents can react with the $-CH=CHCO_2H$ part of the molecule?

1 NaOH(aq)

2 acidified $KMnO_4$

3 HBr

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2008 question paper

9701 CHEMISTRY

9701/01 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2008 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**A**	22	**A**
3	**A**	23	**D**
4	**D**	24	**C**
5	**C**	25	**D**
6	**C**	26	**C**
7	**D**	27	**D**
8	**D**	28	**C**
9	**B**	29	**D**
10	**C**	30	**C**
11	**B**	31	**C**
12	**C**	32	**D**
13	**A**	33	**C**
14	**A**	34	**C**
15	**B**	35	**B**
16	**C**	36	**C**
17	**C**	37	**C**
18	**D**	38	**D**
19	**C**	39	**B**
20	**B**	40	**A**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/01**

Paper 1 Multiple Choice **October/November 2008**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 8 8 0 1 4 6 4 6 2 4 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **13** printed pages and **3** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 *Use of the Data Booklet is relevant to this question.*

Titanium(IV) oxide, TiO_2, is brilliantly white and much of the oxide produced is used in the manufacture of paint.

What is the maximum amount of TiO_2 obtainable from 19.0 tonnes of the ore ilmenite, $FeTiO_3$?

A 10.0 tonnes **B** 12.7 tonnes **C** 14.0 tonnes **D** 17.7 tonnes

2 Carbon disulphide vapour burns in oxygen according to the following equation.

$$CS_2(g) + 3O_2(g) \rightarrow CO_2(g) + 2SO_2(g)$$

A sample of 10 cm^3 of carbon disulphide was burned in 50 cm^3 of oxygen. After measuring the volume of gas remaining, the product was treated with an excess of aqueous sodium hydroxide and the volume of gas measured again. All measurements were made at the same temperature and pressure, under such conditions that carbon disulphide was gaseous.

What were the measured volumes?

	volume of gas after burning / cm^3	volume of gas after adding NaOH(aq) / cm^3
A	30	0
B	30	20
C	50	20
D	50	40

3 In which pair do both atoms have one electron only in an s orbital in their ground states?

A Ca, Sc **B** Cu, Be **C** H, He **D** Li, Cr

4 *Use of the Data Booklet is relevant to this question.*

Hard water contains calcium ions and hydrogencarbonate ions arising from dissolved calcium hydrogencarbonate, $Ca(HCO_3)_2$.

How many electrons are present in the hydrogencarbonate anion?

A 30 **B** 31 **C** 32 **D** 33

5 Which quantity would best indicate the relative strengths of the hydrogen bonds between the molecules in liquid hydrogen halides?

A bond dissociation energies

B enthalpy changes of solution

C enthalpy changes of formation

D enthalpy changes of vaporisation

6 A substance commonly found in the house or garden has the following properties.

- It is combustible.
- It is an electrical insulator.
- It melts over a range of temperature.

What could the substance be?

A brass

B paper

C poly(ethene)

D silicon(IV) oxide

7 Which of the following would behave most like an ideal gas at room temperature?

A carbon dioxide

B helium

C hydrogen

D nitrogen

8 Red lead oxide, Pb_3O_4, is used in metal priming paints. It can be made by heating PbO in air.

$$6PbO(s) + O_2(g) \rightarrow 2Pb_3O_4(s)$$

Which two values are needed to calculate the enthalpy change for this reaction?

A enthalpy change of combustion of lead and enthalpy change of formation of Pb_3O_4

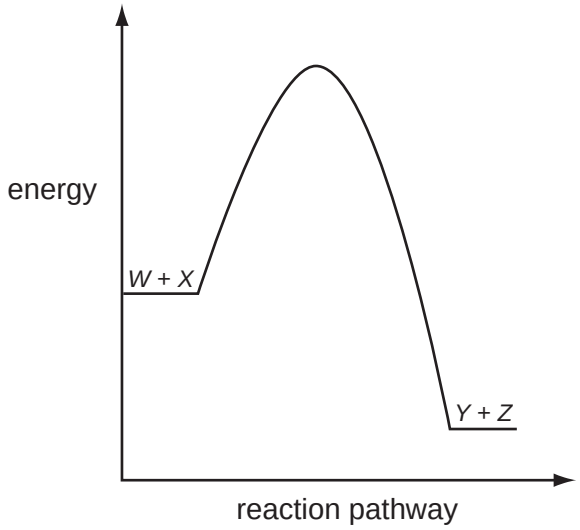
B enthalpy change of combustion of PbO and enthalpy change of formation of Pb_3O_4

C enthalpy change of formation of PbO and enthalpy change of atomisation of O_2

D enthalpy change of formation of PbO and enthalpy change of formation of Pb_3O_4

9 The diagram represents the reaction pathway for the following reaction.

$$W(g) + X(g) \rightarrow Y(g) + Z(g)$$



What statement can be made about the reverse reaction, $Y(g) + Z(g) \rightarrow W(g) + X(g)$?

A It will have a larger activation energy and a positive ΔH.

B It will have a larger activation energy and a negative ΔH.

C It will have a smaller activation energy and a positive ΔH.

D It will have a smaller activation energy and a negative ΔH.

10 For the equilibrium $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, what will change the value of K_p?

A adding a catalyst

B adding more O_2

C increasing the pressure

D increasing the temperature

11 Dinitrogen tetroxide dissociates into nitrogen dioxide on heating.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

In an experiment the partial pressures of the gases at equilibrium were found to be NO_2, 0.33 atm; N_2O_4, 0.67 atm.

What is the numerical value of K_p at the temperature of the experiment?

A 0.16 **B** 0.49 **C** 0.65 **D** 2.03

12 Crotonaldehyde, $CH_3CH=CHCHO$, can be obtained by oxidising butadiene, $CH_2=CHCH=CH_2$, using air or oxygen. One method is to pass a mixture of butadiene and oxygen through a hot aqueous solution of palladium(II) ions, $Pd^{2+}(aq)$, which catalyse the reaction.

Which statement is **not** correct about the action of the $Pd^{2+}(aq)$ ions?

A Changing the concentration of the $Pd^{2+}(aq)$ will have an effect on the rate of the reaction.

B $Pd^{2+}(aq)$ increases the energy of the reacting molecules.

C $Pd^{2+}(aq)$ lowers the activation energy for the reaction.

D When $Pd^{2+}(aq)$ is used, the reaction proceeds by a different route.

13 Which oxide, when mixed with water, will produce the most acidic solution?

A CO **B** CO_2 **C** SiO_2 **D** P_2O_5

14 Which salt is produced by adding aqueous ammonia to aqueous sulphur dioxide until just alkaline?

A NH_4SO_3 **B** NH_4SO_4 **C** $(NH_4)_2SO_3$ **D** $(NH_4)_2SO_4$

15 Aluminium chloride catalyses certain reactions by forming carbocations (carbonium ions) with chloroalkanes as shown.

$$RCl + AlCl_3 \rightarrow R^+ + AlCl_4$$

Which property makes this reaction possible?

A $AlCl_3$ exists as the dimer Al_2Cl_6 in the vapour.

B $AlCl_3$ is a covalent molecule.

C The aluminium atom in $AlCl_3$ has an incomplete octet of electrons.

D The chlorine atom in RCl has a vacant p orbital.

16 Due to their similar ionic radii, the reactions of lithium and magnesium and their corresponding compounds are very similar.

Which statement concerning the reactions of lithium and its compounds is correct?

A Lithium carbonate decomposes on heating at a relatively low temperature, forming lithium oxide and carbon dioxide.

B Lithium nitrate decomposes on heating, forming lithium nitrite and oxygen.

C Lithium burns only slowly in oxygen.

D Lithium reacts violently with cold water, liberating hydrogen.

17 A student observed the reactions when sodium chloride and sodium iodide were each reacted separately with concentrated sulphuric acid and concentrated phosphoric acid. The observations are recorded in the table.

	sodium chloride	sodium iodide
conc. H_2SO_4	colourless acidic gas formed	purple vapour formed
conc. H_3PO_4	colourless acidic gas formed	colourless acidic gas formed

Which deduction can be made from these observations?

A Concentrated phosphoric acid is a stronger oxidising agent than concentrated sulphuric acid.

B Concentrated phosphoric acid is a stronger oxidising agent than iodine.

C Concentrated sulphuric acid is a stronger oxidising agent than chlorine.

D Concentrated sulphuric acid is a stronger oxidising agent than iodine.

18 When gaseous chemicals are transported by road or by rail they are classified as follows.

flammable non-flammable poisonous

Which gas is poisonous?

A butane

B carbon dioxide

C hydrogen

D sulphur dioxide

19 Which statement explains the observation that magnesium hydroxide dissolves in aqueous ammonium chloride, but not in aqueous sodium chloride?

A The ionic radius of the NH_4^+ ion is similar to that of Mg^{2+} but not that of Na^+.

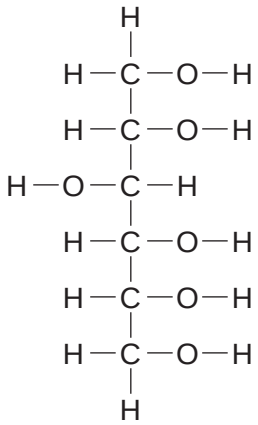
B NH_4Cl dissociates less fully than $NaCl$.

C The Na^+ and Mg^{2+} ions are isoelectronic (have the same number of electrons).

D The NH_4^+ ion acts as an acid.

20 Sorbitol is a naturally-occurring compound with a sweet taste. It is often used as a substitute for sucrose by the food industry.

The diagram shows its structure.



How many chiral centres are present in sorbitol?

A 1 **B** 2 **C** 3 **D** 4

21 The compound 'leaf alcohol' is partly responsible for the smell of new-mown grass.

$CH_3CH_2CH{=}CHCH_2CH_2OH$

leaf alcohol

Which two compounds will be formed when 'leaf alcohol' is oxidised using hot, concentrated manganate(VII) ions?

A CH_3CO_2H and $HOCH_2CH_2CH_2CO_2H$

B CH_3CO_2H and $HO_2CCH_2CH_2CO_2H$

C $CH_3CH_2CO_2H$ and $HO_2CCH_2CO_2H$

D $CH_3CH_2CO_2H$ and $HOCH_2CH_2CO_2H$

22 Which hydrocarbon can form a monochloro-substitution derivative which shows **both** chirality **and** *cis-trans* isomerism?

A $CH_3CH{=}CH_2$

B $(CH_3)_2C{=}CH_2$

C $CH_3CH{=}C(CH_3)_2$

D $CH_3CH{=}CHCH_2CH_3$

23 Four drops of 1-chlorobutane, 1-bromobutane and 1-iodobutane were put separately into three test-tubes containing 1.0 cm^3 of aqueous silver nitrate at 60 °C.

A hydrolysis reaction occurred. (R represents the butane chain C_4H_9– and *X* the halogen atom.)

$$H_2O(l) + R–X(l) + Ag^+(aq) \rightarrow R–OH(aq) + AgX(s) + H^+(aq)$$

The rate of formation of cloudiness in the tubes was in the order RC*l* < RBr < RI.

Why is this?

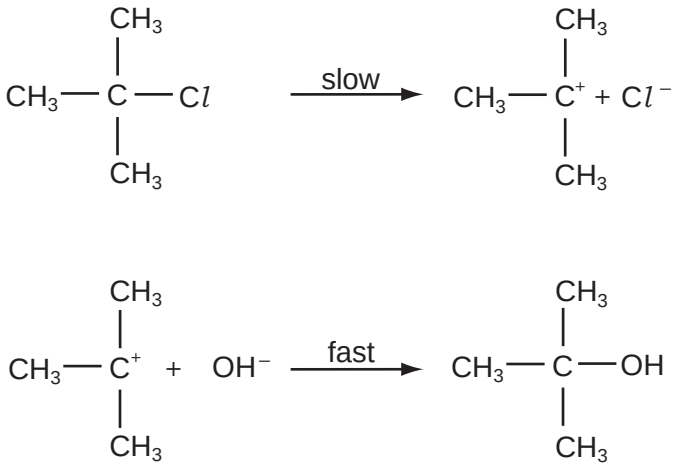
A The R–*X* bond polarity decreases from RC*l* to RI.

B The solubility of Ag*X*(s) decreases from AgC*l* to AgI.

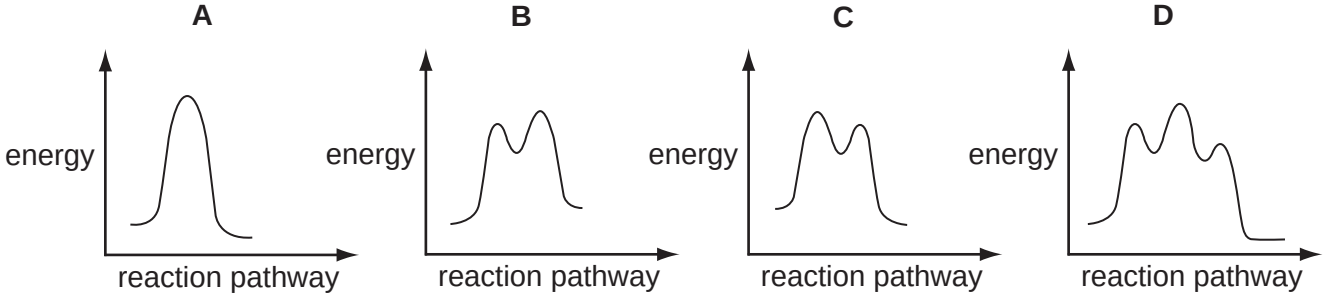
C The ionisation energy of the halogen decreases from C*l* to I.

D The bond energy of R–*X* decreases from RC*l* to RI.

24 A possible mechanism of the exothermic hydrolysis of 2-chloro-2-methylpropane is shown.



Which diagram represents the reaction profile for this mechanism?



25 The functional group in a primary alcohol is $-CH_2OH$.

Which reagent reacts with a primary alcohol, under suitable conditions, to give an organic product with the same number of oxygen atoms as the alcohol?

A Al_2O_3 **B** CH_3CO_2H **C** HBr **D** Na

26 Ethyl phenylethanoate, $C_6H_5CH_2CO_2C_2H_5$, gives a characteristic flowery aroma to honey.

Which sequence of reagents, with heating in each case, leads to the preparation of $C_6H_5CH_2CO_2C_2H_5$ from $C_6H_5CH_2Br$?

A $C_6H_5CH_2Br \xrightarrow{NaOH(aq)} \xrightarrow{C_2H_5COCl}$

B $C_6H_5CH_2Br \xrightarrow{NaOH(aq)} \xrightarrow{C_2H_5CO_2H,\ conc.\ H_2SO_4}$

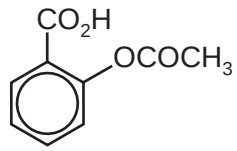
C $C_6H_5CH_2Br \xrightarrow{NaCN(alcoholic)} \xrightarrow{H^+(aq)} \xrightarrow{C_2H_5OH,\ conc.\ H_2SO_4}$

D $C_6H_5CH_2Br \xrightarrow{NaOH(aq)} \xrightarrow{conc.\ MnO_4^-,\ H^+(aq)} \xrightarrow{C_2H_5OH,\ conc.\ H_2SO_4}$

27 The stomach wall can become sensitive to acidic compounds.

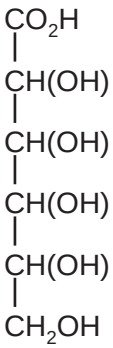
Which is the most acidic compound?

A



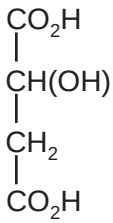
aspirin

B



gluconic acid

C



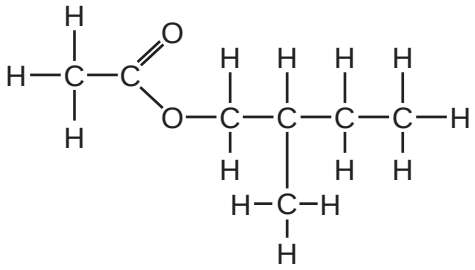
malic acid

D

$CH_3CH(OH)CO_2H$

lactic acid

28 Bees use 2-methylbutyl ethanoate as an 'alarm' pheromone. When disturbed, individual bees on guard will raise their abdomen and emit the alarm pheromone, fanning their wings to aid its dispersal. This alerts other bees to a danger and makes them ready to sting when required.



2-methylbutyl ethanoate

Which starting materials would be required to synthesise 2-methylbutyl ethanoate?

A CH_3CH_2OH and $CH_3CH_2CH(CH_3)CO_2H$

B CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2OH$

C CH_3CH_2OH and $CH_3CH_2CH(CH_3)CH_2CO_2H$

D CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2CO_2H$

29 The product of the reaction between propanone and hydrogen cyanide is hydrolysed under acidic conditions.

What is the formula of the final product?

A $CH_3CH(OH)CO_2H$

B $CH_3CH_2CH_2CO_2H$

C $(CH_3)_2CHCONH_2$

D $(CH_3)_2C(OH)CO_2H$

30 *Use of the Data Booklet is relevant to this question.*

Ethyl ethanoate can be obtained from ethanoic acid and ethanol by the following reaction.

$$CH_3CH_2OH + CH_3CO_2H \rightleftharpoons CH_3CO_2CH_2CH_3 + H_2O$$

Ethanol (30 g) and ethanoic acid (30 g) are heated under reflux together, and 22 g of ethyl ethanoate are obtained.

What is the yield of the ester?

A 25 % **B** 38 % **C** 50 % **D** 77 %

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

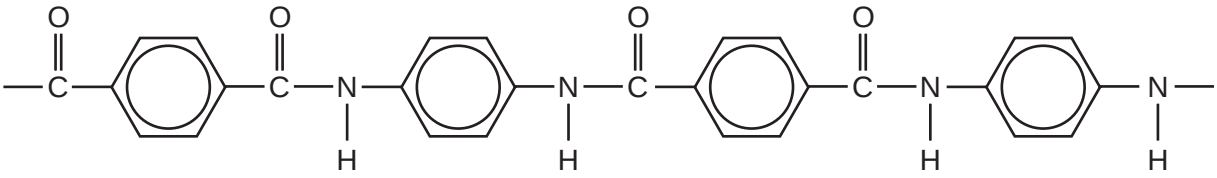
Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 *Kevlar* has the structure below.



Compared to a steel rope of similar dimensions, a *Kevlar* rope is both lighter and stronger.

Which properties of *Kevlar* help to explain these facts?

1 The fibres of *Kevlar* align due to hydrogen bonding.

2 The mass per unit length is less in a *Kevlar* rope than in a steel rope.

3 The *Kevlar* molecule has no permanent dipole.

32 Which of the following can act as a Bronsted-Lowry acid?

1 H_3O^+

2 NH_4^+

3 H_2O

33 Under given conditions, what governs the rate of a forward reaction?

1 the activation energy of the reaction

2 the enthalpy change of the reaction

3 the equilibrium constant of the reaction

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

34 Which statements concerning the Group II elements magnesium, calcium and barium are correct?

1 Their reactivity increases with increasing relative atomic mass.

2 The oxidation number exhibited in their stable compounds is +2.

3 On strong heating, their nitrates give off oxygen only.

35 Chlorine is a greenish-yellow gas, bromine is a dark red liquid and iodine is a dark grey solid.

What causes these differences in volatility?

1 the halogen-halogen bond energy

2 the magnitude of the van der Waals' forces between the molecules

3 the number of electrons in the halogen molecule

36 Which statements about the Haber process for the industrial production of ammonia are correct?

1 The equilibrium constant K_p increases with pressure.

2 As the temperature increases, the equilibrium constant for the forward reaction becomes smaller.

3 The process is usually carried out at between 450 °C and 550 °C at a pressure of at least 150 atm.

37 Which statements about alkenes are correct?

1 They are formed when higher alkanes are cracked.

2 They are used as monomers for polymerisation.

3 They are less reactive than alkanes towards electrophiles.

38 Which of the following would be suitable for use in a fire extinguisher?

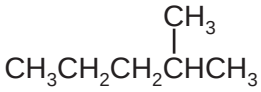
1 $CBrF_3$

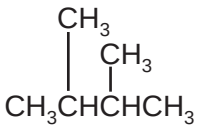
2 $CH_3(CH_2)_5CH_2Br$

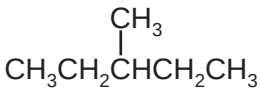
3 HCl

39 During the bromination of methane, the free radical $\dot{C}H_3$ is generated and a possible terminating step of this reaction is the formation of C_2H_6 by the combination of two free radicals.

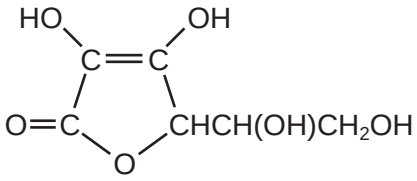
What could be produced in a terminating step during the bromination of propane?

1 

2 

3 

40 The structure of the antioxidant vitamin C is shown in the diagram.



On the basis of this structure, which properties is vitamin C likely to have?

1 It is soluble in water.

2 It decolourises aqueous bromine rapidly.

3 It reduces Fehling's reagent.

BLANK PAGE

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2008 question paper

9701 CHEMISTRY

9701/01 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2008 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**A**	21	**C**
2	**C**	22	**D**
3	**D**	23	**D**
4	**C**	24	**C**
5	**D**	25	**D**
6	**C**	26	**C**
7	**B**	27	**C**
8	**D**	28	**B**
9	**A**	29	**D**
10	**D**	30	**C**
11	**A**	31	**B**
12	**B**	32	**A**
13	**D**	33	**D**
14	**C**	34	**B**
15	**C**	35	**C**
16	**A**	36	**C**
17	**D**	37	**B**
18	**D**	38	**D**
19	**D**	39	**B**
20	**D**	40	**B**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **October/November 2009**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

4953393305

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

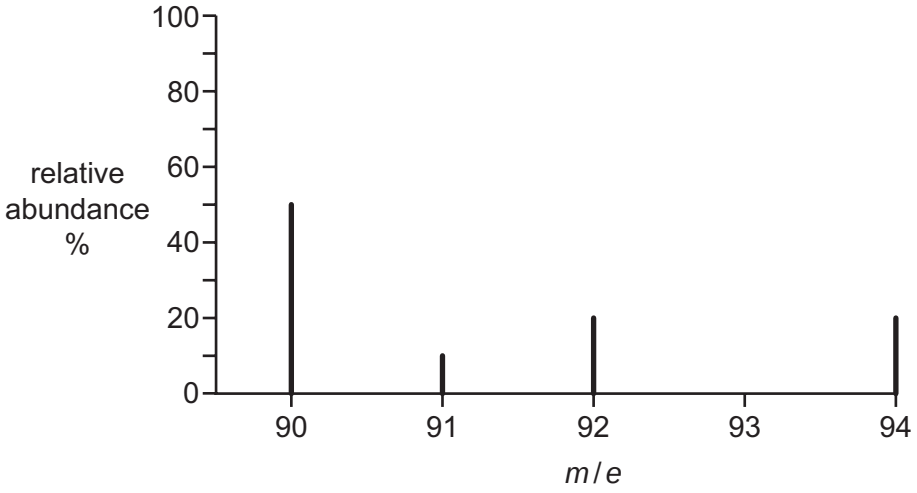
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **16** printed pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 An element **X** consists of four isotopes. The mass spectrum of **X** is shown in the diagram.



What is the relative atomic mass of **X**?

A 91.00 **B** 91.30 **C** 91.75 **D** 92.00

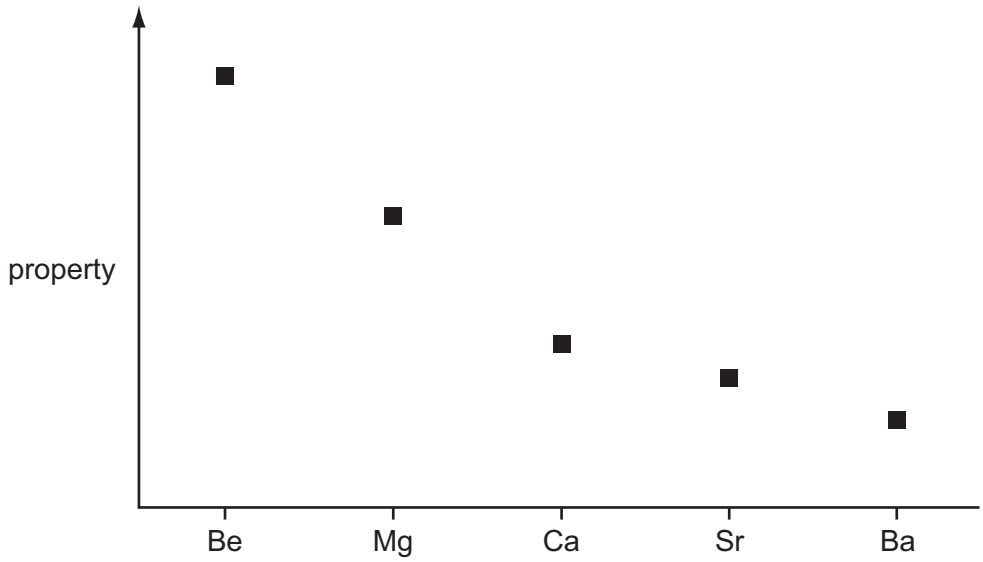
2 0.200 mol of a hydrocarbon undergo complete combustion to give 35.2 g of carbon dioxide and 14.4 g of water as the only products.

What is the molecular formula of the hydrocarbon?

A C_2H_4 **B** C_2H_6 **C** C_4H_4 **D** C_4H_8

3 *Use of the Data Booklet is relevant to this question.*

The graph represents the variation of a property of the Group II elements.



What is this property?

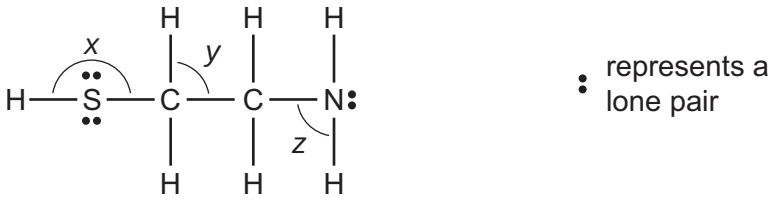
A ionic radius

B ionisation energy

C neutron / proton ratio

D rate of reaction with water

4 The antidote molecule shown can help to prevent liver damage if someone takes too many paracetamol tablets.



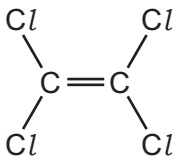
: represents a lone pair

What is the order of **decreasing** size of the bond angles *x*, *y* and *z*?

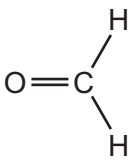
	largest ⟶		smallest
A	*x*	*y*	*z*
B	*x*	*z*	*y*
C	*y*	*z*	*x*
D	*z*	*y*	*x*

5 Which molecule has the largest overall dipole?

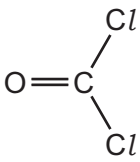
A



B



C



D

6 The first stage in the industrial production of nitric acid from ammonia can be represented by the following equation.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

Using the following standard enthalpy change of formation data, what is the value of the standard enthalpy change, $\Delta H^{\ominus}$, for this reaction?

compound	$\Delta H_f^{\ominus}$ / kJ mol $^{-1}$
$NH_3(g)$	–46.1
$NO(g)$	+90.3
$H_2O(g)$	–241.8

A +905.2 kJ mol $^{-1}$

B –105.4 kJ mol $^{-1}$

C –905.2 kJ mol $^{-1}$

D –1274.0 kJ mol $^{-1}$

7 Which conversion involves a reduction of chromium?

A $CrO_4^{2-} \rightarrow CrO_3$

B $CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$

C $CrO_2Cl_2 \rightarrow CrO_4^{2-}$

D $CrO_2Cl_2 \rightarrow Cr_2O_3$

8 The equilibrium

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g) \qquad \Delta H = +180\,kJ\,mol^{-1}$$

contributes to a series of reactions producing photochemical smog.

Which factors would affect the value of K_p of the above equilibrium?

	change in pressure	change in temperature	presence or absence of a catalyst
A	✓	✓	✗
B	✓	✗	✓
C	✗	✓	✓
D	✗	✓	✗

9 PCl_5 dissociates as follows.

$$PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$$

The extent of dissociation is 13 % at 160 °C and 100 % at 300 °C.

Which pair of statements about this formation of PCl_3 is correct?

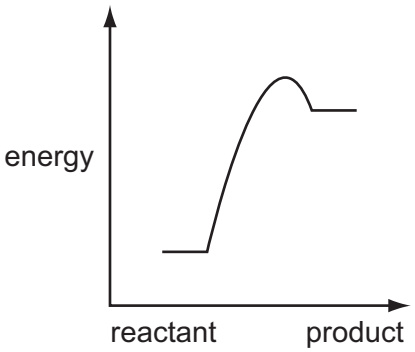
	shape of PCl_3 molecule	the reaction is
A	pyramidal	endothermic
B	pyramidal	exothermic
C	trigonal	endothermic
D	trigonal	exothermic

10 Four reactions of the type shown are studied at the same temperature.

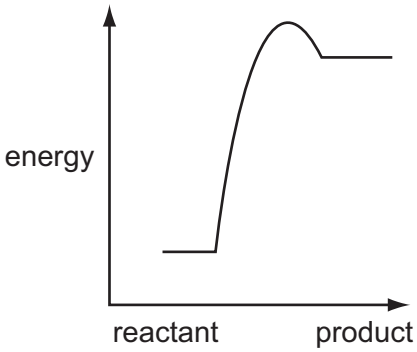
$$X(g) + Y(g) \rightarrow Z(g)$$

Which is the correct reaction pathway diagram for the reaction that would proceed **most** rapidly and with the **highest** yield?

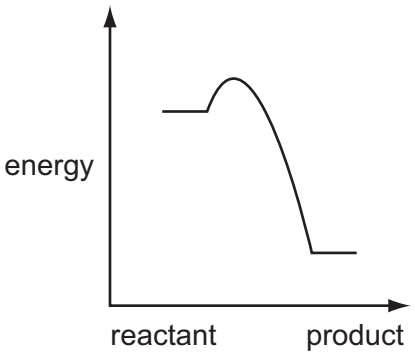
A



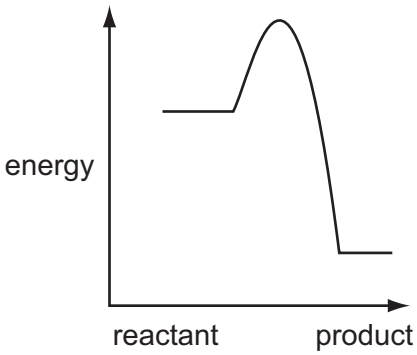
B



C



D



11 Photochromic glass, used for sunglasses, darkens when exposed to bright light and becomes more transparent again when the light is less bright. The depth of colour of the glass is related to the concentration of silver atoms.

The following reactions are involved.

reaction 1 $Ag^+ + Cl \rightleftharpoons Ag + Cl$

reaction 2 $Cu^+ + Cl \rightarrow Cu^{2+} + Cl$

reaction 3 $Cu^{2+} + Ag \rightarrow Cu^+ + Ag^+$

Which statement about these reactions is correct?

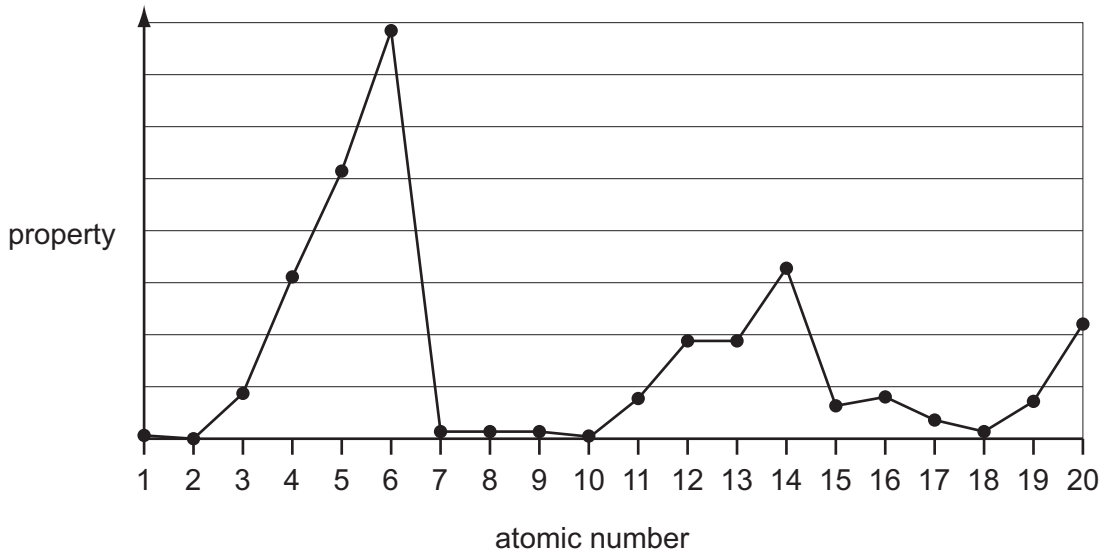
A Cu^+ and Cu^{2+} ions act as catalysts.

B Cu^+ ions act as an oxidising agent in reaction 2.

C Reaction 2 is the one in which light is absorbed.

D Ag^+ ions are oxidised in reaction 1.

12 The following graph shows the variation of a property of the first 20 elements in the Periodic Table with the atomic number of the element.



What is the property?

A atomic radius

B first ionisation energy

C ionic radius

D melting point

13 Which statement correctly describes what happens when silicon tetrachloride is added to water?

A The $SiCl_4$ dissolves to give a neutral solution only.

B The $SiCl_4$ reacts to give an acidic solution only.

C The $SiCl_4$ reacts to give a precipitate and an acidic solution.

D The $SiCl_4$ reacts to give a precipitate and a neutral solution.

14 The oxide and chloride of an element **X** are separately mixed with water. The two resulting solutions have the same effect on litmus.

What is element **X**?

A sodium

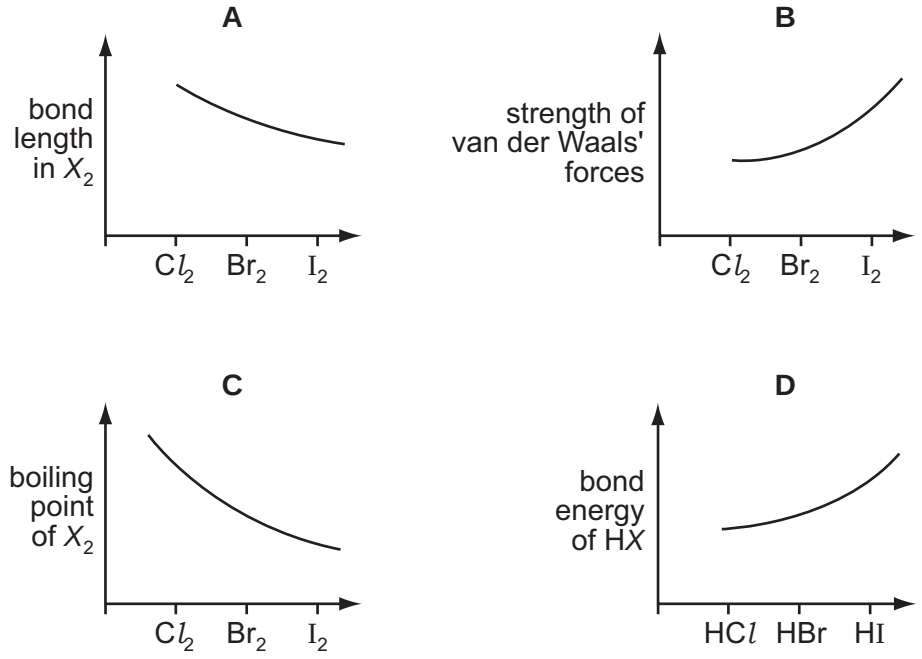
B magnesium

C aluminium

D phosphorus

15 Which graph correctly describes a trend found in the halogen group?

[*X* represents a halogen atom.]



16 During electrolysis of brine in a diaphragm cell, chlorine, hydrogen and sodium hydroxide are produced.

What is the molar ratio of these products?

	chlorine	hydrogen	sodium hydroxide
A	1	1	1
B	1	1	2
C	2	1	1
D	2	2	1

17 When sulfur trioxide is manufactured from sulfur dioxide and oxygen, using the Contact process, which condition affects the value of the equilibrium constant, K_c?

A adjusting the temperature

B adjusting the pressure

C using a catalyst

D removing SO_3 from the equilibrium mixture

18 Most modern cars are fitted with three-way catalytic converters in the exhaust system.

Which three gases are removed by such a catalytic converter?

A carbon monoxide, hydrocarbons, nitrogen oxides

B carbon monoxide, carbon dioxide, nitrogen oxides

C carbon monoxide, nitrogen oxides, sulfur dioxide

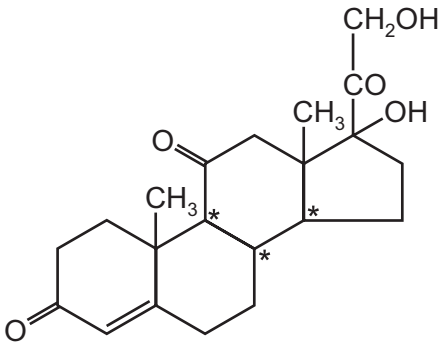
D hydrocarbons, nitrogen oxides, sulfur dioxide

19 In an historically famous experiment Wöhler heated 'inorganic' ammonium cyanate in the absence of air. The only product of the reaction was 'organic' urea, $CO(NH_2)_2$. No other products were formed in the reaction.

What is the formula of the cyanate ion present in ammonium cyanate?

A CNO **B** CNO^2 **C** CO **D** NO

20 The drug cortisone has the formula shown.



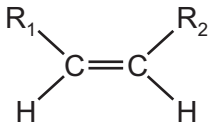
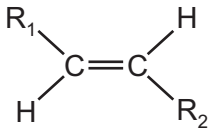
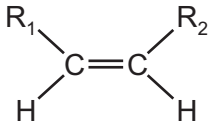
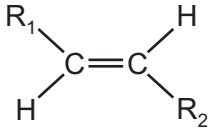
In addition to those chiral centres marked by an asterisk (*), how many other chiral centres are present in the cortisone molecule?

A 0 **B** 1 **C** 2 **D** 3

21 The presence of 11-*cis* retinal, $C_{20}H_{28}O$, in cells in the eye is important for vision.

The structure of retinal includes an aldehyde group, a cyclohexene ring and a long aliphatic side chain, in which a carbon-carbon double bond exists between carbons numbered 11 and 12.

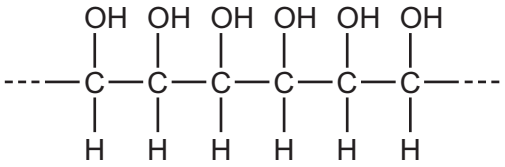
Which pair of statements about 11-*cis* retinal could be correct?

	total number of >C=C< double bonds	arrangement around the adjacent carbons 11 and 12
A	5	
B	5	
C	6	
D	6	

22 What is the least number of carbon atoms in a non-cyclic alkane molecule that has a chiral centre?

A 7 **B** 8 **C** 9 **D** 10

23 The following diagram represents the structure of a possible polymer.



By which method might this polymer be made?

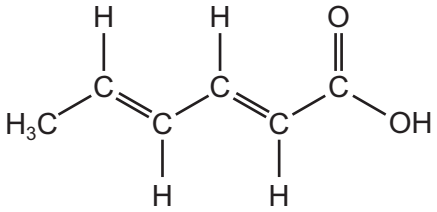
A polymerise ethene followed by hydration

B polymerise ethene followed by oxidation with cold acidified $KMnO_4$

C polymerise 1,2-dichloroethene followed by hydrolysis

D polymerise 1,2-dichloroethene followed by oxidation with cold acidified $KMnO_4$

24 Sorbic acid is used as a food preservative because it kills fungi and moulds.



sorbic acid

Sorbic acid will react with

- hydrogen in the presence of a nickel catalyst,
- bromine in an organic solvent.

How many moles of hydrogen and of bromine will be incorporated into one mole of sorbic acid by these reactions?

	moles of hydrogen	moles of bromine
A	2	2
B	2	$2\frac{1}{2}$
C	3	2
D	3	$2\frac{1}{2}$

25 Bromine reacts with ethene to form 1,2-dibromoethane.

What is the correct description of the organic intermediate in this reaction?

A It has a negative charge.

B It is a free radical.

C It is a nucleophile.

D It is an electrophile.

26 Which equation represents a valid propagation step in the free radical reaction between ethane and chlorine?

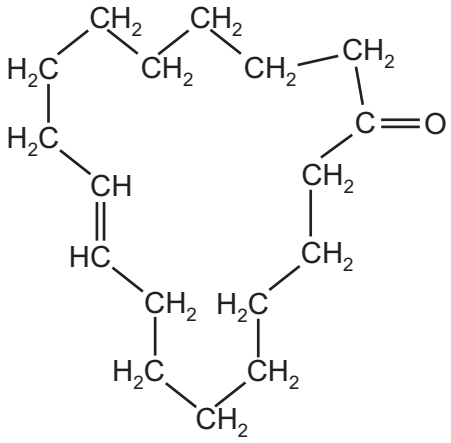
A $C_2H_6 + Cl^{\bullet} \rightarrow C_2H_5Cl + H^{\bullet}$

B $C_2H_5Cl + Cl^{\bullet} \rightarrow C_2H_4Cl^{\bullet} + HCl$

C $C_2H_6 + H^{\bullet} \rightarrow C_2H_5^{\bullet} + HCl$

D $C_2H_5^{\bullet} + Cl^{\bullet} \rightarrow C_2H_5Cl$

27 The naturally-occurring molecule civetone is found in a gland of the African civet cat and has been used in perfumery.



civetone

With which reagent will civetone **not** react?

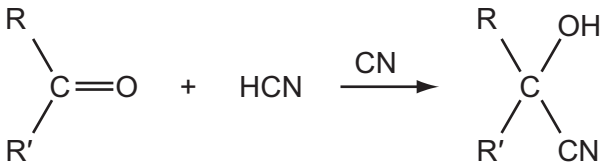
A 2,4-dinitrophenylhydrazine reagent

B Fehling's reagent

C hydrogen bromide

D sodium tetrahydridoborate(III) (sodium borohydride)

28 Cyanohydrins can be made from carbonyl compounds by generating CN^- ions from HCN in the presence of a weak base.



In a similar reaction, $CH_2CO_2CH_3^-$ ions are generated from $CH_3CO_2CH_3$ by strong bases.

Which compound can be made from an aldehyde and $CH_3CO_2CH_3$ in the presence of a strong base?

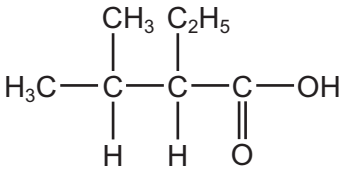
A $CH_3CH(OH)CO_2CH_3$

B $CH_3CO_2CH_2CH(OH)CH_3$

C $CH_3CH_2CH(OH)CH_2CO_2CH_3$

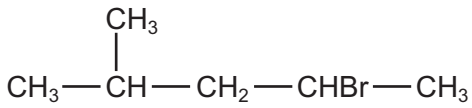
D $(CH_3)_2C(OH)CH_2CO_2CH_3$

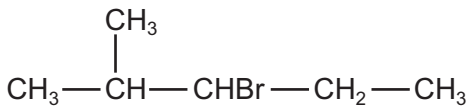
29 The characteristic odour of rum is attributed to the compound 2-ethyl-3-methylbutanoic acid.

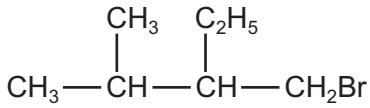


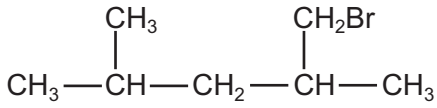
2-ethyl-3-methylbutanoic acid

Which compound will produce 2-ethyl-3-methylbutanoic acid by heating under reflux with alcoholic sodium cyanide and subsequent acid hydrolysis of the reaction product?

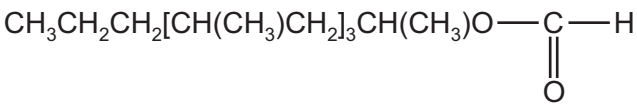
A 

B 

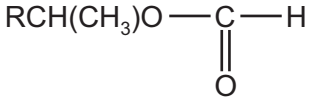
C 

D 

30 The acarid mite releases *lardolure* to attract other mites to a host. This chemical can be destroyed by hydrolysis with acid.



A simplified formula for *lardolure* may be written as follows.



What are the products of its hydrolysis?

A $RCH(CH_3)CO_2H + CH_3OH$

B $RCH(CH_3)CO_2H + HCO_2H$

C $RCH(CH_3)OH + CO_2$

D $RCH(CH_3)OH + HCO_2H$

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 A monomer undergoes addition polymerisation. A 1 mol sample of the monomer is completely polymerised.

How many moles of polymer might, theoretically, be formed?

1 1

2 10^{6}

3 $\frac{1}{6.02 \times 10^{23}}$

32 Which physical properties are due to hydrogen bonding between water molecules?

1 Water has a higher boiling point than H_2S.

2 Ice floats on water.

3 The H O H bond angle in water is approximately 104°.

33 Which equilibria, in which all species are gaseous, would have equilibrium constants, K_p, with no units?

1 sulfur dioxide and oxygen in equilibrium with sulfur trioxide

2 hydrogen and iodine in equilibrium with hydrogen iodide

3 carbon monoxide and steam in equilibrium with carbon dioxide and hydrogen

34 Why does a mixture of hydrogen gas and bromine gas react together faster at a temperature of 500 K than it does at a temperature of 400 K?

1 A higher proportion of effective collisions occurs at 500 K.

2 Hydrogen molecules and bromine molecules collide more frequently at 500 K.

3 The activation energy of the reaction is lower at 500 K.

35 A farmer added lime to damp soil, followed by the nitrogenous fertiliser ammonium sulfate. A chemical reaction occurred in the soil.

Which substances were formed in this reaction?

1 sulfuric acid

2 calcium sulfate

3 ammonia

36 Which statements about the reaction of solid sodium bromide with concentrated sulfuric acid are correct?

1 Hydrogen bromide is a product of the reaction.

2 Sulfuric acid is oxidised to sulfur dioxide.

3 Bromide ions are reduced to bromine.

37 Which statements are true for an S_N2 reaction?

1 One bond is broken as another bond is formed.

2 The formation of a transition state involves the collision of two molecules or ions.

3 A carbon atom in the transition state is bonded, either fully or partially, to five other atoms.

38 The chlorine free radical takes part in the destruction of the ozone layer.

Which statements about this free radical are correct?

1 It is formed by the heterolytic fission of the covalent bond in a chlorine-containing molecule.

2 It has a single unpaired electron.

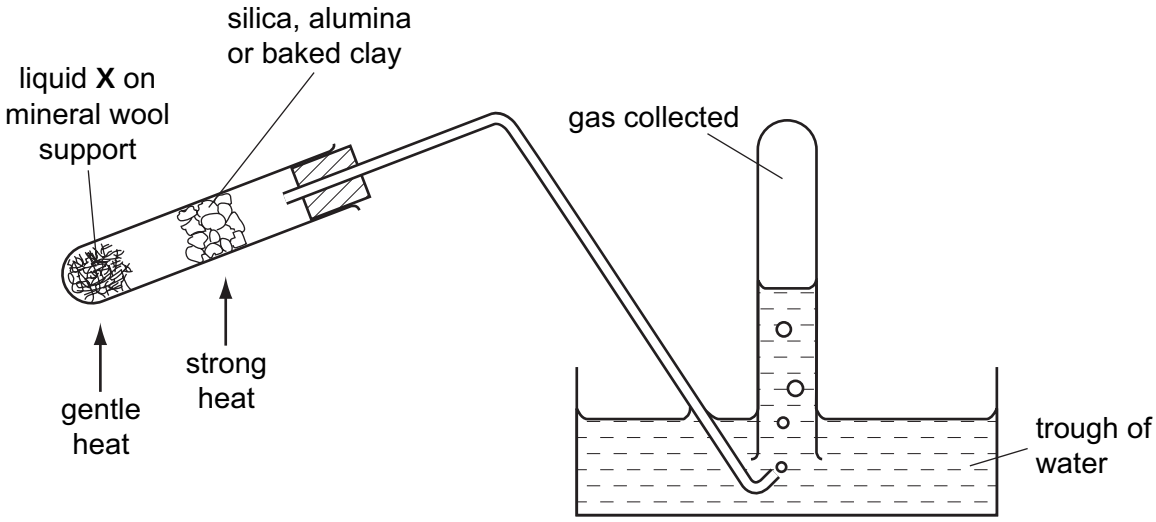
3 It has the same electron arrangement as a chlorine atom.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

39 The diagram shows an experiment.



Which processes could be demonstrated by using the above apparatus?

1 the oxidation of ethanol (the liquid **X)**

2 the dehydration of ethanol (the liquid **X**)

3 the cracking of paraffin (the liquid **X**)

40 A compound has a relative molecular mass of 88 and its molecule contains only four carbon atoms.

What could this compound be?

1 a saturated non-cyclic diol

2 a secondary alcohol containing an aldehyde group

3 a primary alcohol containing a ketone group

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper for the guidance of teachers

9701 CHEMISTRY

9701/11 Paper 11 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2009 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**A**
2	**D**	22	**A**
3	**B**	23	**C**
4	**C**	24	**A**
5	**B**	25	**D**
6	**C**	26	**B**
7	**D**	27	**B**
8	**D**	28	**C**
9	**A**	29	**B**
10	**C**	30	**D**
11	**A**	31	**C**
12	**D**	32	**B**
13	**C**	33	**C**
14	**D**	34	**B**
15	**B**	35	**C**
16	**B**	36	**D**
17	**A**	37	**A**
18	**A**	38	**C**
19	**A**	39	**C**
20	**D**	40	**C**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **October/November 2009**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

6243336735

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

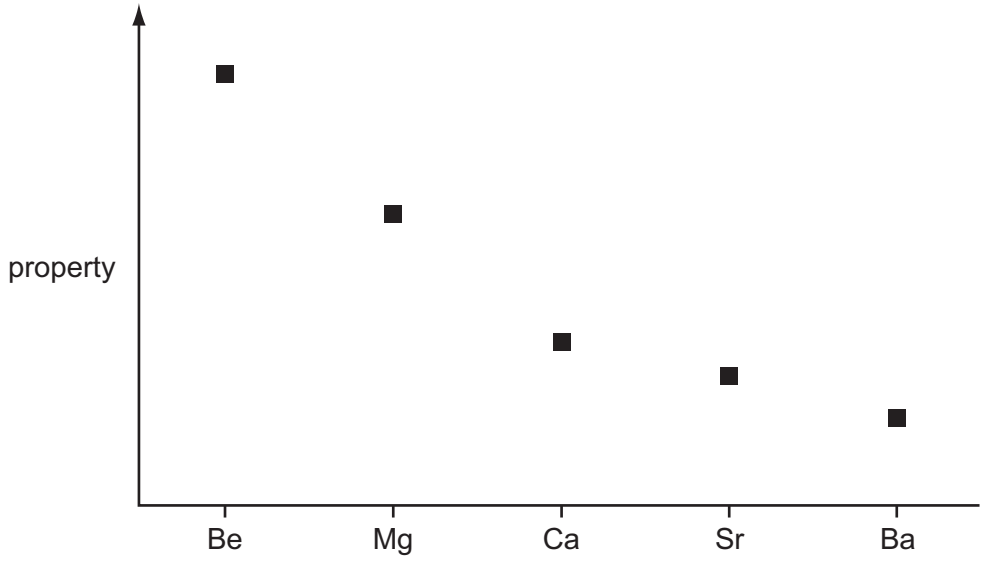
1 0.200 mol of a hydrocarbon undergo complete combustion to give 35.2 g of carbon dioxide and 14.4 g of water as the only products.

What is the molecular formula of the hydrocarbon?

A C_2H_4 **B** C_2H_6 **C** C_4H_4 **D** C_4H_8

2 *Use of the Data Booklet is relevant to this question.*

The graph represents the variation of a property of the Group II elements.



What is this property?

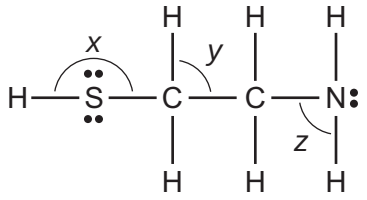
A ionic radius

B ionisation energy

C neutron / proton ratio

D rate of reaction with water

3 The antidote molecule shown can help to prevent liver damage if someone takes too many paracetamol tablets.



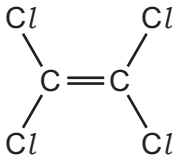
: represents a lone pair

What is the order of **decreasing** size of the bond angles *x*, *y* and *z*?

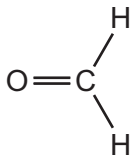
	largest ⟶ smallest		
A	*x*	*y*	*z*
B	*x*	*z*	*y*
C	*y*	*z*	*x*
D	*z*	*y*	*x*

4 Which molecule has the largest overall dipole?

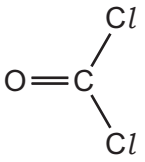
A



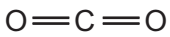
B



C



D



5 The first stage in the industrial production of nitric acid from ammonia can be represented by the following equation.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

Using the following standard enthalpy change of formation data, what is the value of the standard enthalpy change, $\Delta H^{\ominus}$, for this reaction?

compound	$\Delta H_f^{\ominus}$ / kJ mol $^{-1}$
$NH_3(g)$	–46.1
$NO(g)$	+90.3
$H_2O(g)$	–241.8

A +905.2 kJ mol $^{-1}$

B –105.4 kJ mol $^{-1}$

C –905.2 kJ mol $^{-1}$

D –1274.0 kJ mol $^{-1}$

6 Which conversion involves a reduction of chromium?

A $CrO_4^{2-} \rightarrow CrO_3$

B $CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$

C $CrO_2Cl_2 \rightarrow CrO_4^{2-}$

D $CrO_2Cl_2 \rightarrow Cr_2O_3$

7 The equilibrium

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g) \qquad \Delta H = +180\,kJ\,mol^{-1}$$

contributes to a series of reactions producing photochemical smog.

