iGda C ALL EQ Chemistry P3

Contents

Topic 1

iGda 15s31 Q4(a)

(iii) Aspirin is a white solid compound at room temperature.

Describe, without practical details, **one** way in which the purity of a sample of aspirin could be checked.

.....

.....

..... [2]

iGda 13w31 Q1 (a)

1 Sodium chloride (common salt) is obtained from underground deposits in the Earth's crust.

Low-sodium salt is a mixture containing both sodium chloride (melting point 801 °C) and potassium chloride (melting point 770 °C).

(iii) Suggest how a white solid could be tested to discover whether it was common salt or low-sodium salt.

.....

.....

..... [2]

Topic 1 MS

iGda 15s31 Q4 (a)

(iii) measure the melting point ;
compare with published value/ should be same as published value ;

OR

chromatography ;
compare with pure sample ; [2]

iGda 13w31 Q1 (a)

(iii) (try to) find melting point ;
sharp m.pt./801 °C indicates sodium chloride ;
unclear m.pt. indicates mixture/low sodium salt ; [max 2]

Topic 10

iGda 15s31

2 Fig. 2.1 shows apparatus a student uses to study the change in temperature when some metallic zinc is added to copper sulfate solution.

The student checks that the temperature of the copper sulfate solution is steady and then adds powdered zinc.

Data from the experiment are shown in the graph below the apparatus.

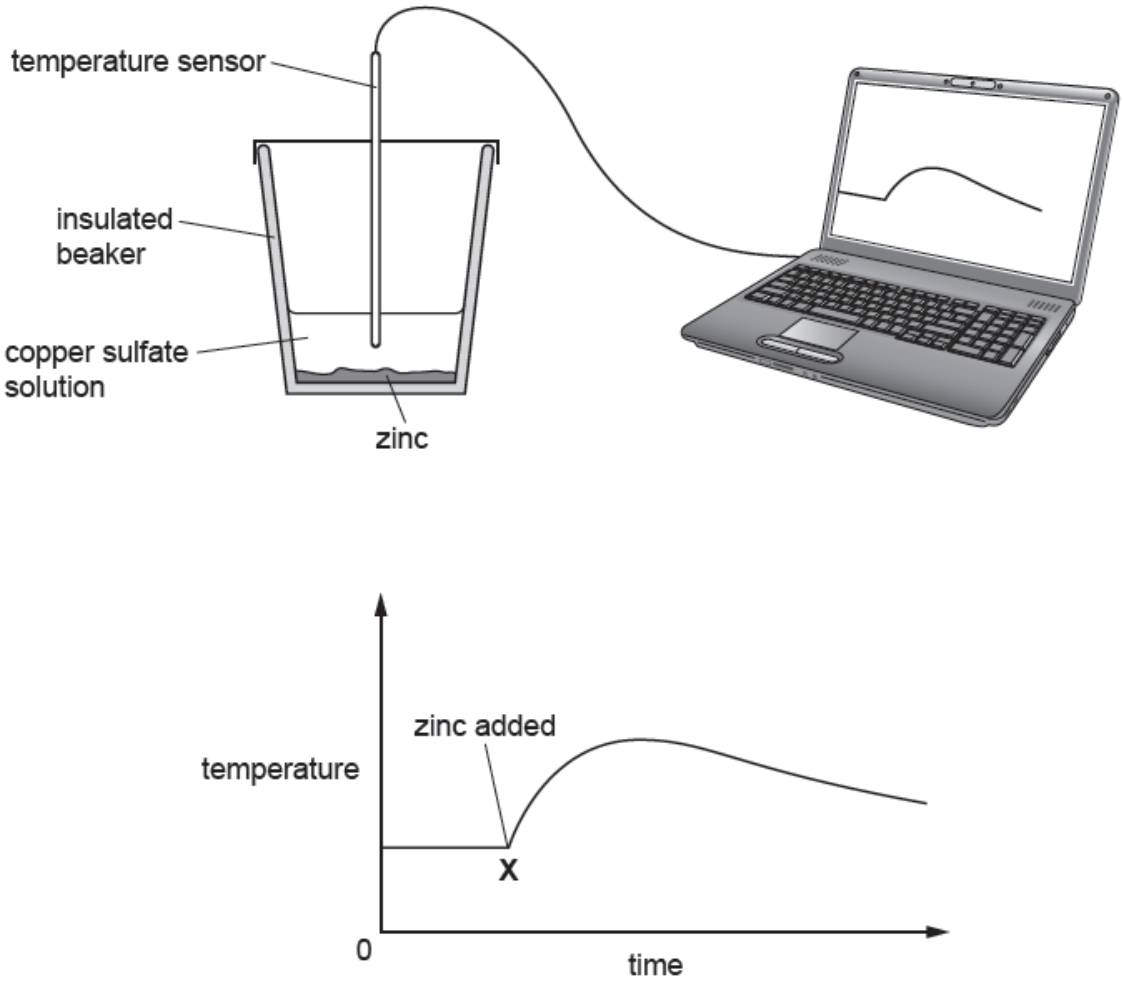


Fig. 2.1

(a)

(iii) Predict and explain the temperature changes, if any, when the student carries out a second experiment in which he adds powdered copper to a zinc sulfate solution.

.....

.....

.....

..... [3]

1 The method used to extract metals from their compounds depends on the reactivity of the metal.

Magnesium is more reactive than iron. Most magnesium is produced industrially using electrolysis.

(a) Name the industrial apparatus used to extract iron.

.....[1]

(b) State the name or give the chemical formula of the main compound from which iron is extracted.

.....[1]

iGda 14w31

5 A student investigates the reactions between dilute hydrochloric acid and five substances.

Fig. 5.1 shows the five substances contained in test-tubes **A** to **E**.

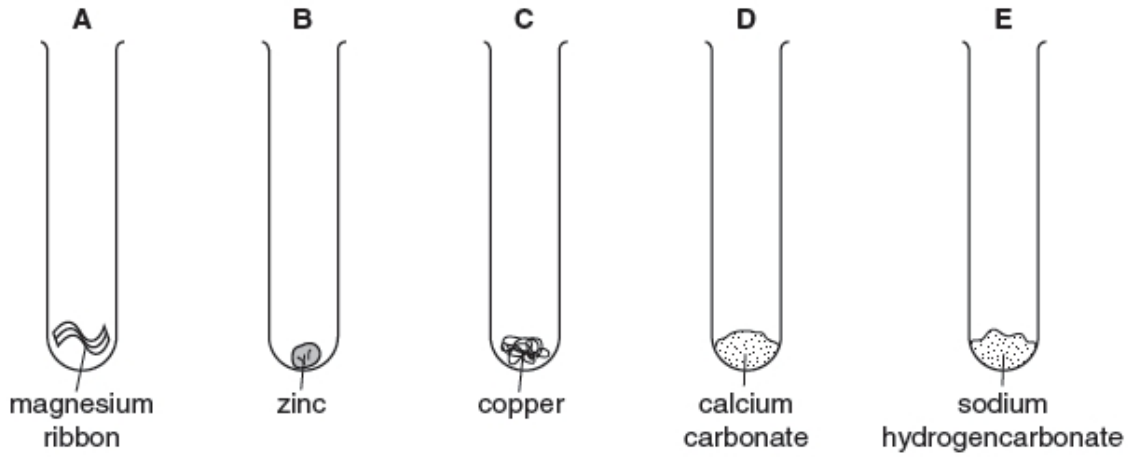


Fig. 5.1

She adds dilute hydrochloric acid to each tube.

Her observations and temperature measurements are shown in Table 5.1.