Which factors would affect the value of K_p of the above equilibrium?

	change in pressure	change in temperature	presence or absence of a catalyst
A	✓	✓	✗
B	✓	✗	✓
C	✗	✓	✓
D	✗	✓	✗

8 PCl_5 dissociates as follows.

$$PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$$

The extent of dissociation is 13 % at 160 °C and 100 % at 300 °C.

Which pair of statements about this formation of PCl_3 is correct?

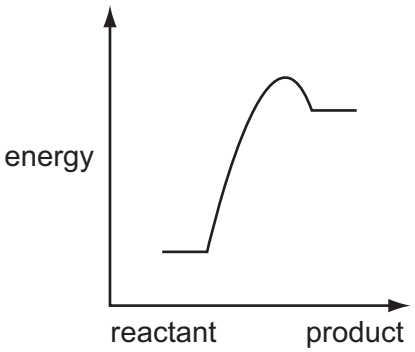
	shape of PCl_3 molecule	the reaction is
A	pyramidal	endothermic
B	pyramidal	exothermic
C	trigonal	endothermic
D	trigonal	exothermic

9 Four reactions of the type shown are studied at the same temperature.

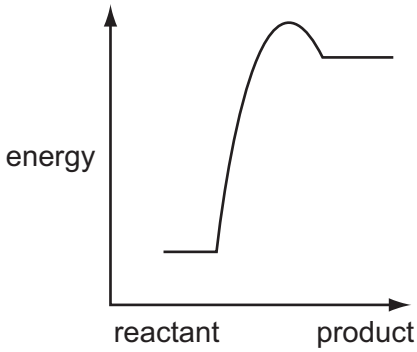
$$X(g) + Y(g) \rightarrow Z(g)$$

Which is the correct reaction pathway diagram for the reaction that would proceed **most** rapidly and with the **highest** yield?

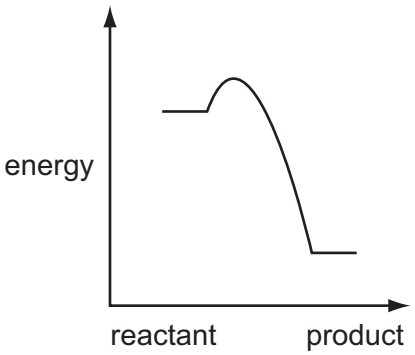
A



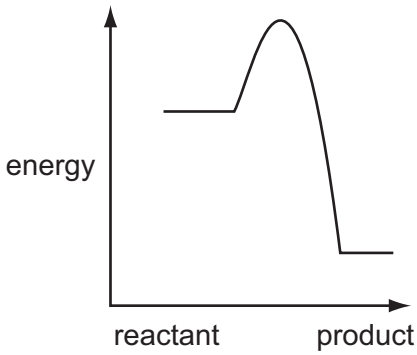
B



C



D



10 Photochromic glass, used for sunglasses, darkens when exposed to bright light and becomes more transparent again when the light is less bright. The depth of colour of the glass is related to the concentration of silver atoms.

The following reactions are involved.

reaction 1 $Ag^+ + Cl \rightleftharpoons Ag + Cl$

reaction 2 $Cu^+ + Cl \rightarrow Cu^{2+} + Cl$

reaction 3 $Cu^{2+} + Ag \rightarrow Cu^+ + Ag^+$

Which statement about these reactions is correct?

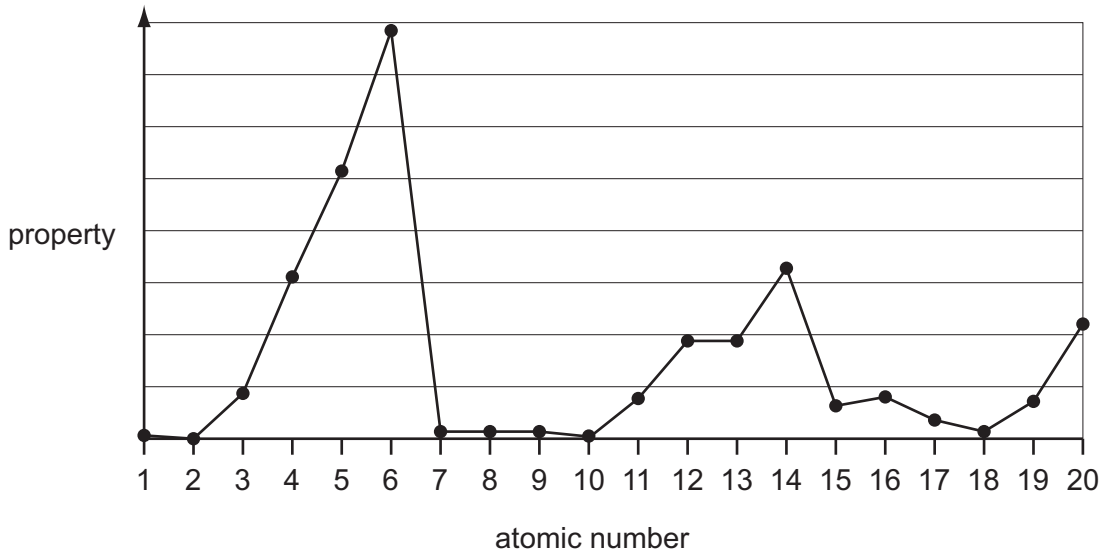
A Cu^+ and Cu^{2+} ions act as catalysts.

B Cu^+ ions act as an oxidising agent in reaction 2.

C Reaction 2 is the one in which light is absorbed.

D Ag^+ ions are oxidised in reaction 1.

11 The following graph shows the variation of a property of the first 20 elements in the Periodic Table with the atomic number of the element.



What is the property?

A atomic radius

B first ionisation energy

C ionic radius

D melting point

12 Which statement correctly describes what happens when silicon tetrachloride is added to water?

A The $SiCl_4$ dissolves to give a neutral solution only.

B The $SiCl_4$ reacts to give an acidic solution only.

C The $SiCl_4$ reacts to give a precipitate and an acidic solution.

D The $SiCl_4$ reacts to give a precipitate and a neutral solution.

13 The oxide and chloride of an element **X** are separately mixed with water. The two resulting solutions have the same effect on litmus.

What is element **X**?

A sodium

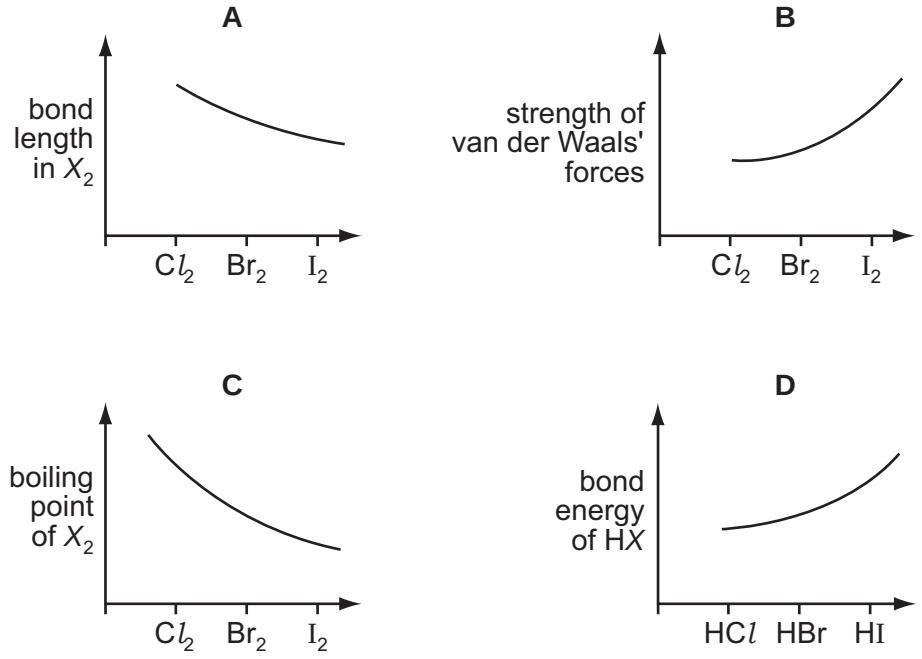
B magnesium

C aluminium

D phosphorus

14 Which graph correctly describes a trend found in the halogen group?

[*X* represents a halogen atom.]



15 During electrolysis of brine in a diaphragm cell, chlorine, hydrogen and sodium hydroxide are produced.

What is the molar ratio of these products?

	chlorine	hydrogen	sodium hydroxide
A	1	1	1
B	1	1	2
C	2	1	1
D	2	2	1

16 When sulfur trioxide is manufactured from sulfur dioxide and oxygen, using the Contact process, which condition affects the value of the equilibrium constant, K_c?

A adjusting the temperature

B adjusting the pressure

C using a catalyst

D removing SO_3 from the equilibrium mixture

17 Most modern cars are fitted with three-way catalytic converters in the exhaust system.

Which three gases are removed by such a catalytic converter?

A carbon monoxide, hydrocarbons, nitrogen oxides

B carbon monoxide, carbon dioxide, nitrogen oxides

C carbon monoxide, nitrogen oxides, sulfur dioxide

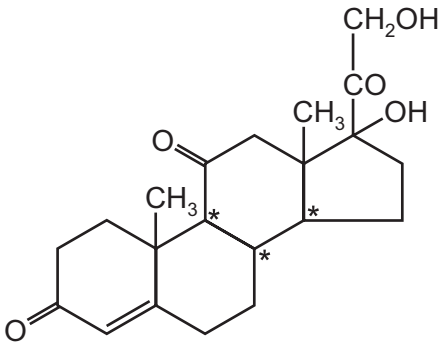
D hydrocarbons, nitrogen oxides, sulfur dioxide

18 In an historically famous experiment Wöhler heated 'inorganic' ammonium cyanate in the absence of air. The only product of the reaction was 'organic' urea, $CO(NH_2)_2$. No other products were formed in the reaction.

What is the formula of the cyanate ion present in ammonium cyanate?

A CNO **B** CNO^2 **C** CO **D** NO

19 The drug cortisone has the formula shown.



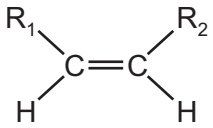
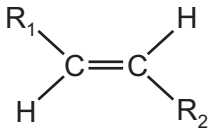
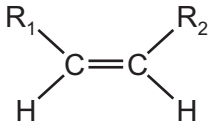
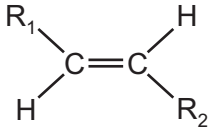
In addition to those chiral centres marked by an asterisk (*), how many other chiral centres are present in the cortisone molecule?

A 0 **B** 1 **C** 2 **D** 3

20 The presence of 11-*cis* retinal, $C_{20}H_{28}O$, in cells in the eye is important for vision.

The structure of retinal includes an aldehyde group, a cyclohexene ring and a long aliphatic side chain, in which a carbon-carbon double bond exists between carbons numbered 11 and 12.

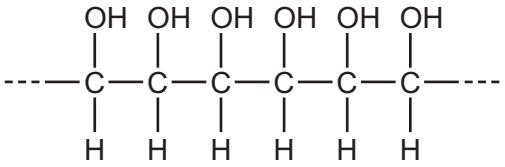
Which pair of statements about 11-*cis* retinal could be correct?

	total number of >C=C< double bonds	arrangement around the adjacent carbons 11 and 12
A	5	
B	5	
C	6	
D	6	

21 What is the least number of carbon atoms in a non-cyclic alkane molecule that has a chiral centre?

A 7 **B** 8 **C** 9 **D** 10

22 The following diagram represents the structure of a possible polymer.



By which method might this polymer be made?

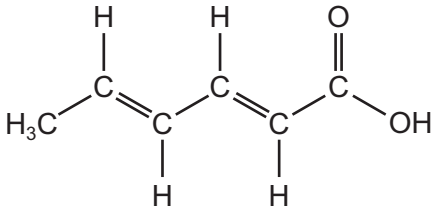
A polymerise ethene followed by hydration

B polymerise ethene followed by oxidation with cold acidified $KMnO_4$

C polymerise 1,2-dichloroethene followed by hydrolysis

D polymerise 1,2-dichloroethene followed by oxidation with cold acidified $KMnO_4$

23 Sorbic acid is used as a food preservative because it kills fungi and moulds.



sorbic acid

Sorbic acid will react with

- hydrogen in the presence of a nickel catalyst,
- bromine in an organic solvent.

How many moles of hydrogen and of bromine will be incorporated into one mole of sorbic acid by these reactions?

	moles of hydrogen	moles of bromine
A	2	2
B	2	$2\frac{1}{2}$
C	3	2
D	3	$2\frac{1}{2}$

24 Bromine reacts with ethene to form 1,2-dibromoethane.

What is the correct description of the organic intermediate in this reaction?

A It has a negative charge.

B It is a free radical.

C It is a nucleophile.

D It is an electrophile.

25 Which equation represents a valid propagation step in the free radical reaction between ethane and chlorine?

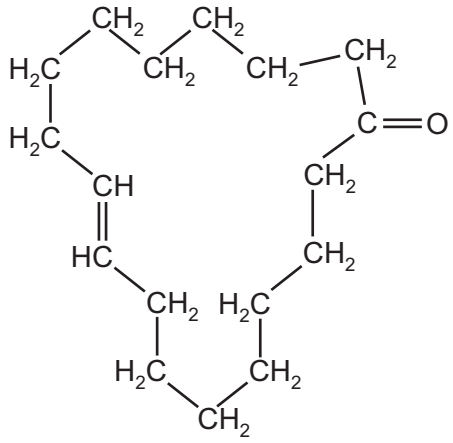
A $C_2H_6 + Cl^{\bullet} \rightarrow C_2H_5Cl + H^{\bullet}$

B $C_2H_5Cl + Cl^{\bullet} \rightarrow C_2H_4Cl^{\bullet} + HCl$

C $C_2H_6 + H^{\bullet} \rightarrow C_2H_5^{\bullet} + HCl$

D $C_2H_5^{\bullet} + Cl^{\bullet} \rightarrow C_2H_5Cl$

26 The naturally-occurring molecule civetone is found in a gland of the African civet cat and has been used in perfumery.



civetone

With which reagent will civetone **not** react?

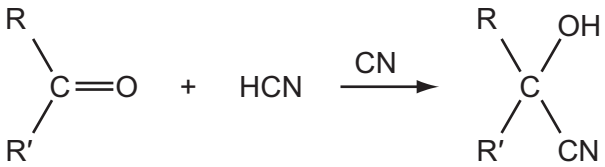
A 2,4-dinitrophenylhydrazine reagent

B Fehling's reagent

C hydrogen bromide

D sodium tetrahydridoborate(III) (sodium borohydride)

27 Cyanohydrins can be made from carbonyl compounds by generating CN^- ions from HCN in the presence of a weak base.



In a similar reaction, $CH_2CO_2CH_3^-$ ions are generated from $CH_3CO_2CH_3$ by strong bases.

Which compound can be made from an aldehyde and $CH_3CO_2CH_3$ in the presence of a strong base?

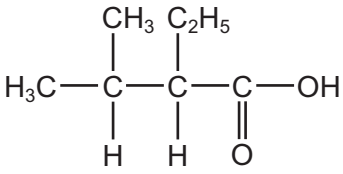
A $CH_3CH(OH)CO_2CH_3$

B $CH_3CO_2CH_2CH(OH)CH_3$

C $CH_3CH_2CH(OH)CH_2CO_2CH_3$

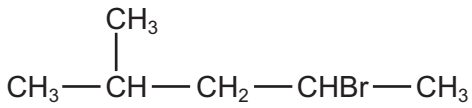
D $(CH_3)_2C(OH)CH_2CO_2CH_3$

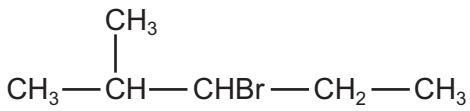
28 The characteristic odour of rum is attributed to the compound 2-ethyl-3-methylbutanoic acid.

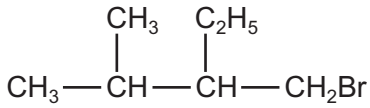


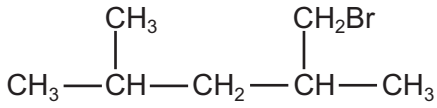
2-ethyl-3-methylbutanoic acid

Which compound will produce 2-ethyl-3-methylbutanoic acid by heating under reflux with alcoholic sodium cyanide and subsequent acid hydrolysis of the reaction product?

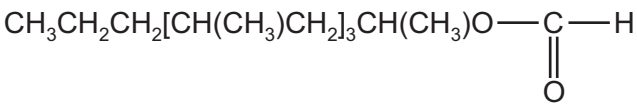
A 

B 

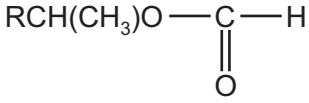
C 

D 

29 The acarid mite releases *lardolure* to attract other mites to a host. This chemical can be destroyed by hydrolysis with acid.



A simplified formula for *lardolure* may be written as follows.



What are the products of its hydrolysis?

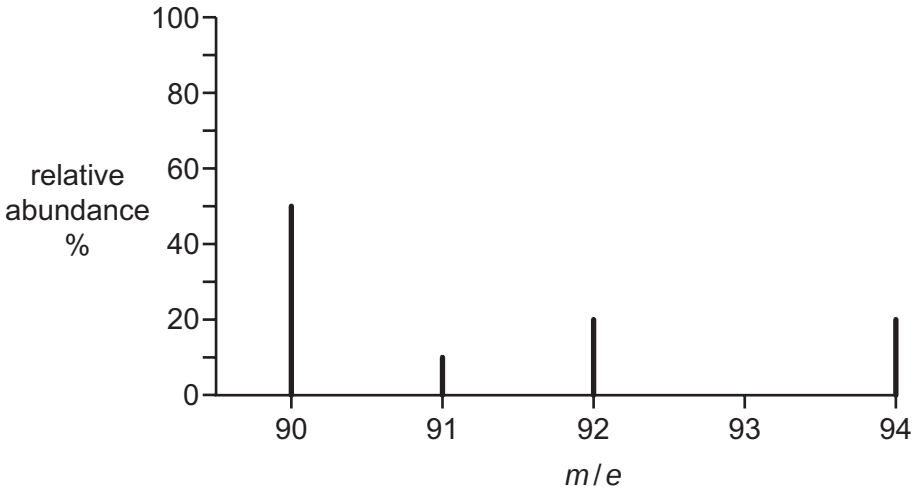
A $RCH(CH_3)CO_2H + CH_3OH$

B $RCH(CH_3)CO_2H + HCO_2H$

C $RCH(CH_3)OH + CO_2$

D $RCH(CH_3)OH + HCO_2H$

30 An element **X** consists of four isotopes. The mass spectrum of **X** is shown in the diagram.



What is the relative atomic mass of **X**?

A 91.00 **B** 91.30 **C** 91.75 **D** 92.00

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Which physical properties are due to hydrogen bonding between water molecules?

1 Water has a higher boiling point than H_2S.

2 Ice floats on water.

3 The H O H bond angle in water is approximately 104°.

32 Which equilibria, in which all species are gaseous, would have equilibrium constants, K_p, with no units?

1 sulfur dioxide and oxygen in equilibrium with sulfur trioxide

2 hydrogen and iodine in equilibrium with hydrogen iodide

3 carbon monoxide and steam in equilibrium with carbon dioxide and hydrogen

33 Why does a mixture of hydrogen gas and bromine gas react together faster at a temperature of 500 K than it does at a temperature of 400 K?

1 A higher proportion of effective collisions occurs at 500 K.

2 Hydrogen molecules and bromine molecules collide more frequently at 500 K.

3 The activation energy of the reaction is lower at 500 K.

34 A farmer added lime to damp soil, followed by the nitrogenous fertiliser ammonium sulfate. A chemical reaction occurred in the soil.

Which substances were formed in this reaction?

1 sulfuric acid

2 calcium sulfate

3 ammonia

35 Which statements about the reaction of solid sodium bromide with concentrated sulfuric acid are correct?

1 Hydrogen bromide is a product of the reaction.

2 Sulfuric acid is oxidised to sulfur dioxide.

3 Bromide ions are reduced to bromine.

36 Which statements are true for an S_N2 reaction?

1 One bond is broken as another bond is formed.

2 The formation of a transition state involves the collision of two molecules or ions.

3 A carbon atom in the transition state is bonded, either fully or partially, to five other atoms.

37 The chlorine free radical takes part in the destruction of the ozone layer.

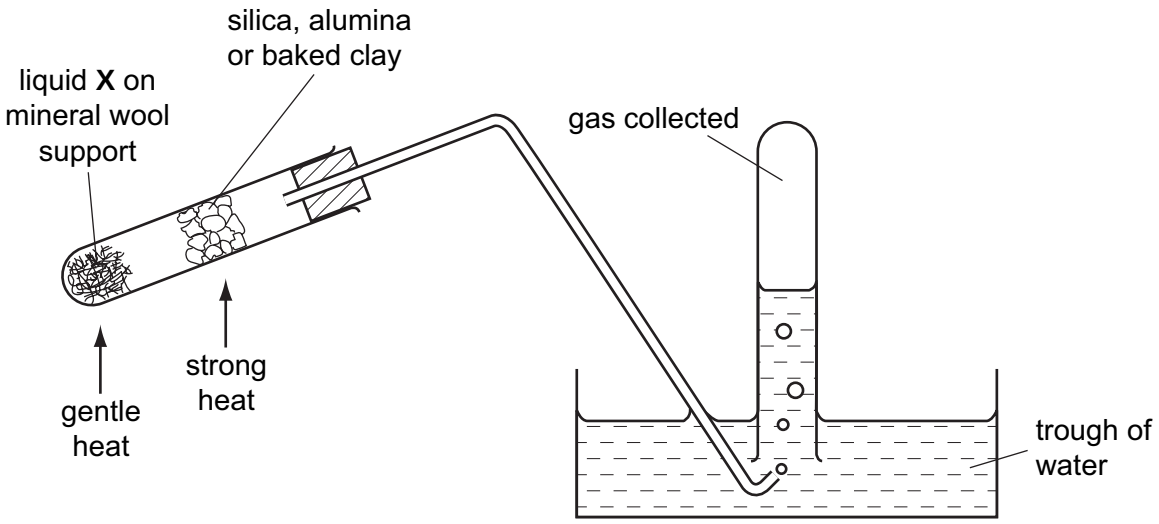
Which statements about this free radical are correct?

1 It is formed by the heterolytic fission of the covalent bond in a chlorine-containing molecule.

2 It has a single unpaired electron.

3 It has the same electron arrangement as a chlorine atom.

38 The diagram shows an experiment.



Which processes could be demonstrated by using the above apparatus?

1 the oxidation of ethanol (the liquid **X)**

2 the dehydration of ethanol (the liquid **X**)

3 the cracking of paraffin (the liquid **X**)

39 A compound has a relative molecular mass of 88 and its molecule contains only four carbon atoms.

What could this compound be?

1 a saturated non-cyclic diol

2 a secondary alcohol containing an aldehyde group

3 a primary alcohol containing a ketone group

40 A monomer undergoes addition polymerisation. A 1 mol sample of the monomer is completely polymerised.

How many moles of polymer might, theoretically, be formed?

1 1

2 10^{6}

3 $\frac{1}{6.02 \times 10^{23}}$

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper for the guidance of teachers

9701 CHEMISTRY

9701/12 Paper 12 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2009 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**A**
2	**B**	22	**C**
3	**C**	23	**A**
4	**B**	24	**D**
5	**C**	25	**B**
6	**D**	26	**B**
7	**D**	27	**C**
8	**A**	28	**B**
9	**C**	29	**D**
10	**A**	30	**B**
11	**D**	31	**B**
12	**C**	32	**C**
13	**D**	33	**B**
14	**B**	34	**C**
15	**B**	35	**D**
16	**A**	36	**A**
17	**A**	37	**C**
18	**A**	38	**C**
19	**D**	39	**C**
20	**A**	40	**C**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/01**

Paper 1 Multiple Choice **May/June 2009**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

5448023915

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **15** printed pages and **1** blank page.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 *Use of the Data Booklet is relevant to this question.*

In leaded petrol there is an additive composed of lead, carbon and hydrogen only. This compound contains 29.7 % carbon and 6.19 % hydrogen by mass.

What is the value of **x** in the empirical formula PbC_8H_x?

A 5 **B** 6 **C** 16 **D** 20

2 A household bleach contains sodium chlorate(I), NaC*l*O, as its active ingredient. The concentration of NaC*l*O in the bleach can be determined by reacting a known amount with aqueous hydrogen peroxide, H_2O_2.

$$NaClO(aq) + H_2O_2(aq) \rightarrow NaCl(aq) + O_2(g) + H_2O(l)$$

When 25.0 cm^3 of bleach is treated with an excess of aqueous H_2O_2, 0.0350 mol of oxygen gas is given off.

What is the concentration of NaC*l*O in the bleach?

A 8.75×10^{-4} mol dm^{-3}

B 0.700 mol dm^{-3}

C 0.875 mol dm^{-3}

D 1.40 mol dm^{-3}

3 The first seven ionisation energies of an element between lithium and neon in the Periodic Table are as follows.

1310 3390 5320 7450 11 000 13 300 71 000 kJ mol^{-1}

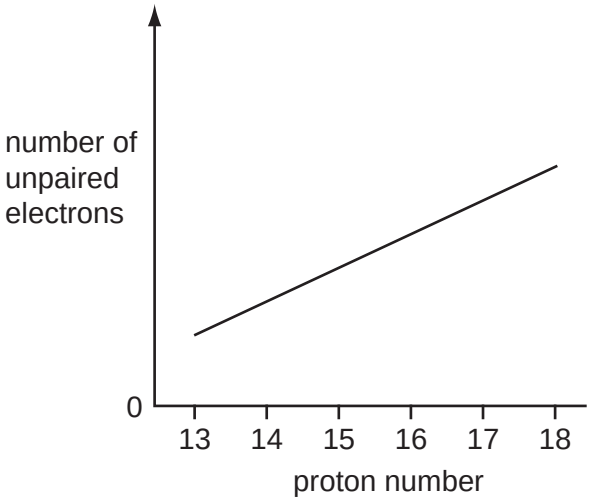
What is the outer electronic configuration of the element?

A $2s^2$ **B** $2s^22p^1$ **C** $2s^22p^4$ **D** $2s^22p^6$

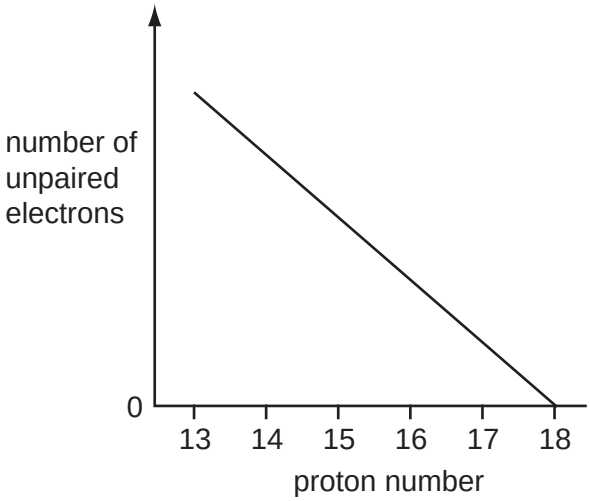
4 *Use of the Data Booklet is relevant to this question.*

Which graph represents the number of unpaired p orbital electrons for atoms with proton numbers 13 to 18?

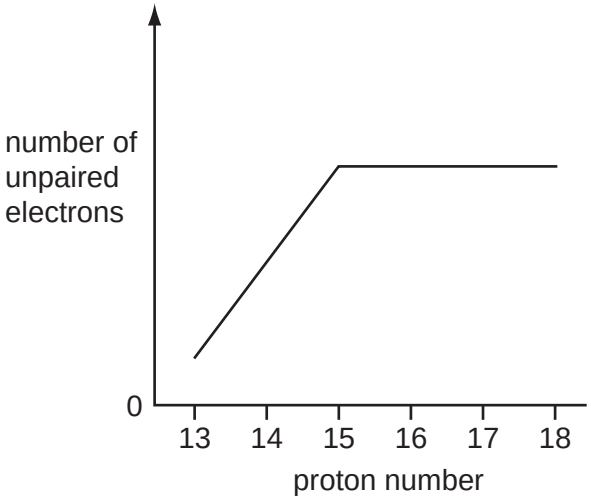
A



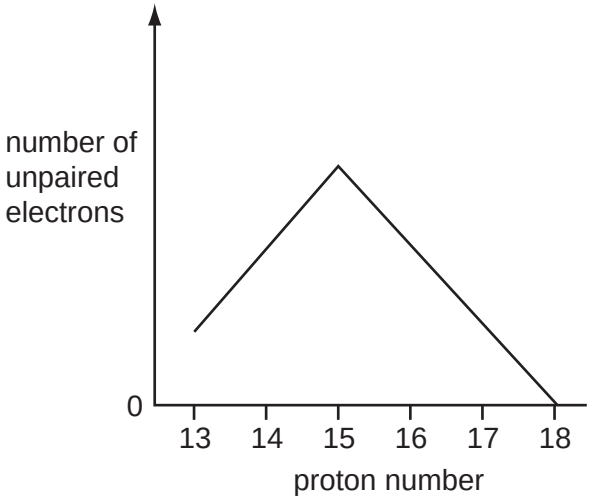
B



C



D



5 Which statement explains why the boiling point of methane is higher than that of neon?
[A_r: H, 1; C, 12; Ne, 20]

A A molecule of methane has a greater mass than a molecule of neon.

B Molecules of methane form hydrogen bonds, but those of neon do not.

C Molecules of methane have stronger intermolecular forces than those of neon.

D The molecule of methane is polar, but that of neon is not.

6 In which reaction does the carbon-containing product have a smaller bond angle than the organic reactant?

A bromoethane refluxed with ethanolic sodium hydroxide

B complete combustion of methane in air

C methane and an excess of chlorine under ultraviolet light

D polymerisation of ethene

7 A crystal of iodine produces a purple vapour when gently heated.

Which pair of statements correctly describes this process?

	type of bond broken	formula of purple species
A	covalent	I
B	covalent	I_2
C	induced dipole-dipole	I_2
D	permanent dipole-dipole	I_2

8 Hydrogen peroxide slowly decomposes into water and oxygen. The enthalpy change of reaction can be calculated using standard enthalpies of formation.

$\Delta H_f^{\ominus}$(hydrogen peroxide(l)) = –187.8 kJ mol^{-1}

$\Delta H_f^{\ominus}$(water(l)) = –285.8 kJ mol^{-1}

Using a Hess cycle, what is the enthalpy change of reaction for this decomposition?

$$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$$

A +98 kJ mol^{-1}

B 98 kJ mol^{-1}

C 196 kJ mol^{-1}

D 947.2 kJ mol^{-1}

9 When copper is extracted from its ores, the metal is not pure enough for electrical uses. The impure copper, which contains small amounts of silver and gold, is purified by electrolysis. During this process a 'sludge' forms beneath the anode which is found to contain silver and traces of gold.

Why is silver found in this sludge?

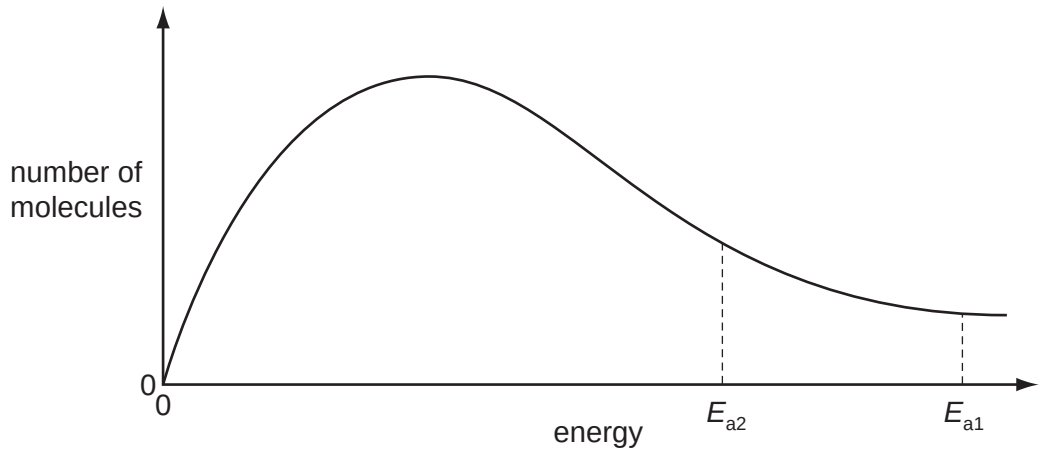
A Silver is less electropositive than copper.

B Silver is more dense than copper and falls off the cathode.

C Silver reacts with the electrolyte to form an insoluble chloride salt.

D Silver reacts with the electrolyte to form an insoluble sulfate salt.

10 The diagram shows the Maxwell-Boltzmann energy distribution curve for molecules of a mixture of two gases at a given temperature. For a reaction to occur the molecules must collide together with sufficient energy.



E_a is the activation energy for the reaction between the gases. Of the two values shown, one is for a catalysed reaction, the other for an uncatalysed one.

Which pair of statements is correct when a catalyst is used?

A	E_{a1}	catalysed reaction fewer effective collisions	E_{a2}	uncatalysed reaction more effective collisions
B	E_{a1}	uncatalysed reaction fewer effective collisions	E_{a2}	catalysed reaction more effective collisions
C	E_{a1}	catalysed reaction more effective collisions	E_{a2}	uncatalysed reaction fewer effective collisions
D	E_{a1}	uncatalysed reaction more effective collisions	E_{a2}	catalysed reaction fewer effective collisions

11 In some fireworks there is a reaction between powdered aluminium and powdered barium nitrate in which heat is evolved and an unreactive gas is produced.

What is the equation for this reaction?

A $2Al + Ba(NO_3)_2 \rightarrow Al_2O_3 + BaO + 2NO$

B $4Al + 4Ba(NO_3)_2 \rightarrow 2Al_2O_3 + 4Ba(NO_2)_2 + O_2$

C $10Al + 3Ba(NO_3)_2 \rightarrow 5Al_2O_3 + 3BaO + 3N_2$

D $10Al + 18Ba(NO_3)_2 \rightarrow 10Al(NO_3)_3 + 18BaO + 3N_2$

12 Which group of particles is in order of increasing size?

A N O F

B N^3 O^2 F

C Na^+ Mg^{2+} Al^{3+}

D Na^+ Ne F

13 River water in a chalky agricultural area may contain Ca^{2+}, Mg^{2+}, CO_3^2, HCO_3, Cl and NO_3 ions. In a waterworks, such water is treated by adding a calculated quantity of calcium hydroxide.

What will be precipitated following the addition of calcium hydroxide?

A $CaCl_2$

B $CaCO_3$

C $Ca(NO_{3)\,2}$

D $Mg(NO_3)_2$

14 Over half a million tonnes of bromine are manufactured annually and are mainly used for making other compounds. One important use is for agricultural chemicals.

What is another important use for bromine?

A antiseptic agents

B bleaches for textiles and the paper industry

C flame-retardants and fire extinguishers

D water purification

15 In black and white photographic film, light converts silver chloride into metallic silver. After the film has been developed, the unreacted silver chloride is removed by reaction with sodium thiosulfate to produce a 'fixed' negative.

$$AgCl + 2Na_2S_2O_3 \rightarrow 4Na^+ + Cl + [Ag(S_2O_3)_2]^3$$

What is the function of the thiosulfate ion?

A to make the silver ions soluble

B to oxidise the silver ions

C to oxidise the silver metal

D to reduce the silver ions

16 Which statement is most likely to be true for astatine, which is below iodine in Group VII of the Periodic Table?

A Astatine and aqueous potassium chloride react to form aqueous potassium astatide and chlorine.

B Potassium astatide and hot dilute sulfuric acid react to form white fumes of only hydrogen astatide.

C Silver astatide reacts with dilute aqueous ammonia in excess to form a solution of a soluble complex.

D Sodium astatide and hot concentrated sulfuric acid react to form astatine.

17 Deposits of ammonium compounds have been discovered in areas of high atmospheric pollution.

They are believed to arise from the following reaction.

$$SO_3 + H_2O + 2NH_3 \rightarrow (NH_4)_2SO_4$$

What does **not** occur in this reaction?

A acid / base neutralisation

B dative bond formation

C ionic bond formation

D oxidation / reduction

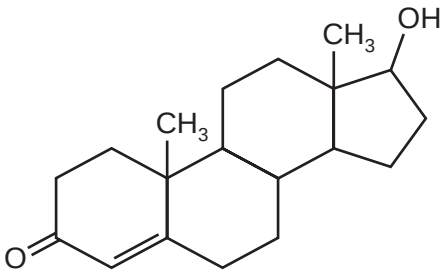
18 Mohr's salt is a pale green crystalline solid which is soluble in water. It is a 'double sulfate' which contains two cations, one of which is Fe^{2+}.

The identity of the second cation was determined by heating solid Mohr's salt with solid sodium hydroxide and a colourless gas was evolved. The gas readily dissolved in water giving an alkaline solution. A grey-green solid residue was also formed which was insoluble in water.

What are the identities of the gas and the solid residue?

	gas	residue
A	H_2	$FeSO_4$
B	NH_3	Na_2SO_4
C	NH_3	$Fe(OH)_2$
D	SO_2	$Fe(OH)_2$

19 In recent years a number of athletes have been banned from sports because of their illegal use of synthetic testosterone, a naturally occurring hormone in the body.



testosterone

How many chiral centres are present in a testosterone molecule?

A 1 **B** 2 **C** 3 **D** 6

20 The compound known as 'gamma-linolenic acid' is found in significant amounts in the seeds of the Evening Primrose plant. There is evidence that the compound may help patients with diabetes.

$$CH_3(CH_2)_4CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_4CO_2H$$

gamma-linolenic acid

How many *cis-trans* isomers does gamma-linolenic acid have?

A 3 **B** 6 **C** 8 **D** 12

21 What always applies to a nucleophile?

A It attacks a double bond.

B It has a lone pair of electrons.

C It is a single atom.

D It is negatively charged.

22 Trichloroethanoic acid, CCl_3CO_2H, is used in cosmetic surgery to perform a 'chemical peel' to remove dead skin.

Trichloroethanoic acid can be made by reacting chlorine with ethanoic acid.

What is the mechanism of this reaction?

A electrophilic addition

B electrophilic substitution

C free radical addition

D free radical substitution

23 Polymerisation of chloroethene gives PVC.

How does the carbon-carbon bond in PVC compare with that in chloroethene?

A longer and stronger

B longer and weaker

C shorter and stronger

D shorter and weaker

24 In the hydrolysis of bromoethane by aqueous sodium hydroxide, what is the nature of the attacking group and of the leaving group?

	attacking group	leaving group
A	electrophile	electrophile
B	electrophile	nucleophile
C	nucleophile	electrophile
D	nucleophile	nucleophile

25 Which reaction would **not** give propene as one product?

A adding an excess of concentrated sulfuric acid to propan-1-ol

B adding warm aqueous sodium hydroxide to 2-bromopropane

C adding warm ethanolic sodium hydroxide to 1-bromopropane

D passing propan-2-ol vapour over heated aluminium oxide

26 Glycol, used in anti-freeze, has the formula $HOCH_2CH_2OH$. It can be oxidised to give a number of products.

What is the molecular formula of an oxidation product of glycol that will **not** react with sodium?

A $C_2H_2O_2$ **B** $C_2H_2O_3$ **C** $C_2H_2O_4$ **D** $C_2H_4O_2$

27 Which ester is formed when the alcohol CH_3CH_2OH is reacted with $CH_3CH_2CH_2CO_2H$?

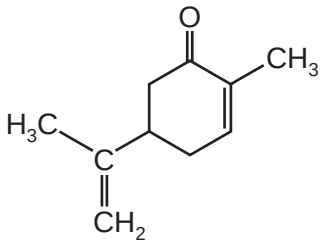
A ethyl propanoate

B ethyl butanoate

C propyl ethanoate

D butyl ethanoate

28 Carvone gives the characteristic flavour to caraway and spearmint.



carvone

Prolonged heating of carvone with hot concentrated acidified potassium manganate(VII) produces carbon dioxide and a compound **X**.

X contains nine carbon atoms and reacts with 2,4-dinitrophenylhydrazine reagent.

What is the maximum number of molecules of 2,4-dinitrophenylhydrazine that will react with one molecule of **X**?

A 1 **B** 2 **C** 3 **D** 4

29 2-Methylbuta-1,3-diene, $CH_2=C(CH_3)–CH=CH_2$, is used as a monomer in the manufacture of synthetic rubbers.

Which compound would **not** produce this monomer on treatment with concentrated sulfuric acid at 170 °C?

A $(CH_3)_2C(OH)CH(OH)CH_3$

B $HOCH_2CH(CH_3)CH_2CH_2OH$

C $HOCH_2CH(CH_3)CH(OH)CH_3$

D $HOCH_2C(CH_3)(OH)CH_2CH_3$

30 A compound **Y** has the following properties.

- It is a liquid at room temperature and atmospheric pressure.
- It does not mix completely with water.
- It does not decolourise acidified potassium manganate(VII).

What could **Y** be?

A ethane

B ethanoic acid

C ethanol

D ethyl ethanoate

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 On a scale in which the mass of a ^{12}C atom is 12 the relative molecular mass of a particular sample of chlorine is 72.

Which properties of the atoms in this sample are always the same?

1 radius

2 nucleon number

3 isotopic mass

32 An ideal gas obeys the gas laws under all conditions of temperature and pressure.

Which of the following are true for an ideal gas?

1 The molecules have negligible volume.

2 There are no forces of attraction between molecules.

3 The molecules have an average kinetic energy which is proportional to its absolute temperature.

33 For which reactions does the value of $\Delta H^{\ominus}$ represent **both** a standard enthalpy change of combustion **and** a standard enthalpy change of formation?

1 $C(s) + O_2(g) \rightarrow CO_2(g)$

2 $2C(s) + O_2(g) \rightarrow 2CO(g)$

3 $CO(g) + \frac{1}{2} O_2(g) \rightarrow CO_2(g)$

34 The following reaction takes place using liquid ammonia as a solvent.

$$Na^+ NH_2^- + NH_4^+Cl \rightarrow Na^+Cl + 2NH_3$$

Which statements best explain why this reaction should be classified as a Brønsted-Lowry acid-base reaction?

1 The ammonium ion acts as a proton donor.

2 Na^+Cl is a salt.

3 Ammonia is always basic.

35 The rock *dolomite* is a double carbonate of magnesium and calcium, $CaCO_3.MgCO_3$.

When heated strongly, a product called *calcined dolomite* is formed which is used to line some furnaces for the production of metals.

Why is *calcined dolomite* used for this purpose?

1 It is a refractory material.

2 It will absorb acidic impurities in metallurgical processes.

3 It will reduce metallic oxides to metals.

36 Which properties in the sequence hydrogen chloride, hydrogen bromide and hydrogen iodide steadily increase?

1 thermal stability

2 bond length

3 ease of oxidation

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

37 A fraction of distilled crude oil contains molecules with between 15 and 19 carbon atoms. This fraction is cracked by strong heating.

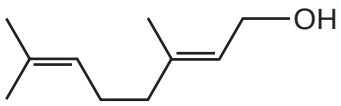
Why is this done?

1 To produce alkenes.

2 To produce smaller molecules which are in higher demand.

3 To insert oxygen atoms into the hydrocarbons.

38 Geraniol is one of several compounds produced by the scent glands of honey bees to help them mark nectar-bearing flowers and locate the entrances to their hives.



geraniol

Which reactions will geraniol undergo?

1 reaction with hot concentrated acidic $KMnO_4$ to give propanone

2 addition of halogens

3 reaction with aqueous $NaHCO_3$ to give CO_2

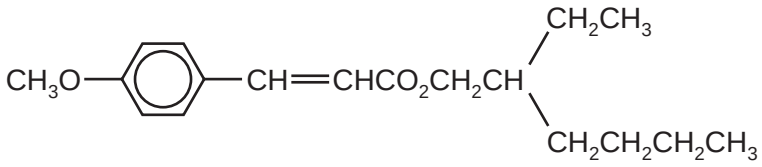
39 How can the rate of reaction between ethanal and aqueous hydrogen cyanide be increased?

1 by irradiation with ultraviolet light

2 by a rise in temperature

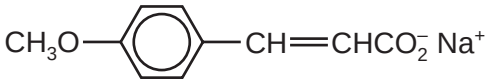
3 by the addition of a small quantity of aqueous sodium cyanide

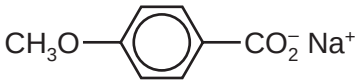
40 A sun protection cream contains the following ester as its active ingredient.



What are the products of its partial or total hydrolysis by aqueous sodium hydroxide?

1 $CH_3CH_2CH_2CH_2CH(CH_2CH_3)CH_2OH$

2 

3 

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2009 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/01 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2009 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**B**
2	**D**	22	**D**
3	**C**	23	**B**
4	**D**	24	**D**
5	**C**	25	**B**
6	**D**	26	**A**
7	**C**	27	**B**
8	**C**	28	**C**
9	**A**	29	**D**
10	**B**	30	**D**
11	**C**	31	**D**
12	**D**	32	**A**
13	**B**	33	**D**
14	**C**	34	**D**
15	**A**	35	**B**
16	**D**	36	**C**
17	**D**	37	**B**
18	**C**	38	**B**
19	**D**	39	**C**
20	**C**	40	**B**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **May/June 2010**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 9 2 6 4 4 7 2 6 4 0 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **14** printed pages and **2** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 *Use of the Data Booklet is relevant to this question*.

What could be the proton number of an element that has three unpaired electrons in each of its atoms?

A 5 **B** 13 **C** 15 **D** 21

2 *Use of the Data Booklet is relevant to this question*.

The elements radon (Rn), francium (Fr) and radium (Ra) have consecutive proton numbers in the Periodic Table.

What is the order of their first ionisation energies?

	least endothermic →		most endothermic
A	Fr	Ra	Rn
B	Fr	Rn	Ra
C	Ra	Fr	Rn
D	Rn	Ra	Fr

3 Which gas closely approaches ideal behaviour at room temperature and pressure?

A ammonia

B carbon dioxide

C helium

D oxygen

4 Some bond energy values are listed below.

bond	bond energy / kJ mol $^{-1}$
C–H	410
C–C*l*	340
C*l*–C*l*	244
Br–Br	193

These bond energy values relate to the following four reactions.

P $Br_2 \rightarrow 2Br$

Q $2Cl \rightarrow Cl_2$

R $CH_3 + Cl \rightarrow CH_3Cl$

S $CH_4 \rightarrow CH_3 + H$

What is the order of enthalpy changes of these reactions from most negative to most positive?

A P → Q → R → S

B Q → R → S → P

C R → Q → P → S

D S → P → Q → R

5 Given the following enthalpy changes,

$$I_2(g) + 3Cl_2(g) \rightarrow 2ICl_3(s) \qquad \Delta H^{\ominus} = -214\,kJ\,mol^{-1}$$

$$I_2(s) \rightarrow I_2(g) \qquad \Delta H^{\ominus} = +38\,kJ\,mol^{-1}$$

What is the standard enthalpy change of formation of iodine trichloride, $ICl_3(s)$?

A +176 kJ mol $^{-1}$

B –88 kJ mol $^{-1}$

C –176 kJ mol $^{-1}$

D –214 kJ mol $^{-1}$

6 Ammonium nitrate, NH_4NO_3, can decompose explosively when heated.

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

What are the changes in the oxidation numbers of the two nitrogen atoms in NH_4NO_3 when this reaction proceeds?

A –2, –4 **B** +2, +6 **C** +4, –6 **D** +4, –4

7 The Haber process for the manufacture of ammonia is represented by the following equation.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ\,mol^{-1}$$

Which statement is correct about this reaction when the temperature is increased?

A Both forward and backward rates increase.

B The backward rate only increases.

C The forward rate only increases.

D There is no effect on the backward or forward rate.

8 *Use of the Data Booklet is relevant to this question.*

2.920 g of a Group II metal, **X**, reacts with an excess of chlorine to form 5.287 g of a compound with formula **X**Cl_2.

What is metal **X**?

A barium

B calcium

C magnesium

D strontium

9 Which mass of gas would occupy a volume of 3 dm^3 at 25 °C and 1 atmosphere pressure?
[1 mol of gas occupies 24 dm^3 at 25 °C and 1 atmosphere pressure.]

A 3.2 g O_2 gas

B 5.6 g N_2 gas

C 8.0 g SO_2 gas

D 11.0 g CO_2 gas

10 The table gives the concentrations and pH values of the aqueous solutions of two compounds, X and Y. Either compound could be an acid or a base.

	X	Y
concentration	$2\,\text{mol dm}^{-3}$	$2\,\text{mol dm}^{-3}$
pH	6	9

Student P concluded that X is a strong acid.

Student Q concluded that the extent of dissociation is lower in X(aq) than in Y(aq).

Which of the students are correct?

A both P and Q

B neither P nor Q

C P only

D Q only

11 Swimming pool water can be kept free of harmful bacteria by adding aqueous sodium chlorate(I), NaOC*l*. This reacts with water to produce HOC*l* molecules which kill bacteria.

$$\text{OC}l\ (\text{aq}) + \text{H}_2\text{O} \rightleftharpoons \text{OH}\ (\text{aq}) + \text{HOC}l(\text{aq})$$

In bright sunshine, the OC*l* ion is broken down by ultra-violet light.

$$\text{OC}l\ (\text{aq}) + \text{uv light} \rightarrow \text{C}l\ (\text{aq}) + \tfrac{1}{2}\text{O}_2(\text{g})$$

Which method would maintain the highest concentration of HOC*l*(aq)?

A acidify the pool water

B add a solution of chloride ions

C add a solution of hydroxide ions

D bubble air through the water

12 $Na_2S_2O_3$ reacts with dilute HCl to give a pale yellow precipitate. If 1 cm^3 of 0.1 mol dm^{-3} HCl is added to 10 cm^3 of 0.02 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms slowly.

If the experiment is repeated with 1 cm^3 of 0.1 mol dm^{-3} HCl and 10 cm^3 of 0.05 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms more quickly.

Why is this?

A The activation energy of the reaction is lower when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

B The reaction proceeds by a different pathway when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

C The collisions between reactant particles are more violent when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

D The reactant particles collide more frequently when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

13 How does concentrated sulfuric acid behave when it reacts with sodium chloride?

A as an acid only

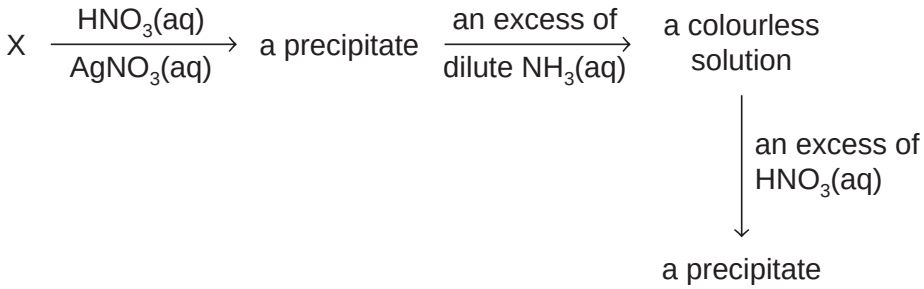
B as an acid and oxidising agent

C as an oxidising agent only

D as a reducing agent only

14 X is a salt of one of the halogens chlorine, bromine, iodine, or astatine (proton number 85).

The reaction scheme shows a series of reactions using a solution of X as the starting reagent.



What could X be?

A sodium chloride

B sodium bromide

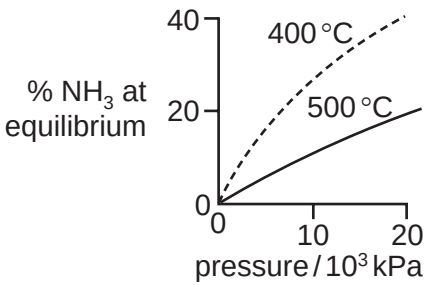
C potassium iodide

D potassium astatide

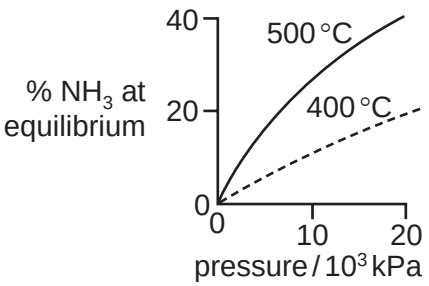
15 The percentage of ammonia obtainable, if equilibrium were established during the Haber process, is plotted against the operating pressure for two temperatures, 400 °C and 500 °C.

Which diagram correctly represents the two graphs?

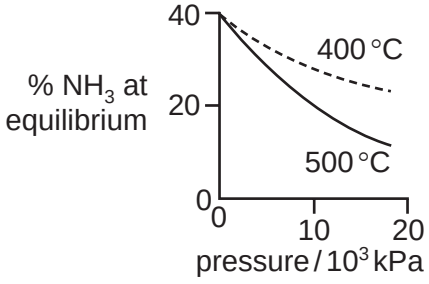
A



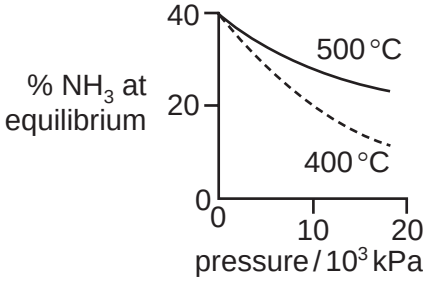
B



C



D



16 Consecutive elements X, Y, Z are in the third period of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point.

What could be the identities of X, Y and Z?

A aluminium, silicon, phosphorus

B magnesium, aluminium, silicon

C silicon, phosphorus, sulfur

D sodium, magnesium, aluminium

17 Which property of Group II elements (beryllium to barium) decreases with increasing atomic number?

A reactivity with water

B second ionisation energy

C solubility of hydroxides

D stability of the carbonates

18 Which element of the third period requires the least number of moles of oxygen for the complete combustion of 1 mol of the element?