Table 5.1

test-tube	observations	temperature of the reactants before reaction/°C	temperature of the mixture in the test-tube after a short time/°C
A	gas given off quickly	18	45
B	gas given off slowly	18	19
C	no gas produced	18	
D	gas given off quickly	18	20
E	gas given off quickly	18	11

(a) **(i)** Name the gas given off when dilute hydrochloric acid is added to test-tubes **A** and **B**.

.....[1]

(ii) The pH of the dilute hydrochloric acid before reacting is 2.

Predict the pH of the solution in test-tube **D** after reaction.

Explain your answer.

prediction .....

explanation .....

.....

.....[2]

(b) Temperature changes are observed in many chemical reactions.

(i) Suggest the temperature of the mixture in test-tube **C** after a short time.

Write your answer in Table 5.1. [1]

(ii) Explain your answer to **(i)**.

.....

.....[1]

(iii) Temperature changes show that the chemical potential energy of the reactants is different from that of the products.

State the letter of the test-tube in which the chemical potential energy of the products is **greater** than that of the reactants. Explain your answer.

test-tube .....

explanation .....

.....

.....[3]

(c) Suggest **two** possible reasons why the rate of production of gas in test-tube **A** is different from that in test-tube **B**.

1 .....

.....

2 .....

.....[2]

iGda 14s31 Q4 (c)

(iii) A metal displacement reaction occurs when magnesium is placed into a solution of silver nitrate.

This reaction may be represented by the ionic equation

$$Mg(s) + 2Ag^{+}(aq) \longrightarrow Mg^{2+}(aq) + 2Ag(s)$$

Using the idea of electron transfer, explain why this is an example of a redox reaction.

.....

.....

..... [2]

iGda 14s31 Q4

(c) A metal displacement reaction may occur when a metal is placed into an aqueous solution of a salt of a different metal.

Metals **L**, **M** and **N** are added to solutions of the nitrates of the same three metals. Table 1.1 shows whether or not a displacement reaction occurs.

Table 1.1

	metal **L**	metal **M**	metal **N**
metal **L** nitrate solution		**no** reaction	reaction
metal **M** nitrate solution	reaction		reaction
metal **N** nitrate solution	**no** reaction	**no** reaction	

(i) Use the results in Table 1.1 to place the three metals, **L**, **M** and **N**, into order according to their relative reactivity starting with the most reactive.

..... (most reactive)

.....

..... [1]

(ii) Explain your answer to **(i)**.

.....

.....

.....

.....

..... [3]

iGda 13w31 Q4

(c) Fig. 4.3 shows a cross section through a blast furnace which is used to extract iron from iron oxide.