A aluminium

B magnesium

C phosphorus

D sodium

19 Two properties of non-metallic elements and their atoms are as follows.

property 1 has an oxide that can form a strong acid in water

property 2 has **no** paired 3p electrons

Which properties do phosphorus and sulfur have?

	phosphorus	sulfur
A	1 and 2	1 only
B	1 only	1 and 2
C	1 and 2	1 and 2
D	2 only	1 only

20 When gaseous chemicals are transported by road or by rail they are classified as follows.

flammable non-flammable poisonous

Which commonly transported gas is non-flammable?

A butane

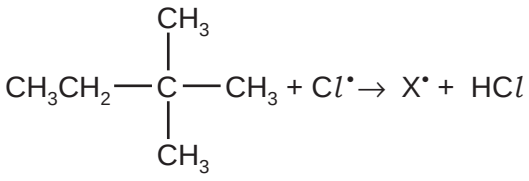
B hydrogen

C oxygen

D propene

21 When heated with chlorine, the hydrocarbon 2,2-dimethylbutane undergoes free radical substitution.

In a propagation step the free radical $X^{\bullet}$ is formed.



How many different forms of $X^{\bullet}$ are possible?

A 1 **B** 2 **C** 3 **D** 4

22 What will react differently with the two isomeric alcohols, $(CH_3)_3CCH_2OH$ and $(CH_3)_2CHCH_2CH_2OH$?

A acidified aqueous potassium manganate(VII)

B concentrated sulfuric acid

C phosphorus pentachloride

D sodium

23 Which reagent will give similar results with both butanone and butanal?

A acidified aqueous potassium dichromate(VI)

B an alkaline solution containing complexed Cu^{2+} ions (Fehling's solution)

C an aqueous solution containing $[Ag(NH_3)_2]^+$ (Tollens' reagent)

D 2,4-dinitrophenylhydrazine reagent

24 What is formed when propanone is refluxed with a solution of $NaBH_4$?

A propanal

B propan-1-ol

C propan-2-ol

D propane

25 Which compound is a product of the hydrolysis of $CH_3CO_2C_3H_7$ by boiling aqueous sodium hydroxide?

A CH_3OH **B** C_3H_7OH **C** $C_3H_7CO_2H$ **D** $C_3H_7CO_2\ Na^+$

26 In many countries plastic waste is collected separately and sorted. Some of this is incinerated to provide heat for power stations.

Why is pvc, polyvinylchloride, removed from any waste that is to be incinerated?

A It destroys the ozone layer.

B It does not burn easily.

C It is easily biodegradable.

D Its combustion products are harmful.

27 Polymerisation of 1,1-dichloroethene produces a dense, high melting point substance that does not allow gases to pass through. It is used as cling wrapping.

Which sequence appears in a short length of the polymer chain?

A $\{CH_2CCl_2CH_2CCl_2CH_2CCl_2\}$

B $\{CHClCHClCHClCHClCHClCHCl\}$

C $\{CCl_2CCl_2CCl_2CCl_2CCl_2CCl_2\}$

D $\{CH_2CCl_2CHClCHClCH_2CCl_2\}$

28 When an isomer Y of molecular formula C_4H_9Br undergoes hydrolysis in aqueous alkali to form an alcohol C_4H_9OH, the rate of reaction is found to be unaffected by changes in the concentration of OH^- ions present.

Which is the most likely molecular structure of Y?

A $CH_3CH_2CH_2CH_2Br$

B $CH_3CH_2CHBrCH_3$

C $(CH_3)_2CHCH_2Br$

D $(CH_3)_3CBr$

29 Which isomer of $C_4H_{10}O$ forms three alkenes on dehydration?

A butan-1-ol

B butan-2-ol

C 2-methylpropan-1-ol

D 2-methylpropan-2-ol

30 Which compound exhibits both *cis-trans* and optical isomerism?

A $CH_3CH=CHCH_2CH_3$

B $CH_3CHBrCH=CH_2$

C $CH_3CBr=CBrCH_3$

D $CH_3CH_2CHBrCH=CHBr$

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

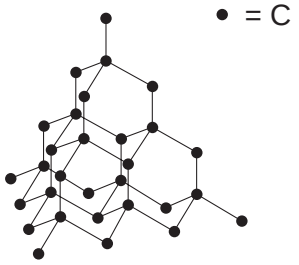
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

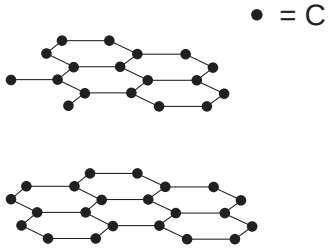
No other combination of statements is used as a correct response.

31 Which diagrams represent part of a giant molecular structure?

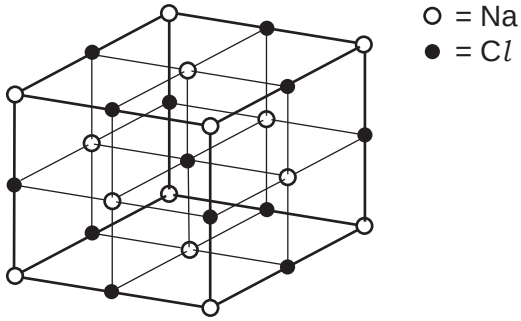
1



2



3



32 Which reactions are redox reactions?

1 $CaBr_2 + 2H_2SO_4 \rightarrow CaSO_4 + Br_2 + SO_2 + 2H_2O$

2 $CaBr_2 + 2H_3PO_4 \rightarrow Ca(H_2PO_4)_2 + 2HBr$

3 $CaBr_2 + 2AgNO_3 \rightarrow Ca(NO_3)_2 + 2AgBr$

33 Sodium hydrogensulfide, NaSH, is used to remove hair from animal hides.

Which statements about the SH^- ion are correct?

1 It contains 18 electrons.

2 Three lone pairs of electrons surround the sulfur atom.

3 Sulfur has an oxidation state of +2.

34 When organic refuse decomposes in water carboxylic acids are formed. The water becomes acidic and aquatic life is destroyed.

Which additives are suitable to remove this acid pollution?

1 calcium carbonate

2 calcium hydroxide

3 potassium nitrate

35 In a car engine, non-metallic element X forms a pollutant oxide Y.

Further oxidation of Y to Z occurs in the atmosphere. In this further oxidation, 1 mol of Y reacts with ½ mol of gaseous oxygen.

What can X be?

1 carbon

2 nitrogen

3 sulfur

36 Sulfur dioxide and sulfites are used in food preservation.

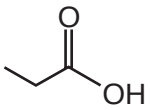
Why are they used for this purpose?

1 They are reducing agents so retard the oxidation of food.

2 They inhibit the growth of aerobic bacteria.

3 They react with $NO_2(g)$ converting it to NO(g).

37 Propanoic acid occurs naturally as a result of the bacterial fermentation of milk, and is partly responsible for the flavour of Swiss cheese.



propanoic acid

Which starting materials could be used to synthesise propanoic acid?

1 $CH_3CH_2CH_2OH$

2 CH_3CH_2CN

3 CH_3CH_2CHO

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

38 Which structural formulae represent 2,2-dimethylpentane?

1 $(CH_3)_2CHCH_2CH(CH_3)_2$

2 $(CH_3)_3CCH_2CH_2CH_3$

3 $CH_3CH_2CH_2C(CH_3)_3$

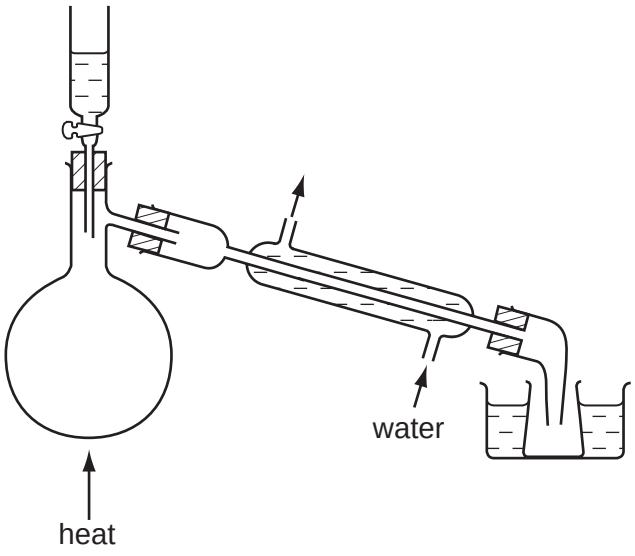
39 Which reactions are examples of nucleophilic substitution?

1 $CH_3CH_2Br + OH \rightarrow CH_3CH_2OH + Br$

2 $CH_3I + H_2O \xrightarrow{H^+} CH_3OH + HI$

3 $CH_3CH_2CH_2Cl + NH_3 \rightarrow CH_3CH_2CH_2NH_2 + HCl$

40 The diagram shows some laboratory apparatus.



Which preparations could this apparatus be used for?

1 bromoethane, from ethanol, sodium bromide and concentrated sulfuric acid

2 ethanal, from ethanol, sodium dichromate(VI) and sulfuric acid

3 1,2-dibromoethane, from bromine and ethene

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/11 Paper 11 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**C**
2	**A**	22	**B**
3	**C**	23	**D**
4	**C**	24	**C**
5	**B**	25	**B**
6	**D**	26	**D**
7	**A**	27	**A**
8	**D**	28	**D**
9	**C**	29	**B**
10	**D**	30	**D**
11	**A**	31	**B**
12	**D**	32	**D**
13	**A**	33	**B**
14	**A**	34	**B**
15	**A**	35	**C**
16	**C**	36	**B**
17	**B**	37	**A**
18	**D**	38	**C**
19	**A**	39	**A**
20	**C**	40	**B**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **October/November 2010**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 6 9 6 1 6 3 7 6 7 0 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **15** printed pages and **1** blank page.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Every year millions of tonnes each of chlorine and sodium hydroxide are manufactured by the electrolysis of brine using a 'diaphragm cell'.

What is the purpose of the diaphragm in such a cell?

A to prevent chlorine gas escaping into the factory

B to prevent the build up of pressure in the electrolysis cell

C to provide a large surface area of electrode

D to stop the products of electrolysis from reacting together

2 A simple ion X^+ contains eight protons.

What is the electronic configuration of X^+?

A $1s^2$ $2s^1$ $2p^6$

B $1s^2$ $2s^2$ $2p^3$

C $1s^2$ $2s^2$ $2p^5$

D $1s^2$ $2s^2$ $2p^7$

3 Equations involving four enthalpy changes are shown.

$Na(g) \rightarrow Na^+(g) + e \quad \Delta H = W$

$Na(g) \rightarrow Na^{2+}(g) + 2e \quad \Delta H = X$

$Na(s) \rightarrow Na(g) \quad \Delta H = Y$

$Na(s) \rightarrow Na^{2+}(g) + 2e \quad \Delta H = Z$

What is the second ionisation energy of sodium?

A 2W **B** X – W **C** Y – W **D** Z – Y

4 Sulfur dioxide, SO_2, is added to wines to prevent oxidation of ethanol by air. To determine the amount of SO_2, a sample of wine is titrated with iodine, I_2. In this reaction, **one** mole of SO_2 is oxidised by **one** mole of I_2.

What is the change in oxidation number of sulfur in this reaction?

A +2 to +4 **B** +2 to +6 **C** +4 to +5 **D** +4 to +6

5 *Use of the Data Booklet is relevant to this question.*

Nickel makes up 20 % of the total mass of a coin. The coin has a mass of 10.0 g.

How many nickel atoms are in the coin?

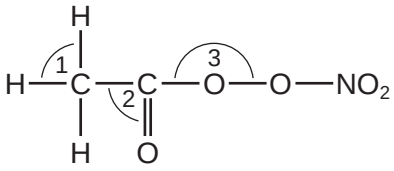
A 2.05×10^{22} **B** 4.30×10^{22} **C** 1.03×10^{23} **D** 1.20×10^{24}

6 Which ion has more electrons than protons and more protons than neutrons?
[H = $^{1}_{1}H$; D = $^{2}_{1}H$; O = $^{16}_{8}O$]

A D **B** H_3O^+ **C** OD **D** OH

7 Organic nitrates in photochemical smog can cause breathing difficulties.

The diagram shows an example of an organic nitrate molecule.



What is the correct order of the bond angles shown in ascending order (smallest first)?

A $1 \rightarrow 2 \rightarrow 3$ **B** $2 \rightarrow 1 \rightarrow 3$ **C** $3 \rightarrow 1 \rightarrow 2$ **D** $3 \rightarrow 2 \rightarrow 1$

8 Enthalpy changes of combustion can be used to determine enthalpy changes of formation. The following equation represents the enthalpy change of formation of butane.

$$4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g)$$

By using the following standard enthalpy of combustion data, what is the value of the standard enthalpy change of formation, $\Delta H_f^{\ominus}$, for this reaction?

compound	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
carbon	–394
hydrogen	–286
butane	–2877

A –5883 kJ mol ^{1}

B –129 kJ mol ^{1}

C +129 kJ mol ^{1}

D +2197 kJ mol ^{1}

9 In a calorimetric experiment 1.60 g of a fuel is burnt. 45 % of the energy released is absorbed by 200 g of water whose temperature rises from 18 °C to 66 °C. The specific heat capacity of water is 4.2 J g ^{1} K ^{1}.

What is the total energy released per gram of fuel burnt?

A 25 200 J **B** 56 000 J **C** 89 600 J **D** 143 360 J

10 The value of the equilibrium constant, K_c, for the reaction to form ethyl ethanoate from ethanol and ethanoic acid is 4.0 at 60 °C.

$$C_2H_5OH + CH_3CO_2H \rightleftharpoons CH_3CO_2C_2H_5 + H_2O$$

When 1.0 mol of ethanol and 1.0 mol of ethanoic acid are allowed to reach equilibrium at 60 °C, what is the number of moles of ethyl ethanoate formed?

A $\frac{1}{3}$ **B** $\frac{2}{3}$ **C** $\frac{1}{4}$ **D** $\frac{3}{4}$

11 Which equation represents the change corresponding to the enthalpy change of atomisation of iodine?

A $\frac{1}{2} I_2(g) \rightarrow I(g)$

B $I_2(g) \rightarrow 2I(g)$

C $\frac{1}{2} I_2(s) \rightarrow I(g)$

D $I_2(s) \rightarrow 2I(g)$

12 Camphor is a white solid which was used to make the early plastic celluloid. Camphor contains the same percentage by mass of hydrogen and oxygen.

What is the molecular formula of camphor?

A $C_{10}H_6O_6$ **B** $C_{10}H_8O$ **C** $C_{10}H_{16}O$ **D** $C_{10}H_{10}O_2$

13 Why is the first ionisation energy of phosphorus greater than the first ionisation energy of silicon?

A A phosphorus atom has one more proton in its nucleus.

B The atomic radius of a phosphorus atom is greater.

C The outer electron in a phosphorus atom is more shielded.

D The outer electron in a phosphorus atom is paired.

14 When magnesium nitrate, $Mg(NO_3)_2.7H_2O$, is heated, which three gases are given off?

A dinitrogen oxide, oxygen, water vapour

B hydrogen, nitrogen, oxygen

C hydrogen, nitrogen dioxide, oxygen

D nitrogen dioxide, oxygen, water vapour

15 Ammonium sulfate in nitrogenous fertilisers in the soil can be slowly oxidised by air producing sulfuric acid, nitric acid and water.

How many moles of oxygen gas are needed to oxidise completely one mole of ammonium sulfate?

A 1 **B** 2 **C** 3 **D** 4

16 Chile saltpetre, $NaNO_3$, contains sodium iodide as an impurity.

Aqueous silver nitrate is added to an aqueous solution of Chile saltpetre. Concentrated aqueous ammonia is then added.

Which observations are made?

	with acidified silver nitrate	with concentrated aqueous ammonia
A	no precipitate	no further reaction
B	no precipitate	precipitate forms
C	precipitate forms	precipitate dissolves
D	precipitate forms	precipitate remains

17 Which statement describes the halogens chlorine, bromine and iodine?

A Their bond energies decrease with increasing proton number.

B Their first ionisation energies increase with increasing proton number.

C They are all coloured gases at room temperature.

D They are all good reducing agents.

18 Sulfur dioxide is used to bleach wood pulp in the production of paper. It is also used as an additive in the production of jam and marmalade, often in the form of sulfite compounds. When it is present in quantities greater than 10 mg / kg it is required to be listed as an ingredient of the jam.

Why is sulfur dioxide added to jam?

A It is a bleaching agent and removes the undesirable colours from the fruit used in the jam.

B It is a preservative that destroys unwanted bacteria and enzymes.

C It is a reducing agent and removes the acids that give the jam a sharp taste.

D It is an acidic gas and maintains the pH of the jam at a suitable value to give it a sharp taste.

19 Which property of beryllium and its compounds is typical of the elements below it in Group II?

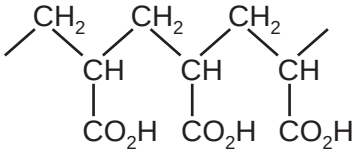
A Be does not react with hot water.

B $BeCl_2$ is covalent.

C $Be(NO_3)_2$ produces BeO on thermal decomposition.

D BeO dissolves in alkalis.

20 One of the characteristics of addition polymerisation is that the empirical formulae of the polymer and of its monomer are the same. The absorbent material in babies' disposable nappies is made from the addition polymer shown.



From which monomer could this addition polymer be obtained?

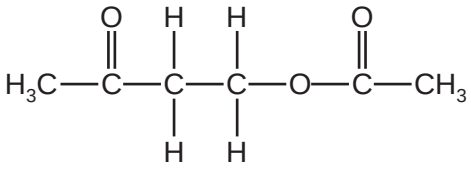
A $CH_3CH(OH)CO_2H$

B $HOCH_2CH_2CO_2H$

C $H_2C{=}CHCO_2H$

D $HO_2CCH{=}CHCO_2H$

21 Compound X reacts with ethanoic acid in the presence of an H^+ catalyst to produce the compound below.



What is the molecular formula of compound X?

A $C_2H_6O_2$ **B** $C_2H_6O_3$ **C** C_4H_8O **D** $C_4H_8O_2$

22 A compound Y has all of the properties below.

- It is a liquid at 25 °C.
- It mixes completely with water.
- It reacts with aqueous sodium hydroxide.

What could Y be?

A ethanoic acid

B ethanol

C ethene

D ethyl ethanoate

23 Tartaric acid is present in some wines. It may be synthesised in the laboratory in two steps.

$$OHCCHO \xrightarrow{\text{step 1}} \text{intermediate} \xrightarrow{\text{step 2}} HO_2CCH(OH)CH(OH)CO_2H$$

tartaric acid

Which reagents could be used for this synthesis?

	step 1	step 2
A	HC*l*(aq)	HCN(g)
B	HCN, NaCN(aq/alcoholic)	H_2SO_4(aq)
C	H_2SO_4(aq)	$K_2Cr_2O_7$ / H_2SO_4(aq)
D	KCN(aq/alcoholic)	$K_2Cr_2O_7$ / H_2SO_4(aq)

24 Which alcohol gives only **one** possible oxidation product when warmed with dilute acidified potassium dichromate(VI)?

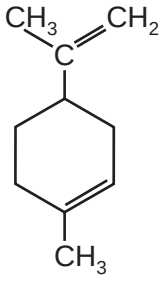
A butan-1-ol

B butan-2-ol

C 2-methylpropan-1-ol

D 2-methylpropan-2-ol

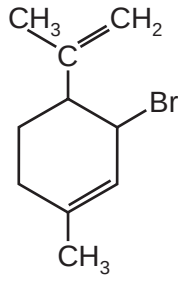
25 Limonene is an oil formed in the peel of citrus fruits.



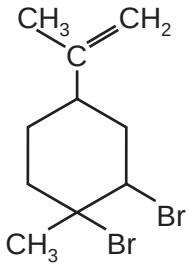
limonene

Which product is formed when an excess of bromine, $Br_2(l)$, reacts with limonene at room temperature in the dark?

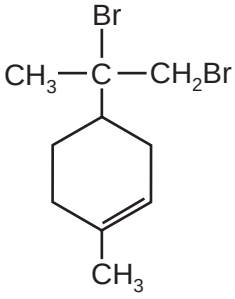
A



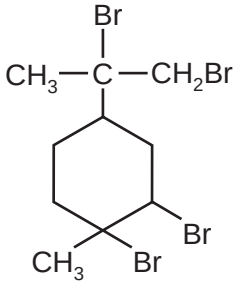
B



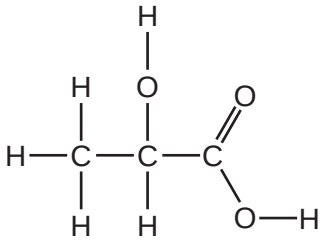
C



D



26 Lactic acid occurs naturally, for example in sour milk.



lactic acid

What is a property of lactic acid?

A It decolourises aqueous bromine rapidly.

B It is insoluble in water.

C It reduces Fehling's reagent.

D Two molecules react with each other in the presence of a strong acid.

27 Which compound would undergo nucleophilic addition?

A bromoethane, C_2H_5Br

B ethanal, CH_3CHO

C ethane, C_2H_6

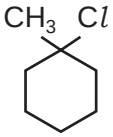
D ethene, C_2H_4

28 Which compound undergoes an S_N1 substitution reaction?

A $CH_3CH_2CH_2Br$

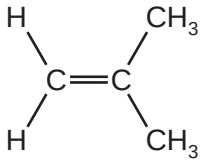
B $(CH_3)_3CCH_2I$

C



D $CH_2{=}CHCl$

29 The compound 2-methylpropene, C_4H_8, is a monomer used in the production of synthetic rubber.



In addition to 2-methylpropene there are x other isomers of C_4H_8, structural or otherwise, which contain a double bond.

What is the value of x?

A 1 **B** 2 **C** 3 **D** 4

30 Which environmental problem is **not** made worse by the release of oxides of nitrogen from car engines?

A acidification of lakes

B corrosion of buildings

C photochemical smog

D the hole in the ozone layer

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Ethanol is manufactured by reacting ethene gas and steam in the presence of phosphoric(V) acid.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H = -45\,kJ\,mol^{-1}$$

The reaction is carried out at 570 K and 60 atm.

What would be the consequences of carrying out the reaction at the same temperature but at a pressure of 200 atm?

1 The manufacturing costs would increase.

2 The maximum yield at equilibrium would be higher.

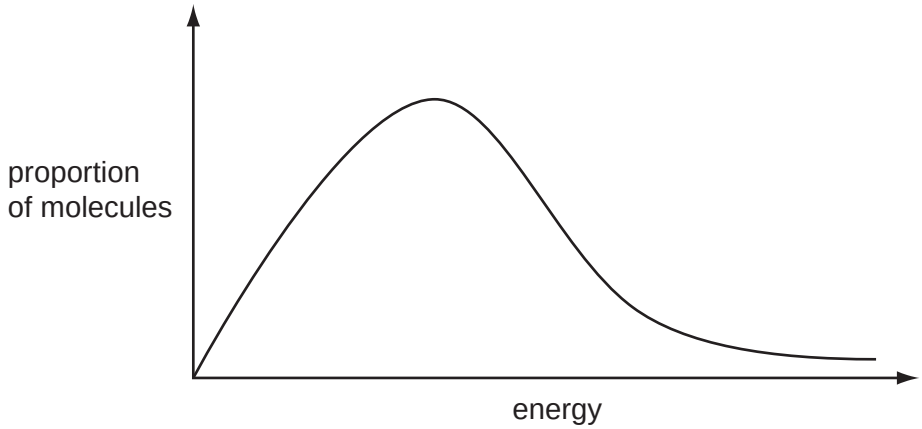
3 The reaction would proceed at a faster rate.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

32 The diagram represents the Boltzmann distribution of molecular energies at a given temperature.



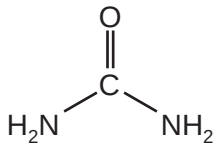
Which of the factors that affect the rate of a reaction can be explained using such a Boltzmann distribution?

1 increasing the concentration of reactants

2 increasing the temperature

3 the addition of a catalyst

33 Which types of intermolecular forces can exist between adjacent urea molecules?



urea

1 hydrogen bonding

2 permanent dipole-dipole forces

3 temporary induced dipole-dipole forces

34 Samples of calcium and barium are separately added to beakers of cold water containing a few drops of litmus solution.

Which observations will be made with **only** the calcium and **not** with the barium?

1 A white suspension appears in the water.

2 The solution turns blue.

3 A gas is evolved.

35 Disproportionation is the term used to describe a reaction in which a reactant is simultaneously both oxidised and reduced.

To which incomplete equations does the term disproportionation apply?

1 $Cl_2(g) + 2OH^-(aq) \rightarrow H_2O(l) + Cl^-(aq) + \ldots\ldots$

2 $3Cl_2(g) + 6OH^-(aq) \rightarrow 3H_2O(l) + ClO_3^-(aq) + \ldots\ldots$

3 $2NO_2(g) + H_2O(l) \rightarrow HNO_3(aq) + \ldots\ldots$

36 Element X is a solid. It occurs as a contaminant of carbonaceous fuels.

Its oxide Y is formed in car engines.

Further oxidation of Y to Z can occur in the atmosphere.

Which statements about Y and Z are correct?

1 Molecule Y has lone pairs of electrons.

2 The atmospheric oxidation of Y to Z is a catalysed reaction.

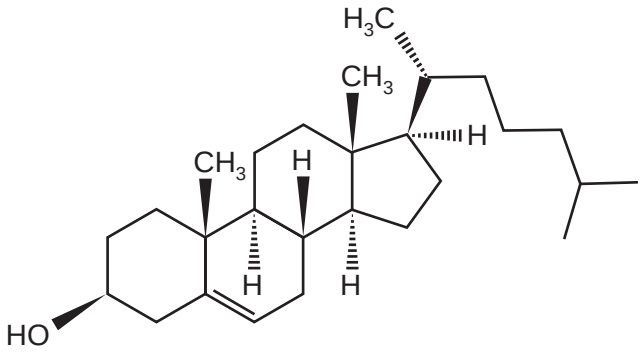
3 Y is a colourless gas.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

37 The diagram shows the structure of the naturally-occurring molecule cholesterol.



cholesterol

Which statements about cholesterol are correct?

1 The molecule contains a secondary alcohol group.

2 The molecule contains two π bonds.

3 All carbon atoms in the four rings lie in the same plane.

38 Glyceraldehyde, $HOCH_2CH(OH)CHO$, is formed during photosynthesis, and contains a chiral carbon atom.

Which reagents will react with glyceraldehyde to produce an organic product **without** a chiral carbon atom?

1 warmed acidified $K_2Cr_2O_7$

2 $NaBH_4$

3 Tollens' reagent

39 An organic compound decolourises aqueous bromine and reacts with sodium to produce hydrogen.

Which molecular formula could represent this compound?

1 C_3H_6O

2 $C_3H_4O_2$

3 C_3H_8O

40 Textiles for use in aircraft are treated with a finish containing a halogenoalkane.

What is the reason for this?

1 The textile burns less easily, improving safety.

2 The fabric forms hydrogen bonds to water more readily, making the fabric easier to wash.

3 The halogenoalkane undergoes addition polymerisation, stiffening the fabric.

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2010 question paper for the guidance of teachers

9701 CHEMISTRY

9701/11 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**D**
2	**B**	22	**A**
3	**B**	23	**B**
4	**D**	24	**B**
5	**A**	25	**D**
6	**D**	26	**D**
7	**C**	27	**B**
8	**B**	28	**C**
9	**B**	29	**C**
10	**B**	30	**D**
11	**C**	31	**A**
12	**C**	32	**C**
13	**A**	33	**A**
14	**D**	34	**D**
15	**D**	35	**A**
16	**D**	36	**A**
17	**A**	37	**D**
18	**B**	38	**B**
19	**C**	39	**B**
20	**C**	40	**D**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **May/June 2010**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 3 4 9 2 9 2 3 3 2 4 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **13** printed pages and **3** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Which gas closely approaches ideal behaviour at room temperature and pressure?

A ammonia

B carbon dioxide

C helium

D oxygen

2 *Use of the Data Booklet is relevant to this question*.

What could be the proton number of an element that has three unpaired electrons in each of its atoms?

A 5 **B** 13 **C** 15 **D** 21

3 *Use of the Data Booklet is relevant to this question*.

The elements radon (Rn), francium (Fr) and radium (Ra) have consecutive proton numbers in the Periodic Table.

What is the order of their first ionisation energies?

	least endothermic →		most endothermic
A	Fr	Ra	Rn
B	Fr	Rn	Ra
C	Ra	Fr	Rn
D	Rn	Ra	Fr

4 Some bond energy values are listed below.

bond	bond energy / kJ mol $^{-1}$
C–H	410
C–C*l*	340
C*l*–C*l*	244
Br–Br	193

These bond energy values relate to the following four reactions.

P $Br_2 \rightarrow 2Br$

Q $2Cl \rightarrow Cl_2$

R $CH_3 + Cl \rightarrow CH_3Cl$

S $CH_4 \rightarrow CH_3 + H$

What is the order of enthalpy changes of these reactions from most negative to most positive?

A P → Q → R → S

B Q → R → S → P

C R → Q → P → S

D S → P → Q → R

5 Given the following enthalpy changes,

$$I_2(g) + 3Cl_2(g) \rightarrow 2ICl_3(s) \qquad \Delta H^{\ominus} = -214\,kJ\,mol^{-1}$$

$$I_2(s) \rightarrow I_2(g) \qquad \Delta H^{\ominus} = +38\,kJ\,mol^{-1}$$

What is the standard enthalpy change of formation of iodine trichloride, $ICl_3(s)$?

A +176 kJ mol $^{-1}$

B –88 kJ mol $^{-1}$

C –176 kJ mol $^{-1}$

D –214 kJ mol $^{-1}$

6 Ammonium nitrate, NH_4NO_3, can decompose explosively when heated.

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

What are the changes in the oxidation numbers of the two nitrogen atoms in NH_4NO_3 when this reaction proceeds?

A –2, –4 **B** +2, +6 **C** +4, –6 **D** +4, –4

7 Which mass of gas would occupy a volume of 3 dm^3 at 25 °C and 1 atmosphere pressure?
[1 mol of gas occupies 24 dm^3 at 25 °C and 1 atmosphere pressure.]

A 3.2 g O_2 gas

B 5.6 g N_2 gas

C 8.0 g SO_2 gas

D 11.0 g CO_2 gas

8 *Use of the Data Booklet is relevant to this question.*

2.920 g of a Group II metal, **X**, reacts with an excess of chlorine to form 5.287 g of a compound with formula **X**Cl_2.

What is metal **X**?

A barium

B calcium

C magnesium

D strontium

9 The table gives the concentrations and pH values of the aqueous solutions of two compounds, X and Y. Either compound could be an acid or a base.

	X	Y
concentration	2 mol dm^{-3}	2 mol dm^{-3}
pH	6	9

Student P concluded that X is a strong acid.

Student Q concluded that the extent of dissociation is lower in X(aq) than in Y(aq).

Which of the students are correct?

A both P and Q

B neither P nor Q

C P only

D Q only

10 The Haber process for the manufacture of ammonia is represented by the following equation.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ\,mol^{-1}$$

Which statement is correct about this reaction when the temperature is increased?

A Both forward and backward rates increase.

B The backward rate only increases.

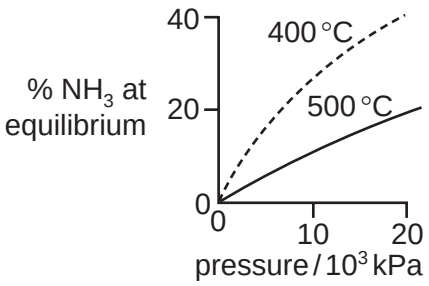
C The forward rate only increases.

D There is no effect on the backward or forward rate.

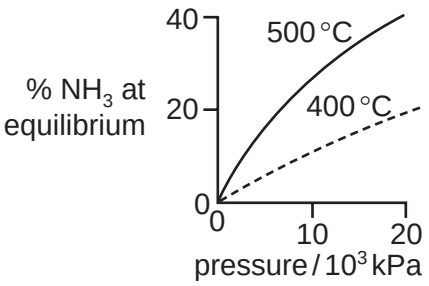
11 The percentage of ammonia obtainable, if equilibrium were established during the Haber process, is plotted against the operating pressure for two temperatures, 400 °C and 500 °C.

Which diagram correctly represents the two graphs?

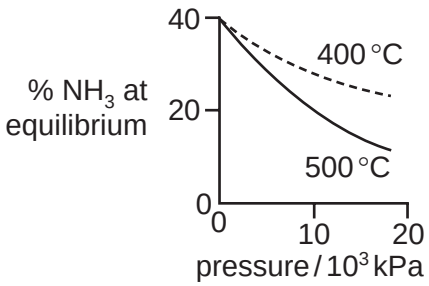
A



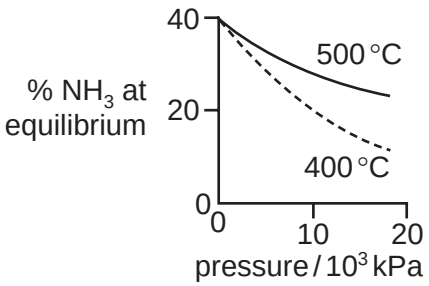
B



C



D



12 Swimming pool water can be kept free of harmful bacteria by adding aqueous sodium chlorate(I), NaOC*l*. This reacts with water to produce HOC*l* molecules which kill bacteria.

$$OCl^- (aq) + H_2O \rightleftharpoons OH^- (aq) + HOCl(aq)$$

In bright sunshine, the OCl^- ion is broken down by ultra-violet light.

$$OCl^- (aq) + \text{uv light} \rightarrow Cl^- (aq) + \tfrac{1}{2}O_2(g)$$

Which method would maintain the highest concentration of HOC*l*(aq)?

A acidify the pool water

B add a solution of chloride ions

C add a solution of hydroxide ions

D bubble air through the water

13 $Na_2S_2O_3$ reacts with dilute HC*l* to give a pale yellow precipitate. If 1 cm^3 of 0.1 mol dm^{-3} HC*l* is added to 10 cm^3 of 0.02 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms slowly.

If the experiment is repeated with 1 cm^3 of 0.1 mol dm^{-3} HC*l* and 10 cm^3 of 0.05 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms more quickly.

Why is this?

A The activation energy of the reaction is lower when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

B The reaction proceeds by a different pathway when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

C The collisions between reactant particles are more violent when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

D The reactant particles collide more frequently when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

14 How does concentrated sulfuric acid behave when it reacts with sodium chloride?

A as an acid only

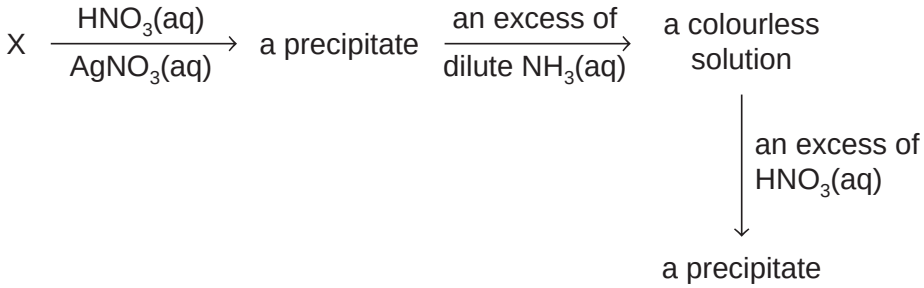
B as an acid and oxidising agent

C as an oxidising agent only

D as a reducing agent only

15 X is a salt of one of the halogens chlorine, bromine, iodine, or astatine (proton number 85).

The reaction scheme shows a series of reactions using a solution of X as the starting reagent.



What could X be?

A sodium chloride

B sodium bromide

C potassium iodide

D potassium astatide

16 Which element of the third period requires the least number of moles of oxygen for the complete combustion of 1 mol of the element?

A aluminium

B magnesium

C phosphorus

D sodium

17 Two properties of non-metallic elements and their atoms are as follows.

property 1 has an oxide that can form a strong acid in water

property 2 has **no** paired 3p electrons

Which properties do phosphorus and sulfur have?

	phosphorus	sulfur
A	1 and 2	1 only
B	1 only	1 and 2
C	1 and 2	1 and 2
D	2 only	1 only

18 Consecutive elements X, Y, Z are in the third period of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point.

What could be the identities of X, Y and Z?

A aluminium, silicon, phosphorus

B magnesium, aluminium, silicon

C silicon, phosphorus, sulfur

D sodium, magnesium, aluminium

19 Which property of Group II elements (beryllium to barium) decreases with increasing atomic number?

A reactivity with water

B second ionisation energy

C solubility of hydroxides

D stability of the carbonates

20 When gaseous chemicals are transported by road or by rail they are classified as follows.

flammable non-flammable poisonous

Which commonly transported gas is non-flammable?

A butane

B hydrogen

C oxygen

D propene

21 What will react differently with the two isomeric alcohols, $(CH_3)_3CCH_2OH$ and $(CH_3)_2CHCH_2CH_2OH$?

A acidified aqueous potassium manganate(VII)

B concentrated sulfuric acid

C phosphorus pentachloride

D sodium

22 Which reagent will give similar results with both butanone and butanal?

A acidified aqueous potassium dichromate(VI)

B an alkaline solution containing complexed Cu^{2+} ions (Fehling's solution)

C an aqueous solution containing $[Ag(NH_3)_2]^+$ (Tollens' reagent)

D 2,4-dinitrophenylhydrazine reagent

23 What is formed when propanone is refluxed with a solution of $NaBH_4$?

A propanal

B propan-1-ol

C propan-2-ol

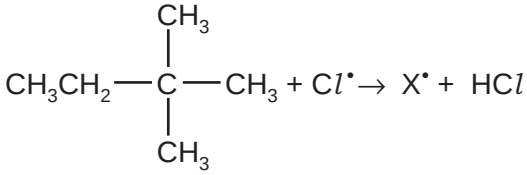
D propane

24 Which compound is a product of the hydrolysis of $CH_3CO_2C_3H_7$ by boiling aqueous sodium hydroxide?

A CH_3OH **B** C_3H_7OH **C** $C_3H_7CO_2H$ **D** $C_3H_7CO_2\ Na^+$

25 When heated with chlorine, the hydrocarbon 2,2-dimethylbutane undergoes free radical substitution.

In a propagation step the free radical $X^\bullet$ is formed.



How many different forms of $X^\bullet$ are possible?

A 1 **B** 2 **C** 3 **D** 4

26 When an isomer Y of molecular formula C_4H_9Br undergoes hydrolysis in aqueous alkali to form an alcohol C_4H_9OH, the rate of reaction is found to be unaffected by changes in the concentration of OH^- ions present.

Which is the most likely molecular structure of Y?

A $CH_3CH_2CH_2CH_2Br$

B $CH_3CH_2CHBrCH_3$

C $(CH_3)_2CHCH_2Br$

D $(CH_3)_3CBr$

27 Which isomer of $C_4H_{10}O$ forms three alkenes on dehydration?

A butan-1-ol

B butan-2-ol

C 2-methylpropan-1-ol

D 2-methylpropan-2-ol

28 Which compound exhibits both *cis-trans* and optical isomerism?

A $CH_3CH{=}CHCH_2CH_3$

B $CH_3CHBrCH{=}CH_2$

C $CH_3CBr{=}CBrCH_3$

D $CH_3CH_2CHBrCH{=}CHBr$

29 In many countries plastic waste is collected separately and sorted. Some of this is incinerated to provide heat for power stations.

Why is pvc, polyvinylchloride, removed from any waste that is to be incinerated?

A It destroys the ozone layer.

B It does not burn easily.

C It is easily biodegradable.

D Its combustion products are harmful.

30 Polymerisation of 1,1-dichloroethene produces a dense, high melting point substance that does not allow gases to pass through. It is used as cling wrapping.

Which sequence appears in a short length of the polymer chain?

A $\{CH_2CCl_2CH_2CCl_2CH_2CCl_2\}$

B $\{CHClCHClCHClCHClCHClCHCl\}$

C $\{CCl_2CCl_2CCl_2CCl_2CCl_2CCl_2\}$

D $\{CH_2CCl_2CHClCHClCH_2CCl_2\}$

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Sodium hydrogensulfide, NaSH, is used to remove hair from animal hides.

Which statements about the SH^- ion are correct?

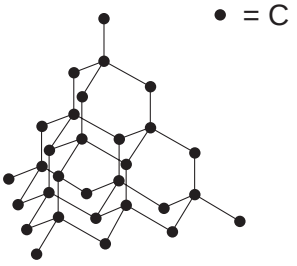
1 It contains 18 electrons.

2 Three lone pairs of electrons surround the sulfur atom.

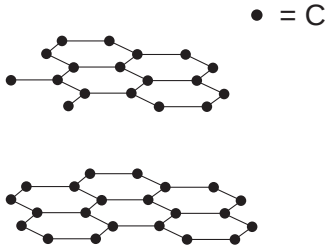
3 Sulfur has an oxidation state of +2.

32 Which diagrams represent part of a giant molecular structure?

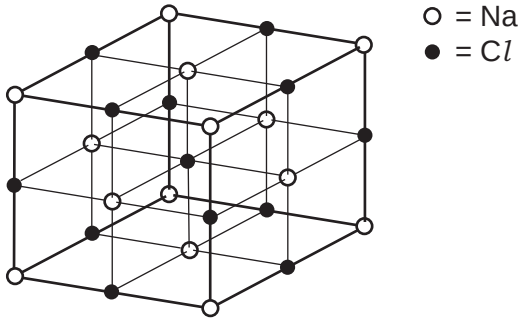
1



2



3



33 Which reactions are redox reactions?

1 $CaBr_2 + 2H_2SO_4 \rightarrow CaSO_4 + Br_2 + SO_2 + 2H_2O$

2 $CaBr_2 + 2H_3PO_4 \rightarrow Ca(H_2PO_4)_2 + 2HBr$

3 $CaBr_2 + 2AgNO_3 \rightarrow Ca(NO_3)_2 + 2AgBr$

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

34 When organic refuse decomposes in water carboxylic acids are formed. The water becomes acidic and aquatic life is destroyed.

Which additives are suitable to remove this acid pollution?

1 calcium carbonate

2 calcium hydroxide

3 potassium nitrate

35 In a car engine, non-metallic element X forms a pollutant oxide Y.

Further oxidation of Y to Z occurs in the atmosphere. In this further oxidation, 1 mol of Y reacts with ½ mol of gaseous oxygen.

What can X be?

1 carbon

2 nitrogen

3 sulfur

36 Sulfur dioxide and sulfites are used in food preservation.

Why are they used for this purpose?

1 They are reducing agents so retard the oxidation of food.

2 They inhibit the growth of aerobic bacteria.

3 They react with $NO_2(g)$ converting it to $NO(g)$.

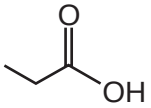
37 Which reactions are examples of nucleophilic substitution?

1 $CH_3CH_2Br + OH \rightarrow CH_3CH_2OH + Br$

2 $CH_3I + H_2O \xrightarrow{H^+} CH_3OH + HI$

3 $CH_3CH_2CH_2Cl + NH_3 \rightarrow CH_3CH_2CH_2NH_2 + HCl$

38 Propanoic acid occurs naturally as a result of the bacterial fermentation of milk, and is partly responsible for the flavour of Swiss cheese.



propanoic acid

Which starting materials could be used to synthesise propanoic acid?

1 $CH_3CH_2CH_2OH$

2 CH_3CH_2CN

3 CH_3CH_2CHO

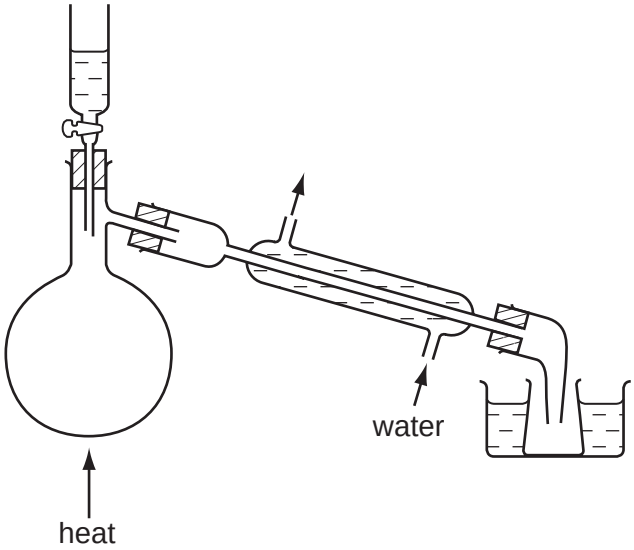
39 Which structural formulae represent 2,2-dimethylpentane?

1 $(CH_3)_2CHCH_2CH(CH_3)_2$

2 $(CH_3)_3CCH_2CH_2CH_3$

3 $CH_3CH_2CH_2C(CH_3)_3$

40 The diagram shows some laboratory apparatus.



Which preparations could this apparatus be used for?

1 bromoethane, from ethanol, sodium bromide and concentrated sulfuric acid

2 ethanal, from ethanol, sodium dichromate(VI) and sulfuric acid

3 1,2-dibromoethane, from bromine and ethene

BLANK PAGE

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/12 Paper 12 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**B**
2	**C**	22	**D**
3	**A**	23	**C**
4	**C**	24	**B**
5	**B**	25	**C**
6	**D**	26	**D**
7	**C**	27	**B**
8	**D**	28	**D**
9	**D**	29	**D**
10	**A**	30	**A**
11	**A**	31	**B**
12	**A**	32	**B**
13	**D**	33	**D**
14	**A**	34	**B**
15	**A**	35	**C**
16	**D**	36	**B**
17	**A**	37	**A**
18	**C**	38	**A**
19	**B**	39	**C**
20	**C**	40	**B**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **October/November 2010**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 2 8 9 9 4 4 8 6 1 9 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **16** printed pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 The ability of an atom in a covalent bond to attract electrons to itself is called its electronegativity.

The greater the difference between the electronegativities of the two atoms in the bond, the more polar is the bond.

Which pair will form the most polar covalent bond between the atoms?

A chlorine and bromine

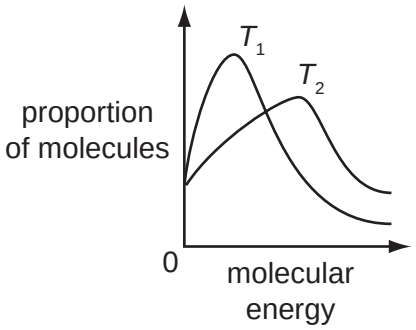
B chlorine and iodine

C fluorine and chlorine

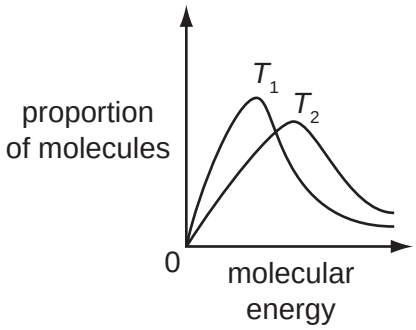
D fluorine and iodine

2 Which diagram correctly represents the Boltzmann distribution of molecular energies at two temperatures T_1 and T_2, where $T_1 = 300\,K$ and $T_2 = 310\,K$?

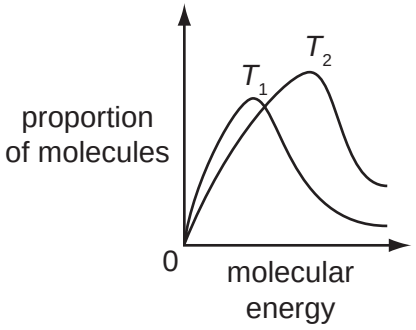
A



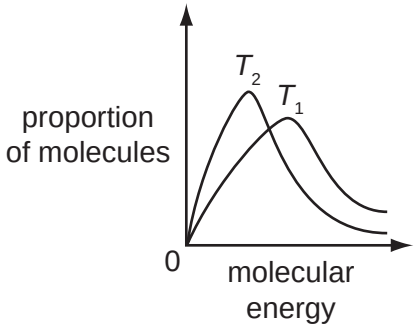
B



C



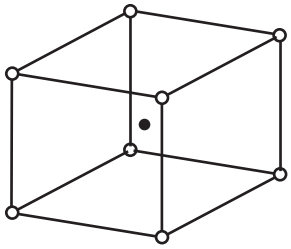
D



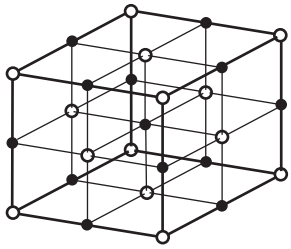
3 The table gives the radii, in pm, of some ions. [1 pm = 10^{-12} m]

ion	radii
Na^+	102
Mg^{2+}	72
Cs^+	167
C*l*	181
O^{2-}	140

Caesium chloride, CsC*l*, has a different lattice structure from both sodium chloride, NaC*l*, and magnesium oxide, MgO.



CsC*l* lattice



NaC*l* and MgO lattice

Which factor appears to determine the type of lattice for these three compounds?

A the charge on the cation

B the ratio of the ionic charges

C the ratio of the ionic radii

D the sum of the ionic charges

4 Methanol may be prepared by the reaction between carbon monoxide and hydrogen.

$$CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$$

The relevant average bond energies are given below.

E(C≡O)	1077 kJ mol^{-1}
E(C–O)	360 kJ mol^{-1}
E(C–H)	410 kJ mol^{-1}
E(H–H)	436 kJ mol^{-1}
E(O–H)	460 kJ mol^{-1}

What is the enthalpy change of this reaction?

A –537 kJ mol^{-1}

B –101 kJ mol^{-1}

C +101 kJ mol^{-1}

D +537 kJ mol^{-1}

5 Which solid has a simple molecular lattice?

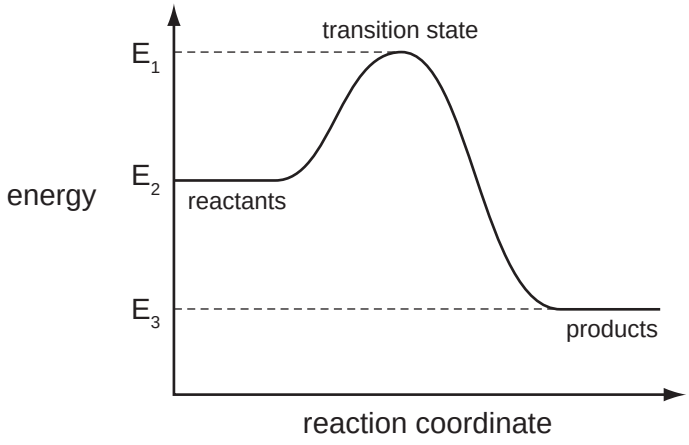
A calcium fluoride

B nickel

C silicon(IV) oxide

D sulfur

6 The reaction pathway diagram below illustrates the energies of reactants, products and the transition state of a reaction.



Which expression represents the activation energy of the forward reaction?

A $E_1 – E_2$ **B** $E_1 – E_3$ **C** $E_2 – E_3$ **D** $(E_1 – E_2) – (E_2 – E_3)$

7 Flask X contains 5 dm^3 of helium at 12 kPa pressure and flask Y contains 10 dm^3 of neon at 6 kPa pressure.

If the flasks are connected at constant temperature, what is the final pressure?

A 8 kPa **B** 9 kPa **C** 10 kPa **D** 11 kPa

8 *Use of the Data Booklet is relevant to this question.*

The enthalpy change of formation, ΔH_f, of hydrated calcium ions is the enthalpy change of the following reaction.

$$Ca(s) + aq - 2e \rightarrow Ca^{2+}(aq)$$

The following enthalpy changes are **not** quoted in the *Data Booklet*.

$$Ca(s) \rightarrow Ca(g) \qquad \Delta H_a = 177\,kJ\,mol^{-1}$$
$$Ca^{2+}(g) + aq \rightarrow Ca^{2+}(aq) \qquad \Delta H_{hyd} = -1565\,kJ\,mol^{-1}$$

What is the enthalpy change of formation of hydrated calcium ions?

A $-1388\,kJ\,mol^{-1}$

B $-798\,kJ\,mol^{-1}$

C $-238\,kJ\,mol^{-1}$

D $+352\,kJ\,mol^{-1}$

9 The following equilibrium is set up in a mixture of concentrated nitric and sulfuric acids.

$$HNO_3 + H_2SO_4 \rightleftharpoons H_2NO_3^+ + HSO_4$$

Which row correctly describes the behaviour of each substance in the equilibrium mixture?

	HNO_3	H_2SO_4	$H_2NO_3^+$	HSO_4
A	acid	acid	base	base
B	acid	base	base	acid
C	base	acid	acid	base
D	base	acid	base	acid

10 Which molecule or structure does **not** contain three atoms bonded at an angle between 109° and 110°?

A ethanoic acid

B graphite

C propane

D silicon(IV) oxide

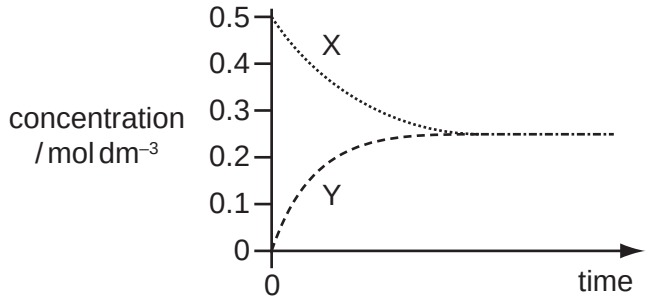
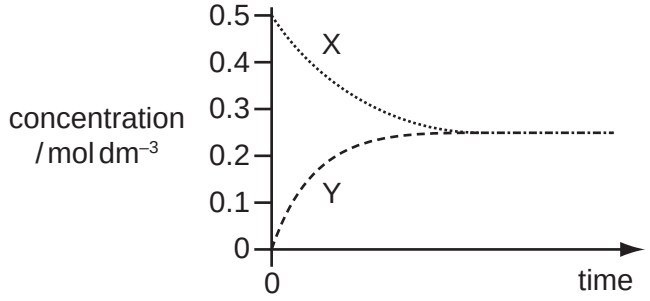
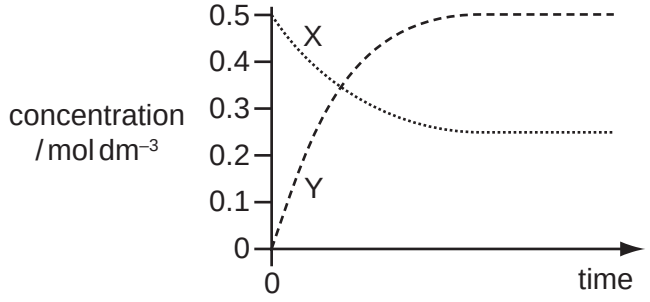
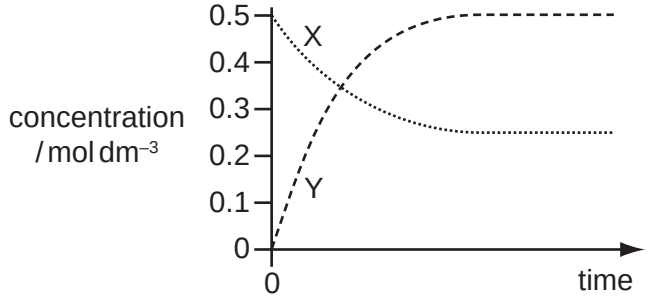
11 A dimer, X, is stable when solid but a dynamic equilibrium is set up in solution.

$$X(aq) \rightleftharpoons 2Y(aq)$$

A solution of X has an initial concentration of 0.50 mol dm ^{3}. When equilibrium has been reached [X(aq)] has fallen to 0.25 mol dm ^{3}.