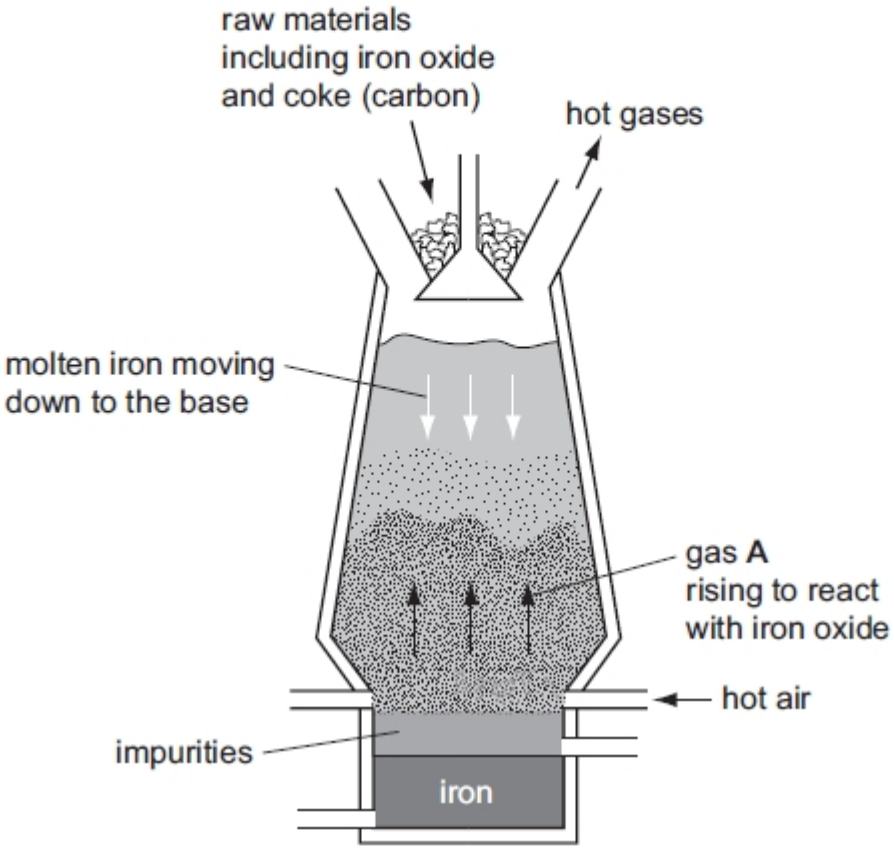


Fig. 4.3

(i) Name gas **A** which reacts with iron oxide to produce iron.

.....[1]

(ii) The mixture of hot gases which is released from the top of the furnace contains carbon dioxide.

State **word** chemical equations for **two** different reactions that produce carbon dioxide inside the blast furnace.

1 .....

2 .....[2]

(iii) Explain how gas **A** in Fig. 4.3 is formed inside the blast furnace.

.....

.....[1]

iGda 13s31 Q1

(c) Hydrogen is often included in the reactivity series of metals.

Use the idea of reactivity to explain the observations shown in Fig. 1.2.

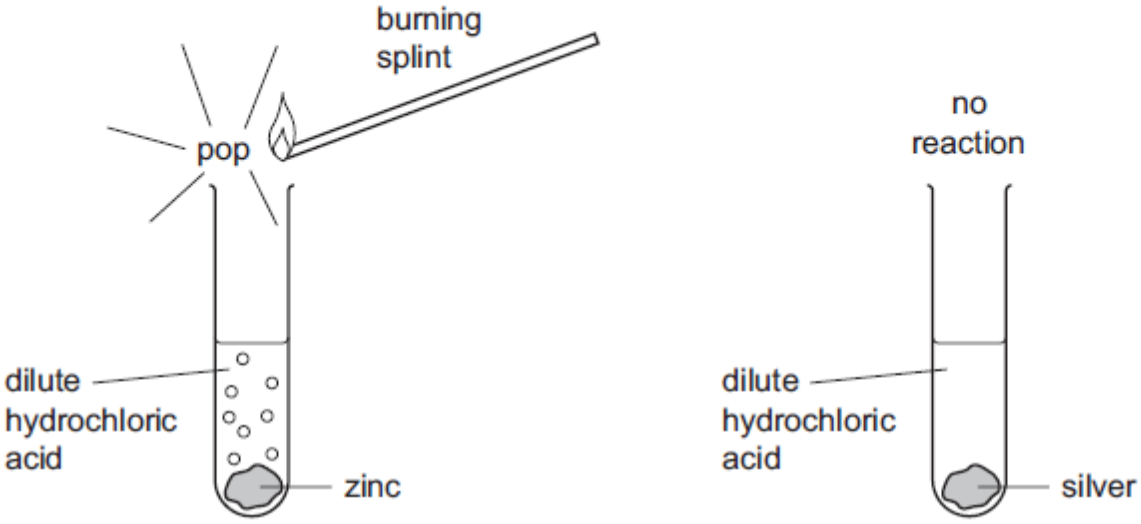


Fig. 1.2

.....

.....

.....

.....

.....