The changes in [X(aq)] and [Y(aq)] are plotted against time until equilibrium is reached. The value of K_c is then calculated.

Which graph and value for K_c are correct?

	graph	K_c / mol dm^{-3}
A		1
B		2
C		1
D		2

12 Equimolar quantities of magnesium carbonate and strontium carbonate are separately heated to bring about complete thermal decomposition. The minimum temperature for this to occur is called T_d.

The cold residues are separately added to equal volumes of water and the change in pH is measured. The change in pH is called ΔpH.

Which metal has the higher value of T_d, and the greater value of ΔpH?

	T_d	ΔpH
A	Mg	Mg
B	Mg	Sr
C	Sr	Mg
D	Sr	Sr

13 In aqueous solution, the acid HIO disproportionates according to the following equation where **m**, **n**, **p** and **q** are simple whole numbers in their lowest ratios.

$$\mathbf{m}HIO \rightarrow \mathbf{n}I_2 + \mathbf{p}HIO_3 + \mathbf{q}H_2O$$

This equation can be balanced using oxidation numbers.

What are the values for **n** and **p**?

	n	**p**
A	1	2
B	2	1
C	4	1
D	4	2

14 *Use of the Data Booklet is relevant to this question.*

Which mass of solid residue can be obtained from the thermal decomposition of 4.10 g of anhydrous calcium nitrate?

A 0.70 g **B** 1.00 g **C** 1.40 g **D** 2.25 g

15 Which statement explains the observation that magnesium hydroxide dissolves in aqueous ammonium chloride, but not in aqueous sodium chloride?

A The ionic radius of the NH_4^+ ion is similar to that of Mg^{2+} but not that of Na^+.

B NH_4Cl dissociates less fully than $NaCl$.

C The Na^+ and Mg^{2+} ions are isoelectronic (have the same number of electrons).

D The NH_4^+ ion can donate a proton.

16 What happens when chlorine is bubbled through aqueous potassium iodide?

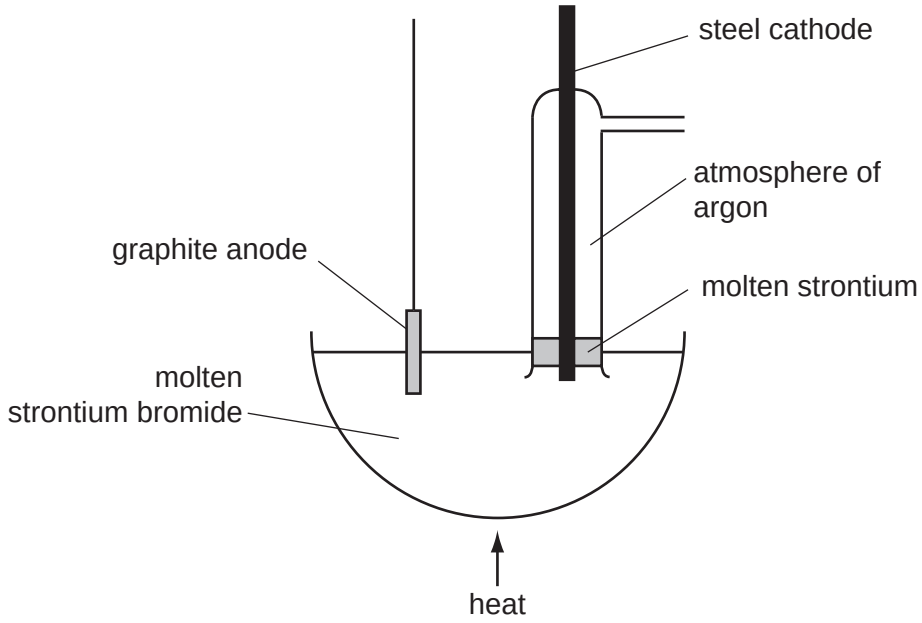
A Chlorine is oxidised to chlorate(V) ions.

B Chlorine is oxidised to chloride ions.

C Iodide ions are oxidised to iodine.

D There is no observable reaction.

17 Strontium metal can be obtained by the electrolysis of molten strontium bromide, $SrBr_2$, using the apparatus shown in the diagram.



Why is an atmosphere of argon used around the cathode?

A A thin film of a compound of strontium and argon forms on the surface protecting the freshly formed metal.

B The argon keeps the strontium molten.

C The argon stops the molten strontium rising too high in the tube.

D Without the argon, strontium oxide would form in the air.

18 Which statement about bromine is correct?

A Bromine is insoluble in non-polar solvents.

B Bromine vapour is more dense than air.

C Bromine will not vapourise significantly under normal conditions.

D Gaseous bromine is purple.

19 Concentrated sulfuric acid reacts with both solid sodium chloride at room temperature and with solid sodium iodide at room temperature.

Which row correctly describes how concentrated sulfuric acid behaves in each of these reactions?

	with sodium chloride	with sodium iodide
A	as an oxidising agent only	as an oxidising agent only
B	as a strong acid and as an oxidising agent	as a strong acid only
C	as a strong acid only	as a strong acid and as an oxidising agent
D	as a strong acid only	as a strong acid only

20 How many structural isomers are there of trichloropropane, $C_3H_5Cl_3$?

A 3 **B** 4 **C** 5 **D** 6

21 Nine compounds have molecular formula $C_4H_8Br_2$.

Which compound may be synthesised from an alkene by an addition reaction?

A 1,1-dibromobutane

B 1,2-dibromobutane

C 1,3-dibromobutane

D 1,3-dibromomethylpropane

22 When ethanal, CH_3CHO, reacts with HCN and the organic product is hydrolysed by aqueous acid, organic compound Y is formed.

When propanal, C_2H_5CHO, is heated under reflux with acidified potassium dichromate(VI), organic compound Z is formed.

What is the difference in relative molecular mass of compounds Y and Z?

A 12 **B** 14 **C** 16 **D** 17

23 Which sequence of reagents may be used in the laboratory to convert propan-1-ol into 2-bromopropane?

A concentrated sulfuric acid, followed by bromine

B concentrated sulfuric acid, followed by hydrogen bromide

C ethanolic sodium hydroxide, followed by bromine

D ethanolic sodium hydroxide, followed by hydrogen bromide

24 Esters are frequently used as solvents and as flavouring agents in fruit drinks and confectionery.

An ester $C_8H_{12}Br_2O_4$ can be prepared in low yield by the reaction shown.

$$CH_3C(Br)(CH_2Br)CO_2H + (CH_3)_2C(OH)CO_2H \rightleftharpoons C_8H_{12}Br_2O_4 + H_2O$$

What is the structural formula of the ester $C_8H_{12}Br_2O_4$?

A $CH_3C(Br)(CH_2Br)CO_2C(CH_3)_2CO_2H$

B $CH_3C(Br)(CH_2Br)CO_2C(OH)(CH_3)CO_2CH_3$

C $CH_3C(Br)(CH_3)CO_2C(CH_3)_2CO_2CH_2Br$

D $(CH_3)_2C(Br)C(CO_2H)(CH_2Br)CO_2CH_3$

25 Many, but not all, organic reactions need to be heated before reaction occurs.

Which reaction occurs at a good rate at room temperature (20 °C)?

A $C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$

B $CH_3CH_2CH_2Br + NH_3 \rightarrow CH_3CH_2CH_2NH_2 + HBr$

C $CH_3CH_2OH + KBr \rightarrow CH_3CH_2Br + KOH$

D $(CH_3)_2CO + H_2NNHC_6H_3(NO_2)_2 \rightarrow (CH_3)_2C{=}NNHC_6H_3(NO_2)_2 + H_2O$

26 Which pair of reagents will take part in a redox reaction?

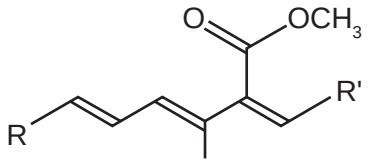
A CH_3CH_2OH + concentrated H_2SO_4

B CH_3CHO + Tollens' reagent

C $CH_3CO_2C_2H_5$ + dilute H_2SO_4

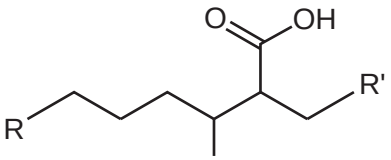
D CH_3COCH_3 + Fehling's solution

27 Part of the structure of strobilurin, a fungicide, is shown. R and R' are inert groups.

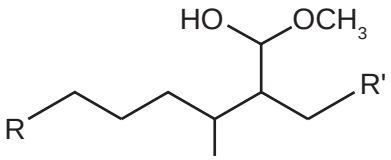


If strobilurin is first warmed with aqueous sulfuric acid, and its product then treated with hydrogen in the presence of a palladium catalyst, what could be the structure of the final product?

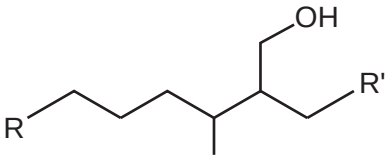
A



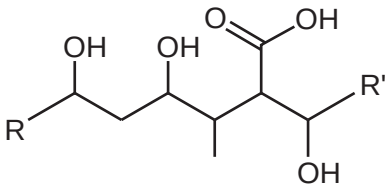
B



C

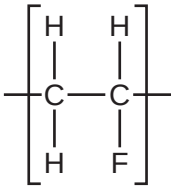


D



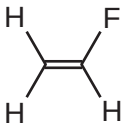
28 Fluoroalkenes are used to make polymers such as poly(vinyl)fluoride (PVF).

PVF is used to make non-flammable interiors for aircraft. The diagram shows the repeat unit of the polymer PVF.



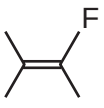
What is the skeletal formula of the monomer of PVF?

A

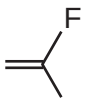


B

C



D



29 $CH_3CH_2COCH_2CH_3$ reacts with hydrogen cyanide to form a cyanohydrin.

Which feature applies to the product?

A It has one chiral centre.

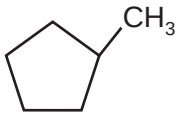
B It is formed by electrophilic addition.

C It is formed via a C–OH intermediate.

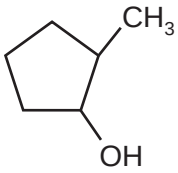
D Its formation requires the use of cyanide ions as a catalyst.

30 Which of the compounds shown have chiral carbon atoms?

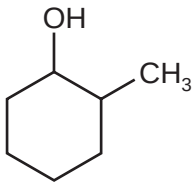
1



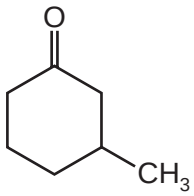
2



3



4



A 1, 2, 3 and 4

B 1 and 4 only

C 2 and 3 only

D 2, 3 and 4 only

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 When ammonia, NH_3, is produced in a school or college laboratory, it is usually dried before being collected.

Which drying agents may be used to dry ammonia?

1 calcium oxide, CaO

2 phosphorus(V) oxide, P_4O_{10}

3 concentrated sulfuric acid, H_2SO_4

32 Zirconium, Zr, proton number 40, is a metal which is used in corrosion-resistant alloys.

Zirconium metal is extracted from the oxide ZrO_2 by the following sequence of reactions.

reaction 1 $ZrO_2 + 2Cl_2 + 2C \rightarrow ZrCl_4 + 2CO$

reaction 2 $ZrCl_4 + 2Mg \rightarrow Zr + 2MgCl_2$

Which statements about this extraction process are correct?

1 Carbon in reaction 1 behaves as a reducing agent.

2 Magnesium in reaction 2 behaves as a reducing agent.

3 Chlorine in reaction 1 behaves as a reducing agent.

33 Which statements about covalent bonds are correct?

1 A triple bond consists of one π bond and two σ bonds.

2 The electron density in a σ bond is highest along the axis between the two bonded atoms.

3 A π bond restricts rotation about the σ bond axis.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

34 A student puts 10 cm^3 of 0.100 mol dm^{-3} sulfuric acid into one test-tube and 10 cm^3 of 0.100 mol dm^{-3} ethanoic acid into another test-tube. He then adds 1.0 g (an excess) of magnesium ribbon to each test-tube and takes suitable measurements. Both acids have the same starting temperature.

Neither reaction is complete after 2 minutes, but both are complete after 20 minutes.

Which statements are correct?

1 After 2 minutes, the sulfuric acid is at a higher temperature than the ethanoic acid.

2 After 2 minutes, the sulfuric acid has produced more gas than the ethanoic acid.

3 After 20 minutes, the sulfuric acid has produced more gas than the ethanoic acid.

35 In which ways are the main reactions in the Haber and Contact processes similar?

1 A higher yield is favoured by higher pressures.

2 The reaction is a redox process.

3 The forward reaction is exothermic.

36 A car burning lead-free fuel has a catalytic converter fitted to its exhaust. On analysis its exhaust gases are shown to contain small quantities of nitrogen oxides.

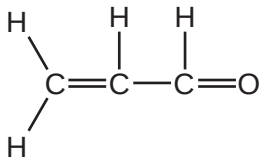
Which modifications would result in lower exhaust concentrations of nitrogen oxides?

1 an increase in the surface area of the catalyst in the converter

2 an increase in the rate of flow of the exhaust gases through the converter

3 a much higher temperature of combustion in the engine

37 The diagram shows a compound present in smoke from burning garden waste.



Which reagents would undergo a colour change on reaction with this compound?

1 aqueous bromine

2 Fehling's reagent

3 warm acidified $K_2Cr_2O_7$

38 Organic acids and alcohols react together to form esters.

Which pairs of compounds could produce a product of molecular formula $C_4H_6O_4$?

1 CH_3CO_2H and C_2H_5OH

2 HCO_2H and $HOCH_2CH_2OH$

3 HO_2CCO_2H and CH_3OH

39 *Use of the Data Booklet is relevant for this question.*

In an organic synthesis, a 62 % yield of product is achieved.

Which of these conversions are consistent with this information?

1 74.00g of butan-2-ol $\rightarrow$ 44.64 g of butanone

2 74.00g of butan-1-ol $\rightarrow$ 54.56 g of butanoic acid

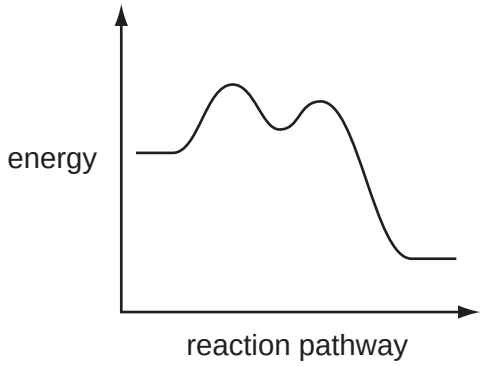
3 74.00g of 2-methylpropan-1-ol $\rightarrow$ 54.56 g of 2-methylpropanoic acid

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

40 A reaction pathway diagram is shown.



Which reactions would have such a profile?

1 $(CH_3)_3CBr + NaOH \rightarrow (CH_3)_3COH + NaBr$

2 $CH_3CH_2Br + NaOH \rightarrow CH_3CH_2OH + NaBr$

3 $(CH_3)_3CCH_2CH_2Cl + 2NH_3 \rightarrow (CH_3)_3CCH_2CH_2NH_2 + NH_4Cl$

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2010 question paper for the guidance of teachers

9701 CHEMISTRY

9701/12 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**B**
2	**B**	22	**C**
3	**C**	23	**B**
4	**B**	24	**A**
5	**D**	25	**D**
6	**A**	26	**B**
7	**A**	27	**A**
8	**D**	28	**B**
9	**C**	29	**D**
10	**B**	30	**D**
11	**C**	31	**D**
12	**D**	32	**B**
13	**B**	33	**C**
14	**C**	34	**A**
15	**D**	35	**A**
16	**C**	36	**D**
17	**D**	37	**A**
18	**B**	38	**C**
19	**C**	39	**A**
20	**C**	40	**D**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/13**

Paper 1 Multiple Choice **May/June 2010**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 2 2 8 8 6 3 3 3 6 9 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **13** printed pages and **3** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Which gas closely approaches ideal behaviour at room temperature and pressure?

A ammonia

B carbon dioxide

C helium

D oxygen

2 *Use of the Data Booklet is relevant to this question.*

The elements radon (Rn), francium (Fr) and radium (Ra) have consecutive proton numbers in the Periodic Table.

What is the order of their first ionisation energies?

	least endothermic ⟶		most endothermic
A	Fr	Ra	Rn
B	Fr	Rn	Ra
C	Ra	Fr	Rn
D	Rn	Ra	Fr

3 *Use of the Data Booklet is relevant to this question.*

What could be the proton number of an element that has three unpaired electrons in each of its atoms?

A 5 **B** 13 **C** 15 **D** 21

4 Given the following enthalpy changes,

$$I_2(g) + 3Cl_2(g) \rightarrow 2ICl_3(s) \qquad \Delta H^{\ominus} = -214\,kJ\,mol^{-1}$$

$$I_2(s) \rightarrow I_2(g) \qquad \Delta H^{\ominus} = +38\,kJ\,mol^{-1}$$

What is the standard enthalpy change of formation of iodine trichloride, $ICl_3(s)$?

A $+176\,kJ\,mol^{-1}$

B $-88\,kJ\,mol^{-1}$

C $-176\,kJ\,mol^{-1}$

D $-214\,kJ\,mol^{-1}$

5 Some bond energy values are listed below.

bond	bond energy / kJ mol ^{1}
C–H	410
C–C*l*	340
C*l*–C*l*	244
Br–Br	193

These bond energy values relate to the following four reactions.

P $Br_2 \rightarrow 2Br$

Q $2C\mathit{l} \rightarrow C\mathit{l}_2$

R $CH_3 + C\mathit{l} \rightarrow CH_3C\mathit{l}$

S $CH_4 \rightarrow CH_3 + H$

What is the order of enthalpy changes of these reactions from most negative to most positive?

A P → Q → R → S

B Q → R → S → P

C R → Q → P → S

D S → P → Q → R

6 Which mass of gas would occupy a volume of 3 dm^3 at 25 °C and 1 atmosphere pressure?
[1 mol of gas occupies 24 dm^3 at 25 °C and 1 atmosphere pressure.]

A 3.2 g O_2 gas

B 5.6 g N_2 gas

C 8.0 g SO_2 gas

D 11.0 g CO_2 gas

7 Ammonium nitrate, NH_4NO_3, can decompose explosively when heated.

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

What are the changes in the oxidation numbers of the two nitrogen atoms in NH_4NO_3 when this reaction proceeds?

A –2, –4 **B** +2, +6 **C** +4, –6 **D** +4, –4

8 The Haber process for the manufacture of ammonia is represented by the following equation.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ\,mol^{-1}$$

Which statement is correct about this reaction when the temperature is increased?

A Both forward and backward rates increase.

B The backward rate only increases.

C The forward rate only increases.

D There is no effect on the backward or forward rate.

9 *Use of the Data Booklet is relevant to this question.*

2.920 g of a Group II metal, **X**, reacts with an excess of chlorine to form 5.287 g of a compound with formula **X**Cl_2.

What is metal **X**?

A barium

B calcium

C magnesium

D strontium

10 The table gives the concentrations and pH values of the aqueous solutions of two compounds, X and Y. Either compound could be an acid or a base.

	X	Y
concentration	$2\,mol\,dm^{-3}$	$2\,mol\,dm^{-3}$
pH	6	9

Student P concluded that X is a strong acid.

Student Q concluded that the extent of dissociation is lower in X(aq) than in Y(aq).

Which of the students are correct?

A both P and Q

B neither P nor Q

C P only

D Q only

11 How does concentrated sulfuric acid behave when it reacts with sodium chloride?

A as an acid only

B as an acid and oxidising agent

C as an oxidising agent only

D as a reducing agent only

12 Swimming pool water can be kept free of harmful bacteria by adding aqueous sodium chlorate(I), NaOC*l*. This reacts with water to produce HOC*l* molecules which kill bacteria.

$$OCl\ (aq) + H_2O \rightleftharpoons OH\ (aq) + HOCl(aq)$$

In bright sunshine, the OC*l* ion is broken down by ultra-violet light.

$$OCl\ (aq) + \text{uv light} \rightarrow Cl\ (aq) + \tfrac{1}{2}O_2(g)$$

Which method would maintain the highest concentration of HOC*l*(aq)?

A acidify the pool water

B add a solution of chloride ions

C add a solution of hydroxide ions

D bubble air through the water

13 $Na_2S_2O_3$ reacts with dilute HC*l* to give a pale yellow precipitate. If 1 cm^3 of 0.1 mol dm^{-3} HC*l* is added to 10 cm^3 of 0.02 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms slowly.

If the experiment is repeated with 1 cm^3 of 0.1 mol dm^{-3} HC*l* and 10 cm^3 of 0.05 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms more quickly.

Why is this?

A The activation energy of the reaction is lower when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

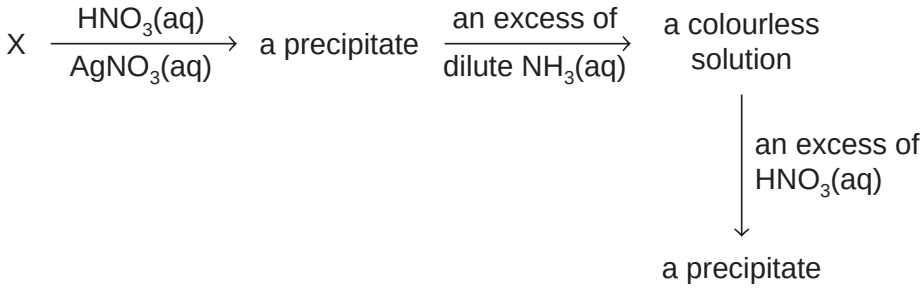
B The reaction proceeds by a different pathway when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

C The collisions between reactant particles are more violent when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

D The reactant particles collide more frequently when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

14 X is a salt of one of the halogens chlorine, bromine, iodine, or astatine (proton number 85).

The reaction scheme shows a series of reactions using a solution of X as the starting reagent.



What could X be?

A sodium chloride

B sodium bromide

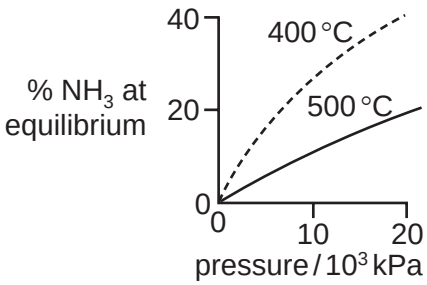
C potassium iodide

D potassium astatide

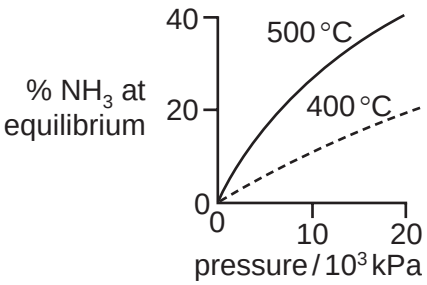
15 The percentage of ammonia obtainable, if equilibrium were established during the Haber process, is plotted against the operating pressure for two temperatures, 400 °C and 500 °C.

Which diagram correctly represents the two graphs?

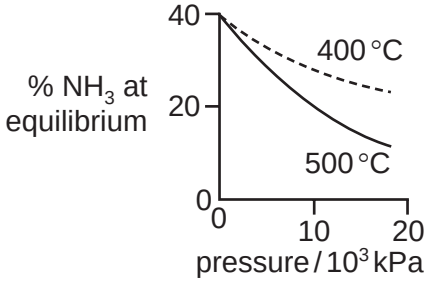
A



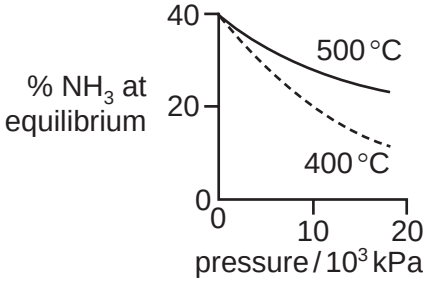
B



C



D



16 Two properties of non-metallic elements and their atoms are as follows.

property 1 has an oxide that can form a strong acid in water

property 2 has **no** paired 3p electrons

Which properties do phosphorus and sulfur have?

	phosphorus	sulfur
A	1 and 2	1 only
B	1 only	1 and 2
C	1 and 2	1 and 2
D	2 only	1 only

17 Consecutive elements X, Y, Z are in the third period of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point.

What could be the identities of X, Y and Z?

A aluminium, silicon, phosphorus

B magnesium, aluminium, silicon

C silicon, phosphorus, sulfur

D sodium, magnesium, aluminium

18 Which property of Group II elements (beryllium to barium) decreases with increasing atomic number?

A reactivity with water

B second ionisation energy

C solubility of hydroxides

D stability of the carbonates

19 Which element of the third period requires the least number of moles of oxygen for the complete combustion of 1 mol of the element?

A aluminium

B magnesium

C phosphorus

D sodium

20 When gaseous chemicals are transported by road or by rail they are classified as follows.

flammable non-flammable poisonous

Which commonly transported gas is non-flammable?

A butane

B hydrogen

C oxygen

D propene

21 What will react differently with the two isomeric alcohols, $(CH_3)_3CCH_2OH$ and $(CH_3)_2CHCH_2CH_2OH$?

A acidified aqueous potassium manganate(VII)

B concentrated sulfuric acid

C phosphorus pentachloride

D sodium

22 What is formed when propanone is refluxed with a solution of $NaBH_4$?

A propanal

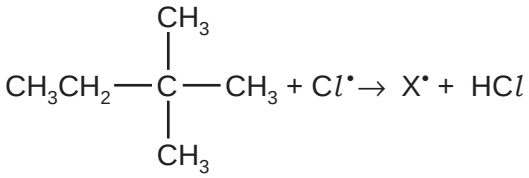
B propan-1-ol

C propan-2-ol

D propane

23 When heated with chlorine, the hydrocarbon 2,2-dimethylbutane undergoes free radical substitution.

In a propagation step the free radical $X^{\bullet}$ is formed.



How many different forms of $X^{\bullet}$ are possible?

A 1 **B** 2 **C** 3 **D** 4

24 Which reagent will give similar results with both butanone and butanal?

A acidified aqueous potassium dichromate(VI)

B an alkaline solution containing complexed Cu^{2+} ions (Fehling's solution)

C an aqueous solution containing $[Ag(NH_3)_2]^+$ (Tollens' reagent)

D 2,4-dinitrophenylhydrazine reagent

25 Which compound is a product of the hydrolysis of $CH_3CO_2C_3H_7$ by boiling aqueous sodium hydroxide?

A CH_3OH **B** C_3H_7OH **C** $C_3H_7CO_2H$ **D** $C_3H_7CO_2\ Na^+$

26 Which compound exhibits both *cis-trans* and optical isomerism?

A $CH_3CH{=}CHCH_2CH_3$

B $CH_3CHBrCH{=}CH_2$

C $CH_3CBr{=}CBrCH_3$

D $CH_3CH_2CHBrCH{=}CHBr$

27 In many countries plastic waste is collected separately and sorted. Some of this is incinerated to provide heat for power stations.

Why is pvc, polyvinylchloride, removed from any waste that is to be incinerated?

A It destroys the ozone layer.

B It does not burn easily.

C It is easily biodegradable.

D Its combustion products are harmful.

28 Polymerisation of 1,1-dichloroethene produces a dense, high melting point substance that does not allow gases to pass through. It is used as cling wrapping.

Which sequence appears in a short length of the polymer chain?

A $\{CH_2CCl_2CH_2CCl_2CH_2CCl_2\}$

B $\{CHClCHClCHClCHClCHClCHCl\}$

C $\{CCl_2CCl_2CCl_2CCl_2CCl_2CCl_2\}$

D $\{CH_2CCl_2CHClCHClCH_2CCl_2\}$

29 When an isomer Y of molecular formula C_4H_9Br undergoes hydrolysis in aqueous alkali to form an alcohol C_4H_9OH, the rate of reaction is found to be unaffected by changes in the concentration of OH^- ions present.

Which is the most likely molecular structure of Y?

A $CH_3CH_2CH_2CH_2Br$

B $CH_3CH_2CHBrCH_3$

C $(CH_3)_2CHCH_2Br$

D $(CH_3)_3CBr$

30 Which isomer of $C_4H_{10}O$ forms three alkenes on dehydration?

A butan-1-ol

B butan-2-ol

C 2-methylpropan-1-ol

D 2-methylpropan-2-ol

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Which reactions are redox reactions?

1 $CaBr_2 + 2H_2SO_4 \rightarrow CaSO_4 + Br_2 + SO_2 + 2H_2O$

2 $CaBr_2 + 2H_3PO_4 \rightarrow Ca(H_2PO_4)_2 + 2HBr$

3 $CaBr_2 + 2AgNO_3 \rightarrow Ca(NO_3)_2 + 2AgBr$

32 Sodium hydrogensulfide, NaSH, is used to remove hair from animal hides.

Which statements about the SH^- ion are correct?

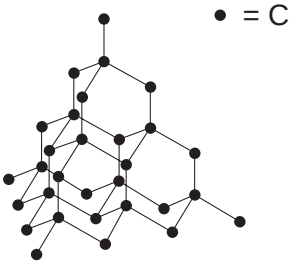
1 It contains 18 electrons.

2 Three lone pairs of electrons surround the sulfur atom.

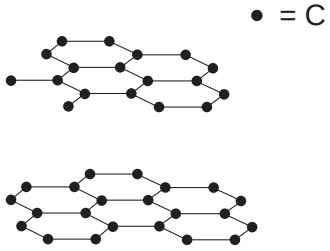
3 Sulfur has an oxidation state of +2.

33 Which diagrams represent part of a giant molecular structure?

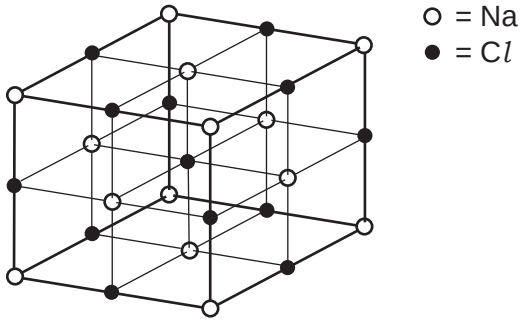
1



2



3



The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

34 In a car engine, non-metallic element X forms a pollutant oxide Y.

Further oxidation of Y to Z occurs in the atmosphere. In this further oxidation, 1 mol of Y reacts with ½ mol of gaseous oxygen.

What can X be?

1 carbon

2 nitrogen

3 sulfur

35 When organic refuse decomposes in water carboxylic acids are formed. The water becomes acidic and aquatic life is destroyed.

Which additives are suitable to remove this acid pollution?

1 calcium carbonate

2 calcium hydroxide

3 potassium nitrate

36 Sulfur dioxide and sulfites are used in food preservation.

Why are they used for this purpose?

1 They are reducing agents so retard the oxidation of food.

2 They inhibit the growth of aerobic bacteria.

3 They react with $NO_2(g)$ converting it to $NO(g)$.

37 Which structural formulae represent 2,2-dimethylpentane?

1 $(CH_3)_2CHCH_2CH(CH_3)_2$

2 $(CH_3)_3CCH_2CH_2CH_3$

3 $CH_3CH_2CH_2C(CH_3)_3$

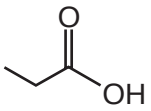
38 Which reactions are examples of nucleophilic substitution?

1 $CH_3CH_2Br + OH \rightarrow CH_3CH_2OH + Br$

2 $CH_3I + H_2O \xrightarrow{H^+} CH_3OH + HI$

3 $CH_3CH_2CH_2Cl + NH_3 \rightarrow CH_3CH_2CH_2NH_2 + HCl$

39 Propanoic acid occurs naturally as a result of the bacterial fermentation of milk, and is partly responsible for the flavour of Swiss cheese.



propanoic acid

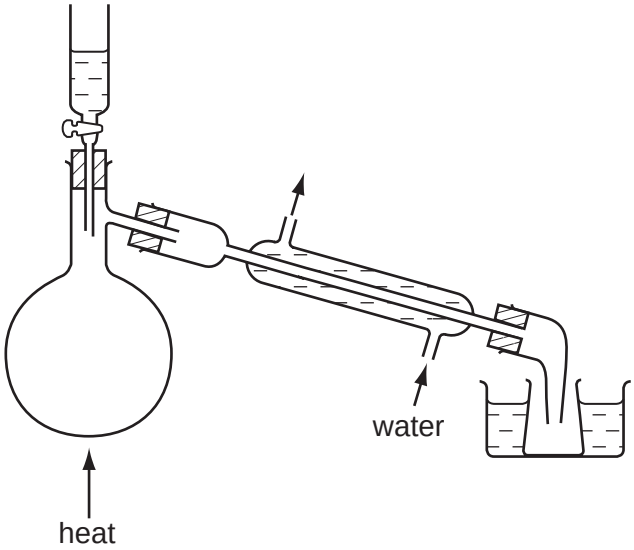
Which starting materials could be used to synthesise propanoic acid?

1 $CH_3CH_2CH_2OH$

2 CH_3CH_2CN

3 CH_3CH_2CHO

40 The diagram shows some laboratory apparatus.



Which preparations could this apparatus be used for?

1 bromoethane, from ethanol, sodium bromide and concentrated sulfuric acid

2 ethanal, from ethanol, sodium dichromate(VI) and sulfuric acid

3 1,2-dibromoethane, from bromine and ethene

BLANK PAGE

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/13 Paper 13 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**B**
2	**A**	22	**C**
3	**C**	23	**C**
4	**B**	24	**D**
5	**C**	25	**B**
6	**C**	26	**D**
7	**D**	27	**D**
8	**A**	28	**A**
9	**D**	29	**D**
10	**D**	30	**B**
11	**A**	31	**D**
12	**A**	32	**B**
13	**D**	33	**B**
14	**A**	34	**C**
15	**A**	35	**B**
16	**A**	36	**B**
17	**C**	37	**C**
18	**B**	38	**A**
19	**D**	39	**A**
20	**C**	40	**B**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/13**

Paper 1 Multiple Choice **October/November 2010**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 6 1 9 6 4 5 6 1 4 3 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **13** printed pages and **3** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 A simple ion X^+ contains eight protons.

What is the electronic configuration of X^+?

A $1s^2\ \ 2s^1\ \ 2p^6$

B $1s^2\ \ 2s^2\ \ 2p^3$

C $1s^2\ \ 2s^2\ \ 2p^5$

D $1s^2\ \ 2s^2\ \ 2p^7$

2 Equations involving four enthalpy changes are shown.

$Na(g) \rightarrow Na^+(g) + e \quad \Delta H = W$

$Na(g) \rightarrow Na^{2+}(g) + 2e \quad \Delta H = X$

$Na(s) \rightarrow Na(g) \quad \Delta H = Y$

$Na(s) \rightarrow Na^{2+}(g) + 2e \quad \Delta H = Z$

What is the second ionisation energy of sodium?

A 2W **B** X – W **C** Y – W **D** Z – Y

3 Which ion has more electrons than protons and more protons than neutrons?
[H = ^1_1H ; D = ^2_1H ; O = $^{16}_8O$]

A D **B** H_3O^+ **C** OD **D** OH

4 Sulfur dioxide, SO_2, is added to wines to prevent oxidation of ethanol by air. To determine the amount of SO_2, a sample of wine is titrated with iodine, I_2. In this reaction, **one** mole of SO_2 is oxidised by **one** mole of I_2.

What is the change in oxidation number of sulfur in this reaction?

A +2 to +4 **B** +2 to +6 **C** +4 to +5 **D** +4 to +6

5 *Use of the Data Booklet is relevant to this question.*

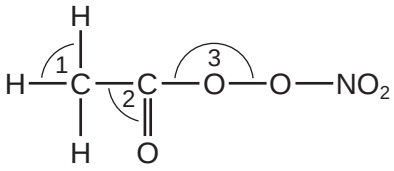
Nickel makes up 20 % of the total mass of a coin. The coin has a mass of 10.0 g.

How many nickel atoms are in the coin?

A 2.05×10^{22} **B** 4.30×10^{22} **C** 1.03×10^{23} **D** 1.20×10^{24}

6 Organic nitrates in photochemical smog can cause breathing difficulties.

The diagram shows an example of an organic nitrate molecule.



What is the correct order of the bond angles shown in ascending order (smallest first)?

A $1 \rightarrow 2 \rightarrow 3$ **B** $2 \rightarrow 1 \rightarrow 3$ **C** $3 \rightarrow 1 \rightarrow 2$ **D** $3 \rightarrow 2 \rightarrow 1$

7 Every year millions of tonnes each of chlorine and sodium hydroxide are manufactured by the electrolysis of brine using a 'diaphragm cell'.

What is the purpose of the diaphragm in such a cell?

A to prevent chlorine gas escaping into the factory

B to prevent the build up of pressure in the electrolysis cell

C to provide a large surface area of electrode

D to stop the products of electrolysis from reacting together

8 Which statement describes the halogens chlorine, bromine and iodine?

A Their bond energies decrease with increasing proton number.

B Their first ionisation energies increase with increasing proton number.

C They are all coloured gases at room temperature.

D They are all good reducing agents.

9 Chile saltpetre, $NaNO_3$, contains sodium iodide as an impurity.

Aqueous silver nitrate is added to an aqueous solution of Chile saltpetre. Concentrated aqueous ammonia is then added.

Which observations are made?

	with acidified silver nitrate	with concentrated aqueous ammonia
A	no precipitate	no further reaction
B	no precipitate	precipitate forms
C	precipitate forms	precipitate dissolves
D	precipitate forms	precipitate remains

10 The value of the equilibrium constant, K_c, for the reaction to form ethyl ethanoate from ethanol and ethanoic acid is 4.0 at 60 °C.

$$C_2H_5OH + CH_3CO_2H \rightleftharpoons CH_3CO_2C_2H_5 + H_2O$$

When 1.0 mol of ethanol and 1.0 mol of ethanoic acid are allowed to reach equilibrium at 60 °C, what is the number of moles of ethyl ethanoate formed?

A $\frac{1}{3}$ **B** $\frac{2}{3}$ **C** $\frac{1}{4}$ **D** $\frac{3}{4}$

11 Enthalpy changes of combustion can be used to determine enthalpy changes of formation. The following equation represents the enthalpy change of formation of butane.

$$4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g)$$

By using the following standard enthalpy of combustion data, what is the value of the standard enthalpy change of formation, $\Delta H_f^{\ominus}$, for this reaction?

compound	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
carbon	–394
hydrogen	–286
butane	–2877

A –5883 kJ mol^{-1}

B –129 kJ mol^{-1}

C +129 kJ mol^{-1}

D +2197 kJ mol^{-1}

12 In a calorimetric experiment 1.60 g of a fuel is burnt. 45 % of the energy released is absorbed by 200 g of water whose temperature rises from 18 °C to 66 °C. The specific heat capacity of water is 4.2 J g^{-1} K^{-1}.

What is the total energy released per gram of fuel burnt?

A 25 200 J **B** 56 000 J **C** 89 600 J **D** 143 360 J

13 Which equation represents the change corresponding to the enthalpy change of atomisation of iodine?

A $\frac{1}{2} I_2(g) \rightarrow I(g)$

B $I_2(g) \rightarrow 2I(g)$

C $\frac{1}{2} I_2(s) \rightarrow I(g)$

D $I_2(s) \rightarrow 2I(g)$

14 Camphor is a white solid which was used to make the early plastic celluloid. Camphor contains the same percentage by mass of hydrogen and oxygen.

What is the molecular formula of camphor?

A $C_{10}H_6O_6$ **B** $C_{10}H_8O$ **C** $C_{10}H_{16}O$ **D** $C_{10}H_{10}O_2$

15 Ammonium sulfate in nitrogenous fertilisers in the soil can be slowly oxidised by air producing sulfuric acid, nitric acid and water.

How many moles of oxygen gas are needed to oxidise completely one mole of ammonium sulfate?

A 1 **B** 2 **C** 3 **D** 4

16 Why is the first ionisation energy of phosphorus greater than the first ionisation energy of silicon?

A A phosphorus atom has one more proton in its nucleus.

B The atomic radius of a phosphorus atom is greater.

C The outer electron in a phosphorus atom is more shielded.

D The outer electron in a phosphorus atom is paired.

17 When magnesium nitrate, $Mg(NO_3)_2.7H_2O$, is heated, which three gases are given off?

A dinitrogen oxide, oxygen, water vapour

B hydrogen, nitrogen, oxygen

C hydrogen, nitrogen dioxide, oxygen

D nitrogen dioxide, oxygen, water vapour

18 Sulfur dioxide is used to bleach wood pulp in the production of paper. It is also used as an additive in the production of jam and marmalade, often in the form of sulfite compounds. When it is present in quantities greater than 10 mg / kg it is required to be listed as an ingredient of the jam.

Why is sulfur dioxide added to jam?

A It is a bleaching agent and removes the undesirable colours from the fruit used in the jam.

B It is a preservative that destroys unwanted bacteria and enzymes.

C It is a reducing agent and removes the acids that give the jam a sharp taste.

D It is an acidic gas and maintains the pH of the jam at a suitable value to give it a sharp taste.

19 Which property of beryllium and its compounds is typical of the elements below it in Group II?

A Be does not react with hot water.

B $BeCl_2$ is covalent.

C $Be(NO_3)_2$ produces BeO on thermal decomposition.

D BeO dissolves in alkalis.

20 A compound Y has all of the properties below.

- It is a liquid at 25 °C.
- It mixes completely with water.
- It reacts with aqueous sodium hydroxide.

What could Y be?

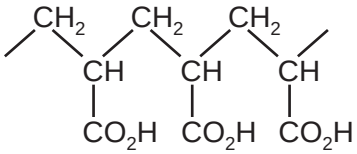
A ethanoic acid

B ethanol

C ethene

D ethyl ethanoate

21 One of the characteristics of addition polymerisation is that the empirical formulae of the polymer and of its monomer are the same. The absorbent material in babies' disposable nappies is made from the addition polymer shown.



From which monomer could this addition polymer be obtained?

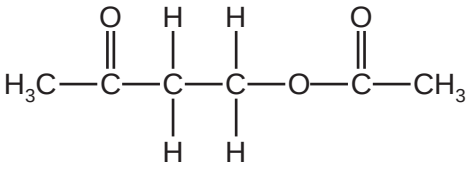
A $CH_3CH(OH)CO_2H$

B $HOCH_2CH_2CO_2H$

C $H_2C{=}CHCO_2H$

D $HO_2CCH{=}CHCO_2H$

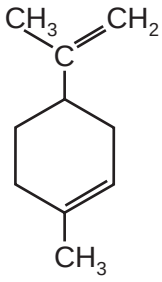
22 Compound X reacts with ethanoic acid in the presence of an H^+ catalyst to produce the compound below.



What is the molecular formula of compound X?

A $C_2H_6O_2$ **B** $C_2H_6O_3$ **C** C_4H_8O **D** $C_4H_8O_2$

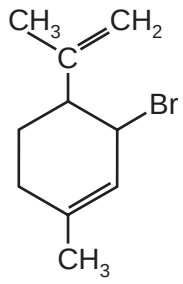
23 Limonene is an oil formed in the peel of citrus fruits.



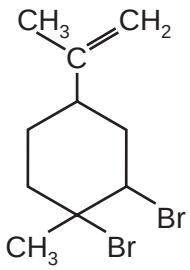
limonene

Which product is formed when an excess of bromine, $Br_2(l)$, reacts with limonene at room temperature in the dark?

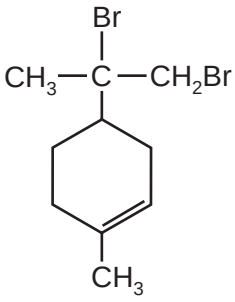
A



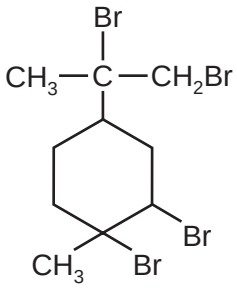
B



C



D



24 Tartaric acid is present in some wines. It may be synthesised in the laboratory in two steps.

$$OHCCHO \xrightarrow{\text{step 1}} \text{intermediate} \xrightarrow{\text{step 2}} HO_2CCH(OH)CH(OH)CO_2H$$

tartaric acid

Which reagents could be used for this synthesis?

	step 1	step 2
A	HC*l*(aq)	HCN(g)
B	HCN, NaCN(aq/alcoholic)	H_2SO_4(aq)
C	H_2SO_4(aq)	$K_2Cr_2O_7$ / H_2SO_4(aq)
D	KCN(aq/alcoholic)	$K_2Cr_2O_7$ / H_2SO_4(aq)

25 Which alcohol gives only **one** possible oxidation product when warmed with dilute acidified potassium dichromate(VI)?

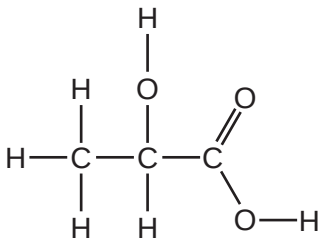
A butan-1-ol

B butan-2-ol

C 2-methylpropan-1-ol

D 2-methylpropan-2-ol

26 Lactic acid occurs naturally, for example in sour milk.



lactic acid

What is a property of lactic acid?

A It decolourises aqueous bromine rapidly.

B It is insoluble in water.

C It reduces Fehling's reagent.

D Two molecules react with each other in the presence of a strong acid.

27 Which compound would undergo nucleophilic addition?

A bromoethane, C_2H_5Br

B ethanal, CH_3CHO

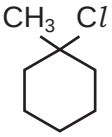
C ethane, C_2H_6

D ethene, C_2H_4

28 Which compound undergoes an S_N1 substitution reaction?

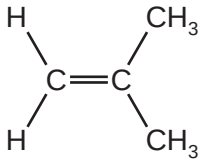
A $CH_3CH_2CH_2Br$

B $(CH_3)_3CCH_2I$

C 

D $CH_2{=}CHCl$

29 The compound 2-methylpropene, C_4H_8, is a monomer used in the production of synthetic rubber.



In addition to 2-methylpropene there are x other isomers of C_4H_8, structural or otherwise, which contain a double bond.

What is the value of x?

A 1 **B** 2 **C** 3 **D** 4

30 Which environmental problem is **not** made worse by the release of oxides of nitrogen from car engines?

A acidification of lakes

B corrosion of buildings

C photochemical smog

D the hole in the ozone layer

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

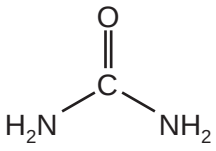
Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Which types of intermolecular forces can exist between adjacent urea molecules?



urea

1 hydrogen bonding

2 permanent dipole-dipole forces

3 temporary induced dipole-dipole forces

32 Ethanol is manufactured by reacting ethene gas and steam in the presence of phosphoric(V) acid.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H = -45\,kJ\,mol^{-1}$$

The reaction is carried out at 570 K and 60 atm.

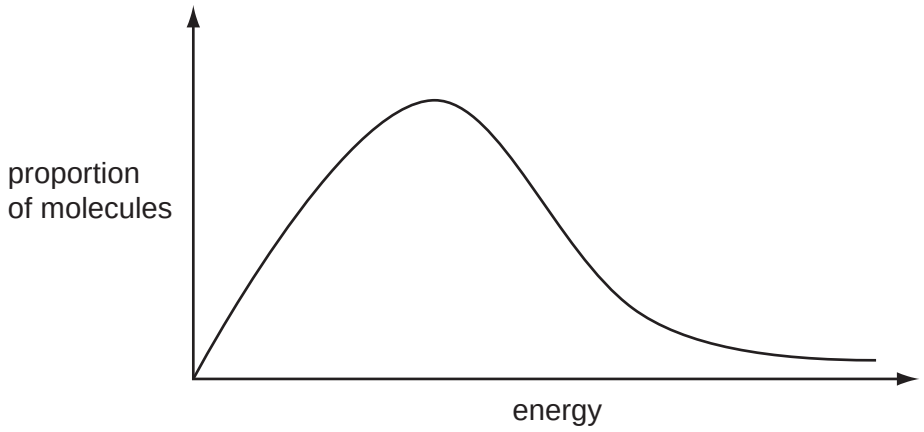
What would be the consequences of carrying out the reaction at the same temperature but at a pressure of 200 atm?

1 The manufacturing costs would increase.

2 The maximum yield at equilibrium would be higher.

3 The reaction would proceed at a faster rate.

33 The diagram represents the Boltzmann distribution of molecular energies at a given temperature.



Which of the factors that affect the rate of a reaction can be explained using such a Boltzmann distribution?

1 increasing the concentration of reactants

2 increasing the temperature

3 the addition of a catalyst

34 Disproportionation is the term used to describe a reaction in which a reactant is simultaneously both oxidised and reduced.

To which incomplete equations does the term disproportionation apply?

1 $Cl_2(g) + 2OH\ (aq) \rightarrow H_2O(l) + Cl\ (aq) + \ldots\ldots$

2 $3Cl_2(g) + 6OH\ (aq) \rightarrow 3H_2O(l) + ClO_3\ (aq) + \ldots\ldots$

3 $2NO_2(g) + H_2O(l) \rightarrow HNO_3(aq) + \ldots\ldots$

35 Samples of calcium and barium are separately added to beakers of cold water containing a few drops of litmus solution.

Which observations will be made with **only** the calcium and **not** with the barium?

1 A white suspension appears in the water.

2 The solution turns blue.

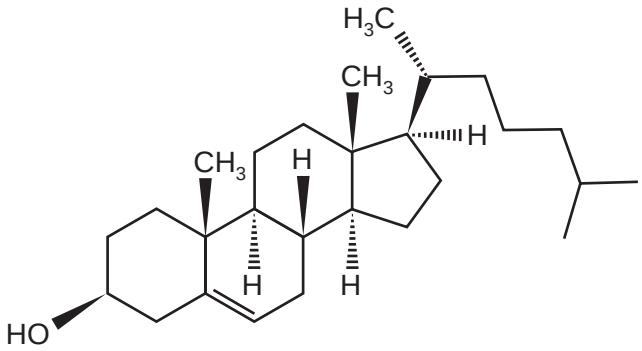
3 A gas is evolved.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

36 The diagram shows the structure of the naturally-occurring molecule cholesterol.



cholesterol

Which statements about cholesterol are correct?

1 The molecule contains a secondary alcohol group.

2 The molecule contains two π bonds.

3 All carbon atoms in the four rings lie in the same plane.

37 Element X is a solid. It occurs as a contaminant of carbonaceous fuels.

Its oxide Y is formed in car engines.

Further oxidation of Y to Z can occur in the atmosphere.

Which statements about Y and Z are correct?

1 Molecule Y has lone pairs of electrons.

2 The atmospheric oxidation of Y to Z is a catalysed reaction.

3 Y is a colourless gas.

38 An organic compound decolourises aqueous bromine and reacts with sodium to produce hydrogen.

Which molecular formula could represent this compound?

1 C_3H_6O

2 $C_3H_4O_2$

3 C_3H_8O

39 Textiles for use in aircraft are treated with a finish containing a halogenoalkane.

What is the reason for this?

1 The textile burns less easily, improving safety.

2 The fabric forms hydrogen bonds to water more readily, making the fabric easier to wash.

3 The halogenoalkane undergoes addition polymerisation, stiffening the fabric.

40 Glyceraldehyde, $HOCH_2CH(OH)CHO$, is formed during photosynthesis, and contains a chiral carbon atom.

Which reagents will react with glyceraldehyde to produce an organic product **without** a chiral carbon atom?

1 warmed acidified $K_2Cr_2O_7$

2 $NaBH_4$

3 Tollens' reagent

BLANK PAGE

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2010 question paper for the guidance of teachers

9701 CHEMISTRY

9701/13 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**C**
2	**B**	22	**D**
3	**D**	23	**D**
4	**D**	24	**B**
5	**A**	25	**B**
6	**C**	26	**D**
7	**D**	27	**B**
8	**A**	28	**C**
9	**D**	29	**C**
10	**B**	30	**D**
11	**B**	31	**A**
12	**B**	32	**A**
13	**C**	33	**C**
14	**C**	34	**A**
15	**D**	35	**D**
16	**A**	36	**D**
17	**D**	37	**A**
18	**B**	38	**B**
19	**C**	39	**D**
20	**A**	40	**B**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **May/June 2011**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

5818048303

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **15** printed pages and **1** blank page.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Which equation represents the second ionisation energy of an element X?

A $X(g) \rightarrow X^{2+}(g) + 2e$

B $X^{+}(g) \rightarrow X^{2+}(g) + e$

C $X(g) + 2e \rightarrow X^{2}(g)$

D $X(g) + e \rightarrow X^{2}(g)$

2 In flooded soils, like those used for rice cultivation, the oxygen content is low. In such soils, anaerobic bacteria cause the loss of nitrogen from the soil as shown in the following sequence.

In which step is the change in oxidation number (oxidation state) of nitrogen different to the changes in the other steps?

$$NO_3^-(aq) \xrightarrow{A} NO_2^-(aq) \xrightarrow{B} NO(g) \xrightarrow{C} N_2O(g) \xrightarrow{D} N_2(g)$$

3 In the extraction of aluminium by the electrolysis of molten aluminium oxide, why is cryolite added to the aluminium oxide?

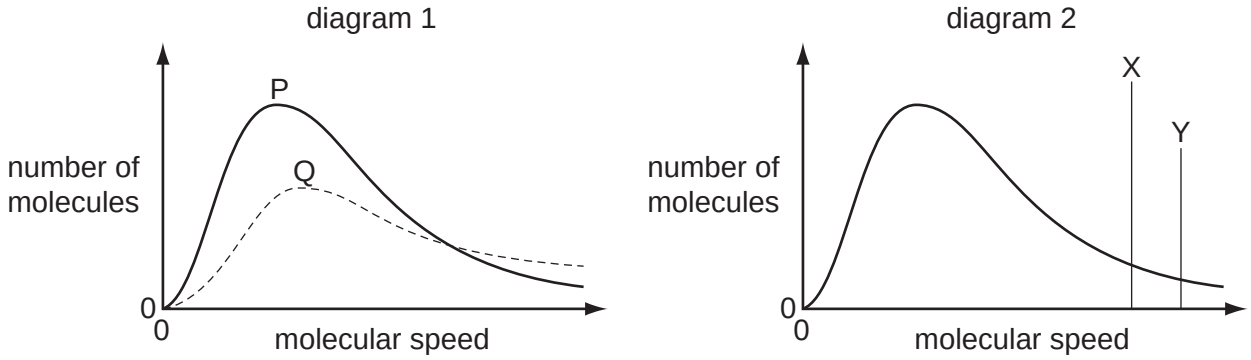
A to ensure the aluminium is not oxidised

B to ensure the anode is not oxidised

C to lower the melting point of the aluminium oxide

D to prevent corrosion of the cathode

4 Different Boltzmann distributions are shown in the diagrams.



In diagram 1, one curve P or Q corresponds to a temperature higher than that of the other curve.

In diagram 2, one line X or Y corresponds to the activation energy for a catalysed reaction and the other line corresponds to the activation energy of the same reaction when uncatalysed.

Which combination gives the correct curve and line?

	higher temperature	presence of catalyst
A	P	X
B	P	Y
C	Q	X
D	Q	Y

5 Which factor helps to explain why the first ionisation energies of the Group I elements decrease from lithium to sodium to potassium to rubidium?

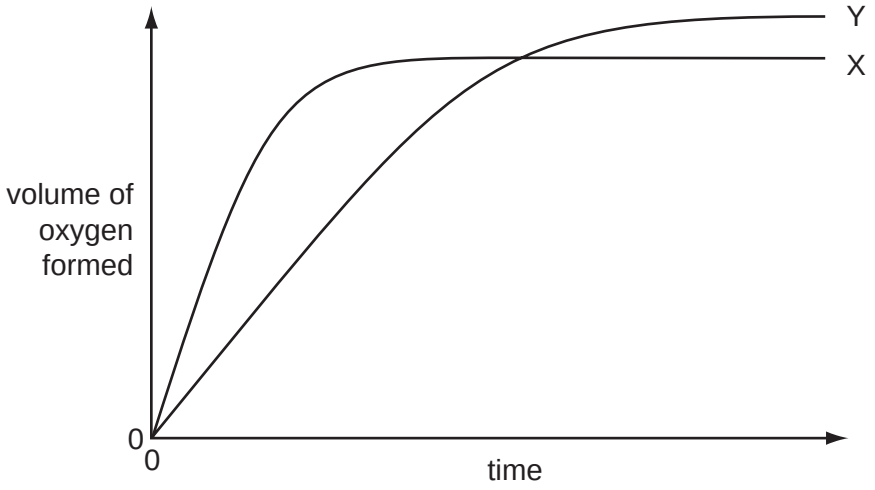
A The nuclear charge of the elements increases.

B The outer electron is in an ‘s’ subshell.

C The repulsion between spin-paired electrons increases.

D The shielding effect of the inner shells increases.

6 In the diagram, curve X was obtained by observing the decomposition of 100 cm^3 of 1.0 mol dm^{-3} hydrogen peroxide, catalysed by manganese(IV) oxide.



Which alteration to the original experimental conditions would produce curve Y?

A adding some 0.1 mol dm^{-3} hydrogen peroxide

B adding water

C lowering the temperature

D using less manganese(IV) oxide

7 In the last century the Haber process was sometimes run at pressures of 1000 atm and higher. Now it is commonly run at pressures below 100 atm.

What is the reason for this change?

A An iron catalyst is used.

B Maintaining the higher pressures is more expensive.

C The equilibrium yield of ammonia is increased at lower pressures.

D The rate of the reaction is increased at lower pressures.

8 The equation below represents the combination of gaseous atoms of non-metal X and of hydrogen to form gaseous X_2H_6 molecules.

$$2X(g) + 6H(g) \rightarrow X_2H_6(g) \qquad \Delta H = -2775\ kJ\ mol^{-1}$$

The bond energy of an X–H bond is 395 kJ mol^{-1}.

What is the bond energy of an X–X bond?

A $-405.0\ kJ\ mol^{-1}$

B $-202.5\ kJ\ mol^{-1}$

C $+202.5\ kJ\ mol^{-1}$

D $+405.0\ kJ\ mol^{-1}$

9 50 cm^3 of 2.50 mol dm^{-3} hydrochloric acid was placed in a polystyrene beaker of negligible heat capacity. Its temperature was recorded and then 50 cm^3 of 2.50 mol dm^{-3} NaOH at the same temperature was quickly added, with stirring. The temperature rose by 17 °C.

The resulting solution may be considered to have a specific heat capacity of 4.2 J g^{-1} K^{-1}.

What is an approximate value for the molar enthalpy change of neutralisation of hydrochloric acid and sodium hydroxide from this experiment?

A $\frac{(50 \times 4.2 \times 17)}{(0.050 \times 2.5)}$ J mol^{-1}

B $\frac{(50 \times 4.2 \times 17)}{(0.10 \times 2.5)}$ J mol^{-1}

C $\frac{(100 \times 4.2 \times 17)}{(0.050 \times 2.5)}$ J mol^{-1}

D $\frac{(100 \times 4.2 \times 17)}{(50 \times 2.5)}$ J mol^{-1}

10 Three substances, R, S and T, have physical properties as shown.

substance	R	S	T
mp / °C	801	2852	3550
bp / °C	1413	3600	4827
electrical conductivity of solid	poor	poor	good

What could be the identities of R, S and T?

	R	S	T
A	MgO	NaCl	C [graphite]
B	MgO	NaCl	SiO_2
C	NaCl	MgO	C [graphite]
D	NaCl	MgO	SiO_2

11 In which change would only van der Waals' forces have to be overcome?

A evaporation of ethanol $C_2H_5OH(l) \rightarrow C_2H_5OH(g)$

B melting of ice $H_2O(s) \rightarrow H_2O(l)$

C melting of solid carbon dioxide $CO_2(s) \rightarrow CO_2(l)$

D solidification of butane $C_4H_{10}(l) \rightarrow C_4H_{10}(s)$

12 Hydrazine, N_2H_4, is widely used as a rocket fuel because it reacts with oxygen as shown, producing 'environmentally friendly' gases.

$$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \Delta H = -534\,kJ\,mol^{-1}$$

Despite its use as a rocket fuel, hydrazine does not burn spontaneously in oxygen.

Which statement explains why hydrazine does **not** burn spontaneously?

A Hydrazine is a liquid.

B The activation energy is too high.

C The N≡N bond is very strong.

D The reaction is exothermic.

13 0.02 mol of aluminium is burned in oxygen and the product is reacted with 2.00 mol dm^{-3} hydrochloric acid.

What minimum volume of acid will be required for complete reaction?

A 15 cm^3 **B** 20 cm^3 **C** 30 cm^3 **D** 60 cm^3

14 Steam is passed over heated magnesium to give compound X and hydrogen.

What is **not** a property of compound X?

A It has an M_r of 40.3.

B It is basic.

C It is a white solid.

D It is very soluble in water.

15 X, Y and Z represent different halogens. The table shows the results of nine experiments in which aqueous solutions of X_2, Y_2 and Z_2 were separately added to separate aqueous solutions containing X^-, Y^- and Z^- ions.

	$X^-(aq)$	$Y^-(aq)$	$Z^-(aq)$
$X_2(aq)$	no reaction	no reaction	no reaction
$Y_2(aq)$	X_2 formed	no reaction	Z_2 formed
$Z_2(aq)$	X_2 formed	no reaction	no reaction

Which row in the following table contains the ions X^-, Y^- and Z^- in order of their decreasing strength as reducing agents?

	strongest ⟶		weakest
A	X^-	Y^-	Z^-
B	X^-	Z^-	Y^-
C	Y^-	Z^-	X^-
D	Z^-	X^-	Y^-

16 A student observed the reactions when sodium chloride and sodium iodide were each reacted separately with concentrated sulfuric acid and with concentrated phosphoric acid. The observations are recorded in the table.

	sodium chloride	sodium iodide
conc. H_2SO_4	colourless acidic gas formed	purple vapour formed
conc. H_3PO_4	colourless acidic gas formed	colourless acidic gas formed

Which deduction can be made from these observations?

A Concentrated phosphoric acid is a stronger oxidising agent than concentrated sulfuric acid.

B Concentrated phosphoric acid is a stronger oxidising agent than iodine.

C Concentrated sulfuric acid is a stronger oxidising agent than chlorine.

D Concentrated sulfuric acid is a stronger oxidising agent than iodine.

17 Ammonium nitrate, NH_4NO_3, is manufactured in large quantities for use in fertiliser.

Which statement about ammonium nitrate fertiliser is **not** correct?

A It can cause environmental problems.

B It consists of 35 % nitrogen by mass.

C It is insoluble in water.

D Nitric acid is used in its manufacture.

18 Nitrogen monoxide, NO, is a primary pollutant produced by petrol engines and is found in their exhaust gases.

Which reaction occurs in a catalytic converter and decreases the emission of nitrogen monoxide?

A $NO(g) + CO(g) \rightarrow NO_2(g) + C(s)$

B $NO(g) + CO_2(g) \rightarrow NO_2(g) + CO(g)$

C $2NO(g) + 2CO(g) \rightarrow N_2(g) + 2CO_2(g)$

D $2NO(g) + CO_2(g) \rightarrow 2NO_2(g) + C(s)$

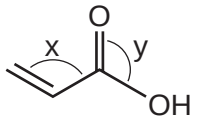
19 In the reaction pathway below, an alkane is converted into a carboxylic acid through several stages.

$$C_{10}H_{22} \xrightarrow{\text{stage 1}} C_2H_4 \xrightarrow[\text{catalytic hydration}]{\text{stage 2}} C_2H_5OH \xrightarrow{\text{stage 3}} CH_3CO_2H$$

Which processes occur at stage 1 and at stage 3?

	stage 1	stage 3
A	condensation	combustion
B	cracking	dehydration
C	cracking	oxidation
D	dehydration	combustion

20 Acrylic acid is produced from propene, a gaseous product of oil refineries.



acrylic acid

Which statement about acrylic acid is **not** correct?

A Both bond angles x and y are approximately 120°.

B It decolourises aqueous bromine.

C It gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent.

D It reacts with an alcohol to give an ester.

21 Butanedioic acid occurs in amber, algae, lichens, sugar cane and beets. It may be synthesised in two steps from 1,2-dibromoethane.

$$BrCH_2CH_2Br \xrightarrow{\text{step 1}} X \xrightarrow{\text{step 2}} HO_2CCH_2CH_2CO_2H$$

Which reagents could be used for this synthesis?

	step 1	step 2
A	HCN(g)	HC*l*(aq)
B	HCO_2Na(aq)	HC*l*(aq)
C	KCN(aq / alcoholic)	H_2SO_4(aq)
D	NaOH(aq)	$K_2Cr_2O_7$ / H_2SO_4(aq)

22 The formula CH_3 can represent an anion, a cation or a free radical. Species with the molecular formula CH_3 can act as an electrophile, a free radical or a nucleophile depending on the number of outer shell electrons on the central carbon atom.

How many outer shell electrons must be present for CH_3 to act in these different ways?

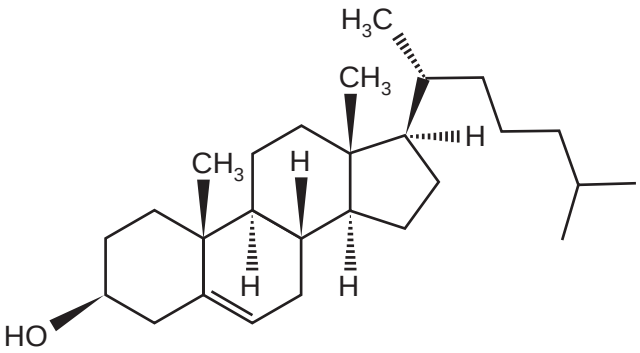
	CH_3 as an electrophile	CH_3 as a free radical	CH_3 as a nucleophile
A	6	7	8
B	6	8	7
C	7	6	8
D	8	7	6

23 Pentanol, $C_5H_{11}OH$, has four structural isomers that are primary alcohols.

How many of these primary alcohols contain a chiral carbon atom?

A 0 **B** 1 **C** 2 **D** 3

24 The diagram shows the structure of the naturally-occurring molecule cholesterol.



cholesterol

Student X claimed that the seventeen carbon atoms in the four rings all lie in the same plane.

Student Y claimed that this molecule displays *cis-trans* isomerism at the C=C double bond.

Which of the students are correct?

A both X and Y

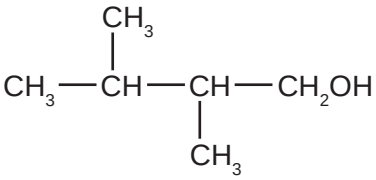
B neither X nor Y

C X only

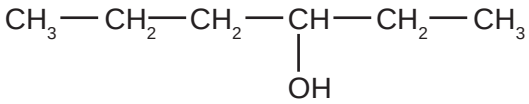
D Y only

25 Which isomer of $C_6H_{13}OH$ gives the greatest number of different alkenes when it is dehydrated?

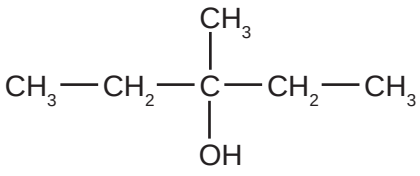
A



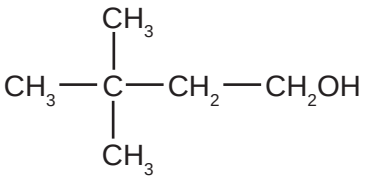
B



C



D



26 Compound X changes the colour of warm acidified sodium dichromate(VI) from orange to green. 1 mol of X reacts with 2 mol of HCN in the presence of KCN.

What could X be?

A $CH_3CH_2CH_2CHO$

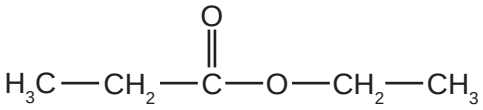
B $CH_3COCH_2COCH_3$

C $H_2C{=}CHCH_2CHO$

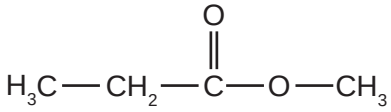
D $OHCCH_2CH_2CHO$

27 Which formula represents an ester which will form sodium ethanoate on hydrolysis with aqueous sodium hydroxide?

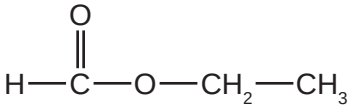
A



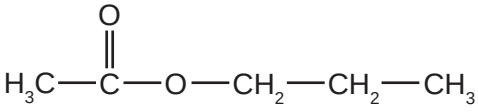
B



C



D



28 A compound Y is treated with warm acidified potassium dichromate(VI). The resulting organic product gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent but does not give a silver mirror with Tollens' reagent.

What is Y?

A butan-1-ol

B butan-2-ol

C butanal

D 2-methylpropan-2-ol

29 Aldehydes and ketones are carbonyl compounds.

Which of them react with $NaBH_4$ **and** react with Fehling's reagent?

A both aldehydes and ketones

B aldehydes only

C ketones only

D neither aldehydes nor ketones

30 The functional group in a primary alcohol is $-CH_2OH$.

Which reagent reacts with a primary alcohol, under suitable conditions, to give an organic product with the same number of oxygen atoms as the alcohol?

A Al_2O_3 **B** CH_3CO_2H **C** HBr **D** Na

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Which statements are correct in terms of the Brønsted-Lowry theory of acids and bases?

1 Water can act as either an acid or a base.

2 Sulfuric acid, H_2SO_4, does not behave as an acid when dissolved in ethanol, C_2H_5OH.

3 The ammonium ion acts as a base when dissolved in liquid ammonia.

32 Which are features of the structure of metallic copper?

1 a lattice of ions

2 delocalised electrons

3 ionic bonds

33 *Use of the Data Booklet is relevant to this question.*

Zinc reacts with hydrochloric acid according to the following equation.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Which statements are correct?

[All volumes are measured at room conditions.]

1 A 3.27 g sample of zinc reacts with an excess of hydrochloric acid to give 0.050 mol of zinc chloride.

2 A 6.54 g sample of zinc reacts completely with exactly 100 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

3 A 13.08 g sample of zinc reacts with an excess of hydrochloric acid to give 9.60 dm^3 of hydrogen.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

34 Which statements are correct?

1 Aluminium chloride dissolves in water to give an acidic solution.

2 Magnesium chloride dissolves in water to give a slightly acidic solution.

3 Sodium chloride dissolves in water to give an alkaline solution.

35 Which oxides react with water to give a solution of pH 10 or higher?

1 CaO

2 Na_2O

3 SrO

36 *Use of the Data Booklet is relevant to this question.*

The element astatine lies below iodine in Group VII of the Periodic Table.

What will be the properties of astatine?

1 It forms diatomic molecules which dissociate more readily than chlorine molecules.

2 It reacts explosively with hydrogen.

3 It can oxidise iodide to iodine.

37 Which descriptions of the ammonium ion are correct?

1 It contains ten electrons.

2 It has a bond angle of 109.5°.

3 It has only three bonding pairs of electrons.

38 Which alkenes, on reaction with steam at 600 K and 6 x 10^6 Pa pressure in the presence of a phosphoric acid catalyst, could produce an alcohol containing a chiral carbon atom?

1 $(CH_3)_2C=CH_2$

2 $CH_3CH=CHCH_3$

3 $CH_3CH_2CH=CH_2$

39 Bromoethane undergoes all of the conversions shown.

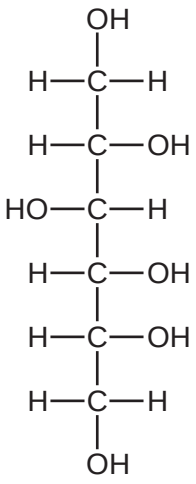
Which conversions are examples of nucleophilic substitution?

1 $C_2H_5Br \rightarrow C_2H_5CN$

2 $C_2H_5Br \rightarrow C_2H_5OH$

3 $C_2H_5Br \rightarrow C_2H_5NH_2$

40 Sorbitol is an artificial sweetener used to sweeten chocolate which is suitable for diabetics.



sorbitol

Which functional groups can be produced when this molecule is subjected to oxidation under suitable conditions?

1 aldehyde

2 carboxylic acid

3 ketone

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/11 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**C**
2	**A**	22	**A**
3	**C**	23	**B**
4	**C**	24	**B**
5	**D**	25	**B**
6	**A**	26	**D**
7	**B**	27	**D**
8	**D**	28	**B**
9	**C**	29	**B**
10	**C**	30	**D**
11	**C**	31	**D**
12	**B**	32	**B**
13	**C**	33	**D**
14	**D**	34	**B**
15	**B**	35	**A**
16	**D**	36	**D**
17	**C**	37	**B**
18	**C**	38	**C**
19	**C**	39	**A**
20	**C**	40	**A**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **October/November 2011**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

IB11 11_9701_11/3RP

UNIVERSITY of CAMBRIDGE International Examinations

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Three elements, **X**, **Y** and **Z**, have the physical properties shown in the table.

element	melting point / °C	boiling point / °C	density / g cm^{-3}
X	–7	59	3.12
Y	98	883	0.97
Z	649	1107	1.74

What could be the identities of **X**, **Y** and **Z**?

	X	**Y**	**Z**
A	Br_2	A*l*	Si
B	Br_2	Na	Mg
C	I_2	Mg	Na
D	I_2	Si	K

2 *Use of the Data Booklet is relevant to this question.*

Lead(IV) chloride will oxidise bromide ions to bromine. The Pb^{4+} ions are reduced to Pb^{2+} ions in this reaction.

If 6.980 g of lead(IV) chloride is added to an excess of sodium bromide solution, what mass of bromine would be produced?

A 0.799 g **B** 1.598 g **C** 3.196 g **D** 6.392 g

3 Which element has an equal number of electron pairs and of unpaired electrons within orbitals of principal quantum number 2?

A beryllium

B carbon

C nitrogen

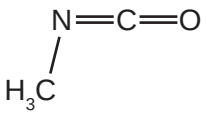
D oxygen

4 Methyl isocyanate, CH_3NCO, is a toxic liquid which is used in the manufacture of some pesticides.

In the methyl isocyanate molecule, the sequence of atoms is $H_3C—N=C=O$.

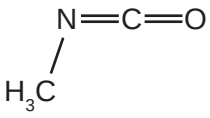
What is the approximate angle between the bonds formed by the N atom?

A



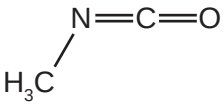
104°

B



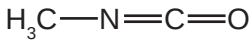
109°

C



120°

D



180°

5 At room temperature and pressure chlorine does not behave as an ideal gas.

At which temperature and pressure would the behaviour of chlorine become more ideal?

	pressure / kPa	temperature / K
A	50	200
B	50	400
C	200	200
D	200	400

6 The standard enthalpy change for the reaction

$$2NF_3(g) \rightarrow 2N(g) + 6F(g) \qquad \text{is } \Delta H^{\ominus} = +1668\,\text{kJ}$$

What is the bond energy of the N–F bond?

A $-556\,\text{kJ mol}^{-1}$

B $-278\,\text{kJ mol}^{-1}$

C $+278\,\text{kJ mol}^{-1}$

D $+556\,\text{kJ mol}^{-1}$

7 When chlorine and aqueous sodium hydroxide are heated together the following overall reaction occurs.

$$3Cl_2(aq) + 6NaOH(aq) \rightarrow 5NaCl(aq) + NaClO_3(aq) + 3H_2O(l)$$

What are the oxidation numbers for chlorine in each of the following species?

	Cl_2	$NaCl$	$NaClO_3$
A	0	+1	–5
B	+2	–1	+3
C	0	–1	+5
D	–2	+1	–3

8 Sulfur dioxide is used as a preservative in wine making.

The following equations describe how sulfur dioxide dissolves.

$$H_2O + SO_2 \rightleftharpoons HSO_3^- + H^+$$

$$HSO_3^- + H^+ \rightleftharpoons SO_3^{2-} + 2H^+$$

Which statement about these two reactions is correct?

A HSO_3^- acts as a base.

B SO_2 acts as an oxidising agent.

C SO_3^{2-} acts as an acid.

D SO_3^{2-} acts as a reducing agent.

9 An aqueous solution was prepared containing 1.0 mol of $AgNO_3$ and 1.0 mol of $FeSO_4$ in 1.00 dm^3 of water. When equilibrium was established, there was 0.44 mol of $Ag^+(aq)$ in the mixture.

$$Ag^+(aq) + Fe^{2+}(aq) \rightleftharpoons Ag(s) + Fe^{3+}(aq)$$

What is the numerical value of K_c?

A 0.35 **B** 0.62 **C** 1.62 **D** 2.89

10 When gaseous iodine is heated with hydrogen at 450 °C, an equilibrium is established.

$$\underset{\text{colourless}}{H_2(g)} + \underset{\text{purple}}{I_2(g)} \rightleftharpoons \underset{\text{colourless}}{2HI(g)} \qquad \Delta H = +53\,\text{kJ mol}^{-1}$$

Which change of conditions will cause the purple colour of the equilibrium mixture to become paler?

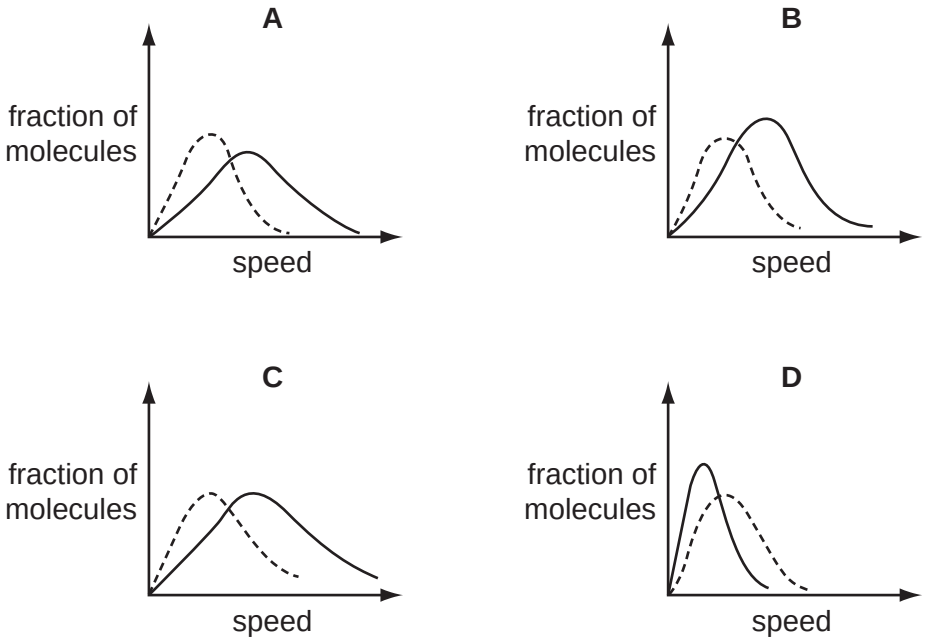
A decrease in pressure

B decrease in temperature

C increase in pressure

D increase in temperature

11 Which solid-line curve most accurately represents the distribution of molecular speeds in a gas at 500 K if the dotted-line curve represents the corresponding distribution for the same gas at 300 K?



12 Butanedioate ions can be dehydrogenated to form *trans*-butenedioate ions. The enzyme fumarase speeds up this reaction.

Why does fumarase speed up this reaction?

A Fumarase is a protein.

B Fumarase is effective at body temperature.

C Fumarase lowers the activation energy of the dehydrogenation reaction.

D The enzyme fumarase is specific for this dehydrogenation reaction.

13 Which element shows the greatest tendency to form some covalent compounds?

A aluminium

B magnesium

C neon

D potassium

14 *Use of the Data Booklet is relevant to this question.*

A significant contribution to atmospheric carbon dioxide levels comes from the thermal decomposition of limestone, in the manufacture of cement and of lime for agricultural purposes.

Cement works roast 1000 million tonnes of limestone per year and a further 200 million tonnes is roasted in kilns to make lime.

What is the total annual mass output of carbon dioxide (in million tonnes) from these two processes?

A 440 **B** 527 **C** 660 **D** 880

15 *Use of the Data Booklet is relevant to this question.*

A 5.00 g sample of an anhydrous Group II metal nitrate loses 3.29 g in mass when heated strongly.

Which metal is present?

A magnesium

B calcium

C strontium

D barium

16 Aqueous sodium chloride (brine) is electrolysed by using inert electrodes in a cell which is stirred so that products of electrolysis react with each other. The cell is kept cold.

Which pair of substances is among the major products?

A hydrogen and chlorine

B hydrogen and sodium chlorate(I)

C hydrogen and sodium chlorate(V)

D sodium hydroxide and chlorine

17 Why do the halogens become less volatile as Group VII is descended?

A The halogen-halogen bond energy decreases.

B The halogen-halogen bond length increases.

C The number of electrons in each molecule increases.

D The van der Waals' forces between molecules become weaker.

18 Total removal of the pollutant sulfur dioxide, SO_2, is difficult, both for economic and technical reasons. The quantities emitted from furnace chimneys can be lowered by using desulfurisation plants. The gases are scrubbed (washed) with calcium hydroxide to remove the SO_2.

What is the main product formed **initially**?

A $Ca(HSO_4)_2$ **B** CaS **C** $CaSO_3$ **D** $CaSO_4$

19 Which reaction is endothermic?

A $2HBr \rightarrow H_2 + Br_2$

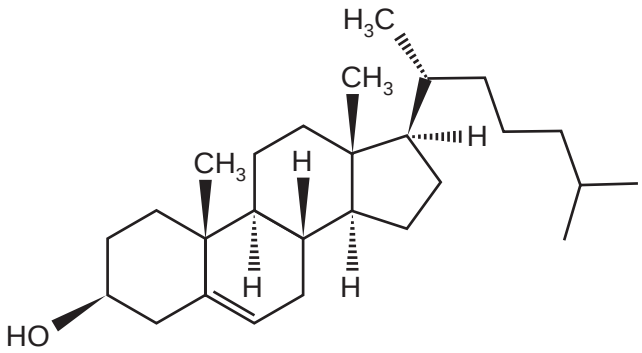
B $N_2 + 3H_2 \rightarrow 2NH_3$

C $2SO_2 + O_2 \rightarrow 2SO_3$

D $SO_3 + H_2O \rightarrow H_2SO_4$

20 This question should be answered by considering the reactions of $KMnO_4$ with different functional groups under the stated conditions.

The diagram shows the structure of the naturally-occurring molecule cholesterol.



cholesterol

Separate oxidation reactions are carried out using different conditions.

- cold, dilute acidified $KMnO_4$
- hot, concentrated acidified $KMnO_4$

Which statements about the **products** formed are correct?

	cold, dilute acidified $KMnO_4$: number of hydroxy groups present	hot, concentrated acidified $KMnO_4$: number of 6-membered rings remaining
A	1	2
B	1	3
C	3	2
D	3	3

21 Many different compounds have been used in aerosol sprays, refrigerators and in making foamed plastics.

Which compound will cause the **most** ozone depletion?

A CCl_3F

B $CH_2FCHClF$

C $CH_3CH_2CH_2CH_3$

D N_2O

22 In the general formula of which class of compound, is the ratio of hydrogen atoms to carbon atoms the highest?

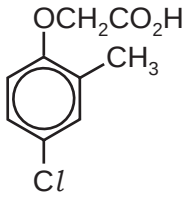
A alcohols

B aldehydes

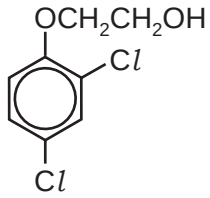
C carboxylic acids

D halogenoalkanes

23 **Y** and **Z** are two widely-used selective weed killers.



Y



Z

Which reagent will distinguish **Y** from **Z**?

A acidified $AgNO_3(aq)$

B Fehling's solution

C Na

D $Na_2CO_3(aq)$

24 What is involved in the mechanism of the reaction between aqueous sodium hydroxide and 1-bromobutane?

A attack by a nucleophile on a carbon atom with a partial positive charge

B heterolytic bond fission and attack by a nucleophile on a carbocation

C homolytic bond fission and attack by an electrophile on a carbanion

D homolytic bond fission and attack by a nucleophile on a carbocation

25 *Use of the Data Booklet is relevant to this question.*

2.76 g of ethanol were mixed with an excess of aqueous acidified potassium dichromate(VI). The reaction mixture was then boiled under reflux for one hour. The organic product was then collected by distillation.

The yield of product was 75.0 %.

What mass of product was collected?

A 1.98 g **B** 2.07 g **C** 2.70 g **D** 4.80 g

26 Energy is released in the human body by the oxidation of glucose in a complex sequence of reactions. Part of this sequence is the Krebs cycle. One reaction in the Krebs cycle is the conversion of fumaric acid into malic acid.

$$HO_2CCH{=}CHCO_2H \rightarrow HO_2CCH(OH)CH_2CO_2H$$

fumaric acid malic acid

Which reagents could achieve this transformation in the laboratory?

A acidified $KMnO_4$

B $Br_2(aq)$ followed by hot NaOH(aq)

C H_2O with Pt catalyst

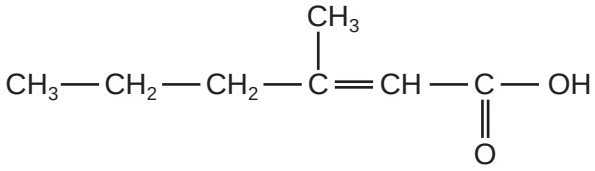
D steam with H_2SO_4

27 A reaction between chlorine and propane in ultraviolet light produces two isomeric monochloropropanes, C_3H_7Cl, as products.

Which information about this reaction is correct?

	type of bond fission in initiation step	expected ratio of 1-chloropropane to 2-chloropropane produced
A	heterolytic	1 : 1
B	heterolytic	3 : 1
C	homolytic	1 : 1
D	homolytic	3 : 1

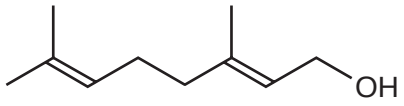
28 An unpleasant smelling chemical produced in the human armpit is 3-methylhex-2-enoic acid.



If this compound is reacted with a cold, dilute, acidified solution of potassium manganate(VII), how many chiral centres will be produced?

A 0 **B** 1 **C** 2 **D** 3

29 Geraniol is a constituent of some perfumes.



geraniol

Which statement about geraniol is **not** correct?

A Geraniol causes hot acidified potassium dichromate(VI) to change colour from orange to green.

B Geraniol decolourises bromine water.

C There are three methyl groups and three methylene (CH_2) groups in geraniol.

D There are two pairs of *cis-trans* isomers of geraniol.

30 Which pair of substances could react to give the ester $CH_3CH_2CO_2CH_3$?

A ethanol and ethanoic acid

B methanol and ethanoic acid

C methanol and propanoic acid

D propan-1-ol and methanoic acid

[Turn over

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 The definitions of many chemical terms can be illustrated by chemical equations.

Which terms can be illustrated by an equation that shows the formation of a positive ion?

1 first ionisation energy

2 heterolytic fission

3 enthalpy change of atomisation

32 Why does aluminium chloride, Al_2Cl_6, sublime at the relatively low temperature of 180 °C?

1 The intermolecular forces between the Al_2Cl_6 molecules are weak.

2 The co-ordinate bonds between aluminium and chlorine are weak.

3 The covalent bonds between aluminium and chlorine are weak.

33 The three statements that follow are all true.

Which of these can be explained, at least in part, by reference to hydrogen bonding?

1 At 0 °C ice floats on water.

2 The boiling point of propan-2-ol is 82 °C. The boiling point of propanone is 56 °C.

3 At 20 °C propanone and propanal mix completely.

34 A farmer spreads lime on land which has already been treated with an ammonium nitrate fertiliser.

Which reactions will occur in the treated soil?

1 $Ca(OH)_2 + 2NH_4^+(aq) \rightarrow Ca^{2+}(aq) + 2NH_3 + 2H_2O$

2 $Ca(OH)_2 + 2H^+(aq) \rightarrow Ca^{2+}(aq) + 2H_2O$

3 $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

35 Which of the halide ions, chloride, bromide or iodide, acts as a reducing agent when its sodium salt reacts with concentrated sulfuric acid?

1 at least one of Cl , Br and I

2 at least two of Cl , Br and I

3 all three of Cl , Br and I

36 In a car engine, non-metallic element X forms a pollutant oxide Y.

Further oxidation of Y to Z occurs spontaneously in the atmosphere. In this further oxidation, 1 mol of Y reacts with 0.5 mol of gaseous oxygen.

Which statements about X, Y and Z are correct?

1 X forms a basic hydride.

2 Y is a diatomic molecule.

3 Z is a polar molecule.

37 Disaccharides, $C_{12}H_{22}O_{11}$, are important in the human diet. For example, sucrose is found in pastries and lactose occurs in milk products.

Both of these compounds can be hydrolysed.

$$\text{sucrose} + H_2O \rightarrow \underset{\text{glucose}}{CH_2OH(CHOH)_4CHO} + \underset{\text{fructose}}{CH_2OH(CHOH)_3COCH_2OH}$$

$$\text{lactose} + H_2O \rightarrow \underset{\text{glucose}}{CH_2OH(CHOH)_4CHO} + \underset{\text{galactose}}{CH_2OH(CHOH)_4CHO}$$

Which statements about these hydrolysis products are correct?

1 Glucose and fructose have structural isomers.

2 Glucose and galactose are optical isomers.

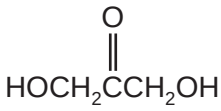
3 Glucose and galactose are ketones.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

38 DHA is a colourless liquid which reacts with protein in skin to cause it to darken. It has the structure shown.



DHA

Which observations would be made when testing this substance?

1 Hydrogen is produced when sodium is added.

2 A coloured precipitate is produced when 2,4-dinitrophenylhydrazine reagent is added.

3 A silver precipitate is produced when Tollens' reagent is added.

39 On acid hydrolysis, which compounds produce propanoic acid?

1 $CH_3CH_2CO_2CH_3$

2 $CH_3CH_2CH_2CN$

3 $CH_3CH_2CH_2Cl$

40 **X** is an organic compound. **X** gives a precipitate with aqueous silver nitrate. Some or all of this precipitate remains undissolved when an excess of dilute aqueous ammonia is added.

What could be the identity of **X**?

1 2-chlorobutane

2 2-bromobutane

3 iodomethane

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9701 CHEMISTRY

9701/11 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**A**
2	**C**	22	**A**
3	**D**	23	**D**
4	**C**	24	**A**
5	**B**	25	**C**
6	**C**	26	**D**
7	**C**	27	**D**
8	**A**	28	**C**
9	**D**	29	**D**
10	**D**	30	**C**
11	**A**	31	**B**
12	**C**	32	**D**
13	**A**	33	**B**
14	**B**	34	**A**
15	**B**	35	**B**
16	**B**	36	**A**
17	**C**	37	**B**
18	**C**	38	**B**
19	**A**	39	**D**
20	**C**	40	**C**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **May/June 2011**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 4 6 2 5 3 4 1 9 1 2 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **14** printed pages and **2** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Helium, He, is the second element in the Periodic Table.

Tritium is the isotope of hydrogen ^{3}H.

What is the same in an atom of ^{4}He and an atom of ^{3}H?

A the number of electrons

B the number of neutrons

C the number of protons

D the relative atomic mass

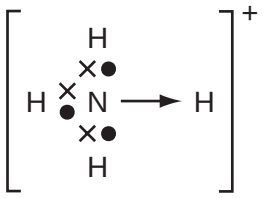
2 Which diagram correctly shows the bonding in the ammonium ion, NH_4^+?

key

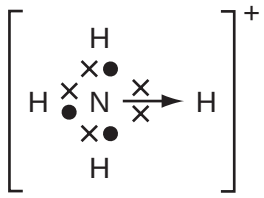
● N electron

× H electron

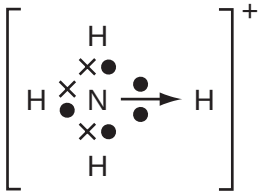
A



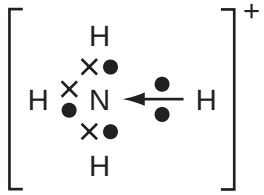
B



C



D



3 Aluminium is the most abundant metal in the Earth's crust. The extraction of aluminium is carried out by the electrolysis of aluminium oxide dissolved in molten cryolite.

Which material is used for each of the electrodes in this electrolysis?

	anode	cathode
A	aluminium	carbon
B	carbon	carbon
C	carbon	steel
D	steel	aluminium

4 The esterification reaction

$$\text{ethanol + ethanoic acid} \rightleftharpoons \text{ethyl ethanoate + water}$$

is an equilibrium. The forward reaction is exothermic.

How can the value of the equilibrium constant K_C be increased?

A by adding a little concentrated sulfuric acid as a catalyst

B by increasing the initial concentration of ethanol

C by lowering the temperature

D by raising the temperature

5 Ammonia is manufactured on a large scale by the Haber process.

In a particular plant, conditions of 400 °C and 250 atm in the presence of an iron catalyst are used.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H^{\ominus} = -92\,\text{kJ mol}^{-1}$$

What could contribute most to increasing the equilibrium yield of ammonia?

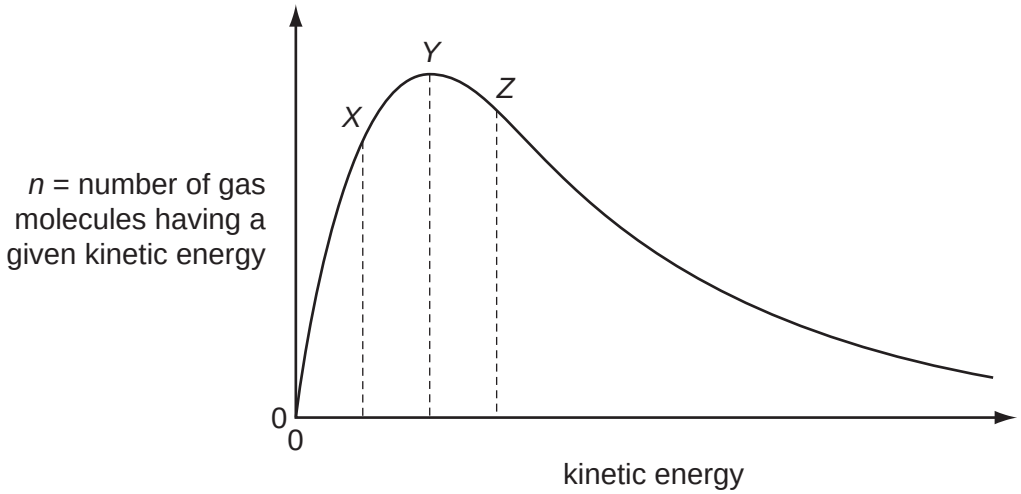
A adding more catalyst

B increasing the pressure to 400 atm

C increasing the temperature to 1000 °C

D using air rather than nitrogen

6 The Boltzmann distribution for a gas at constant temperature is shown below.



If the temperature of the gas is **reduced** by 10 °C the graph changes shape.

What happens to the values of *n* for the points marked *X*, *Y* and *Z*?

	X	*Y*	*Z*
A	higher	lower	higher
B	higher	lower	lower
C	lower	higher	lower
D	lower	lower	lower

7 Titanium occurs naturally as the mineral rutile, TiO_2. One possible method of extraction of titanium is to reduce the rutile by heating with carbon.

$$TiO_2(s) + 2C(s) \rightarrow Ti(s) + 2CO(g)$$

The standard enthalpy changes of formation of $TiO_2(s)$ and $CO(g)$ are –940 kJ mol^{-1} and –110 kJ mol^{-1} respectively.

What is the standard enthalpy change of this reaction?

A –830 kJ mol^{-1}

B –720 kJ mol^{-1}

C +720 kJ mol^{-1}

D +830 kJ mol^{-1}

8 Which reaction has an enthalpy change equal to the standard enthalpy change of formation of propane?

A $3C(g) + 4H_2(g) \rightarrow C_3H_8(g)$

B $3C(g) + 8H(g) \rightarrow C_3H_8(g)$

C $3C(s) + 4H_2(g) \rightarrow C_3H_8(g)$

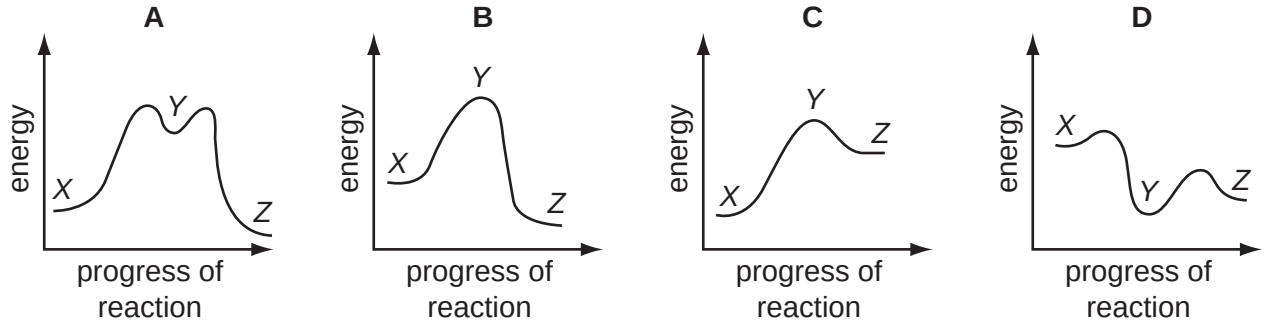
D $3C(s) + 4H_2(g) \rightarrow C_3H_8(l)$

9 In the conversion of compound *X* into compound *Z*, it was found that the reaction proceeded by way of compound *Y*, which could be isolated. The following steps were involved.

$X \rightarrow Y$; ΔH, positive

$Y \rightarrow Z$; ΔH, negative

Which reaction profile fits these data?



10 Tanzanite is used as a gemstone for jewellery. It is a hydrated calcium aluminium silicate mineral with a chemical formula $Ca_2Al_xSi_yO_{12}(OH).6½H_2O$. Tanzanite has M_r of 571.5.

Its chemical composition is 14.04 % calcium, 14.17 % aluminium, 14.75 % silicon, 54.59 % oxygen and 2.45 % hydrogen.

(A_r values: H = 1.0, O = 16.0, Al = 27.0, Si = 28.1, Ca = 40.1)

What are the values of x and y?

	x	y
A	1	1
B	2	3
C	3	3
D	6	1

11 0.144 g of an aluminium compound **X** react with an excess of water, to produce a gas. This gas burns completely in O_2 to form H_2O and 72 cm^3 of CO_2 only. The volume of CO_2 was measured at room temperature and pressure.

What could be the formula of **X**?
[C = 12.0, Al = 27.0; 1 mole of any gas occupies 24 dm^3 at room temperature and pressure]

A Al_2C_3 **B** Al_3C_4 **C** Al_4C_3 **D** Al_5C_3

12 *Use of the Data Booklet is relevant to this question.*

Which element is likely to have an electronegativity similar to that of aluminium?

A barium

B beryllium

C magnesium

D strontium

13 In 1999, researchers working in the USA believed that they had made a new element and that it had the following electronic configuration.

$$[Rn]\ 5f^{14}6d^{10}7s^{2}7p^{6}$$

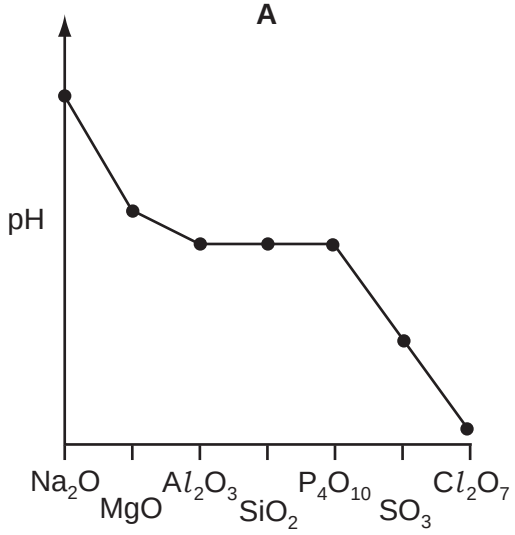
In which Group of the Periodic Table would you expect to find this element?

A II **B** IV **C** VI **D** 0

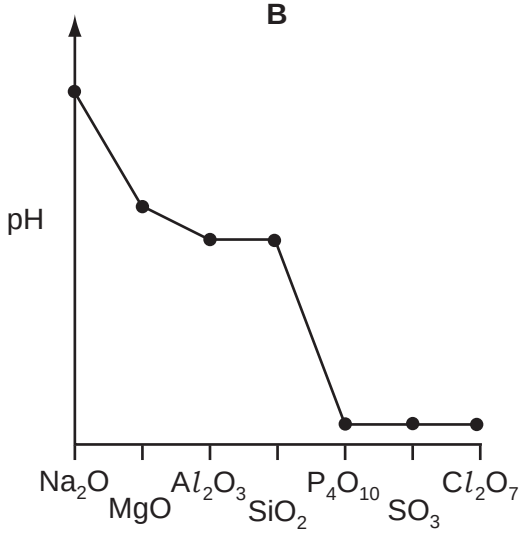
14 The highest oxides of the elements sodium to chlorine are separately added to water.

Which diagram best represents the pH of the resulting mixtures?

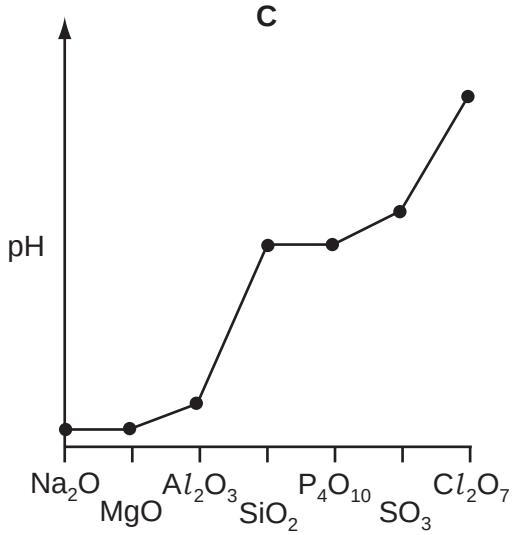
A



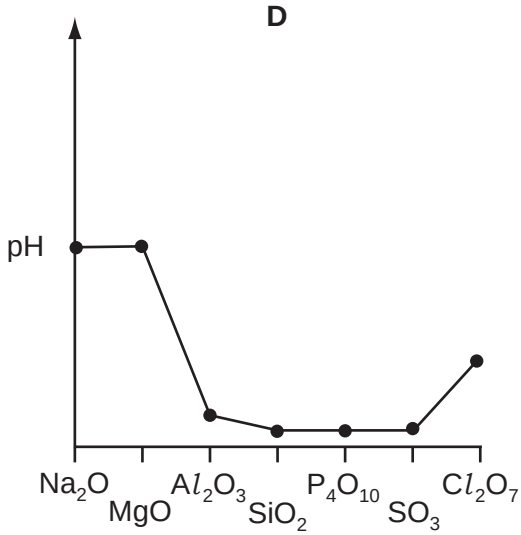
B



C

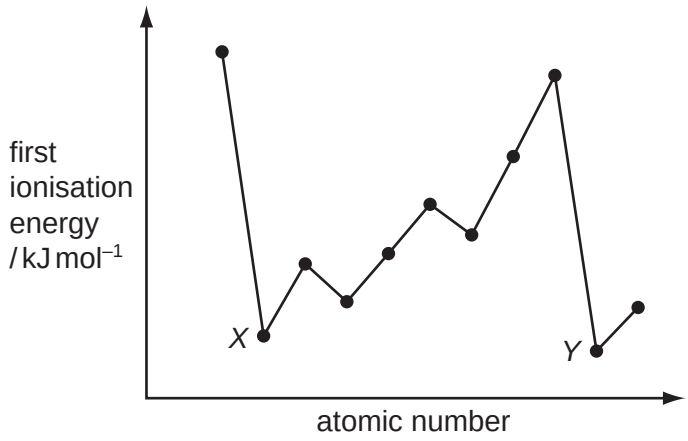


D



[Turn over

15 The diagram shows the first ionisation energies of 11 consecutive elements.



Which type of elements are labelled *X* and *Y*?

A Group I metals

B Group II metals

C halogens

D noble gases

16 Why does aluminium oxide dissolve in sodium hydroxide solution?

A Aluminium oxide can behave as a base.

B Aluminium oxide can behave as an acid.

C Aluminium oxide has a giant structure.

D The bonding in aluminium oxide is ionic.

17 Concentrated sulfuric acid can behave **both** as a strong acid **and** as an oxidising agent.

With which compound does concentrated sulfuric acid react in this way?

A ethanol

B magnesium carbonate

C propanenitrile

D sodium bromide

18 In the Contact process, what is the nature of the gaseous product and what is the identity of the catalyst?

	nature of gaseous product	catalyst
A	acidic	Fe
B	acidic	V_2O_5
C	basic	Fe
D	basic	V_2O_5

19 Which compound contains two different elements with identical oxidation states?

A HC*l*O **B** $Mg(OH)_2$ **C** Na_2SO_4 **D** NH_4Cl

20 Which reagent gives the same visible result with propanal and with propan-2-ol?

A 2,4-dinitrophenylhydrazine reagent

B acidified potassium dichromate(VI)

C sodium

D Tollens' reagent

21 Which halogenoalkane will undergo an S_N1 reaction and produce a yellow precipitate when $AgNO_3$(aq) is added to it?

A 1-chlorobutane

B 1-iodobutane

C 2-chloro-2-methylpropane

D 2-iodo-2-methylpropane

22 Which reaction will give 2-chloropropane in the best yield?

A propane gas with chlorine gas in the presence of ultraviolet light

B propan-2-ol with dilute NaC*l*(aq)

C propan-2-ol with $SOCl_2$

D propene with dilute HC*l*(aq)

23 The products obtained by cracking an alkane, **X**, are methane, ethene and propene.

The mole fraction of ethene in the products is 0.5.

What is the identity of **X**?

A C_6H_{14} **B** C_8H_{18} **C** C_9H_{20} **D** $C_{11}H_{24}$

24 Which compound does **not** show cis-trans isomerism?

A 2-methylpent-2-ene

B 3-methylpent-2-ene

C 3,4-dimethylhex-3-ene

D pent-2-ene

25 Which formulae show propanone and propanal as different compounds?

A empirical, molecular, structural **and** displayed formulae

B molecular, structural and displayed formulae **only**

C structural and displayed formulae **only**

D displayed formulae **only**

26 How many isomers with the formula C_5H_{10} have structures that involve π bonding?

A 3 **B** 4 **C** 5 **D** 6

27 1,1-dichloropropane reacts with aqueous sodium hydroxide in a series of steps to give propanal.

$$CH_3CH_2CHCl_2 \xrightarrow{NaOH(aq)} CH_3CH_2CHO$$

Which term describes the first step of this reaction?