..... [3]

iGda 13s31

7 The metal vanadium is mixed with iron and carbon to make vanadium steel.

(a) (i) Vanadium metal may be obtained by reducing vanadium oxide with magnesium.

Suggest the **word** chemical equation for this reaction.

..... [1]

(ii) Vanadium is a transition metal and magnesium is in Group 2 of the Periodic Table.

Suggest **two** differences in properties between vanadium and magnesium.

1 .....

.....

2 .....

..... [2]

iGda 12s31 Q8

(b) Most metallic elements occur combined with non-metals in the Earth's crust. For thousands of years, humans have carried out chemical reactions to extract metals from their ores.

Fig. 8.1 shows a cross-section through a shaft furnace which was a simple reaction vessel used by ancient civilisations to extract iron.

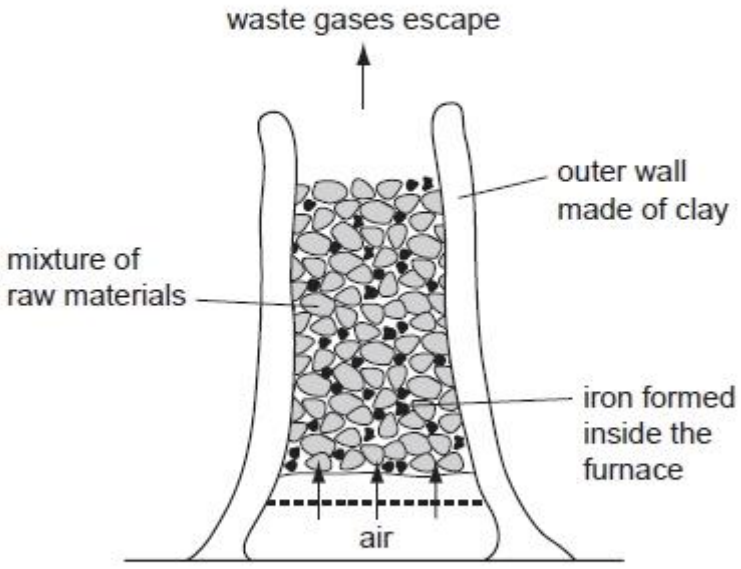


Fig. 8.1

In this shaft furnace the mixture of raw materials consisted of charcoal and iron ore. Charcoal contains mainly carbon, and iron ore contains iron oxide.

Nowadays iron is extracted from iron ore in a blast furnace.

(i) Name another raw material, which is added to a modern blast furnace but which is **not** present in the shaft furnace in Fig. 8.1.

Explain briefly why this material is used.

name of material .....

reason this material is used .....

..... [2]

(ii) Iron is extracted from iron ore when a gaseous oxide of carbon reacts with iron oxide.

Write a **word** chemical equation for this reaction.

..... [2]

(c) (i) Suggest, in terms of relative reactivity, why a mixture of zinc oxide and carbon does **not** produce any metallic zinc in a blast furnace.

.....

.....

..... [2]

(ii) A thin coating of zinc is often applied to steel to prevent rusting. Zinc provides sacrificial protection for the steel.

Explain briefly the meaning of the term *sacrificial protection*.

.....

.....

..... [2]

iGda 11w31

8 (a) Table 8.1 shows some properties of three solid elements **A**, **B** and **C**.

Table 8.1

element	density	electrical conductivity
A	low	high
B	low	low
C	high	high

One of the elements in Table 8.1 is a transition metal.

Suggest and explain which element, **A**, **B** or **C**, has properties that are typical of a transition metal.

element .....

explanation .....

..... [1]

(b) The diagram in Fig. 8.1 is a common way of showing how the atoms are arranged in a small cross-section of a metallic element.

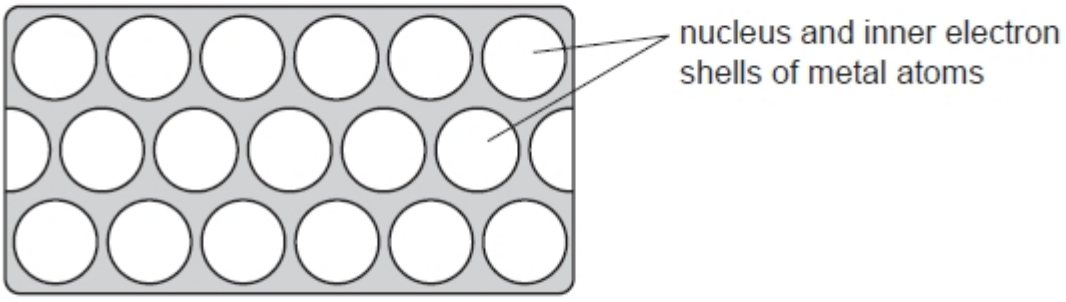


Fig. 8.1

(i) State briefly what the shaded area between the atoms in Fig. 8.1 represents.

.....

..... [1]

(ii) A metal such as copper is malleable because layers of atoms slip past one another when a force is applied to the metal.

Explain why bronze, an alloy of copper and tin, is **less** malleable than copper. You should draw a simple diagram to help you to answer this question.

.....

.....

..... [3]

(c) Fig. 8.2 shows two electrical cells, **X** and **Y**, in which copper is used as one of the electrodes. The same electrolyte is used in both cells.

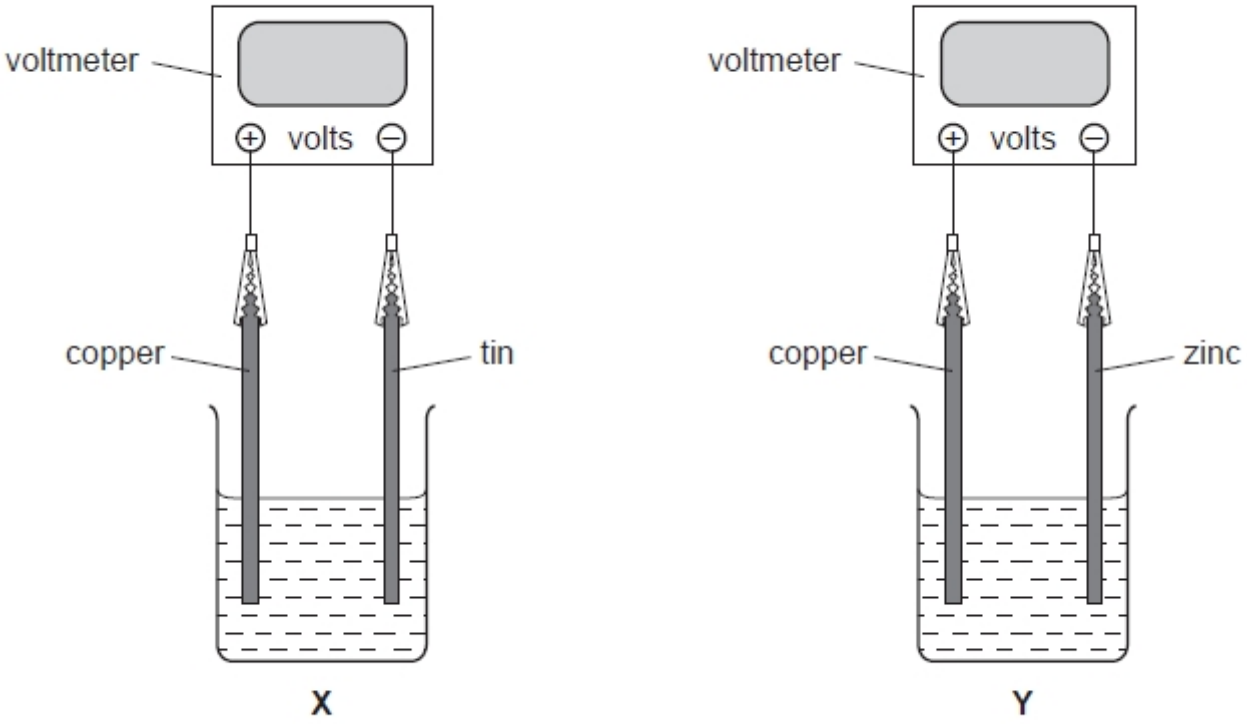


Fig. 8.2

The relative reactivity of the three metals involved in these cells is shown below.