A electrophilic addition

B elimination

C nucleophilic substitution

D oxidation

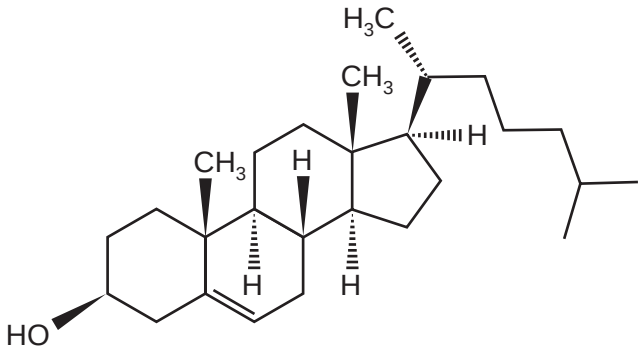
28 The ester $CH_3CH_2CH_2CO_2CH_3$ is responsible for the aroma of apples.

When this ester is hydrolysed by acid in the stomach, what is the empirical formula of the organic acid produced?

A CH_2O **B** CH_4O **C** C_2H_4O **D** $C_3H_6O_2$

29 This question should be answered by considering the reactions of $KMnO_4$ with different functional groups under the stated conditions.

The diagram shows the structure of the naturally-occurring molecule cholesterol.



cholesterol

Cholesterol is separately treated with

- cold, dilute acidified $KMnO_4$,
- hot, concentrated acidified $KMnO_4$.

What is the change in the **number** of chiral carbon atoms in the molecule during each reaction?

	cold, dilute acidified $KMnO_4$	hot, concentrated acidified $KMnO_4$
A	+1	0
B	+1	–1
C	+2	0
D	+2	–1

30 Which reaction would **not** give ethanoic acid as a product?

A heating ethanenitrile under reflux with dilute sodium hydroxide

B heating ethanenitrile under reflux with dilute sulfuric acid

C heating ethanal under reflux with acidified sodium dichromate(VI)

D heating ethanol under reflux with acidified sodium dichromate(VI)

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Solid calcium carbonate is added to 100 cm^3 of dilute hydrochloric acid and the rate of the reaction is measured. 100 cm^3 of distilled water is then added to a second 100 cm^3 portion of the acid, and the experiment repeated under the same conditions.

Why does the addition of water decrease the rate of the reaction?

1 Adding water reduces the frequency of collisions between reactant molecules.

2 Adding water reduces the proportion of effective collisions between reactant molecules.

3 Adding water reduces the proportion of reactant molecules possessing the activation energy.

32 When a sample of a gas is compressed at constant temperature from 1500 kPa to 6000 kPa, its volume changes from 76.0 cm^3 to 20.5 cm^3.

Which statements are possible explanations for this behaviour?

1 The gas behaves non-ideally.

2 The gas partially liquefies.

3 Gas is adsorbed on to the vessel walls.

33 Which equations apply to an ideal gas?
[p = pressure, V = volume, M = molar mass, ρ = density, c = concentration, R = gas constant, T = temperature]

1 $p = \frac{\rho RT}{M}$ **2** $pV = MRT$ **3** $pV = \frac{cRT}{M}$

34 What is involved when a hydrogen bond is formed between two molecules?

1 a hydrogen atom bonded to an atom less electronegative than itself

2 a lone pair of electrons

3 an electrostatic attraction between opposite charges

35 When the yellow liquid NCl_3 is stirred into aqueous sodium hydroxide, the reaction that occurs can be represented by the following equation.

$$2NCl_3(l) + 6NaOH(aq) \rightarrow N_2(g) + 3NaCl(aq) + 3NaOCl(aq) + 3H_2O(l)$$

What will be the result of this reaction?

1 The nitrogen undergoes a redox reaction.

2 A bleaching solution remains after the reaction.

3 The final solution gives a precipitate with acidified silver nitrate.

36 In a car engine pollutant oxide **Y**, which contains non-metallic element **X**, is formed.

Further oxidation of **Y** to **Z** occurs in the atmosphere. In this further oxidation, 1 mol of **Y** reacts with 0.5 mol of gaseous oxygen.

X could be either nitrogen or sulfur.

Which statements about **X**, **Y** and **Z** can be correct?

1 The oxidation number of **X** increases by two from **Y** to **Z**.

2 **Y** may have an unpaired electron in its molecule.

3 **Y** is a polar molecule.

37 Which compounds can be obtained from ethene in a **single** reaction?

1 CH_3CH_3

2 $-(-CH_2CH_2-)_n-$

3 $HOCH_2CH_2OH$

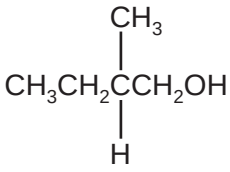
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

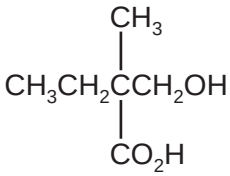
No other combination of statements is used as a correct response.

38 Which compounds when heated under reflux with an excess of hot acidified potassium dichromate(VI), give a product with a chiral centre?

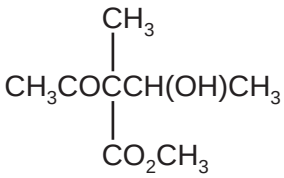
1



2



3



39 In the reaction between an aldehyde and HCN, catalysed by NaCN, which statements about the reaction mechanism are correct?

1 A new carbon-carbon bond is formed.

2 In the intermediate, the oxygen carries a negative charge.

3 The last stage involves the formation of a hydrogen-oxygen bond.

40 An organic compound, **X**, will react with an excess of calcium metal to produce a salt with the empirical formula $CaC_4H_6O_4$.

What could be the identity of **X**?

1 ethanoic acid

2 butanedioic acid

3 methylpropanedioic acid

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/12 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**D**
2	**C**	22	**C**
3	**B**	23	**B**
4	**C**	24	**A**
5	**B**	25	**C**
6	**B**	26	**D**
7	**C**	27	**C**
8	**C**	28	**C**
9	**A**	29	**D**
10	**C**	30	**A**
11	**C**	31	**D**
12	**B**	32	**D**
13	**D**	33	**D**
14	**B**	34	**C**
15	**A**	35	**A**
16	**B**	36	**A**
17	**D**	37	**A**
18	**B**	38	**D**
19	**A**	39	**A**
20	**B**	40	**D**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **October/November 2011**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

2652326564

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **13** printed and **3** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 In the Haber process for the manufacture of ammonia, why is the heterogeneous catalyst iron in a finely divided state?

A to increase its surface area

B to produce the maximum reduction in the activation energy

C to reduce its loss during the reaction

D to reduce its surface area

2 The following equations the letters **W**, **X**, **Y** and **Z** all represent whole numbers.

When correctly balanced, which equation requires one of letters **W**, **X**, **Y** or **Z** to be 5?

A $\mathbf{W}C_3H_7COOH + \mathbf{X}O_2 \rightarrow \mathbf{Y}CO_2 + \mathbf{Z}H_2O$

B $\mathbf{W}C_4H_8 + \mathbf{X}O_2 \rightarrow \mathbf{Y}CO_2 + \mathbf{Z}H_2O$

C $\mathbf{W}H_3PO_4 + \mathbf{X}NaOH \rightarrow \mathbf{Y}Na_2HPO_4 + \mathbf{Z}H_2O$

D $\mathbf{W}NH_3 + \mathbf{X}O_2 \rightarrow \mathbf{Y}N_2 + \mathbf{Z}H_2O$

3 *Use of the Data Booklet is relevant to this question.*

From which particle is the removal of an electron the most difficult?

A Cl (g) **B** F (g) **C** K^+(g) **D** Na^+(g)

4 *Use of the Data Booklet is relevant to this question.*

560 kg of nitrogen and 120 kg of hydrogen are pressurised, heated and passed over an iron catalyst. When the mixture of gases reaches equilibrium, it contains 96 kg of hydrogen.

Which mass of ammonia does it contain?

A 24 kg **B** 68 kg **C** 136 kg **D** 680 kg

5 The presence of dipoles helps to explain why the element Br_2 and the compound $CHCl_3$ exist as liquids at room temperature.

Which types of dipole are involved?

	Br_2	$CHCl_3$
A	induced dipoles and permanent dipoles	induced dipoles and permanent dipoles
B	induced dipoles and permanent dipoles	induced dipoles only
C	induced dipoles only	induced dipoles and permanent dipoles
D	induced dipoles only	induced dipoles only

6 Three compounds have the physical properties shown in the table.

compound	**P**	**Q**	**R**
melting point / °C	2852	993	–119
boiling point / °C	3600	1695	39
conductivity (solid)	poor	poor	poor
conductivity (liquid)	good	good	poor
conductivity (aqueous)	insoluble	good	insoluble

What might be the identities of **P**, **Q** and **R**?

	P	**Q**	**R**
A	MgO	KCl	NH_3
B	MgO	NaF	C_2H_5Br
C	SiO_2	KCl	C_2H_5Br
D	SiO_2	NaF	HCl

7 For the equilibrium $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, what will change the value of K_p?

A adding a catalyst

B adding more O_2

C increasing the pressure

D increasing the temperature

8 Which pollutant, present in the exhaust fumes of an internal combustion engine, has an element in the +2 oxidation state and an odd number of electrons in one molecule of the pollutant?

A CO **B** H_2S **C** NO **D** NO_2

9 The use of sucrose in food processing depends in part on osmotic pressure, symbol Π.

In dilute solution, Π varies with concentration in a similar way to gas behaviour. The equation $\Pi V = nRT$ can be used, where n is the number of moles of solute molecules contained in volume V at temperature T. The number of moles of solvent molecules should be ignored.

Under aqueous acidic conditions sucrose is hydrolysed.

$$\underset{\text{sucrose}}{C_{12}H_{22}O_{11}} + H_2O \rightarrow \underset{\text{glucose}}{CH_2OH(CHOH)_4CHO} + \underset{\text{fructose}}{CH_2OH(CHOH)_3COCH_2OH}$$

What can be deduced from this hydrolysis equation?

	the osmotic pressure	glucose and fructose are
A	decreases	optical isomers
B	decreases	structural isomers
C	increases	optical isomers
D	increases	structural isomers

10 Hess's Law can be used to calculate the average C-H bond energy in methane.

$\Delta H^{\ominus}_{at}$ = standard enthalpy change of atomisation

$\Delta H^{\ominus}_{f}$ = standard enthalpy change of formation

$\Delta H^{\ominus}_{c}$ = standard enthalpy change of combustion

Which data values are needed in order to perform the calculation?

A $\Delta H^{\ominus}_{at}$ (C), $\Delta H^{\ominus}_{at}$ (H), $\Delta H^{\ominus}_{f}$ (CH_4)

B $\Delta H^{\ominus}_{c}$ (C), $\Delta H^{\ominus}_{c}$ (H_2), $\Delta H^{\ominus}_{c}$ (CH_4)

C $\Delta H^{\ominus}_{c}$ (C), $\Delta H^{\ominus}_{c}$ (H_2), $\Delta H^{\ominus}_{f}$ (CH_4)

D $\Delta H^{\ominus}_{f}$ (CH_4) only, as $\Delta H^{\ominus}_{f}$ (C), and $\Delta H^{\ominus}_{f}$ (H_2), are defined as zero

11 The amount of titanium dioxide in an ore can be determined by using the following reaction.

$$3TiO_2 + 4BrF_3 \rightarrow 3TiF_4 + 2Br_2 + 3O_2$$

Which element increases in oxidation number in this reaction?

A bromine

B fluorine

C oxygen

D titanium

12 For the reaction

$$W(aq) + 2X(aq) \rightleftharpoons 2Y(aq) + 3Z(aq)$$

what are the correct units for the equilibrium constant K_c?

A $mol\,dm^{-3}$ **B** $mol^2\,dm^{-6}$ **C** $mol^{-1}\,dm^3$ **D** $mol^{-2}\,dm^6$

13 Methyl mercaptan, CH_3SH, has a foul smell and is often used to impart a smell to natural gas.

What will be formed when CH_3SH is burned in an excess of air?

A CO H_2O SO_2

B CO_2 H_2O H_2S

C CO_2 H_2O SO_2

D CO_2 H_2O SO_3

14 Nitrogenous fertilisers are used extensively in modern farming. If rainwater washes excess fertiliser into a nearby lake, a process called eutrophication may occur.

Three of the stages of eutrophication are described below.

P Water plants growing on the lake bed die due to lack of sunlight.

Q An excessive growth of algae occurs.

R Excessive bacterial activity causes a reduction in oxygen levels.

In which order do these three stages occur?

A P → Q → R

B P → R → Q

C Q → P → R

D Q → R → P

15 Chlorine can be manufactured from brine in a diaphragm cell.

Which row represents the correct electrodes?

	nature of anode	nature of cathode
A	graphite	titanium
B	steel	titanium
C	titanium	graphite
D	titanium	steel

16 Sodium iodide reacts with concentrated sulfuric acid. The equation which represents one of the reactions that takes place is shown.

$$8NaI + 9H_2SO_4 \rightarrow 8NaHSO_4 + 4I_2 + H_2S + 4H_2O$$

Which species has been oxidised in this reaction?

A H^+ **B** I **C** Na^+ **D** SO_4^{2}

17 The standard enthalpy changes of formation of HCl and HI are –92 kJ mol ^{1} and +26 kJ mol ^{1} respectively.

Which statement is **most** important in explaining this difference?

A Chlorine is more electronegative than iodine.

B The activation energy for the $H_2 + Cl_2$ reaction is much less than that for the $H_2 + I_2$ reaction.

C The bond energy of HI is smaller than the bond energy of HCl.

D The bond energy of I_2 is smaller than the bond energy of Cl_2.

18 Lime mortar is made from quicklime, water and sand. Over a period of time, lime mortar changes into a much harder form. Both fresh and old lime mortar react with aqueous hydrochloric acid but only the old lime mortar effervesces during the reaction.

Which equation describes the change from fresh to old lime mortar?

A $CaO + CO_2 \rightarrow CaCO_3$

B $CaO + H_2O \rightarrow Ca(OH)_2$

C $Ca(OH)_2 \rightarrow CaO + H_2O$

D $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

19 Ar, Ca^{2+} and K^+, contain the same number of electrons.

In which order do their radii increase?

	smallest radius ⟶		largest radius
A	Ar	K^+	Ca^{2+}
B	Ca^{2+}	Ar	K^+
C	Ca^{2+}	K^+	Ar
D	K^+	Ar	Ca^{2+}

20 Bromine and propene undergo an addition reaction.

Which is a property of the product?

A It exists in *cis-trans* isomers.

B It is more volatile than propene.

C It possesses a chiral centre.

D It possesses hydrogen bonding.

21 Buta-1,3-diene is currently obtained from fossil fuel sources. In future it may be obtained from ethanol, which can be produced from non-food agricultural crops. The sequence of reactions is as follows.

$$CH_3CH_2OH \xrightarrow{\text{step 1}} CH_3CHO \xrightarrow{\text{step 2}} CH_3CH(OH)CH_2CHO \xrightarrow{\text{step 3}} CH_2{=}CHCH{=}CH_2$$

buta-1,3-diene

Which term could be used to describe step 1?

A condensation

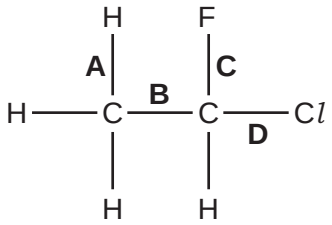
B dehydration

C dehydrogenation

D hydrogenation

22 *Use of the Data Booklet is relevant to this question.*

Which bond in the structure below has the lowest bond energy?



23 Ethanal, CH_3CHO, can be reduced using $NaBH_4$ in aqueous ethanol.

This is a nucleophilic addition reaction.

What could be the first step of this mechanism?

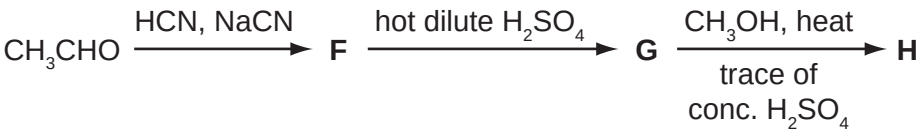
A attack of an H ion at the carbon atom of the carbonyl group

B attack of an H ion at the oxygen atom of the carbonyl group

C attack of an H^+ ion at the carbon atom of the carbonyl group

D attack of an H^+ ion at the oxygen atom of the carbonyl group

24 In a sequence of reactions, ethanal is converted into a compound **H**.



What could **H** be?

A $CH_3CH_2COOCH_3$

B $CH_3CH(OH)COOCH_3$

C $CH_3CH(OH)OCOCH_3$

D $CH_3CH(OCH_3)COOH$

25 What is involved in the mechanism of the reaction between aqueous sodium hydroxide and 2-bromo-2-methylbutane?

A heterolytic bond fission, attack by an electrophile on a carbanion

B heterolytic bond fission, attack by a nucleophile on a carbocation

C homolytic bond fission, attack by an electrophile on a carbanion

D homolytic bond fission, attack by a nucleophile on a carbocation

26 *Use of the Data Booklet is relevant to this question.*

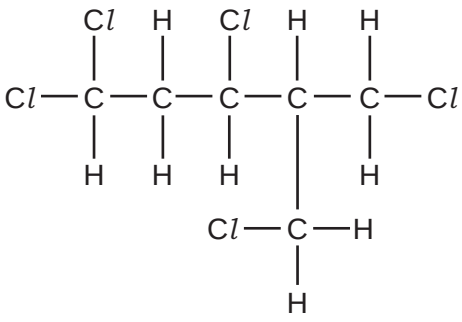
2.30 g of ethanol were mixed with aqueous acidified potassium dichromate(VI). The desired product was collected by immediate distillation under gentle warming.

The yield of product was 70.0 %.

What mass of product was collected?

A 1.54 g **B** 1.61 g **C** 2.10 g **D** 3.14 g

27 The molecule shown is optically active.



How many chiral carbon atoms are present in this molecule?

A 1 **B** 2 **C** 3 **D** 4

28 Which reagent could best be used to distinguish between cyclohexene and cyclohexanol?

A $Ag(NH_3)_2^+$ in H_2O

B Br_2 in CCl_4

C 2,4-dinitrophenylhydrazine in CH_3OH

D $NaBH_4$ in CH_3OH

29 Compound X, molecular formula C_4H_8, undergoes the following reactions.

$$\underset{\textbf{X}}{C_4H_8} \xrightarrow{Br_2} \underset{\textbf{Y}}{C_4H_8Br_2} \xrightarrow{\text{aq.NaOH / heat}} \underset{\textbf{Z}}{C_4H_{10}O_2}$$

$$\underset{\textbf{X}}{C_4H_8} \xrightarrow{H_2 / Ni} \text{methylpropane}$$

What is the formula of compound Z?

A $CH_3CH_2CH(OH)CH_2OH$

B $CH_3CH(OH)CH(OH)CH_3$

C $CH_3CH(CH_2OH)CH_2OH$

D $(CH_3)_2C(OH)CH_2OH$

30 How many of the isomeric alcohols with the formula C_4H_9OH will produce an alkene that has cis and trans isomers, on treatment with conc. H_2SO_4?

A 1 **B** 2 **C** 3 **D** 4

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

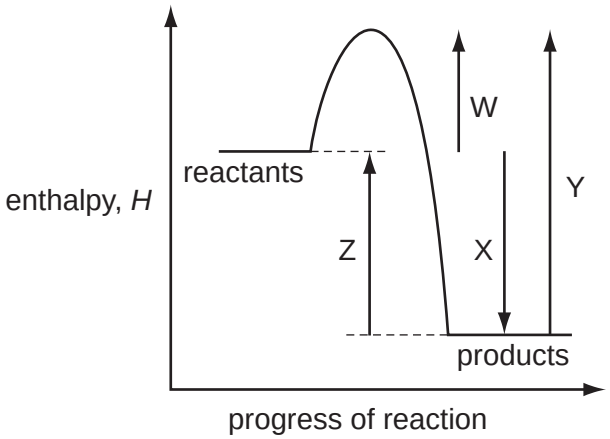
31 Which statements about bond angles are correct?

1 The bond angle in SO_2 is smaller than the bond angle in CO_2.

2 The bond angle in H_2O is smaller than the bond angle in CH_4.

3 The bond angle in NH_3 is smaller than the bond angle in BF_3.

32 An energy profile diagram is shown.



What do the labels on the diagram represent?

1 W = ΔH of the forward reaction, Y = E_a of the backward reaction

2 Z = ΔH of the backward reaction, Y = E_a of the backward reaction

3 X = ΔH of the forward reaction, W = E_a of the forward reaction

33 Which are assumptions of the kinetic theory of gases and hence of the ideal gas equation, $PV = nRT$?

1 Molecules move without interacting with one another except for collisions.

2 Intermolecular forces are negligible.

3 Intermolecular distances are much greater than the molecular size.

34 *Use of the Data Booklet is relevant to this question.*

Which properties would be expected for radium, $_{88}Ra$, or its compounds?

1 Radium carbonate would not decompose at the temperature of a Bunsen flame.

2 Radium hydroxide is very insoluble.

3 Radium does not react with cold water.

35 When a firework is lit, a fuel and an oxidising agent react together.

In one such firework, magnesium is the fuel and barium nitrate is the oxidising agent.

Which solids are produced when the firework is lit?

1 BaO

2 MgO

3 $Mg(NO_3)_2$

36 In a car engine, non-metallic element ***X*** forms a pollutant oxide ***Y***.

Further oxidation of ***Y*** to ***Z*** occurs spontaneously in the atmosphere. In this further oxidation, 1 mol of ***Y*** reacts with 0.5 mol of gaseous oxygen.

Which statements about ***X***, ***Y*** and ***Z*** are correct?

1 The oxidation number of ***X*** increases by 2 from ***Y*** to ***Z***.

2 The molecule of ***Y*** has no unpaired electrons.

3 The molecule of ***Z*** contains three oxygen atoms.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

37 Compound **X** has molecular formula $C_4H_{10}O$. Separate samples of **X** are tested with three different reagents.

Which results could **not** be obtained?

	Tollens' reagent	2,4-dinitrophenylhydrazine reagent	warm acidified potassium dichromate(VI) solution
1	silver mirror forms	orange precipitate forms	colour changes from orange to green
2	no change	no change	no change
3	no change	no change	colour changes from orange to green

38 **Y** is an organic compound. **Y** gives a precipitate with aqueous silver nitrate. All of this precipitate dissolves when concentrated aqueous ammonia is added.

What is a possible identity for **Y**?

1 1-bromopropane

2 chloroethane

3 2-iodo-2-methylpropane

39 Which compounds will produce ethanoic acid when boiled under reflux with dilute alkali followed by acidification?

1 CH_3CH_2Cl

2 $CH_3CO_2CH_3$

3 CH_3CN

40 Which pairs of homologous series have the same C:H ratio in their general formulae?

1 aldehydes and ketones

2 carboxylic acids and esters

3 alkenes and ketones

BLANK PAGE

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9701 CHEMISTRY

9701/12 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**A**	21	**C**
2	**A**	22	**D**
3	**D**	23	**A**
4	**C**	24	**B**
5	**C**	25	**B**
6	**B**	26	**A**
7	**D**	27	**A**
8	**C**	28	**B**
9	**D**	29	**D**
10	**A**	30	**A**
11	**C**	31	**A**
12	**B**	32	**C**
13	**C**	33	**A**
14	**C**	34	**D**
15	**D**	35	**B**
16	**B**	36	**D**
17	**C**	37	**D**
18	**D**	38	**B**
19	**C**	39	**C**
20	**C**	40	**A**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/13**

Paper 1 Multiple Choice **May/June 2011**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 4 2 9 8 6 4 6 2 5 4 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **14** printed pages and **2** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Which equation represents the second ionisation energy of an element X?

A $X(g) \rightarrow X^{2+}(g) + 2e$

B $X^{+}(g) \rightarrow X^{2+}(g) + e$

C $X(g) + 2e \rightarrow X^{2}(g)$

D $X(g) + e \rightarrow X^{2}(g)$

2 Which factor helps to explain why the first ionisation energies of the Group I elements decrease from lithium to sodium to potassium to rubidium?

A The nuclear charge of the elements increases.

B The outer electron is in an 's' subshell.

C The repulsion between spin-paired electrons increases.

D The shielding effect of the inner shells increases.

3 In the extraction of aluminium by the electrolysis of molten aluminium oxide, why is cryolite added to the aluminium oxide?

A to ensure the aluminium is not oxidised

B to ensure the anode is not oxidised

C to lower the melting point of the aluminium oxide

D to prevent corrosion of the cathode

4 In flooded soils, like those used for rice cultivation, the oxygen content is low. In such soils, anaerobic bacteria cause the loss of nitrogen from the soil as shown in the following sequence.

In which step is the change in oxidation number (oxidation state) of nitrogen different to the changes in the other steps?

$$NO_3^-(aq) \xrightarrow{\textbf{A}} NO_2^-(aq) \xrightarrow{\textbf{B}} NO(g) \xrightarrow{\textbf{C}} N_2O(g) \xrightarrow{\textbf{D}} N_2(g)$$

5 In the last century the Haber process was sometimes run at pressures of 1000 atm and higher. Now it is commonly run at pressures below 100 atm.

What is the reason for this change?

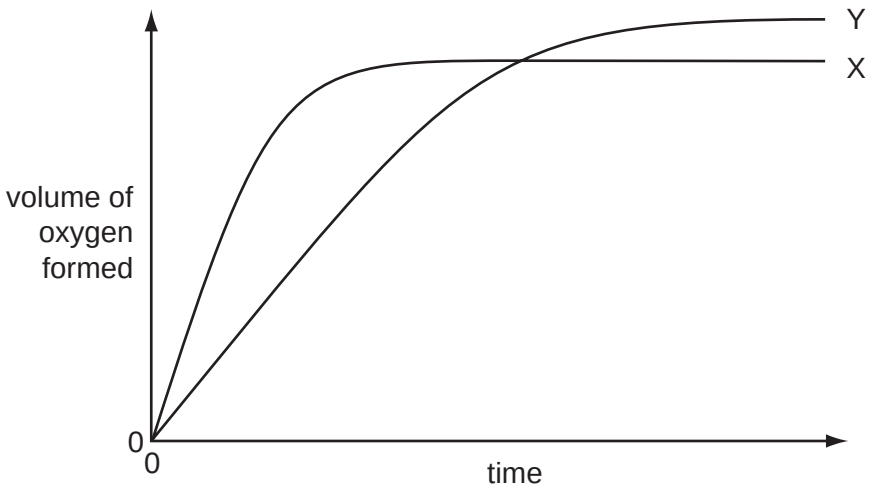
A An iron catalyst is used.

B Maintaining the higher pressures is more expensive.

C The equilibrium yield of ammonia is increased at lower pressures.

D The rate of the reaction is increased at lower pressures.

6 In the diagram, curve X was obtained by observing the decomposition of 100 cm^3 of 1.0 mol dm^{-3} hydrogen peroxide, catalysed by manganese(IV) oxide.



Which alteration to the original experimental conditions would produce curve Y?

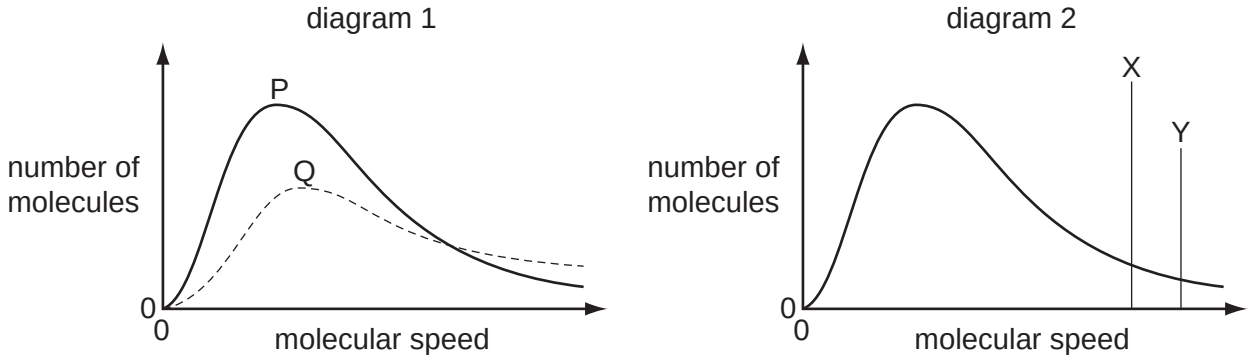
A adding some 0.1 mol dm^{-3} hydrogen peroxide

B adding water

C lowering the temperature

D using less manganese(IV) oxide

7 Different Boltzmann distributions are shown in the diagrams.



In diagram 1, one curve P or Q corresponds to a temperature higher than that of the other curve.

In diagram 2, one line X or Y corresponds to the activation energy for a catalysed reaction and the other line corresponds to the activation energy of the same reaction when uncatalysed.

Which combination gives the correct curve and line?

	higher temperature	presence of catalyst
A	P	X
B	P	Y
C	Q	X
D	Q	Y

8 50 cm^3 of 2.50 mol dm^{-3} hydrochloric acid was placed in a polystyrene beaker of negligible heat capacity. Its temperature was recorded and then 50 cm^3 of 2.50 mol dm^{-3} NaOH at the same temperature was quickly added, with stirring. The temperature rose by 17 °C.

The resulting solution may be considered to have a specific heat capacity of 4.2 J g^{-1} K^{-1}.

What is an approximate value for the molar enthalpy change of neutralisation of hydrochloric acid and sodium hydroxide from this experiment?

A $\frac{(50 \times 4.2 \times 17)}{(0.050 \times 2.5)}$ J mol^{-1}

B $\frac{(50 \times 4.2 \times 17)}{(0.10 \times 2.5)}$ J mol^{-1}

C $\frac{(100 \times 4.2 \times 17)}{(0.050 \times 2.5)}$ J mol^{-1}

D $\frac{(100 \times 4.2 \times 17)}{(50 \times 2.5)}$ J mol^{-1}

9 The equation below represents the combination of gaseous atoms of non-metal X and of hydrogen to form gaseous X_2H_6 molecules.

$$2X(g) + 6H(g) \rightarrow X_2H_6(g) \qquad \Delta H = -2775\,kJ\,mol^{-1}$$

The bond energy of an X–H bond is 395 kJ mol $^{-1}$.

What is the bond energy of an X–X bond?

A $-405.0\,kJ\,mol^{-1}$

B $-202.5\,kJ\,mol^{-1}$

C $+202.5\,kJ\,mol^{-1}$

D $+405.0\,kJ\,mol^{-1}$

10 In which change would only van der Waals' forces have to be overcome?

A evaporation of ethanol $C_2H_5OH(l) \rightarrow C_2H_5OH(g)$

B melting of ice $H_2O(s) \rightarrow H_2O(l)$

C melting of solid carbon dioxide $CO_2(s) \rightarrow CO_2(l)$

D solidification of butane $C_4H_{10}(l) \rightarrow C_4H_{10}(s)$

11 Hydrazine, N_2H_4, is widely used as a rocket fuel because it reacts with oxygen as shown, producing 'environmentally friendly' gases.

$$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \Delta H = -534\,kJ\,mol^{-1}$$

Despite its use as a rocket fuel, hydrazine does not burn spontaneously in oxygen.

Which statement explains why hydrazine does **not** burn spontaneously?

A Hydrazine is a liquid.

B The activation energy is too high.

C The N≡N bond is very strong.

D The reaction is exothermic.

12 0.02 mol of aluminium is burned in oxygen and the product is reacted with 2.00 mol dm $^{-3}$ hydrochloric acid.

What minimum volume of acid will be required for complete reaction?

A $15\,cm^3$ **B** $20\,cm^3$ **C** $30\,cm^3$ **D** $60\,cm^3$

13 Three substances, R, S and T, have physical properties as shown.

substance	R	S	T
mp / °C	801	2852	3550
bp / °C	1413	3600	4827
electrical conductivity of solid	poor	poor	good

What could be the identities of R, S and T?

	R	S	T
A	MgO	NaCl	C [graphite]
B	MgO	NaCl	SiO_2
C	NaCl	MgO	C [graphite]
D	NaCl	MgO	SiO_2

14 Steam is passed over heated magnesium to give compound X and hydrogen.

What is **not** a property of compound X?

A It has an M_r of 40.3.

B It is basic.

C It is a white solid.

D It is very soluble in water.

15 Nitrogen monoxide, NO, is a primary pollutant produced by petrol engines and is found in their exhaust gases.

Which reaction occurs in a catalytic converter and decreases the emission of nitrogen monoxide?

A $NO(g) + CO(g) \rightarrow NO_2(g) + C(s)$

B $NO(g) + CO_2(g) \rightarrow NO_2(g) + CO(g)$

C $2NO(g) + 2CO(g) \rightarrow N_2(g) + 2CO_2(g)$

D $2NO(g) + CO_2(g) \rightarrow 2NO_2(g) + C(s)$

16 X, Y and Z represent different halogens. The table shows the results of nine experiments in which aqueous solutions of X_2, Y_2 and Z_2 were separately added to separate aqueous solutions containing X^-, Y^- and Z^- ions.

	$X^-(aq)$	$Y^-(aq)$	$Z^-(aq)$
$X_2(aq)$	no reaction	no reaction	no reaction
$Y_2(aq)$	X_2 formed	no reaction	Z_2 formed
$Z_2(aq)$	X_2 formed	no reaction	no reaction

Which row in the following table contains the ions X^-, Y^- and Z^- in order of their decreasing strength as reducing agents?

	strongest ⟶		weakest
A	X^-	Y^-	Z^-
B	X^-	Z^-	Y^-
C	Y^-	Z^-	X^-
D	Z^-	X^-	Y^-

17 A student observed the reactions when sodium chloride and sodium iodide were each reacted separately with concentrated sulfuric acid and with concentrated phosphoric acid. The observations are recorded in the table.

	sodium chloride	sodium iodide
conc. H_2SO_4	colourless acidic gas formed	purple vapour formed
conc. H_3PO_4	colourless acidic gas formed	colourless acidic gas formed

Which deduction can be made from these observations?

A Concentrated phosphoric acid is a stronger oxidising agent than concentrated sulfuric acid.

B Concentrated phosphoric acid is a stronger oxidising agent than iodine.

C Concentrated sulfuric acid is a stronger oxidising agent than chlorine.

D Concentrated sulfuric acid is a stronger oxidising agent than iodine.

18 Ammonium nitrate, NH_4NO_3, is manufactured in large quantities for use in fertiliser.

Which statement about ammonium nitrate fertiliser is **not** correct?

A It can cause environmental problems.

B It consists of 35 % nitrogen by mass.

C It is insoluble in water.

D Nitric acid is used in its manufacture.

19 Butanedioic acid occurs in amber, algae, lichens, sugar cane and beets. It may be synthesised in two steps from 1,2-dibromoethane.

$$BrCH_2CH_2Br \xrightarrow{\text{step 1}} X \xrightarrow{\text{step 2}} HO_2CCH_2CH_2CO_2H$$

Which reagents could be used for this synthesis?

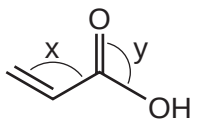
	step 1	step 2
A	HCN(g)	HC*l*(aq)
B	HCO_2Na(aq)	HC*l*(aq)
C	KCN(aq / alcoholic)	H_2SO_4(aq)
D	NaOH(aq)	$K_2Cr_2O_7$ / H_2SO_4(aq)

20 The formula CH_3 can represent an anion, a cation or a free radical. Species with the molecular formula CH_3 can act as an electrophile, a free radical or a nucleophile depending on the number of outer shell electrons on the central carbon atom.

How many outer shell electrons must be present for CH_3 to act in these different ways?

	CH_3 as an electrophile	CH_3 as a free radical	CH_3 as a nucleophile
A	6	7	8
B	6	8	7
C	7	6	8
D	8	7	6

21 Acrylic acid is produced from propene, a gaseous product of oil refineries.



acrylic acid

Which statement about acrylic acid is **not** correct?

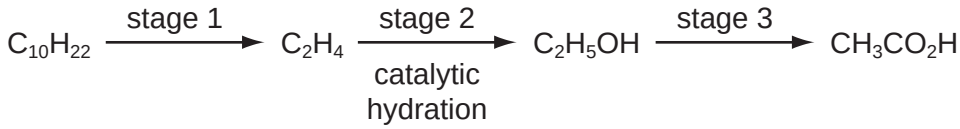
A Both bond angles x and y are approximately 120°.

B It decolourises aqueous bromine.

C It gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent.

D It reacts with an alcohol to give an ester.

22 In the reaction pathway below, an alkane is converted into a carboxylic acid through several stages.



Which processes occur at stage 1 and at stage 3?

	stage 1	stage 3
A	condensation	combustion
B	cracking	dehydration
C	cracking	oxidation
D	dehydration	combustion

23 A compound Y is treated with warm acidified potassium dichromate(VI). The resulting organic product gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent but does not give a silver mirror with Tollens' reagent.

What is Y?

A butan-1-ol

B butan-2-ol

C butanal

D 2-methylpropan-2-ol

24 Compound X changes the colour of warm acidified sodium dichromate(VI) from orange to green. 1 mol of X reacts with 2 mol of HCN in the presence of KCN.

What could X be?

A $CH_3CH_2CH_2CHO$

B $CH_3COCH_2COCH_3$

C $H_2C{=}CHCH_2CHO$

D $OHCCH_2CH_2CHO$

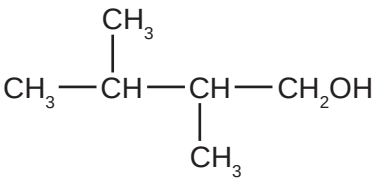
25 Pentanol, $C_5H_{11}OH$, has four structural isomers that are primary alcohols.

How many of these primary alcohols contain a chiral carbon atom?

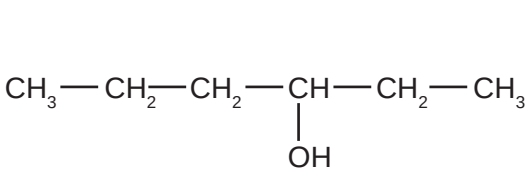
A 0 **B** 1 **C** 2 **D** 3

26 Which isomer of $C_6H_{13}OH$ gives the greatest number of different alkenes when it is dehydrated?

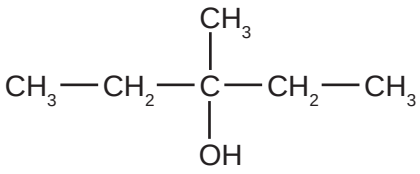
A



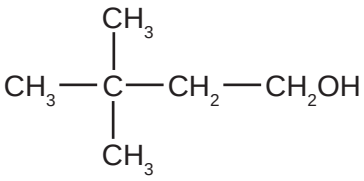
B



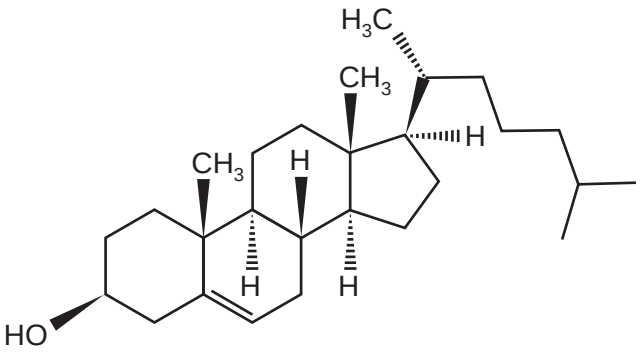
C



D



27 The diagram shows the structure of the naturally-occurring molecule cholesterol.



cholesterol

Student X claimed that the seventeen carbon atoms in the four rings all lie in the same plane.

Student Y claimed that this molecule displays *cis-trans* isomerism at the C=C double bond.

Which of the students are correct?

A both X and Y

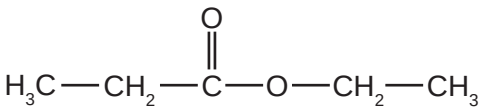
B neither X nor Y

C X only

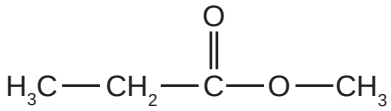
D Y only

28 Which formula represents an ester which will form sodium ethanoate on hydrolysis with aqueous sodium hydroxide?

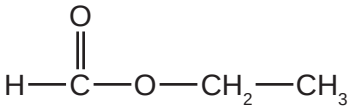
A



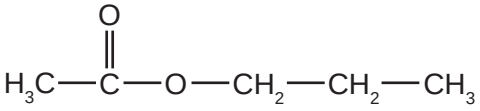
B



C



D



29 The functional group in a primary alcohol is $–CH_2OH$.

Which reagent reacts with a primary alcohol, under suitable conditions, to give an organic product with the same number of oxygen atoms as the alcohol?

A Al_2O_3 **B** CH_3CO_2H **C** HBr **D** Na

30 Aldehydes and ketones are carbonyl compounds.

Which of them react with $NaBH_4$ **and** react with Fehling's reagent?

A both aldehydes and ketones

B aldehydes only

C ketones only

D neither aldehydes nor ketones

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Which are features of the structure of metallic copper?

1 a lattice of ions

2 delocalised electrons

3 ionic bonds

32 *Use of the Data Booklet is relevant to this question.*

Zinc reacts with hydrochloric acid according to the following equation.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Which statements are correct?

[All volumes are measured at room conditions.]

1 A 3.27 g sample of zinc reacts with an excess of hydrochloric acid to give 0.050 mol of zinc chloride.

2 A 6.54 g sample of zinc reacts completely with exactly 100 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

3 A 13.08 g sample of zinc reacts with an excess of hydrochloric acid to give 9.60 dm^3 of hydrogen.

33 Which statements are correct in terms of the Brønsted-Lowry theory of acids and bases?

1 Water can act as either an acid or a base.

2 Sulfuric acid, H_2SO_4, does not behave as an acid when dissolved in ethanol, C_2H_5OH.

3 The ammonium ion acts as a base when dissolved in liquid ammonia.

34 Which descriptions of the ammonium ion are correct?

1 It contains ten electrons.

2 It has a bond angle of 109.5°.

3 It has only three bonding pairs of electrons.

35 *Use of the Data Booklet is relevant to this question.*

The element astatine lies below iodine in Group VII of the Periodic Table.

What will be the properties of astatine?

1 It forms diatomic molecules which dissociate more readily than chlorine molecules.

2 It reacts explosively with hydrogen.

3 It can oxidise iodide to iodine.

36 Which statements are correct?

1 Aluminium chloride dissolves in water to give an acidic solution.

2 Magnesium chloride dissolves in water to give a slightly acidic solution.

3 Sodium chloride dissolves in water to give an alkaline solution.

37 Which alkenes, on reaction with steam at 600 K and 6 x 10^6 Pa pressure in the presence of a phosphoric acid catalyst, could produce an alcohol containing a chiral carbon atom?

1 $(CH_3)_2C=CH_2$

2 $CH_3CH=CHCH_3$

3 $CH_3CH_2CH=CH_2$

38 Which oxides react with water to give a solution of pH 10 or higher?

1 CaO

2 Na_2O

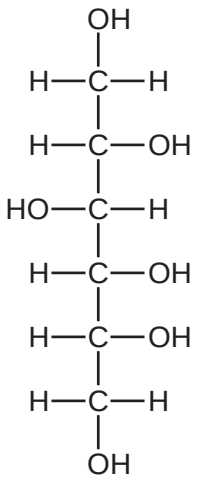
3 SrO

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

39 Sorbitol is an artificial sweetener used to sweeten chocolate which is suitable for diabetics.



sorbitol

Which functional groups can be produced when this molecule is subjected to oxidation under suitable conditions?

1 aldehyde

2 carboxylic acid

3 ketone

40 Bromoethane undergoes all of the conversions shown.

Which conversions are examples of nucleophilic substitution?

1 $C_2H_5Br \rightarrow C_2H_5CN$

2 $C_2H_5Br \rightarrow C_2H_5OH$

3 $C_2H_5Br \rightarrow C_2H_5NH_2$

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/13 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**C**
2	**D**	22	**C**
3	**C**	23	**B**
4	**A**	24	**D**
5	**B**	25	**B**
6	**A**	26	**B**
7	**C**	27	**D**
8	**C**	28	**D**
9	**D**	29	**D**
10	**C**	30	**B**
11	**B**	31	**B**
12	**C**	32	**D**
13	**C**	33	**D**
14	**D**	34	**B**
15	**C**	35	**D**
16	**B**	36	**B**
17	**D**	37	**C**
18	**C**	38	**A**
19	**C**	39	**A**
20	**A**	40	**A**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/13**

Paper 1 Multiple Choice **October/November 2011**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

3160072507

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **13** printed pages and **3** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 *Use of the Data Booklet is relevant to this question.*

Lead(IV) chloride will oxidise bromide ions to bromine. The Pb^{4+} ions are reduced to Pb^{2+} ions in this reaction.

If 6.980 g of lead(IV) chloride is added to an excess of sodium bromide solution, what mass of bromine would be produced?

A 0.799 g **B** 1.598 g **C** 3.196 g **D** 6.392 g

2 Which element has an equal number of electron pairs and of unpaired electrons within orbitals of principal quantum number 2?

A beryllium

B carbon

C nitrogen

D oxygen

3 Three elements, **X**, **Y** and **Z**, have the physical properties shown in the table.

element	melting point / °C	boiling point / °C	density / g cm^{-3}
X	–7	59	3.12
Y	98	883	0.97
Z	649	1107	1.74

What could be the identities of **X**, **Y** and **Z**?

	X	**Y**	**Z**
A	Br_2	A*l*	Si
B	Br_2	Na	Mg
C	I_2	Mg	Na
D	I_2	Si	K

4 At room temperature and pressure chlorine does not behave as an ideal gas.

At which temperature and pressure would the behaviour of chlorine become more ideal?

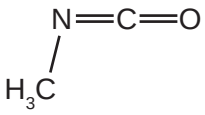
	pressure /kPa	temperature /K
A	50	200
B	50	400
C	200	200
D	200	400

5 Methyl isocyanate, CH_3NCO, is a toxic liquid which is used in the manufacture of some pesticides.

In the methyl isocyanate molecule, the sequence of atoms is $H_3C—N=C=O$.

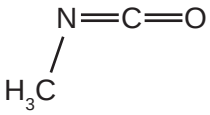
What is the approximate angle between the bonds formed by the N atom?

A



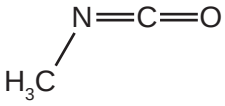
104°

B



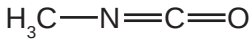
109°

C



120°

D



180°

6 When chlorine and aqueous sodium hydroxide are heated together the following overall reaction occurs.

$$3Cl_2(aq) + 6NaOH(aq) \rightarrow 5NaCl(aq) + NaClO_3(aq) + 3H_2O(l)$$

What are the oxidation numbers for chlorine in each of the following species?

	Cl_2	$NaCl$	$NaClO_3$
A	0	+1	–5
B	+2	–1	+3
C	0	–1	+5
D	–2	+1	–3

7 The standard enthalpy change for the reaction

$$2NF_3(g) \rightarrow 2N(g) + 6F(g) \qquad \text{is } \Delta H^{\ominus} = +1668\,\text{kJ}$$

What is the bond energy of the N–F bond?

A $-556\,\text{kJ mol}^{-1}$

B $-278\,\text{kJ mol}^{-1}$

C $+278\,\text{kJ mol}^{-1}$

D $+556\,\text{kJ mol}^{-1}$

8 When gaseous iodine is heated with hydrogen at 450 °C, an equilibrium is established.

$$\underset{\text{colourless}}{H_2(g)} + \underset{\text{purple}}{I_2(g)} \rightleftharpoons \underset{\text{colourless}}{2HI(g)} \qquad \Delta H = +53\,\text{kJ mol}^{-1}$$

Which change of conditions will cause the purple colour of the equilibrium mixture to become paler?

A decrease in pressure

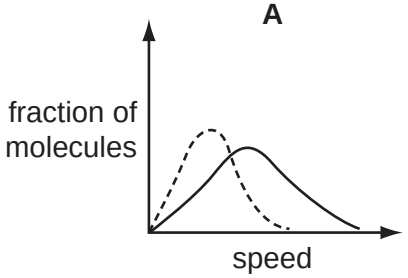
B decrease in temperature

C increase in pressure

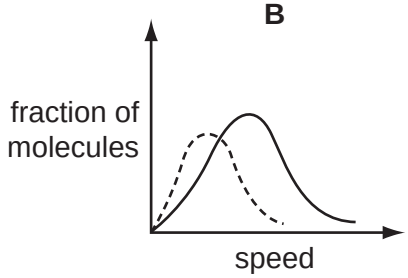
D increase in temperature

9 Which solid-line curve most accurately represents the distribution of molecular speeds in a gas at 500 K if the dotted-line curve represents the corresponding distribution for the same gas at 300 K?

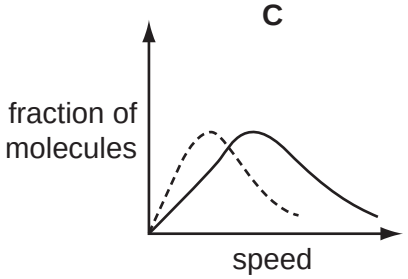
A



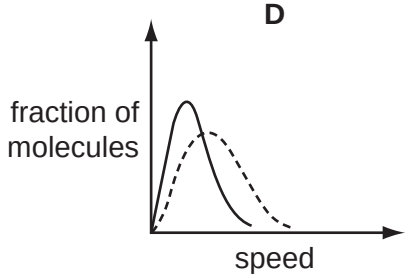
B



C



D



10 Sulfur dioxide is used as a preservative in wine making.

The following equations describe how sulfur dioxide dissolves.

$$H_2O + SO_2 \rightleftharpoons HSO_3^- + H^+$$

$$HSO_3^- + H^+ \rightleftharpoons SO_3^{2-} + 2H^+$$

Which statement about these two reactions is correct?

A HSO_3^- acts as a base.

B SO_2 acts as an oxidising agent.

C SO_3^{2-} acts as an acid.

D SO_3^{2-} acts as a reducing agent.

11 Butanedioate ions can be dehydrogenated to form *trans*-butenedioate ions. The enzyme fumarase speeds up this reaction.

Why does fumarase speed up this reaction?

A Fumarase is a protein.

B Fumarase is effective at body temperature.

C Fumarase lowers the activation energy of the dehydrogenation reaction.

D The enzyme fumarase is specific for this dehydrogenation reaction.

12 An aqueous solution was prepared containing 1.0 mol of $AgNO_3$ and 1.0 mol of $FeSO_4$ in 1.00 dm^3 of water. When equilibrium was established, there was 0.44 mol of $Ag^+(aq)$ in the mixture.

$$Ag^+(aq) + Fe^{2+}(aq) \rightleftharpoons Ag(s) + Fe^{3+}(aq)$$

What is the numerical value of K_c?

A 0.35 **B** 0.62 **C** 1.62 **D** 2.89

13 Which element shows the greatest tendency to form some covalent compounds?

A aluminium

B magnesium

C neon

D potassium

14 *Use of the Data Booklet is relevant to this question.*

A 5.00 g sample of an anhydrous Group II metal nitrate loses 3.29 g in mass when heated strongly.

Which metal is present?

A magnesium

B calcium

C strontium

D barium

15 *Use of the Data Booklet is relevant to this question.*

A significant contribution to atmospheric carbon dioxide levels comes from the thermal decomposition of limestone, in the manufacture of cement and of lime for agricultural purposes.

Cement works roast 1000 million tonnes of limestone per year and a further 200 million tonnes is roasted in kilns to make lime.

What is the total annual mass output of carbon dioxide (in million tonnes) from these two processes?

A 440 **B** 527 **C** 660 **D** 880

16 Why do the halogens become less volatile as Group VII is descended?

A The halogen-halogen bond energy decreases.

B The halogen-halogen bond length increases.

C The number of electrons in each molecule increases.

D The van der Waals' forces between molecules become weaker.

17 Aqueous sodium chloride (brine) is electrolysed by using inert electrodes in a cell which is stirred so that products of electrolysis react with each other. The cell is kept cold.

Which pair of substances is among the major products?

A hydrogen and chlorine

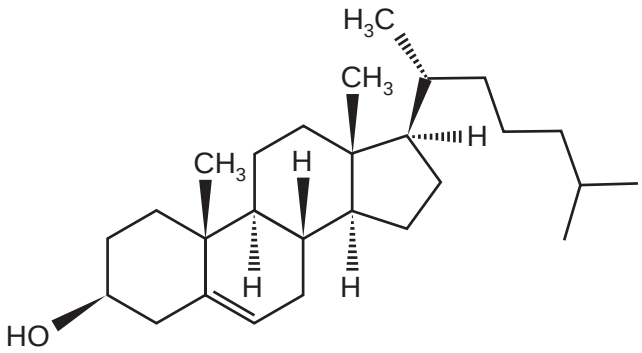
B hydrogen and sodium chlorate(I)

C hydrogen and sodium chlorate(V)

D sodium hydroxide and chlorine

18 This question should be answered by considering the reactions of $KMnO_4$ with different functional groups under the stated conditions.

The diagram shows the structure of the naturally-occurring molecule cholesterol.



cholesterol

Separate oxidation reactions are carried out using different conditions.

- cold, dilute acidified $KMnO_4$
- hot, concentrated acidified $KMnO_4$

Which statements about the **products** formed are correct?

	cold, dilute acidified $KMnO_4$: number of hydroxy groups present	hot, concentrated acidified $KMnO_4$: number of 6-membered rings remaining
A	1	2
B	1	3
C	3	2
D	3	3

19 Which reaction is endothermic?

A $2HBr \rightarrow H_2 + Br_2$

B $N_2 + 3H_2 \rightarrow 2NH_3$

C $2SO_2 + O_2 \rightarrow 2SO_3$

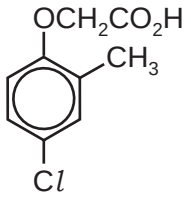
D $SO_3 + H_2O \rightarrow H_2SO_4$

20 Total removal of the pollutant sulfur dioxide, SO_2, is difficult, both for economic and technical reasons. The quantities emitted from furnace chimneys can be lowered by using desulfurisation plants. The gases are scrubbed (washed) with calcium hydroxide to remove the SO_2.

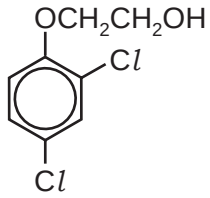
What is the main product formed **initially**?