zinc	(most reactive)
tin	
copper	(least reactive)

Explain which cell has the **lower** voltage.

cell .....

explanation .....

.....

.....

..... [2]

iGda 11s31 Q5

(b) Fig. 5.2 shows a simplified diagram of two types of atom, **P** and **Q**, in mild steel.

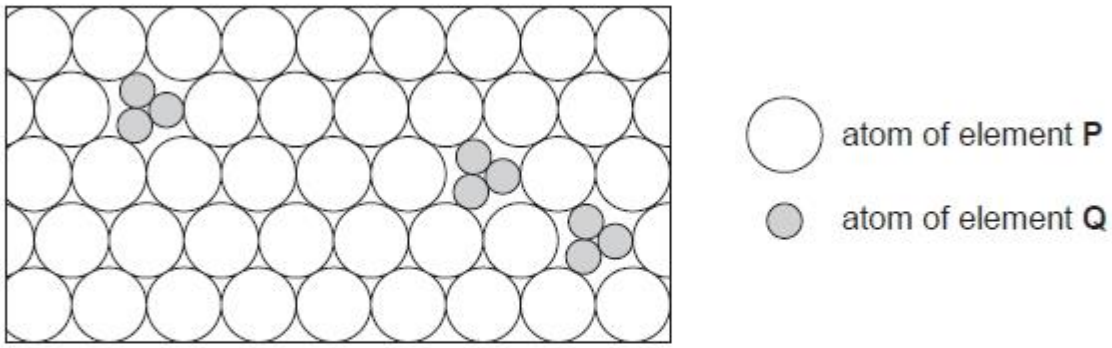


Fig. 5.2

(i) Suggest the name of element **Q**. ..... [1]

(ii) Use Fig. 5.2 to explain why an alloy such as mild steel is less malleable than a pure metal such as iron.

.....

.....

..... [2]

iGda 10w31 Q4

(c) Table 4.1 shows information about some metallic materials.

Table 4.1

material	strength	density
mild steel	very high	very high
aluminium	low	low
duralumin (an aluminium alloy)	very high	low

(i) Duralumin is used in the manufacture of aircraft.

Explain why the properties of this material make it suitable for this purpose.

.....

.....

.....

.....

..... [2]

iGda 09s31 Q9

(c) Fig. 9.3 shows a pencil sharpener. Both the case and the blades are made using alloys.

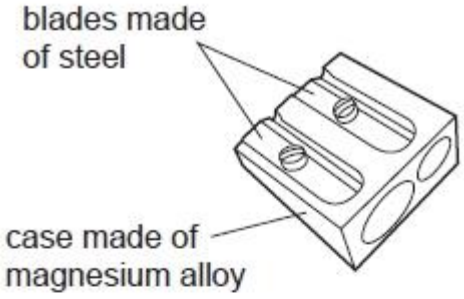


Fig. 9.3

Alloys rather than pure metals are used because they are stronger and less malleable.

Draw diagrams to show part of the giant structures of a pure metal and an alloy.
Use your diagrams to help you to explain why alloys are less malleable than the pure metals they contain.

diagram of the structure of a pure metal

diagram of the structure of an alloy

.....

.....

.....