A $Ca(HSO_4)_2$ **B** CaS **C** $CaSO_3$ **D** $CaSO_4$

21 **Y** and **Z** are two widely-used selective weed killers.



Y



Z

Which reagent will distinguish **Y** from **Z**?

A acidified $AgNO_3(aq)$

B Fehling's solution

C Na

D $Na_2CO_3(aq)$

22 What is involved in the mechanism of the reaction between aqueous sodium hydroxide and 1-bromobutane?

A attack by a nucleophile on a carbon atom with a partial positive charge

B heterolytic bond fission and attack by a nucleophile on a carbocation

C homolytic bond fission and attack by an electrophile on a carbanion

D homolytic bond fission and attack by a nucleophile on a carbocation

23 In the general formula of which class of compound, is the ratio of hydrogen atoms to carbon atoms the highest?

A alcohols

B aldehydes

C carboxylic acids

D halogenoalkanes

24 Many different compounds have been used in aerosol sprays, refrigerators and in making foamed plastics.

Which compound will cause the **most** ozone depletion?

A CCl_3F

B $CH_2FCHClF$

C $CH_3CH_2CH_2CH_3$

D N_2O

25 *Use of the Data Booklet is relevant to this question.*

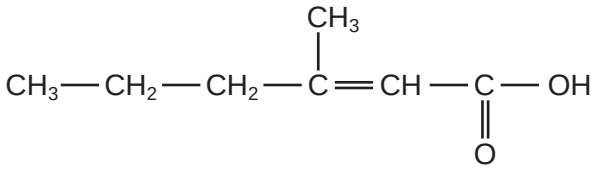
2.76 g of ethanol were mixed with an excess of aqueous acidified potassium dichromate(VI). The reaction mixture was then boiled under reflux for one hour. The organic product was then collected by distillation.

The yield of product was 75.0 %.

What mass of product was collected?

A 1.98 g **B** 2.07 g **C** 2.70 g **D** 4.80 g

26 An unpleasant smelling chemical produced in the human armpit is 3-methylhex-2-enoic acid.



If this compound is reacted with a cold, dilute, acidified solution of potassium manganate(VII), how many chiral centres will be produced?

A 0 **B** 1 **C** 2 **D** 3

27 Energy is released in the human body by the oxidation of glucose in a complex sequence of reactions. Part of this sequence is the Krebs cycle. One reaction in the Krebs cycle is the conversion of fumaric acid into malic acid.

$$HO_2CCH{=}CHCO_2H \rightarrow HO_2CCH(OH)CH_2CO_2H$$

fumaric acid malic acid

Which reagents could achieve this transformation in the laboratory?

A acidified $KMnO_4$

B Br_2(aq) followed by hot NaOH(aq)

C H_2O with Pt catalyst

D steam with H_2SO_4

28 A reaction between chlorine and propane in ultraviolet light produces two isomeric monochloropropanes, C_3H_7Cl, as products.

Which information about this reaction is correct?

	type of bond fission in initiation step	expected ratio of 1-chloropropane to 2-chloropropane produced
A	heterolytic	1 : 1
B	heterolytic	3 : 1
C	homolytic	1 : 1
D	homolytic	3 : 1

29 Which pair of substances could react to give the ester $CH_3CH_2CO_2CH_3$?

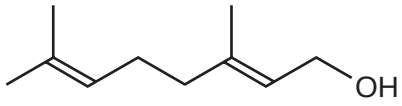
A ethanol and ethanoic acid

B methanol and ethanoic acid

C methanol and propanoic acid

D propan-1-ol and methanoic acid

30 Geraniol is a constituent of some perfumes.



geraniol

Which statement about geraniol is **not** correct?

A Geraniol causes hot acidified potassium dichromate(VI) to change colour from orange to green.

B Geraniol decolourises bromine water.

C There are three methyl groups and three methylene (CH_2) groups in geraniol.

D There are two pairs of *cis-trans* isomers of geraniol.

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 The definitions of many chemical terms can be illustrated by chemical equations.

Which terms can be illustrated by an equation that shows the formation of a positive ion?

1 first ionisation energy

2 heterolytic fission

3 enthalpy change of atomisation

32 The three statements that follow are all true.

Which of these can be explained, at least in part, by reference to hydrogen bonding?

1 At 0 °C ice floats on water.

2 The boiling point of propan-2-ol is 82 °C. The boiling point of propanone is 56 °C.

3 At 20 °C propanone and propanal mix completely.

33 Which of the halide ions, chloride, bromide or iodide, acts as a reducing agent when its sodium salt reacts with concentrated sulfuric acid?

1 at least one of Cl , Br and I

2 at least two of Cl , Br and I

3 all three of Cl , Br and I

34 Why does aluminium chloride, Al_2Cl_6, sublime at the relatively low temperature of 180 °C?

1 The intermolecular forces between the Al_2Cl_6 molecules are weak.

2 The co-ordinate bonds between aluminium and chlorine are weak.

3 The covalent bonds between aluminium and chlorine are weak.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

35 A farmer spreads lime on land which has already been treated with an ammonium nitrate fertiliser.

Which reactions will occur in the treated soil?

1 $Ca(OH)_2 + 2NH_4^+(aq) \rightarrow Ca^{2+}(aq) + 2NH_3 + 2H_2O$

2 $Ca(OH)_2 + 2H^+(aq) \rightarrow Ca^{2+}(aq) + 2H_2O$

3 $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

36 In a car engine, non-metallic element X forms a pollutant oxide Y.

Further oxidation of Y to Z occurs spontaneously in the atmosphere. In this further oxidation, 1 mol of Y reacts with 0.5 mol of gaseous oxygen.

Which statements about X, Y and Z are correct?

1 X forms a basic hydride.

2 Y is a diatomic molecule.

3 Z is a polar molecule.

37 **X** is an organic compound. **X** gives a precipitate with aqueous silver nitrate. Some or all of this precipitate remains undissolved when an excess of dilute aqueous ammonia is added.

What could be the identity of **X**?

1 2-chlorobutane

2 2-bromobutane

3 iodomethane

38 On acid hydrolysis, which compounds produce propanoic acid?

1 $CH_3CH_2CO_2CH_3$

2 $CH_3CH_2CH_2CN$

3 $CH_3CH_2CH_2Cl$

39 Disaccharides, $C_{12}H_{22}O_{11}$, are important in the human diet. For example, sucrose is found in pastries and lactose occurs in milk products.

Both of these compounds can be hydrolysed.

$$\text{sucrose} + H_2O \rightarrow \underset{\text{glucose}}{CH_2OH(CHOH)_4CHO} + \underset{\text{fructose}}{CH_2OH(CHOH)_3COCH_2OH}$$

$$\text{lactose} + H_2O \rightarrow \underset{\text{glucose}}{CH_2OH(CHOH)_4CHO} + \underset{\text{galactose}}{CH_2OH(CHOH)_4CHO}$$

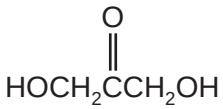
Which statements about these hydrolysis products are correct?

1 Glucose and fructose have structural isomers.

2 Glucose and galactose are optical isomers.

3 Glucose and galactose are ketones.

40 DHA is a colourless liquid which reacts with protein in skin to cause it to darken. It has the structure shown.



DHA

Which observations would be made when testing this substance?

1 Hydrogen is produced when sodium is added.

2 A coloured precipitate is produced when 2,4-dinitrophenylhydrazine reagent is added.

3 A silver precipitate is produced when Tollens' reagent is added.

BLANK PAGE

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9701 CHEMISTRY

9701/13 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**D**
2	**D**	22	**A**
3	**B**	23	**A**
4	**B**	24	**A**
5	**C**	25	**C**
6	**C**	26	**C**
7	**C**	27	**D**
8	**D**	28	**D**
9	**A**	29	**C**
10	**A**	30	**D**
11	**C**	31	**B**
12	**D**	32	**B**
13	**A**	33	**B**
14	**B**	34	**D**
15	**B**	35	**A**
16	**C**	36	**A**
17	**B**	37	**C**
18	**C**	38	**D**
19	**A**	39	**B**
20	**C**	40	**B**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **May/June 2012**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **14** printed pages and **2** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 In which species does the underlined atom have an incomplete outer shell?

A $\underline{B}F_3$ **B** $\underline{C}H_3^-$ **C** $F_2\underline{O}$ **D** $H_3\underline{O}^+$

2 Ammonia is manufactured by the Haber Process, in an exothermic reaction.

Assuming that the amount of catalyst remains constant, which change will **not** bring about an increase in the rate of the forward reaction?

A decreasing the size of the catalyst pieces

B increasing the pressure

C increasing the temperature

D removing the ammonia as it is formed

3 The equation for a reaction is shown.

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l)\ ;\ \Delta H = x\ \text{kJ mol}^{-1}$$

Which pair of descriptions is fully correct for this reaction?

	type(s) of enthalpy change	value of *x*
A	formation only	positive
B	formation only	negative
C	combustion, formation	positive
D	combustion, formation	negative

4 The value of the second ionisation energy of calcium is 1150 kJ mol^{-1}.

Which equation correctly represents this statement?

A $Ca(g) \rightarrow Ca^{2+}(g) + 2e\ ;\quad \Delta H^{\ominus} = +1150\ \text{kJ mol}^{-1}$

B $Ca^{+}(g) \rightarrow Ca^{2+}(g) + e\ ;\quad \Delta H^{\ominus} = +1150\ \text{kJ mol}^{-1}$

C $Ca^{+}(g) \rightarrow Ca^{2+}(g) + e\ ;\quad \Delta H^{\ominus} = -1150\ \text{kJ mol}^{-1}$

D $Ca(g) \rightarrow Ca^{2+}(g) + 2e\ ;\quad \Delta H^{\ominus} = -1150\ \text{kJ mol}^{-1}$

5 Two conversions are outlined below.

$$NH_4^+ \rightarrow NH_3$$

$$C_2H_4 \rightarrow C_2H_6$$

What similar feature do these two conversions have?

A a lone pair of electrons in the product

B change in oxidation state of an element

C decrease in bond angle of the species involved

D disappearance of a π bond

6 *Use of the Data Booklet is relevant to this question.*

The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

0.56 g of ethene gas is contained in a vessel at a pressure of 102 kPa and a temperature of 30 °C.

What is the volume of the vessel?

A 49 cm^3 **B** 494 cm^3 **C** 48 900 cm^3 **D** 494 000 cm^3

7 Propanone has the molecular formula C_3H_6O.

The enthalpy change of combustion of hydrogen is –286 kJ mol^{-1}.
The enthalpy change of combustion of carbon is –394 kJ mol^{-1}.
The enthalpy change of combustion of propanone is –1786 kJ mol^{-1}.

Using this information, what is the enthalpy change of formation of propanone?

A –1106 kJ mol^{-1}

B –540 kJ mol^{-1}

C –254 kJ mol^{-1}

D +1106 kJ mol^{-1}

8 Under which set of conditions is a gas most likely to behave ideally?

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

9 Two moles of compound P were placed in a vessel. The compound P was partly decomposed by heating. A dynamic equilibrium between chemicals P, Q and R was established.

At equilibrium, *x* mol of R were present and the total number of moles present was (2 + *x*).

What is the equation for this equilibrium?

A $P \rightleftharpoons 2Q + R$

B $2P \rightleftharpoons 2Q + R$

C $2P \rightleftharpoons Q + R$

D $2P \rightleftharpoons Q + 2R$

10 The oxide of titanium, TiO_2, is used as a 'whitener' in toothpaste. It is obtained from the ore iron(II) titanate, $FeTiO_3$.

What is the change, if any, in the oxidation number (oxidation state) of titanium in the reaction $FeTiO_3 \rightarrow TiO_2$?

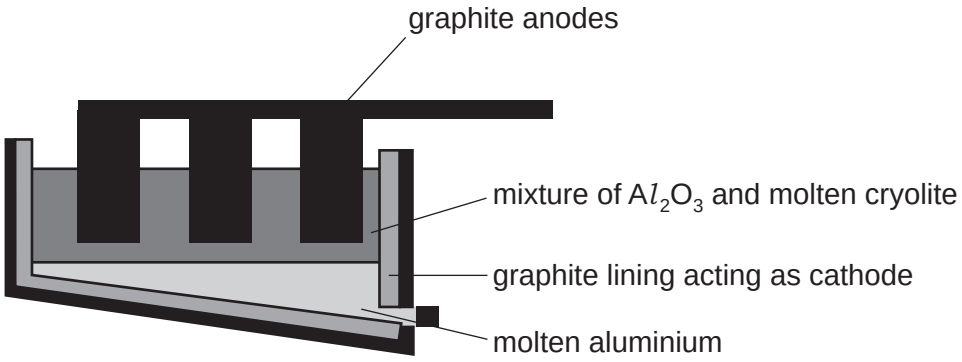
A It is oxidised from +3 to +4.

B It is reduced from +3 to +2.

C It is reduced from +6 to +4.

D There is no change in the oxidation number.

11 The diagram shows a cell for the manufacture of aluminium.



Which statement is **incorrect**?

A Aluminium ions are oxidised in this process.

B Aluminium is liberated at the cathode by the reaction $Al^{3+} + 3e \rightarrow Al$.

C The cryolite acts as a solvent.

D The graphite anode burns away.

12 Aluminium chloride catalyses certain reactions by forming carbocations with chloroalkanes as shown.

$$RCl + AlCl_3 \rightarrow R^+ + AlCl_4$$

Which property makes this reaction possible?

A $AlCl_3$ exists as the dimer Al_2Cl_6 in the vapour.

B $AlCl_3$ is a covalent molecule.

C The aluminium atom in $AlCl_3$ has an incomplete octet of electrons.

D The chlorine atom in RCl has a vacant p orbital.

13 *Use of the Data Booklet is relevant to this question.*

When a mineral was heated in a Bunsen flame to constant mass, a colourless gas that turned lime water milky was evolved. The remaining solid was cooled and then added to aqueous hydrochloric acid. Vigorous effervescence was seen.

What was the mineral?

A aragonite, $CaCO_3$

B artinite, $MgCO_3.Mg(OH)_2.3H_2O$

C barytocalcite, $BaCO_3.CaCO_3$

D dolomite, $CaCO_3.MgCO_3$

14 *Use of the Data Booklet is relevant to this question.*

The reaction between aluminium powder and anhydrous barium nitrate is used as the propellant in some fireworks. The metal oxides and nitrogen are the only products.

Which volume of nitrogen, measured under room conditions, is produced when 0.783 g of anhydrous barium nitrate reacts with an excess of aluminium?

A 46.8 cm^3 **B** 72.0 cm^3 **C** 93.6 cm^3 **D** 144 cm^3

15 The oxides BaO, CaO, MgO and SrO all produce alkaline solutions when added to water.

Which oxide produces the saturated solution with the highest pH?

A BaO(aq) **B** CaO(aq) **C** MgO(aq) **D** SrO(aq)

16 In the treatment of domestic water supplies, chlorine is added to the water to form HC*l*O.

$$Cl_2(aq) + H_2O(l) \rightarrow H^+(aq) + Cl^-(aq) + HClO(aq)$$

The HC*l*O reacts further to give C*l*O$^-$ ions.

$$HClO(aq) + H_2O(l) \rightarrow H_3O^+(aq) + ClO^-(aq)$$

Both HC*l*O and C*l*O$^-$ kill bacteria by oxidation.

What is the overall change in oxidation number of chlorine when forming the C*l*O$^-$ ion from the aqueous chlorine?

A –1 **B** 0 **C** +1 **D** +2

17 What trend is observed on descending Group VII?

A The colours of the elements become lighter.

B The elements become more volatile.

C The hydrides of the elements become more thermally stable.

D The reactions of the elements with hydrogen become less vigorous.

18 The following two experiments are carried out with anhydrous potassium chloride and observations X and Y are made at the end of each experiment.

Concentrated sulfuric acid is added to the potassium chloride and the fumes produced are bubbled into aqueous potassium iodide solution - observation X.

The potassium chloride is dissolved in aqueous ammonia and this is then added to aqueous silver nitrate - observation Y.

What are the observations X and Y?

	X	Y
A	brown solution	colourless solution
B	brown solution	white precipitate
C	colourless solution	colourless solution
D	colourless solution	white precipitate

19 Carbon monoxide, CO, nitrogen monoxide, NO, and sulfur dioxide, SO_2, may all be present in the exhaust fumes from a car engine.

Which reaction concerning these compounds occurs in the atmosphere?

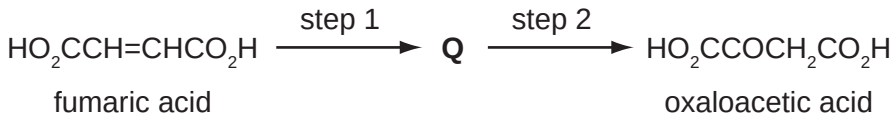
A CO is spontaneously oxidised to CO_2

B NO_2 is reduced to NO by CO

C NO_2 is reduced to NO by SO_2

D SO_2 is oxidised to SO_3 by CO_2

20 Fumaric acid can be converted into oxaloacetic acid by a two-step process involving the intermediate **Q**.



Each of these steps can be achieved in the laboratory by a single reagent.

What could be the intermediate **Q** and the reagent for step 2?

	Q	reagent for step 2
A	$HO_2CCHBrCH_2CO_2H$	warm acidified $KMnO_4$
B	$HO_2CCHBrCH(OH)CO_2H$	warm NaOH(aq)
C	$HO_2CCH(OH)CH_2CO_2H$	Fehling's solution
D	$HO_2CCH(OH)CH_2CO_2H$	warm acidified $K_2Cr_2O_7$

21 An organic compound **J** reacts with sodium to produce an organic ion with a charge of –3. **J** reacts with NaOH(aq) to produce an organic ion with a charge of –1.

What could be the structural formula of **J**?

A $HO_2CCH(OH)CH_2CO_2H$

B $HO_2CCH(OH)CH_2CHO$

C $HOCH_2CH(OH)CH_2CO_2H$

D $HOCH_2COCH_2CHO$

22 *Use of the Data Booklet is relevant to this question.*

A sample of ethyl propanoate is hydrolysed by heating under reflux with aqueous sodium hydroxide. The two organic products of the hydrolysis are separated, purified and weighed.

Out of the total mass of products obtained, what is the percentage by mass of each product?

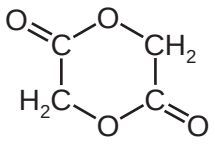
A 32.4 % and 67.6 %

B 38.3 % and 61.7 %

C 42.3 % and 57.7 %

D 50.0 % and 50.0 %

23 Compound C is used in textile and leather processing.



compound C

Which starting material(s), on gentle heating with a few drops of concentrated sulfuric acid, generates compound C?

A CH_3COOH only

B $HOCH_2COOH$ only

C CH_3COOCH_2COOH only

D CH_3COOH mixed with $HOCH_2COOH$

24 How many isomeric esters have the molecular formula $C_4H_8O_2$?

A 2 **B** 3 **C** 4 **D** 5

25 Which compound, on reaction with hydrogen cyanide, produces a compound with a chiral centre?

A CH_3CHO

B $CH_3CH_2COCH_2CH_3$

C $CH_3CO_2CH_3$

D HCHO

26 $CH_3COCH_2CH_2OH$ *W* CH_3COCH_2CHO *X* $CH_3CH(OH)CH_2CH_3$ *Y* $CH_3CH_2CH_2CHO$ *Z*

Which of these compounds can be oxidised by acidified dichromate(VI) solution and also gives a positive response to Tollens' reagent?

A *W* and *X* only

B *W* and *Y* only

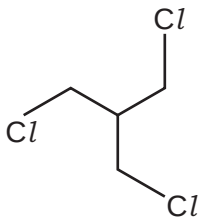
C *X* and *Z* only

D *Y* and *Z* only

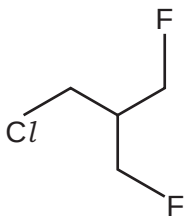
27 The presence of halogen in an organic compound may be detected by warming the organic compound with aqueous silver nitrate.

Which compound would produce a precipitate quickest?

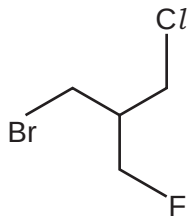
A



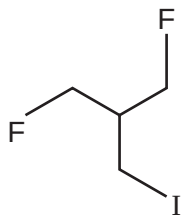
B



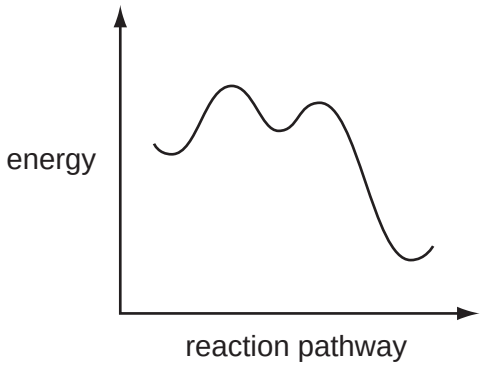
C



D



28 A reaction pathway diagram is shown.



Which reaction does **not** have such a profile?

A $CH_3CHO + HCN \xrightarrow{NaCN} CH_3CH(OH)CN$

B $C_2H_5Br + NaOH \rightarrow C_2H_5OH + NaBr$

C $(CH_3)_3CBr + NaOH \rightarrow (CH_3)_3COH + NaBr$

D 

29 The depletion of the ozone layer in the upper atmosphere reduces the Earth's natural protection from harmful ultraviolet radiation.

Which compound would cause the most depletion of the ozone layer?

A CCl_3F **B** CF_4 **C** $CHClF_2$ **D** CH_2F_2

30 Which statement does **not** correctly describe the polymer PVC?

A Combustion of PVC waste produces a highly acidic gas.

B PVC molecules are saturated.

C The empirical formula of PVC is the same as the empirical formula of its monomer.

D The repeat unit of PVC is –(CHClCHCl)–.

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

where each symbol has its usual meaning.

Which statements are correct?

1 One mole of an ideal gas occupies the same volume under the same conditions of temperature and pressure.

2 The density of an ideal gas at constant pressure is inversely proportional to the temperature, T.

3 The volume of a given mass of an ideal gas is doubled if its temperature is raised from 25 °C to 50 °C at constant pressure.

32 *Use of the Data Booklet is relevant to this question.*

In which pairs do both species have the same number of unpaired p electrons?

1 O and Cl^+

2 F^+ and Ga

3 P and Ne^+

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

33 Nitrogen and phosphorus are both in Group V of the Periodic Table. Phosphorus forms a chloride with the formula PCl_5.

Why is it **not** possible for nitrogen to form NCl_5?

1 Nitrogen's outer shell can only contain eight electrons.

2 Nitrogen cannot have oxidation state +5.

3 Nitrogen is almost inert.

34 Ammonia and chlorine react in the gas phase.

$$8NH_3 + 3Cl_2 \rightarrow N_2 + 6NH_4Cl$$

Which statements are correct?

1 Ammonia behaves as a reducing agent.

2 Ammonia behaves as a base.

3 The oxidation number of the hydrogen changes

35 Which statements are correct for all three halogens, chlorine, bromine and iodine?

1 They all form hydrides that are strong acids in aqueous solution.

2 They all react with aqueous sodium hydroxide to form oxo-anions.

3 They all require one more electron to fill the p orbitals of their outer shells.

36 In the manufacture of sulfuric acid the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ usually takes place at 400 °C and 1 atm pressure. In one industrial plant, it is decided to change the pressure to 20 atm.

What will be the consequences of this change?

1 increased running costs

2 an increased percentage of sulfur trioxide in the equilibrium mixture

3 the rate of the backward reaction increases

37 What is **always** involved in a carbon-carbon π bond?

1 a shared pair of electrons

2 a sideways overlap of p orbitals

3 delocalised electrons

38 A number of alcohols with the formula $C_4H_{10}O$ are separately oxidised. Using 70 g of the alcohols a 62 % yield of organic product is achieved.

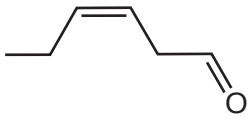
What mass of product could be obtained?

1 42.2 g of butanone

2 51.6 g of butanoic acid

3 51.6 g of 2-methyl propanoic acid

39 The compound *cis*-hex-3-enal is responsible for the characteristic smell of cut grass. The human nose is particularly sensitive to this compound, being able to detect 0.25 parts per billion in air.



cis-hex-3-enal

Which reagents will react with *cis*-hex-3-enal?

1 sodium

2 sodium borohydride

3 Fehling's reagent

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

40 How can a good yield of ethylamine be made using bromoethane as starting material?

1 by heating bromoethane with an excess of ammonia gas in a sealed tube

2 by adding dilute aqueous ammonia to bromoethane at room temperature

3 by heating bromoethane under reflux with aqueous ammonium chloride

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/11 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2012 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**A**	21	**C**
2	**D**	22	**A**
3	**D**	23	**B**
4	**B**	24	**C**
5	**C**	25	**A**
6	**B**	26	**C**
7	**C**	27	**D**
8	**B**	28	**B**
9	**B**	29	**A**
10	**D**	30	**D**
11	**A**	31	**B**
12	**C**	32	**B**
13	**C**	33	**D**
14	**B**	34	**B**
15	**A**	35	**A**
16	**C**	36	**A**
17	**D**	37	**B**
18	**C**	38	**A**
19	**C**	39	**C**
20	**D**	40	**D**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **May/June 2012**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

7046687152

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

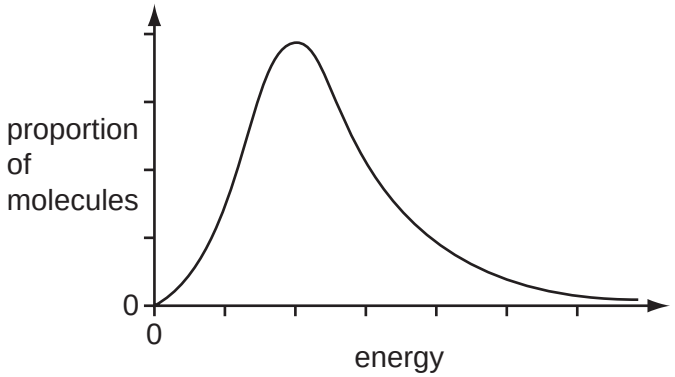
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **14** printed pages and **2** blank pages.

Section A

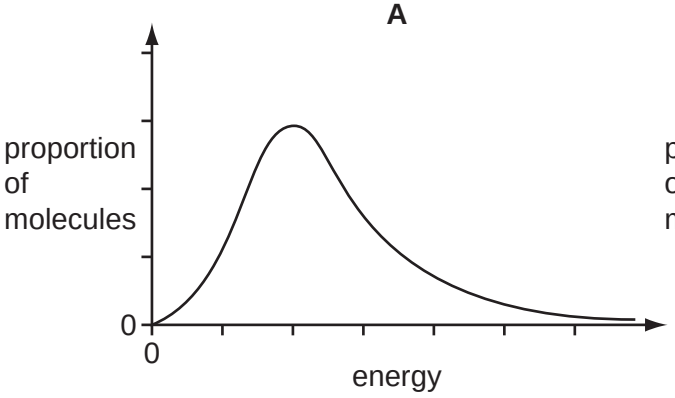
For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 The molecular energy distribution curve represents the variation in energy of the molecules of a gas at room temperature.

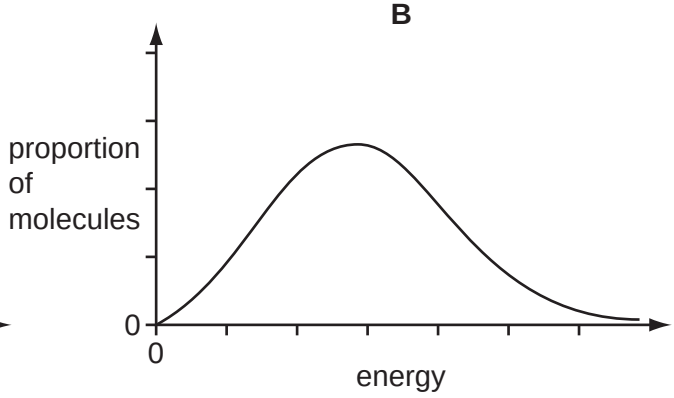


Which curve applies for the same gas at a lower temperature?

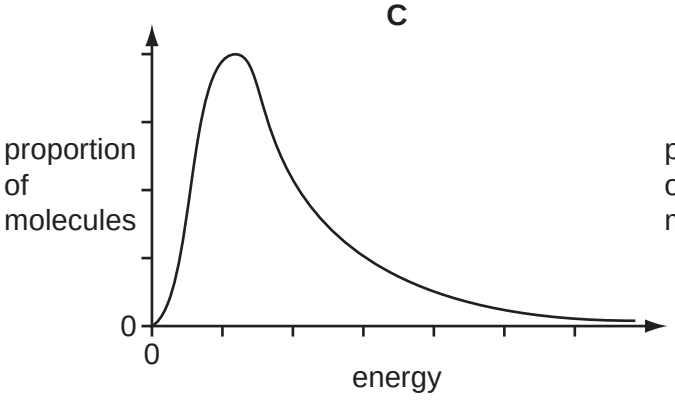
A



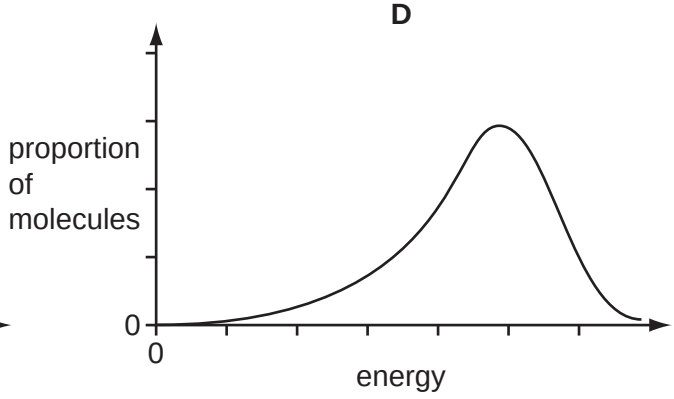
B



C



D

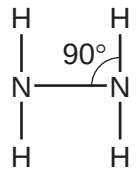


2 In which species are the numbers of protons, neutrons and electrons all different?

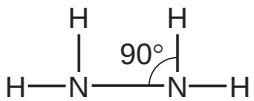
A $^{11}_{5}B$ **B** $^{19}_{9}F$ **C** $^{23}_{11}Na^{+}$ **D** $^{24}_{12}Mg^{2+}$

3 What is the **most** likely shape of a molecule of hydrazine, N_2H_4?

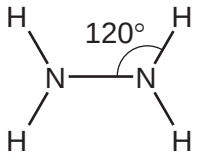
A



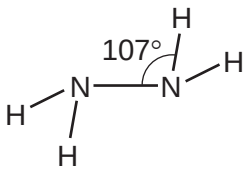
B



C



D



4 In which species does the underlined atom have an incomplete outer shell?

A $\underline{Al}_2Cl_6$ **B** $\underline{C}H_3^+$ **C** $Cl_2\underline{O}$ **D** $H_2\underline{Cl}C\bullet$

5 Which solid contains more than one kind of bonding?

A iodine

B silicon dioxide

C sodium chloride

D zinc

6 *Use of the Data Booklet is relevant to this question.*

The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

0.96 g of oxygen gas is contained in a glass vessel of volume 7000 cm^3 at a temperature of 30 °C.

What is the pressure in the vessel?

A 1.1 kPa **B** 2.1 kPa **C** 10.8 kPa **D** 21.6 kPa

7 Two moles of compound P were placed in a vessel. The vessel was heated and compound P was partly decomposed to produce Q and R. A dynamic equilibrium between chemicals P, Q and R was established.

At equilibrium x moles of R were present and the total number of moles present was $(2 + \frac{x}{2})$.

What is the equation for this equilibrium reaction?

A $P \rightleftharpoons 2Q + R$

B $2P \rightleftharpoons 2Q + R$

C $2P \rightleftharpoons Q + R$

D $2P \rightleftharpoons Q + 2R$

8 The value of the third ionisation energy of aluminium is 2740 kJ mol ^{1}.

Which correctly represents this statement?

A $Al(g) \rightarrow Al^{3+}(g) + 3e$ $\Delta H^{e} = -2740\,kJ\,mol^{1}$

B $Al^{2+}(g) \rightarrow Al^{3+}(g) + e$ $\Delta H^{e} = -2740\,kJ\,mol^{1}$

C $Al(g) \rightarrow Al^{3+}(g) + 3e$ $\Delta H^{e} = +2740\,kJ\,mol^{1}$

D $Al^{2+}(g) \rightarrow Al^{3+}(g) + e$ $\Delta H^{e} = +2740\,kJ\,mol^{1}$

9 Methanol is manufactured by reacting carbon dioxide and hydrogen.

$$CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g) \qquad \Delta H = -49\,kJ\,mol^{1}$$

What would increase the equilibrium yield of methanol in this process?

A adding a catalyst

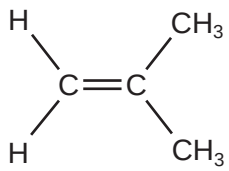
B adding an excess of steam

C increasing the pressure

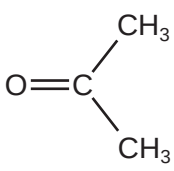
D increasing the temperature

10 Which molecule has the largest overall dipole?

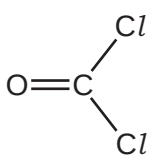
A



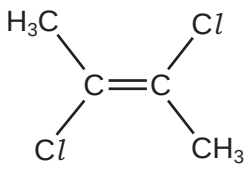
B



C



D



11 In which substance does nitrogen exhibit the highest oxidation state?

A NO **B** N_2O **C** N_2O_4 **D** $NaNO_2$

12 Red lead oxide, Pb_3O_4, is used in metal priming paints. It can be made by heating PbO in air.

$$6PbO(s) + O_2(g) \rightarrow 2Pb_3O_4(s)$$

Which two values are needed to calculate the enthalpy change for this reaction?

A enthalpy change of atomisation of O_2 and enthalpy change of formation of Pb_3O_4

B enthalpy change of formation of O_2 and enthalpy change of formation of Pb_3O_4

C enthalpy change of formation of PbO and enthalpy change of atomisation of O_2

D enthalpy change of formation of PbO and enthalpy change of formation of Pb_3O_4

13 Which gas is present in the exhaust fumes of a car engine in a much greater amount than any other gas?

A carbon dioxide

B carbon monoxide

C nitrogen

D water vapour

14 Slaked lime, $Ca(OH)_2$, may be made from limestone, $CaCO_3$.

On heating in a lime kiln at 1000 °C, limestone decomposes as follows.

reaction 1 $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

Water is then reacted with calcium oxide, CaO, as follows.

reaction 2 $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$

What are the enthalpy changes of these reactions?

	reaction 1	reaction 2
A	endothermic	endothermic
B	endothermic	exothermic
C	exothermic	endothermic
D	exothermic	exothermic

15 The period 4 elements gallium (Ga), germanium (Ge), arsenic (As) and selenium (Se) are the elements below aluminium, silicon, phosphorus and sulfur in the Periodic Table, a portion of which is shown below.

period 3 elements	Al	Si	P	S
period 4 elements	Ga	Ge	As	Se

The properties of each period 4 element resemble those of the period 3 element directly above it.

Which period 4 elements form oxides that dissolve in water to give an acid solution?

A As and Se **B** Ga and Ge **C** Ga and Se **D** Se only

16 Chlorine shows oxidation states ranging from –1 to +7 in its compounds.

What are the reagent(s) and conditions necessary for the oxidation of elemental chlorine into a compound containing chlorine in the +5 oxidation state?

A $AgNO_3(aq)$ followed by $NH_3(aq)$ at room temperature

B concentrated H_2SO_4 at room temperature

C cold dilute NaOH(aq)

D hot concentrated NaOH(aq)

17 What can be seen when a piece of magnesium ribbon is placed in cold water?

A A vigorous effervescence occurs.

B Bubbles of gas form slowly on the magnesium.

C The magnesium floats on the surface of the water and reacts quickly.

D The magnesium glows and a white solid is produced.

18 *Use of the Data Booklet is relevant to this question.*

Sodium and sulfur react together to form sodium sulfide, Na_2S.

How do the atomic radius and ionic radius of sodium compare with those of sulfur?

	atomic radius	ionic radius
A	sodium > sulfur	sodium > sulfur
B	sodium > sulfur	sodium < sulfur
C	sodium < sulfur	sodium > sulfur
D	sodium < sulfur	sodium < sulfur

19 Which substance does **not** produce a poisonous gas, when burnt in a limited amount of air?

A hydrogen

B methane

C propene

D sulfur

20 *Use of the Data Booklet is relevant to this question.*

A sample of propyl ethanoate is hydrolysed by heating under reflux with aqueous sodium hydroxide. The two organic products of the hydrolysis are separated, purified and weighed.

Out of the total mass of products obtained, what is the percentage by mass of each product?

A 32.4 % and 67.6 %

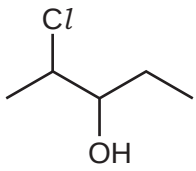
B 38.3 % and 61.7 %

C 42.3 % and 57.7 %

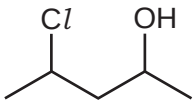
D 50.0 % and 50.0 %

21 Which diagram gives the skeletal formula of 2-chloropentan-3-ol?

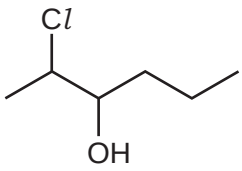
A



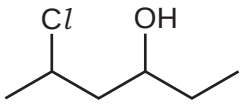
B



C



D

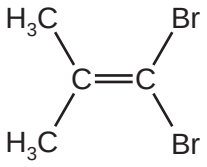


22 When 1-bromopropane is treated in succession with two reagents, X and Y, it produces propanoic acid.

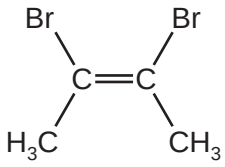
What are reagents X and Y?

	X	Y
A	NaOH(aq)	$H^+ / Cr_2O_7^{2-}$ (aq)
B	NaOH(aq)	CO_2
C	KCN in ethanol	HCl(aq)
D	KCN in ethanol	NaOH(aq)

23 Isomers **X** and **Y** both react with HBr.



X



Y

A mixture of **X** and **Y** is reacted with HBr.

Which three structures represent three **different** possible products of this reaction?

A	$(CH_3)_2CHCBr_3$	$(CH_3)_2CBrCHBr_2$	$CH_3CHBrCHBrCH_3$
B	$(CH_3)_2CHCBr_3$	$(CH_3)_2CBrCHBr_2$	$CH_3CBr_2CHBrCH_3$
C	$(CH_3)_2CBrCBr_3$	$(CH_3)_2CHCBr_3$	$CH_3CBr_2CHBrCH_3$
D	$(CH_3)_2CBrCHBr_2$	$CHBr_2CBr(CH_3)CH_3$	$CH_3CHBrCBr_2CH_3$

24 Oct-1-ene, $CH_3(CH_2)_5CH{=}CH_2$, is subjected to thermal cracking.

Which combination of compounds W, X, Y and Z can be obtained?

$CH_2{=}CH_2$	$CH_3CH{=}CH_2$	$CH_3CH_2CH_3$	$CH_2{=}CHCH{=}CH_2$
W	X	Y	Z

A W, X, Y and Z

B W, X and Y only

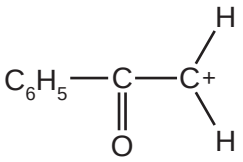
C W, X and Z only

D W and X only

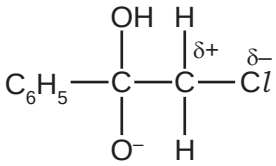
25 When phenacyl chloride, $C_6H_5COCH_2Cl$, is reacted with aqueous NaOH, the substitution reaction follows an S_N2 mechanism.

Which structure represents a species formed during the reaction?

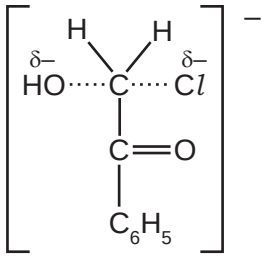
A



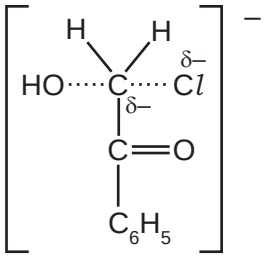
B



C



D



26 Complete combustion of compound X gives carbon dioxide and water only. A sample of X is mixed with aqueous potassium(V) dichromate and boiled under reflux for one hour. The mixture is then distilled and the only organic substance present is collected.

The organic substance collected reacts with sodium to give hydrogen, but does not react with 2,4-dinitrophenylhydrazine reagent and does not react with ethanol in the presence of concentrated sulfuric acid to give an ester.

What can be deduced from this information?

A X is a carboxylic acid.

B X is a ketone.

C X is an alcohol.

D X is an alkane.

27 A compound **Y** has the following properties.

- It is a liquid at room temperature and atmospheric pressure.
- It does not mix completely with water.
- It does not give steamy fumes with PCl_5.

What could **Y** be?

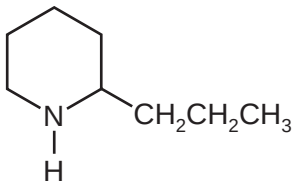
A ethane

B ethanoic acid

C ethanol

D ethyl ethanoate

28 Coniine is the major constituent of the poison 'oil of hemlock'.



coniine

Coniine can be synthesised by reacting ammonia with a dibromo compound, **X**.

$$NH_3 + C_8H_{16}Br_2 \rightarrow \text{coniine} + 2HBr$$

X

What is the name of compound **X**?

A 1,1-dibromo-2-propylcyclopentane

B 1,2-dibromo-2-propylcyclopentane

C 1,4-dibromooctane

D 1,5-dibromooctane

29 A common industrial solvent is a mixture of propanone, CH_3COCH_3, and pentyl ethanoate $CH_3CO_2(CH_2)_4CH_3$.

Which reagent would have **no** reaction with this industrial solvent?

A HCl(aq)

B HCN(aq) with a little KCN

C Na(s)

D $NaBH_4$

30 An organic compound will decolorise dilute acidified aqueous potassium manganate(VII) on warming, but will not decolorise bromine water.

What could the organic compound be?

A butane

B ethanol

C ethene

D ethanoic acid

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Which of the following molecules and ions have a regular trigonal planar shape?

1 BF_3

2 CH_3^+

3 $AlCl_3$

32 Ammonia and chlorine react in the gas phase.

$$8NH_3 + 3Cl_2 \rightarrow N_2 + 6NH_4Cl$$

Which statements are correct?

1 Each nitrogen atom is oxidised.

2 Each chlorine atom is reduced.

3 Ammonia behaves as a base.

33 Concentrated sulfuric acid behaves as a strong acid when it reacts with water.

$$H_2SO_4(l) + aq \rightarrow H^+(aq) + HSO_4\ (aq)$$

The HSO_4 ion formed behaves as a weak acid.

$$HSO_4\ (aq) \rightleftharpoons H^+(aq) + SO_4^{2}\ (aq)$$

Which statements are true for $1.0\,mol\,dm^{-3}$ sulfuric acid?

1 $[H^+(aq)]$ is high

2 $[SO_4^{2}\ (aq)]$ is high

3 $[HSO_4\ (aq)] = [SO_4^{2}\ (aq)]$

34 Silver chloride dissolves in aqueous ammonia.

What happens in this process?

1 A co-ordinate bond is formed.

2 The oxidation number of nitrogen is unchanged.

3 Ammonia acts as a Brønsted-Lowry base.

35 Compared with the HC*l* molecule, the bond ……**X**…… of the HBr molecule is ……**Y**……

Which pairs of words correctly complete the above sentence?

	X	**Y**
1	energy	less
2	polarity	less
3	length	greater

36 Which statements are true about the Haber process for the manufacture of ammonia?

1 At higher temperatures, the yield goes down but the rate of production of ammonia is faster.

2 At higher pressures, the yield goes down but the rate of production of ammonia is faster.

3 In the presence of a catalyst, the yield goes down but the rate of production of ammonia is faster.

37 Which compounds can be obtained from propene in a **single** reaction?

1 $CH_2OHCHOHCH_3$

2 $(CH_2CH(CH_3))_n$

3 $CH_2BrCH_2CH_2Br$

38 What are the same for a pair of optical isomers?

1 their empirical formula

2 their functional groups

3 their structural formula

39 Which statements about the photochemical chlorination of ethane are correct?

1 Hydrogen gas is one of the products.

2 A propagation step in the mechanism is $C_2H_6 + Cl\bullet \rightarrow C_2H_5\bullet + HCl$.

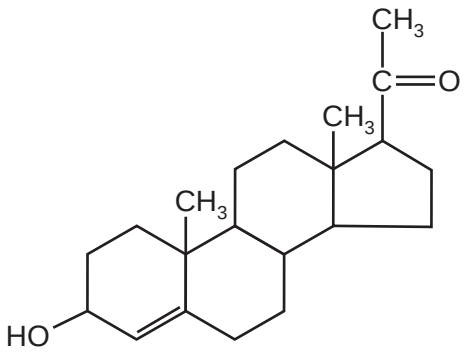
3 The initiation step is the homolytic fission of chlorine.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

40 The compound shown is a hormone produced during pregnancy to suppress ovulation.



Which reagents would give positive results with this compound?

1 aqueous bromine

2 2,4-dinitrophenylhydrazine

3 Fehling's reagent

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/12 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2012 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**A**
2	**C**	22	**A**
3	**D**	23	**B**
4	**B**	24	**A**
5	**A**	25	**C**
6	**C**	26	**C**
7	**D**	27	**D**
8	**D**	28	**D**
9	**C**	29	**C**
10	**B**	30	**B**
11	**C**	31	**A**
12	**D**	32	**C**
13	**C**	33	**D**
14	**B**	34	**B**
15	**A**	35	**A**
16	**D**	36	**D**
17	**B**	37	**B**
18	**B**	38	**A**
19	**A**	39	**C**
20	**C**	40	**B**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/13**

Paper 1 Multiple Choice **May/June 2012**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 3 2 6 7 9 8 9 5 5 5 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **14** printed pages and **2** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Ammonia is manufactured by the Haber Process, in an exothermic reaction.

Assuming that the amount of catalyst remains constant, which change will **not** bring about an increase in the rate of the forward reaction?

A decreasing the size of the catalyst pieces

B increasing the pressure

C increasing the temperature

D removing the ammonia as it is formed

2 In which species does the underlined atom have an incomplete outer shell?

A $\underline{B}F_3$ **B** $\underline{C}H_3^-$ **C** $F_2\underline{O}$ **D** $H_3\underline{O}^+$

3 The value of the second ionisation energy of calcium is 1150 kJ mol^{-1}.

Which equation correctly represents this statement?

A $Ca(g) \rightarrow Ca^{2+}(g) + 2e^-$; $\Delta H^\ominus = +1150\,kJ\,mol^{-1}$

B $Ca^+(g) \rightarrow Ca^{2+}(g) + e^-$; $\Delta H^\ominus = +1150\,kJ\,mol^{-1}$

C $Ca^+(g) \rightarrow Ca^{2+}(g) + e^-$; $\Delta H^\ominus = -1150\,kJ\,mol^{-1}$

D $Ca(g) \rightarrow Ca^{2+}(g) + 2e^-$; $\Delta H^\ominus = -1150\,kJ\,mol^{-1}$

4 The equation for a reaction is shown.

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l) \; ; \; \Delta H = x\,kJ\,mol^{-1}$$

Which pair of descriptions is fully correct for this reaction?

	type(s) of enthalpy change	value of x
A	formation only	positive
B	formation only	negative
C	combustion, formation	positive
D	combustion, formation	negative

5 Propanone has the molecular formula C_3H_6O.

The enthalpy change of combustion of hydrogen is –286 kJ mol ^{1}.
The enthalpy change of combustion of carbon is –394 kJ mol ^{1}.
The enthalpy change of combustion of propanone is –1786 kJ mol ^{1}.

Using this information, what is the enthalpy change of formation of propanone?

A –1106 kJ mol ^{1}

B –540 kJ mol ^{1}

C –254 kJ mol ^{1}

D +1106 kJ mol ^{1}

6 Two conversions are outlined below.

$$NH_4^+ \rightarrow NH_3$$

$$C_2H_4 \rightarrow C_2H_6$$

What similar feature do these two conversions have?

A a lone pair of electrons in the product

B change in oxidation state of an element

C decrease in bond angle of the species involved

D disappearance of a π bond

7 *Use of the Data Booklet is relevant to this question.*

The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

0.56 g of ethene gas is contained in a vessel at a pressure of 102 kPa and a temperature of 30 °C.

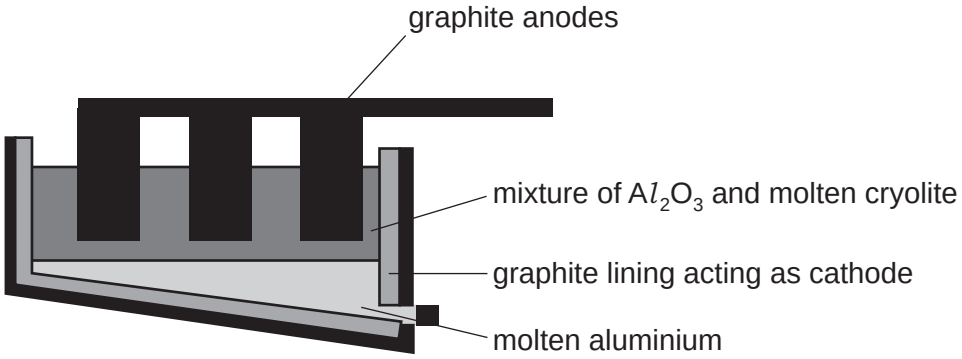
What is the volume of the vessel?

A 49 cm^3 **B** 494 cm^3 **C** 48 900 cm^3 **D** 494 000 cm^3

8 Under which set of conditions is a gas most likely to behave ideally?

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

9 The diagram shows a cell for the manufacture of aluminium.



Which statement is **incorrect**?

A Aluminium ions are oxidised in this process.

B Aluminium is liberated at the cathode by the reaction $Al^{3+} + 3e \rightarrow Al$.

C The cryolite acts as a solvent.

D The graphite anode burns away.

10 The oxide of titanium, TiO_2, is used as a 'whitener' in toothpaste. It is obtained from the ore iron(II) titanate, $FeTiO_3$.

What is the change, if any, in the oxidation number (oxidation state) of titanium in the reaction $FeTiO_3 \rightarrow TiO_2$?

A It is oxidised from +3 to +4.

B It is reduced from +3 to +2.

C It is reduced from +6 to +4.

D There is no change in the oxidation number.

11 Two moles of compound P were placed in a vessel. The compound P was partly decomposed by heating. A dynamic equilibrium between chemicals P, Q and R was established.

At equilibrium, *x* mol of R were present and the total number of moles present was (2 + *x*).

What is the equation for this equilibrium?

A $P \rightleftharpoons 2Q + R$

B $2P \rightleftharpoons 2Q + R$

C $2P \rightleftharpoons Q + R$

D $2P \rightleftharpoons Q + 2R$

12 *Use of the Data Booklet is relevant to this question.*

When a mineral was heated in a Bunsen flame to constant mass, a colourless gas that turned lime water milky was evolved. The remaining solid was cooled and then added to aqueous hydrochloric acid. Vigorous effervescence was seen.

What was the mineral?

A aragonite, $CaCO_3$

B artinite, $MgCO_3.Mg(OH)_2.3H_2O$

C barytocalcite, $BaCO_3.CaCO_3$

D dolomite, $CaCO_3.MgCO_3$

13 Aluminium chloride catalyses certain reactions by forming carbocations with chloroalkanes as shown.

$$RCl + AlCl_3 \rightarrow R^+ + AlCl_4$$

Which property makes this reaction possible?

A $AlCl_3$ exists as the dimer Al_2Cl_6 in the vapour.

B $AlCl_3$ is a covalent molecule.

C The aluminium atom in $AlCl_3$ has an incomplete octet of electrons.

D The chlorine atom in RCl has a vacant p orbital.

14 The oxides BaO, CaO, MgO and SrO all produce alkaline solutions when added to water.

Which oxide produces the saturated solution with the highest pH?

A BaO(aq) **B** CaO(aq) **C** MgO(aq) **D** SrO(aq)

15 *Use of the Data Booklet is relevant to this question.*

The reaction between aluminium powder and anhydrous barium nitrate is used as the propellant in some fireworks. The metal oxides and nitrogen are the only products.

Which volume of nitrogen, measured under room conditions, is produced when 0.783 g of anhydrous barium nitrate reacts with an excess of aluminium?

A 46.8 cm^3 **B** 72.0 cm^3 **C** 93.6 cm^3 **D** 144 cm^3

16 The following two experiments are carried out with anhydrous potassium chloride and observations X and Y are made at the end of each experiment.

Concentrated sulfuric acid is added to the potassium chloride and the fumes produced are bubbled into aqueous potassium iodide solution - observation X.

The potassium chloride is dissolved in aqueous ammonia and this is then added to aqueous silver nitrate - observation Y.

What are the observations X and Y?

	X	Y
A	brown solution	colourless solution
B	brown solution	white precipitate
C	colourless solution	colourless solution
D	colourless solution	white precipitate

17 In the treatment of domestic water supplies, chlorine is added to the water to form HClO.

$$Cl_2(aq) + H_2O(l) \rightarrow H^+(aq) + Cl^-(aq) + HClO(aq)$$

The HClO reacts further to give ClO$^-$ ions.

$$HClO(aq) + H_2O(l) \rightarrow H_3O^+(aq) + ClO^-(aq)$$

Both HClO and ClO$^-$ kill bacteria by oxidation.

What is the overall change in oxidation number of chlorine when forming the ClO$^-$ ion from the aqueous chlorine?

A –1 **B** 0 **C** +1 **D** +2

18 What trend is observed on descending Group VII?

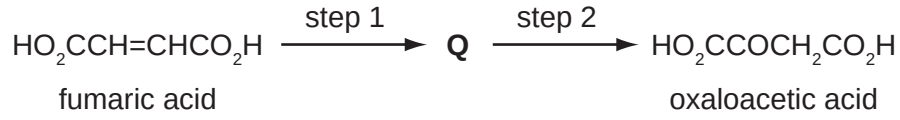
A The colours of the elements become lighter.

B The elements become more volatile.

C The hydrides of the elements become more thermally stable.

D The reactions of the elements with hydrogen become less vigorous.

19 Fumaric acid can be converted into oxaloacetic acid by a two-step process involving the intermediate **Q**.



Each of these steps can be achieved in the laboratory by a single reagent.

What could be the intermediate **Q** and the reagent for step 2?

	Q	reagent for step 2
A	$HO_2CCHBrCH_2CO_2H$	warm acidified $KMnO_4$
B	$HO_2CCHBrCH(OH)CO_2H$	warm NaOH(aq)
C	$HO_2CCH(OH)CH_2CO_2H$	Fehling's solution
D	$HO_2CCH(OH)CH_2CO_2H$	warm acidified $K_2Cr_2O_7$

20 Carbon monoxide, CO, nitrogen monoxide, NO, and sulfur dioxide, SO_2, may all be present in the exhaust fumes from a car engine.

Which reaction concerning these compounds occurs in the atmosphere?

A CO is spontaneously oxidised to CO_2

B NO_2 is reduced to NO by CO

C NO_2 is reduced to NO by SO_2

D SO_2 is oxidised to SO_3 by CO_2

21 An organic compound **J** reacts with sodium to produce an organic ion with a charge of –3. **J** reacts with NaOH(aq) to produce an organic ion with a charge of –1.

What could be the structural formula of **J**?

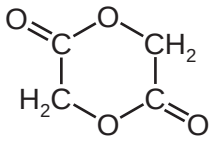
A $HO_2CCH(OH)CH_2CO_2H$

B $HO_2CCH(OH)CH_2CHO$

C $HOCH_2CH(OH)CH_2CO_2H$

D $HOCH_2COCH_2CHO$

22 Compound C is used in textile and leather processing.



compound C

Which starting material(s), on gentle heating with a few drops of concentrated sulfuric acid, generates compound C?

A CH_3COOH only

B $HOCH_2COOH$ only

C CH_3COOCH_2COOH only

D CH_3COOH mixed with $HOCH_2COOH$

23 How many isomeric esters have the molecular formula $C_4H_8O_2$?

A 2 **B** 3 **C** 4 **D** 5

24 *Use of the Data Booklet is relevant to this question.*

A sample of ethyl propanoate is hydrolysed by heating under reflux with aqueous sodium hydroxide. The two organic products of the hydrolysis are separated, purified and weighed.

Out of the total mass of products obtained, what is the percentage by mass of each product?

A 32.4 % and 67.6 %

B 38.3 % and 61.7 %

C 42.3 % and 57.7 %

D 50.0 % and 50.0 %

25 $CH_3COCH_2CH_2OH$ *W* CH_3COCH_2CHO *X* $CH_3CH(OH)CH_2CH_3$ *Y* $CH_3CH_2CH_2CHO$ *Z*

Which of these compounds can be oxidised by acidified dichromate(VI) solution and also gives a positive response to Tollens' reagent?

A *W* and *X* only

B *W* and *Y* only

C *X* and *Z* only

D *Y* and *Z* only

26 Which compound, on reaction with hydrogen cyanide, produces a compound with a chiral centre?

A CH_3CHO

B $CH_3CH_2COCH_2CH_3$

C $CH_3CO_2CH_3$

D HCHO

27 The depletion of the ozone layer in the upper atmosphere reduces the Earth's natural protection from harmful ultraviolet radiation.

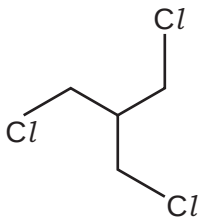
Which compound would cause the most depletion of the ozone layer?

A CCl_3F **B** CF_4 **C** $CHClF_2$ **D** CH_2F_2

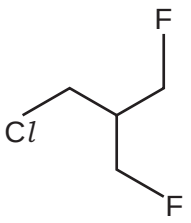
28 The presence of halogen in an organic compound may be detected by warming the organic compound with aqueous silver nitrate.

Which compound would produce a precipitate quickest?

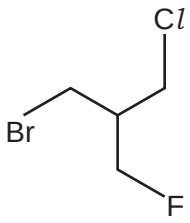
A



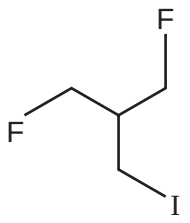
B



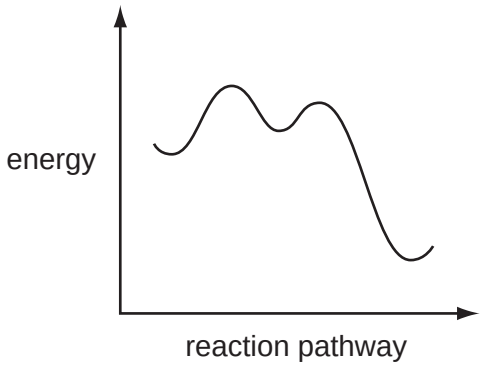
C



D



29 A reaction pathway diagram is shown.



Which reaction does **not** have such a profile?

A $CH_3CHO + HCN \xrightarrow{NaCN} CH_3CH(OH)CN$

B $C_2H_5Br + NaOH \rightarrow C_2H_5OH + NaBr$

C $(CH_3)_3CBr + NaOH \rightarrow (CH_3)_3COH + NaBr$

D 

30 Which statement does **not** correctly describe the polymer PVC?

A Combustion of PVC waste produces a highly acidic gas.

B PVC molecules are saturated.

C The empirical formula of PVC is the same as the empirical formula of its monomer.

D The repeat unit of PVC is –(CHC*l*CHC*l*)–.

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 Nitrogen and phosphorus are both in Group V of the Periodic Table. Phosphorus forms a chloride with the formula PCl_5.

Why is it **not** possible for nitrogen to form NCl_5?

1 Nitrogen's outer shell can only contain eight electrons.

2 Nitrogen cannot have oxidation state +5.

3 Nitrogen is almost inert.

32 *Use of the Data Booklet is relevant to this question.*

In which pairs do both species have the same number of unpaired p electrons?

1 O and Cl^+

2 F^+ and Ga

3 P and Ne^+

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

33 The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

where each symbol has its usual meaning.

Which statements are correct?

1 One mole of an ideal gas occupies the same volume under the same conditions of temperature and pressure.

2 The density of an ideal gas at constant pressure is inversely proportional to the temperature, T.

3 The volume of a given mass of an ideal gas is doubled if its temperature is raised from 25 °C to 50 °C at constant pressure.

34 Which statements are correct for all three halogens, chlorine, bromine and iodine?

1 They all form hydrides that are strong acids in aqueous solution.

2 They all react with aqueous sodium hydroxide to form oxo-anions.

3 They all require one more electron to fill the p orbitals of their outer shells.

35 In the manufacture of sulfuric acid the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ usually takes place at 400 °C and 1 atm pressure. In one industrial plant, it is decided to change the pressure to 20 atm.

What will be the consequences of this change?

1 increased running costs

2 an increased percentage of sulfur trioxide in the equilibrium mixture

3 the rate of the backward reaction increases

36 Ammonia and chlorine react in the gas phase.

$$8NH_3 + 3Cl_2 \rightarrow N_2 + 6NH_4Cl$$

Which statements are correct?

1 Ammonia behaves as a reducing agent.

2 Ammonia behaves as a base.

3 The oxidation number of the hydrogen changes.

37 A number of alcohols with the formula $C_4H_{10}O$ are separately oxidised. Using 70 g of the alcohols a 62 % yield of organic product is achieved.

What mass of product could be obtained?

1 42.2 g of butanone

2 51.6 g of butanoic acid

3 51.6 g of 2-methyl propanoic acid

38 What is **always** involved in a carbon-carbon π bond?

1 a shared pair of electrons

2 a sideways overlap of p orbitals

3 delocalised electrons

39 How can a good yield of ethylamine be made using bromoethane as starting material?

1 by heating bromoethane with an excess of ammonia gas in a sealed tube

2 by adding dilute aqueous ammonia to bromoethane at room temperature

3 by heating bromoethane under reflux with aqueous ammonium chloride

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

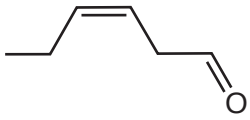
Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

40 The compound *cis*-hex-3-enal is responsible for the characteristic smell of cut grass. The human nose is particularly sensitive to this compound, being able to detect 0.25 parts per billion in air.



cis-hex-3-enal

Which reagents will react with *cis*-hex-3-enal?

1 sodium

2 sodium borohydride

3 Fehling's reagent

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/13 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2012 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**C**
2	**A**	22	**B**
3	**B**	23	**C**
4	**D**	24	**A**
5	**C**	25	**C**
6	**C**	26	**A**
7	**B**	27	**A**
8	**B**	28	**D**
9	**A**	29	**B**
10	**D**	30	**D**
11	**B**	31	**D**
12	**C**	32	**B**
13	**C**	33	**B**
14	**A**	34	**A**
15	**B**	35	**A**
16	**C**	36	**B**
17	**C**	37	**A**
18	**D**	38	**B**
19	**D**	39	**D**
20	**C**	40	**C**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **May/June 2013**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 7 9 0 0 7 8 4 2 1 7 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
Electronic calculators may be used.

This document consists of **14** printed pages and **2** blank pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Solutions containing chlorate(I) ions are used as household bleaches and disinfectants. These solutions decompose on heating as shown.

$$3ClO \rightarrow ClO_3 + 2Cl$$

Which oxidation state is shown by chlorine in each of these three ions?

	ClO	ClO_3	Cl
A	+1	+3	–1
B	–1	+3	+1
C	+1	+5	–1
D	–1	+5	+1

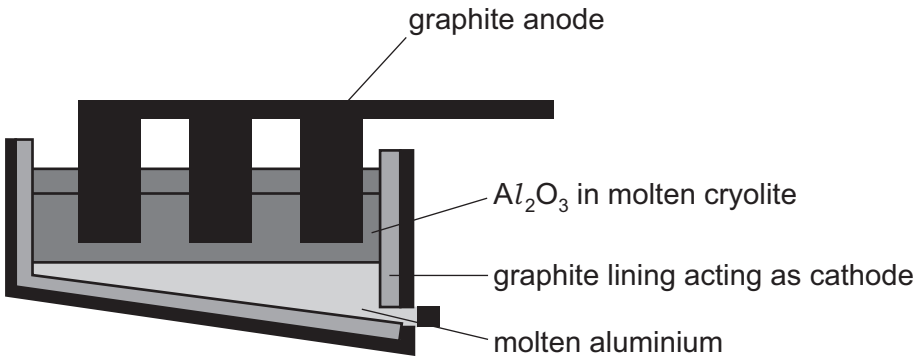
2 A mixture of 10 cm^3 of methane and 10 cm^3 of ethane was sparked with an excess of oxygen. After cooling to room temperature, the residual gas was passed through aqueous potassium hydroxide.

All gas volumes were measured at the same temperature and pressure.

What volume of gas was absorbed by the alkali?

A 15 cm^3 **B** 20 cm^3 **C** 30 cm^3 **D** 40 cm^3

3 The diagram shows an electrolytic cell for the extraction of aluminium.



Which statement is correct?

A Aluminium ions are oxidised in this process.

B Aluminium is liberated at the anode by the reaction $Al^{3+} + 3e \rightarrow Al$.

C Cryolite is purified aluminium oxide.

D The graphite anode burns away.

4 *Use of the Data Booklet is relevant to this question*.

The elements radon (Rn), francium (Fr) and radium (Ra) have proton numbers 86, 87 and 88 respectively.

What is the order of their first ionisation energies?

	least endothermic ⟶		most endothermic
A	Fr	Ra	Rn
B	Fr	Rn	Ra
C	Ra	Fr	Rn
D	Rn	Ra	Fr

5 In which species are the numbers of protons, neutrons and electrons all different?

A $^{27}_{13}Al$ **B** $^{35}_{17}Cl$ **C** $^{32}_{16}S^{2}$ **D** $^{39}_{19}K^{+}$

6 An experiment is set up to measure the rate of hydrolysis of ethyl ethanoate.

$$CH_3CO_2C_2H_5 + H_2O \rightleftharpoons CH_3CO_2H + C_2H_5OH$$

The hydrolysis is found to be slow in neutral aqueous solution but it proceeds at a measurable rate when the solution is acidified with hydrochloric acid.

What is the function of the hydrochloric acid?

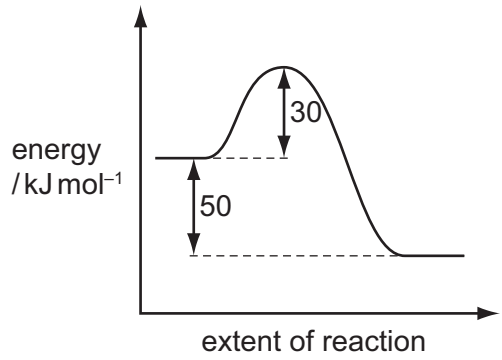
A to dissolve the ethyl ethanoate

B to ensure that the reaction reaches equilibrium

C to increase the reaction rate by catalytic action

D to suppress ionisation of the ethanoic acid formed

7 The reaction pathway for a reversible reaction is shown below.



Which statement is correct?

A The activation energy of the reverse reaction is +80 kJ mol ^{1}.

B The enthalpy change for the forward reaction is +30 kJ mol ^{1}.

C The enthalpy change for the forward reaction is +50 kJ mol ^{1}.

D The enthalpy change for the reverse reaction is +30 kJ mol ^{1}.

8 Why does the rate of a gaseous reaction increase when the pressure is increased at a constant temperature?

A More particles have energy that exceeds the activation energy.

B The particles have more space in which to move.

C The particles move faster.

D There are more frequent collisions between particles.

9 Which would behave the **least** like an ideal gas at room temperature?

A carbon dioxide

B helium

C hydrogen

D nitrogen

10 The general gas equation can be used to calculate the M_r value of a gas.

For a sample of a gas of mass m g, which expression will give the value of M_r?

A $M_r = \frac{mpV}{RT}$ **B** $M_r = \frac{pVRT}{m}$ **C** $M_r = \frac{mRT}{pV}$ **D** $M_r = \frac{pV}{mRT}$

11 A solution of Sn^{2+} ions will reduce an acidified solution of MnO_4^- ions to Mn^{2+} ions. The Sn^{2+} ions are oxidised to Sn^{4+} ions in this reaction.

How many moles of Mn^{2+} ions are formed when a solution containing 9.5 g of $SnCl_2$ (M_r: 190) is added to an excess of acidified $KMnO_4$ solution?

A 0.010 **B** 0.020 **C** 0.050 **D** 0.125

12 *Use of the Data Booklet is relevant to this question.*

This question should be answered using bond enthalpy data. The equation for the complete combustion of methane is given below.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

What is the enthalpy change of combustion of methane?

A –1530 kJ mol^{-1}

B –1184 kJ mol^{-1}

C –770 kJ mol^{-1}

D –688 kJ mol^{-1}

13 In which row of the table are all statements comparing the compounds of magnesium and barium correct?

	solubility of hydroxides		solubility of sulfates	
	solubility of magnesium hydroxide	solubility of barium hydroxide	solubility of magnesium sulfate	solubility of barium sulfate
A	higher	lower	higher	lower
B	higher	lower	lower	higher
C	lower	higher	higher	lower
D	lower	higher	lower	higher

14 What happens when iodine solution is added to a solution of sodium bromide?

A A reaction occurs without changes in oxidation state.

B Bromide ions are oxidised, iodine atoms are reduced.

C Bromide ions are reduced, iodine atoms are oxidised.

D No reaction occurs.

15 Element 85, astatine, is in Group VII. Concentrated sulfuric acid is added to sodium astatide. The mixture of products includes astatine, hydrogen astatide, hydrogen sulfide, and sodium sulfate.

Which product is formed by the oxidation of one of the constituents of sodium astatide?

A astatine

B hydrogen astatide

C hydrogen sulfide

D sodium sulfate

16 *Use of the Data Booklet is relevant to this question.*

Magnesium nitrate, $Mg(NO_3)_2$, will decompose when heated to give a white solid and a mixture of gases. One of the gases released is an oxide of nitrogen, X.

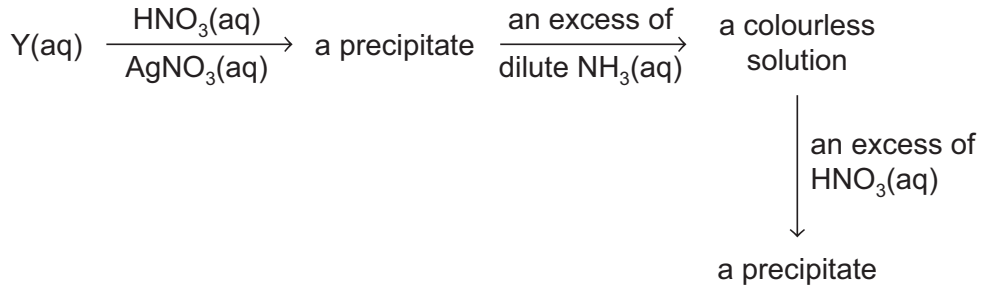
7.4 g of anhydrous magnesium nitrate is heated until no further reaction takes place.

What mass of X is produced?

A 1.5 g **B** 2.3 g **C** 3.0 g **D** 4.6 g

17 Y is a salt of one of the halogens chlorine, bromine, iodine, or astatine (element 85).

The reaction scheme shows a series of reactions using a solution of Y as the starting reagent.



What could Y be?

A sodium chloride

B sodium bromide

C potassium iodide

D potassium astatide

18 Sulfur trioxide is manufactured from sulfur dioxide and oxygen, using the Contact process.

Which condition affects the value of the equilibrium constant, K_c?

A adjusting the temperature

B increasing the pressure

C removing SO_3 from the equilibrium mixture

D using a catalyst

19 Which reagent, when mixed and heated with ammonium sulfate, liberates ammonia?

A aqueous bromine

B dilute hydrochloric acid

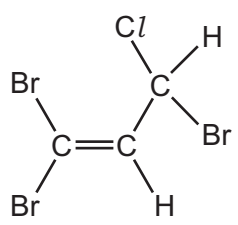
C limewater

D potassium dichromate(VI) in acidic solution

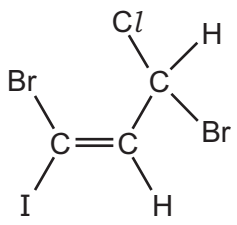
20 The following compounds are found in the seaweed *Asparagopsis taxiformis*.

Which compound could show **both** *cis-trans* isomerism and optical isomerism?

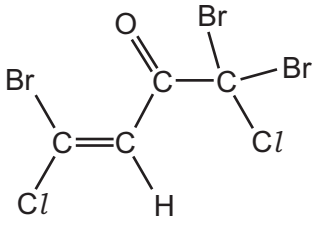
A



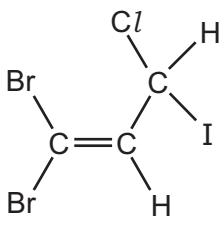
B



C



D



21 Lactic acid (2-hydroxypropanoic acid), $CH_3CH(OH)CO_2H$, is found in sour milk.

Which reaction could occur with lactic acid?

A $CH_3CH(OH)CO_2H + CH_3OH \rightarrow CH_3CH(OCH_3)CO_2H + H_2O$

B $CH_3CH(OH)CO_2H + HCO_2H \rightarrow CH_3CH(O_2CH)CO_2H + H_2O$

C $CH_3CH(OH)CO_2H + NaHCO_3 \rightarrow CH_3CH(ONa)CO_2H + H_2O + CO_2$

D $CH_3CH(OH)CO_2H + Cl_2 \rightarrow CH_3CH(Cl)CO_2H + HOCl$

22 Bromine reacts with ethene to form 1,2-dibromoethane.

What is the correct description of the organic intermediate in this reaction?

A It has a negative charge.

B It is a free radical.

C It is a nucleophile.

D It is an electrophile.

23 Chloroethane can be used to make sodium propanoate.

chloroethane $\rightarrow$ Q $\rightarrow$ sodium propanoate

The intermediate, Q, is hydrolysed with boiling aqueous sodium hydroxide, to give sodium propanoate.

Which reagent would produce the intermediate, Q, from chloroethane?

A concentrated ammonia solution

B dilute sulfuric acid

C hydrogen cyanide

D potassium cyanide

24 Aqueous sodium hydroxide reacts with 1-bromopropane to give propan-1-ol.

How should the first step in the mechanism be described?

A by a curly arrow from a lone pair on the OH ion to the $C^{\delta+}$ atom of 1-bromopropane

B by a curly arrow from the $C^{\delta+}$ atom of 1-bromopropane to the OH ion

C by a curly arrow from the C–Br bond to the C atom

D by the homolytic fission of the C–Br bond

25 Pentane, C_5H_{12}, is reacted with chlorine in the presence of ultraviolet light. A compound R is found in the products. R has molecular formula $C_5H_{10}Cl_2$. Each molecule of R contains **one** chiral carbon atom.

Which two atoms of the pentane chain could be bonded to chlorine atoms in this isomer?

A 1 and 3 **B** 1 and 5 **C** 2 and 3 **D** 2 and 4

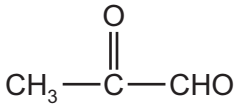
26 *Use of the Data Booklet is relevant to this question.*

2.30 g of ethanol were mixed with an excess of aqueous acidified potassium dichromate(VI). The reaction mixture was then boiled under reflux for one hour. The desired organic product was then collected by distillation. The yield of product was 60.0 %.

What mass of product was collected?

A 1.32 g **B** 1.38 g **C** 1.80 g **D** 3.20 g

27 Burnt sugar has a characteristic smell caused partly by the following compound.



This compound contains two functional groups.

Which reagent will react with **only one** of the functional groups?

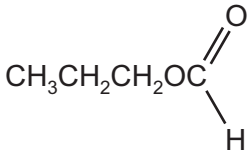
A acidified potassium dichromate(VI)

B 2,4-dinitrophenylhydrazine

C hydrogen cyanide

D sodium hydroxide

28 The structural formula of a compound **X** is shown below.



What is the name of compound **X** and how does its boiling point compare with that of butanoic acid?

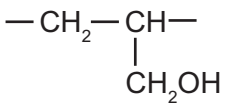
	name of **X**	boiling point of **X**
A	methyl propanoate	higher
B	methyl propanoate	lower
C	propyl methanoate	higher
D	propyl methanoate	lower

29 Synthetic resins, plasticisers and many other chemicals can be made by polymerisation of a variety of monomers including prop-2-en-1-ol, $CH_2{=}CHCH_2OH$.

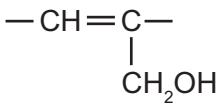
Which structure represents the repeat unit in poly(prop-2-en-1-ol)?

A $-CH_2-CH-CH_2-OH-$

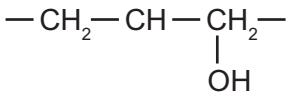
B



C



D

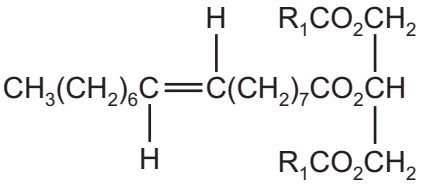


30 Some vegetable oils contain 'trans fats' that are associated with undesirable increases in the amount of cholesterol in the blood.

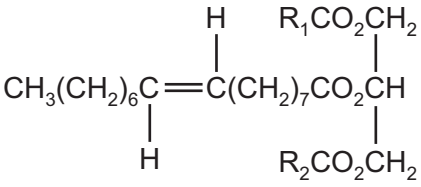
In the diagrams below, R_1 and R_2 are different hydrocarbon chains.

Which diagram correctly illustrates an optically active 'trans fat'?

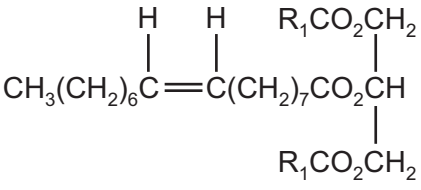
A



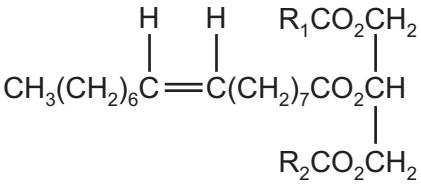
B



C



D



Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 *Use of the Data Booklet is relevant to this question.*

Free-radicals play an important part in reactions involving the destruction of the ozone layer and the substitution of alkanes by chlorine.

Some free-radicals contain two unpaired electrons. Such species are called diradicals.

Which species are diradicals?

1 O

2 C*l*

3 CH_3

32 The Group II metals have higher melting points than the Group I metals.

Which factors could contribute towards the higher melting points?

1 There are smaller interatomic distances in the metallic lattices of the Group II metals.

2 More electrons are available from each Group II metal atom for bonding the atom into the metallic lattice.

3 Group II metals have a higher first ionisation energy than the corresponding Group I metal.

33 Valence shell electron pair repulsion theory should be used to answer this question.

Which species are trigonal planar?

1 BH_3

2 CH_3^+

3 PH_3

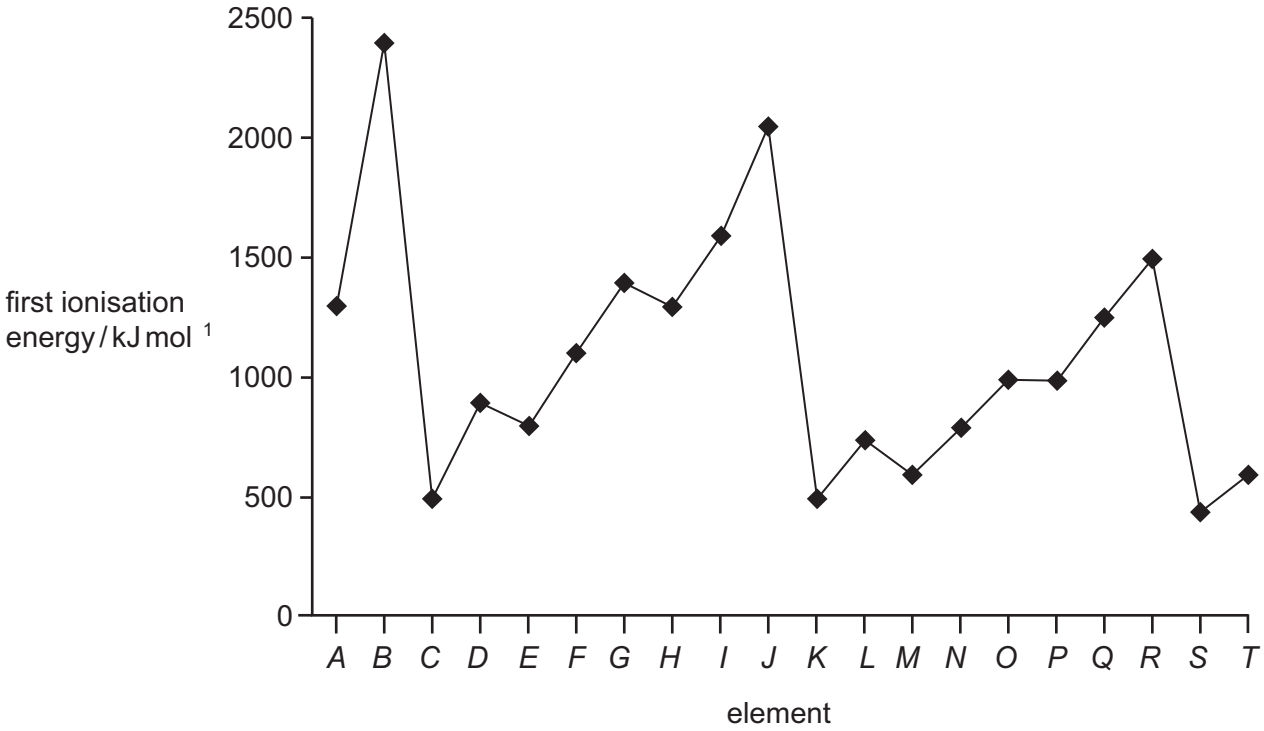
The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

34 The first ionisation energies of twenty successive elements in the Periodic Table are represented in the graph.

The letters given are not the normal symbols for these elements.



Which statements about this graph are correct?

1 Elements *B*, *J* and *R* are in Group 0 of the Periodic Table.

2 Atoms of elements *D* and *L* contain two electrons in their outer shells.

3 Atoms of elements *G* and *O* contain a half-filled p subshell.

35 Solids **W**, **X**, **Y** and **Z** are compounds of two different Group II metals. Some of their applications are described below.

Compound **W** is used as a refractory lining material in kilns.

Compound **X** is used as a building material. It can also be heated in a kiln to form compound **Y**. When **Y** is hydrated, it forms compound **Z** which is used agriculturally to treat soils.

Which statements about these compounds are correct?

1 More acid is neutralised by 1 g of **W** than by 1 g of **X**.

2 The metallic element in **W** reacts with water more quickly than the metallic element in **Y**.

3 Adding **Z** to a soil decreases the pH of the soil.

36 When a red-hot platinum wire is plunged into a test tube of hydrogen iodide, the gas is decomposed into its elements. If the experiment is repeated with hydrogen chloride, no change occurs.

Which factors contribute to this behaviour?

1 the strength of the hydrogen-halogen bond

2 the size of the halogen atom

3 the standard enthalpy of formation, $\Delta H_f^{\ominus}$, of each of the products of decomposition

37 Which molecules would be present in the mixture produced by the photochemical chlorination of methane?

1 hydrogen

2 hydrogen chloride

3 dichloromethane

38 In which reactions is the organic compound oxidised by the given reagent?

1 CH_3CH_2CHO + Fehling's reagent

2 $CH_3CH_2CH_2CHO$ + Tollens' reagent

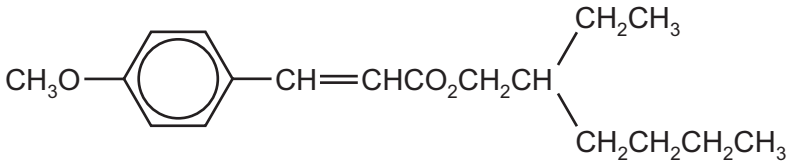
3 CH_3CHO + 2,4-dinitrophenylhydrazine reagent

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

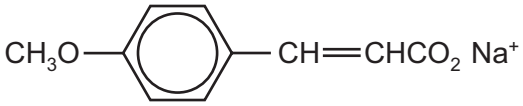
No other combination of statements is used as a correct response.

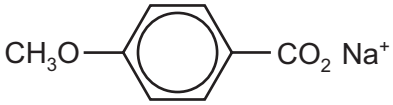
39 A sun protection cream contains the following ester as its active ingredient.



Which substances are present in the products of its hydrolysis by aqueous sodium hydroxide?

1 $CH_3CH_2CH_2CH_2CH(CH_2CH_3)CH_2OH$

2 

3 

40 Which reagents, when used in an excess, can be used to make sodium lactate, $CH_3CH(OH)CO_2Na$, from lactic acid, $CH_3CH(OH)CO_2H$?

1 Na

2 $NaHCO_3$

3 NaOH

BLANK PAGE

BLANK PAGE

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2013 series

9701 CHEMISTRY

9701/11 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**B**
2	**C**	22	**D**
3	**D**	23	**D**
4	**A**	24	**A**
5	**D**	25	**A**
6	**C**	26	**C**
7	**A**	27	**A**
8	**D**	28	**D**
9	**A**	29	**B**
10	**C**	30	**B**
11	**B**	31	**D**
12	**D**	32	**B**
13	**C**	33	**B**
14	**D**	34	**A**
15	**A**	35	**D**
16	**D**	36	**B**
17	**A**	37	**C**
18	**A**	38	**B**
19	**C**	39	**B**
20	**B**	40	**C**

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY (US) **9185/13**

Paper 1 Multiple Choice **May/June 2013**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Center number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
Electronic calculators may be used.

IB13 06_9185_13/RP

UNIVERSITY of CAMBRIDGE International Examinations

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 In the redox reaction shown, how do the oxidation states of vanadium and sulfur change?

$$VO_2^+ + SO_2 \rightarrow V^{3+} + SO_4^{2}$$

	vanadium		sulfur	
	from	to	from	to
A	+1	+3	0	–2
B	+1	+3	+4	+6
C	+5	+3	0	–2
D	+5	+3	+4	+6

2 *Use of the Data Booklet is relevant to this question.*

In which species are the numbers of protons, neutrons and electrons **all** different?

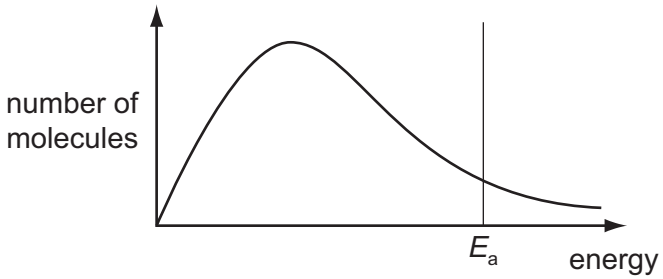
A $^{19}_{9}F$ **B** $^{23}_{11}Na^+$ **C** $^{31}_{15}P$ **D** $^{32}_{16}S^{2}$

3 The first six ionization energies of four elements are given.

Which element is most likely to be in Group IV of the Periodic Table?

	ionization energy / kJ mol ^{1}					
	1st	2nd	3rd	4th	5th	6th
A	494	4 560	6 940	9 540	13 400	16 600
B	736	1 450	7 740	10 500	13 600	18 000
C	1 090	2 350	4 610	6 220	37 800	47 000
D	1 400	2 860	4 590	7 480	9 400	53 200

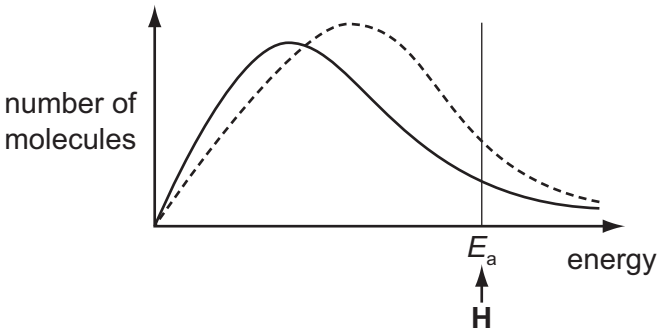
4 The diagram represents, for a given temperature, the Boltzmann distribution of the kinetic energies of the molecules in a mixture of two gases that will react together. The activation energy for the reaction, E_a, is marked.



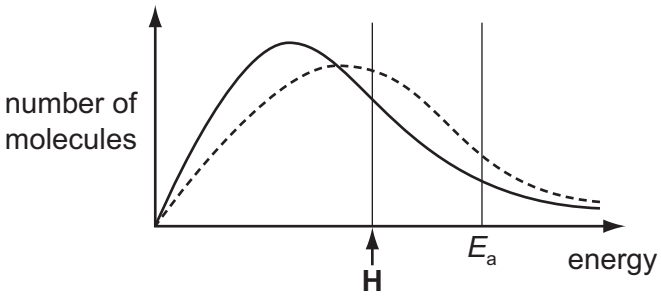
The dotted curves below show the Boltzmann distribution for the same reaction at a higher temperature. On these diagrams, **H** represents the activation energy at the higher temperature.

Which diagram is correct?

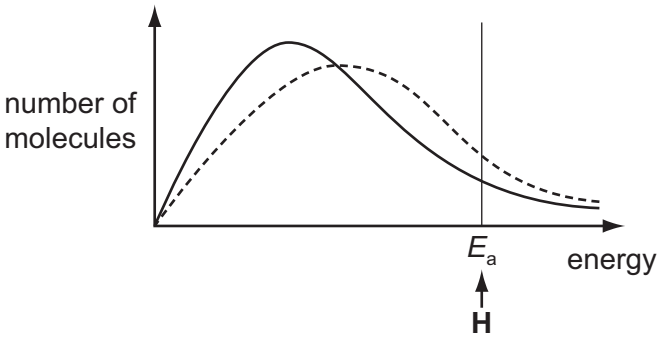
A



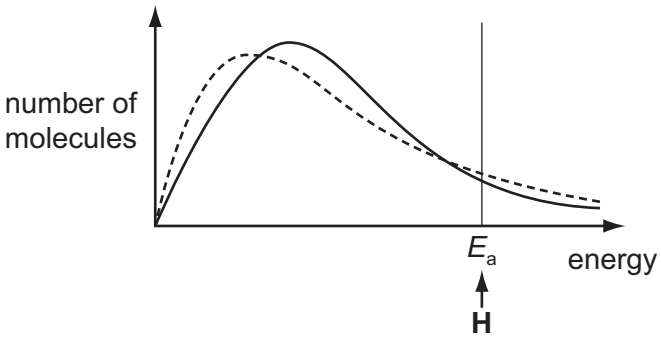
B



C



D



5 Crotonaldehyde, $CH_3CH=CHCHO$, can be obtained by oxidizing butadiene, $CH_2=CHCH=CH_2$, using air or oxygen. One method is to pass a mixture of butadiene and oxygen through a hot aqueous solution of palladium(II) ions, $Pd^{2+}(aq)$, which catalyze the reaction.

Which statement is **not** correct about the action of the $Pd^{2+}(aq)$ ions?

A Changing the concentration of the $Pd^{2+}(aq)$ will have an effect on the rate of the reaction.

B $Pd^{2+}(aq)$ increases the energy of the reacting molecules.

C $Pd^{2+}(aq)$ lowers the activation energy for the reaction.

D $Pd^{2+}(aq)$ provides a different route for the reaction.

6 Which **least** resembles an ideal gas at room temperature and pressure?

A ammonia

B helium

C hydrogen

D methane

7 *Use of the Data Booklet is relevant to this question.*

When 0.15 g of an organic compound is vaporized, it occupies a volume of 65.0 cm^3 at 405 K and 1.00×10^5 Nm^{-2}.

Using the expression $pV = nRT$, which of the following expressions should be used to calculate the relative molecular mass, M_r, of the compound?

A $\frac{0.15 \times 65 \times 10^{-6} \times 1 \times 10^5}{8.31 \times 405}$

B $\frac{0.15 \times 8.31 \times 405}{1 \times 10^5 \times 65 \times 10^{-3}}$

C $\frac{0.15 \times 65 \times 10^{-3} \times 1 \times 10^5}{8.31 \times 405}$

D $\frac{0.15 \times 8.31 \times 405}{1 \times 10^5 \times 65 \times 10^{-6}}$

8 Which compound is the only gas at room temperature and pressure?

A $CH_3CH_2CH_2NH_2$ $M_r = 59.0$

B $CH_3CH_2CH_2OH$ $M_r = 60.0$

C CH_2OHCH_2OH $M_r = 62.0$

D CH_3CH_2Cl $M_r = 64.5$

9 Which formula represents the empirical formula of a compound?

A CH_4O **B** C_2H_4 **C** C_6H_{12} **D** H_2O_2

10 *Use of the Data Booklet is relevant to this question.*

A washing powder contains sodium hydrogencarbonate, $NaHCO_3$, as one of the ingredients. In a titration, a solution containing 1.00 g of washing powder requires 7.15 cm^3 of 0.100 mol dm^{-3} sulfuric acid for complete reaction. The sodium hydrogencarbonate is the only ingredient that reacts with the acid.

What is the percentage by mass of sodium hydrogencarbonate in the washing powder?

A 3.0 **B** 6.0 **C** 12.0 **D** 24.0

11 *Use of the Data Booklet is relevant to this question.*

This question should be answered using bond enthalpy data. The equation for the complete combustion of methanal is given below.

$$H_2C{=}O + O_2 \rightarrow CO_2 + H_2O$$

What is the enthalpy change of combustion of methanal?

A $+416\,kJ\,mol^{-1}$

B $+396\,kJ\,mol^{-1}$

C $-344\,kJ\,mol^{-1}$

D $-690\,kJ\,mol^{-1}$

12 *Use of the Data Booklet is relevant to this question.*

Anhydrous magnesium nitrate, $Mg(NO_3)_2$, will decompose when heated, giving a white solid and a mixture of two gases **X** and **Y**.

Y is oxygen.

What is the ratio $\frac{\text{mass of } \mathbf{X} \text{ released}}{\text{mass of } \mathbf{Y} \text{ released}}$?

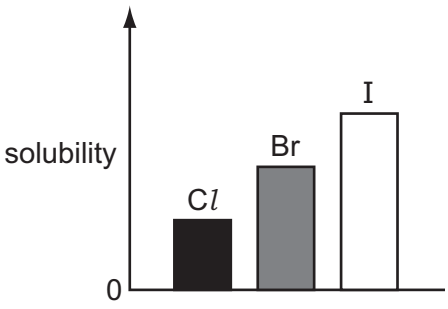
A $\frac{1}{0.174}$ **B** $\frac{1}{0.267}$ **C** $\frac{1}{0.348}$ **D** $\frac{1}{3.43}$

13 In which row of the table are all statements comparing magnesium and barium correct?

	fourth ionization energy of magnesium	fourth ionization energy of barium	reaction of magnesium with cold water	reaction of barium with cold water
A	higher	lower	faster	slower
B	higher	lower	slower	faster
C	lower	higher	faster	slower
D	lower	higher	slower	faster

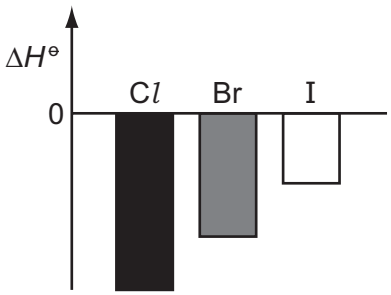
14 Two students, P and Q, were asked to draw bar charts to represent how some properties of the halogens and their compounds differ in magnitude. Their diagrams are shown.

student P



solubility of AgX(s) in $NH_3(aq)$

student Q



$\Delta H^{\ominus}$ for $H_2(g) + X_2(g) \rightarrow 2HX(g)$

Which of the student's diagrams are correct?

A both P and Q

B P only

C Q only

D neither P nor Q

15 When iodine is heated, a vapor is produced.

Which row of the table correctly identifies the species in the vapor and its color?

	species	color
A	I(g)	brown
B	I(g)	purple
C	$I_2(g)$	brown
D	$I_2(g)$	purple

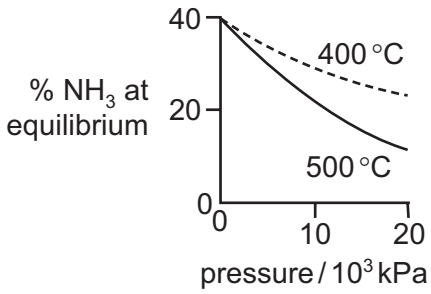
16 How do the strengths of the covalent bonds within molecules, and the van der Waals' forces between molecules, vary going down Group VII from chlorine to bromine to iodine?

	strength of covalent bonds	strength of van der Waals' forces
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

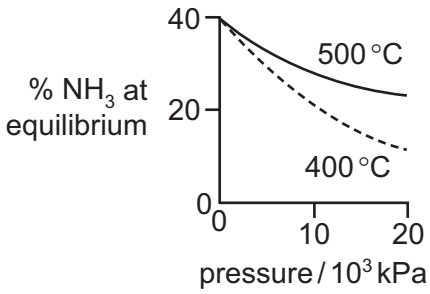
17 Graphs can be drawn to show the percentage of ammonia at equilibrium when nitrogen and hydrogen are mixed at different temperatures and pressures.

Which diagram correctly represents these two graphs?

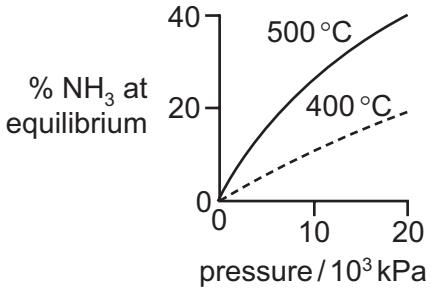
A



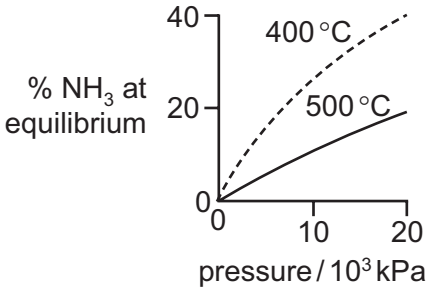
B



C



D



18 In a famous experiment, Wöhler heated "inorganic" ammonium cyanate in the absence of air. The only product of the reaction was "organic" urea, $CO(NH_2)_2$. No other products were formed in the reaction.

What is the formula of the cyanate ion present in ammonium cyanate?

A CNO **B** CNO^2 **C** CO **D** NO

19 Transition elements and their compounds are important as catalysts.

In which process is a transition element compound used, rather than the element itself?

A catalytic converters

B Contact process

C Haber process

D hydrogenation of oils

20 Ethene reacts with steam in the presence of sulfuric acid.

$$C_2H_4 + H_2O \rightarrow CH_3CH_2OH$$

What type of reaction is this?

A acid / base

B addition

C hydrolysis

D substitution

21 What is true of every nucleophile?

A It attacks a double bond.

B It has a lone pair of electrons.

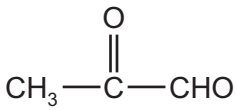
C It is a single atom.

D It is negatively charged.

22 How many isomers, including structural and stereoisomers, with the formula C_4H_8 have structures that involve π bonding?

A 1 **B** 2 **C** 3 **D** 4

23 Burnt sugar has a characteristic smell caused partly by the following compound.



This compound contains two functional groups.

Which reagent will react with **both** functional groups?

A acidified potassium dichromate(VI)

B Fehling's solution

C hydrogen cyanide

D sodium hydroxide

24 Which sequence of reagents may be used in the laboratory to convert propan-1-ol into 2-bromopropane?

A concentrated sulfuric acid, followed by bromine

B concentrated sulfuric acid, followed by hydrogen bromide

C ethanolic sodium hydroxide, followed by bromine

D ethanolic sodium hydroxide, followed by hydrogen bromide

25 A carbanion is an organic ion in which a carbon atom has a negative charge. A carbocation is an organic ion in which a carbon atom has a positive charge.

What is involved in the mechanism of the reaction between aqueous sodium hydroxide and 2-bromo-2-methylbutane?

A heterolytic bond fission followed by an attack by an electrophile on a carbanion

B heterolytic bond fission followed by an attack by a nucleophile on a carbocation

C homolytic bond fission followed by an attack by an electrophile on a carbanion

D homolytic bond fission followed by an attack by a nucleophile on a carbocation

26 Which compound gives an organic product with a lower boiling point when it is heated under reflux with an excess of acidified potassium dichromate(VI)?

A 2-methylbutan-1-ol

B 2-methylbutan-2-ol

C pentan-1-ol

D pentan-2-ol

27 *Use of the Data Booklet is relevant to this question.*

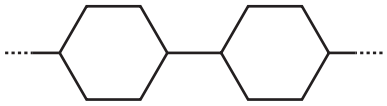
Which volume of oxygen, at room temperature and pressure, is needed for complete combustion of 0.1 mol of ethanol?

A 7.2 dm^3 **B** 8.4 dm^3 **C** 14.4 dm^3 **D** 16.8 dm^3

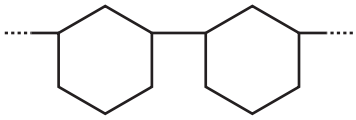
28 Cyclohexene, shown below, can form an addition polymer.

Which structure represents a section of the polymer including two cyclohexene residues?

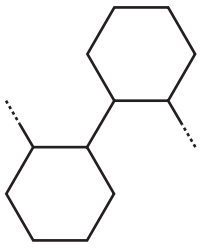
A



B



C



D

29 How many isomeric esters, including structural isomers and stereoisomers, can be made with the molecular formula $C_5H_{10}O_2$, if methanoic acid is one of the two reactants used?

A 2 **B** 3 **C** 4 **D** 5

30 CCl_2FCClF_2 can be converted into CH_2FCF_3 by the following route.

$$CCl_2FCClF_2 \xrightarrow{\text{step 1}} CCl_3CF_3 \xrightarrow{\text{step 2}} CCl_2FCF_3 \xrightarrow{\text{step 3}} CH_2FCF_3$$

What type of reaction is step 1?

A addition

B elimination

C isomerization

D oxidation

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 A space shuttle's upward thrust came from the following reaction between aluminum and ammonium perchlorate.

$$10Al + 6NH_4ClO_4 \rightarrow 4Al_2O_3 + 2AlCl_3 + 12H_2O + 3N_2$$

Which statements about this reaction are correct?

1 Aluminum is oxidized.

2 Chlorine is reduced.

3 Nitrogen is oxidized.

32 *Use of the Data Booklet is relevant to this question.*

Which statements are correct when referring to the atoms ^{23}Na and ^{24}Mg?

1 They have the same number of full electron orbitals.

2 They have the same number of neutrons.

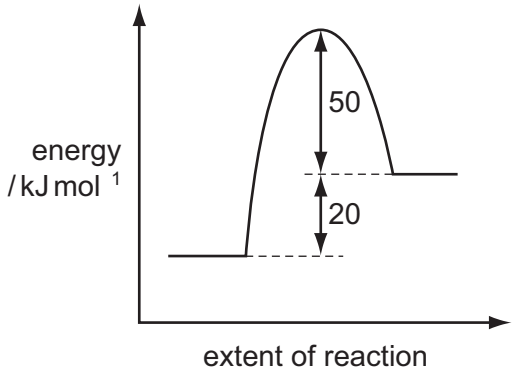
3 They are both reducing agents.

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

33 The reaction pathway for a reversible reaction is shown below.



Which statements are correct?

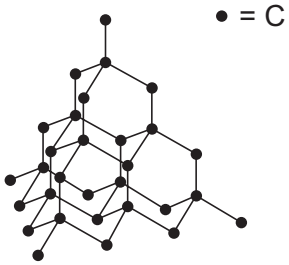
1 The enthalpy change for the backward reaction is –20 kJ mol $^{-1}$.

2 The forward reaction is endothermic.

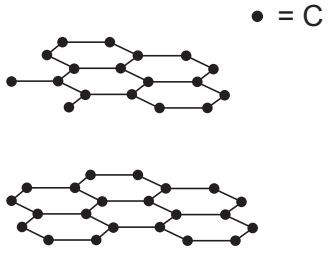
3 The activation energy for the forward reaction is +70 kJ mol $^{-1}$.

34 Which diagrams represent part of a giant molecular structure?

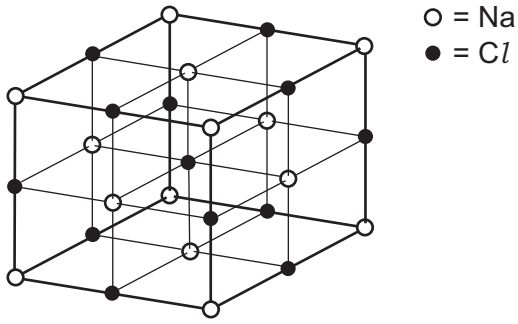
1



2



3



35 Solids **W**, **X**, **Y** and **Z** are compounds of two different Group II metals. Some of their applications are described below.

Compound **W** is used as a refractory lining material in kilns.

Compound **X** is used as a building material. It can also be heated in a kiln to form compound **Y**. When **Y** is hydrated, it forms compound **Z** which is used agriculturally to treat soils.

Which statements about these compounds are correct?

1 More acid is neutralized by 2.0 g of **X** than by 2.0 g of **W**.

2 The M_r of **X** is greater than the M_r of **Y** by 44.0.

3 The metallic element in **Y** reacts with cold water more quickly then the metallic element in **W**.

36 Element **J** is a solid. It occurs as a contaminant of fossil fuels.

Its oxide **K** is formed in car engines.

In the atmosphere, **K** can be further oxidized to **L**.

Which statements about **J**, **K** and **L** are correct?

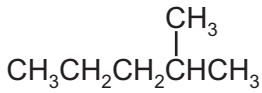
1 Atoms of **J** have paired p electrons.

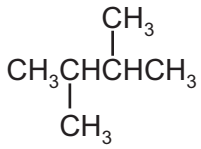
2 The atmospheric oxidation of **K** to **L** is a catalyzed reaction.

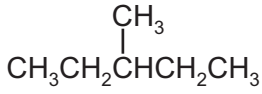
3 With water, **L** forms a strong acid.

37 During the bromination of methane, the free radical $CH_3\bullet$ is generated. A possible terminating step of this reaction is the formation of C_2H_6 by the combination of two free radicals.

What could be produced in a terminating step during the bromination of **propane**?

1 

2 

3 

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

38 Fabrics for use in aircraft seating are treated with a coating containing a halogenoalkane.

Why is this coating used?

1 The treated fabric burns less easily, improving safety.

2 The treated fabric forms hydrogen bonds to water more readily, so it is easier to wash.

3 The halogenoalkane undergoes addition polymerization, stiffening the fabric.

39 A liquid **X** is known to be either a single organic compound or a mixture of organic compounds. When treated with sodium, **X** gives off hydrogen gas.

When treated with 2,4-dinitrophenylhydrazine reagent, **X** gives orange crystals.

Which deductions about **X** can definitely be made?

1 At least one component of **X** is a carbonyl compound.

2 Only one of the components of **X** is a carbonyl compound.

3 At least one component of **X** is an alcohol.

40 Ethanoic acid, CH_3CO_2H, is an important chemical which is used in the industrial manufacture of rayon and aspirin.

Which processes can be used to make ethanoic acid?

1 hydrolysis of ethanenitrile

2 oxidation of ethanol

3 oxidation of ethanal

BLANK PAGE

BLANK PAGE

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2013 series

9185 CHEMISTRY

9185/13 Paper 1 (Multiple Choice), maximum raw mark 40

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

CAMBRIDGE
International Examinations

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**B**
2	**B**	22	**D**
3	**C**	23	**C**
4	**C**	24	**B**
5	**B**	25	**B**
6	**A**	26	**D**
7	**D**	27	**A**
8	**D**	28	**C**
9	**A**	29	**D**
10	**C**	30	**C**
11	**C**	31	**A**
12	**A**	32	**C**
13	**B**	33	**A**
14	**C**	34	**B**
15	**D**	35	**C**
16	**B**	36	**A**
17	**D**	37	**B**
18	**A**	38	**D**
19	**B**	39	**D**
20	**B**	40	**A**