..... [4]

iGda 08w31

9 Fig. 9.1 shows the apparatus and substances used by a student to make an electrical cell.

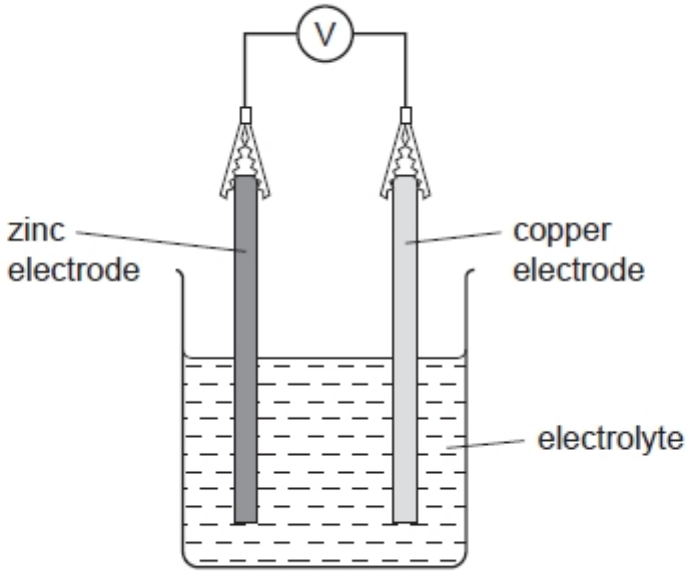


Fig. 9.1

(b) The student knows that the electrode made from the more reactive metal is the negative electrode of the cell.

The student has three other electrodes made of unknown metals **X**, **Y** and **Z**. The results of experiments involving all five metals are shown in Table 9.1.

Table 9.1

experiment	negative electrode	positive electrode	cell voltage / volts
1	zinc	copper	1.1
2	**X**	copper	2.7
3	**Y**	copper	1.5
4	**X**	**Z**	3.2

(i) Use the results shown in Table 9.1 to place the metals in order of reactivity. Copper has already been placed in position.

..... (most reactive)

.....

.....

copper .....

..... (least reactive) [2]

(ii) State and explain briefly which one of the metals above has atoms which change into ions most easily.

.....

.....

..... [2]

Topic 10 MS

iGda 15s31 Q2a

(iii) no temperature change ;
because no reaction occurs ;
because copper is less reactive than zinc ; [3]

iGda 14w31

1 (a) blast furnace ; [1]

(b) iron oxide / iron(III) oxide / Fe_2O_3 ; [1]

iGda 14w31

5 (a) (i) hydrogen ; [1]

(ii) greater than 2 but less than 7 ;
some of the acid has reacted/been used up/acid concentration is lower/lower concentration means higher pH ; [2]

(b) (i) 18 (°C) ; [1]

(ii) copper does not react with dilute acid/there is no reaction ; [1]

(iii) **E** ;
thermal energy has been converted into chemical energy/reference to takes in heat energy/thermal energy from the surroundings ;
shown by reaction being endothermic/temperature decrease ; [3]

(c) *[answers must relate answers to the test-tubes or materials]*
in tube **A** the metal has 'different' surface area/greater degree of division ;
(metal in) tube **A** magnesium is more reactive than zinc/or metal in **A** more reactive ;
reaction in **A** is more exothermic **OR** higher temperature produces higher rate ; [max 2]

iGda 14s31 Q4 (c)

(iii) magnesium (atoms)/Mg lose electrons and are oxidised ;
silver (ions)/Ag^+ gain electrons and are reduced ;
general statement that loss of electrons defined as oxidation **AND** gain of electrons defined as reduction ; [max 2]

iGda 14s31 Q4

(c) (i) **N** (most reactive)
L
M ; [1]

(ii) general statement that more reactive metal displaces less reactive metal ;
N displaces both/**L** and **M** and so is more reactive than them/most reactive ;
M displaces neither/**L** nor **N** and so is least reactive/less reactive than them ;
L displaces **M** and so is more reactive than **M** ;
L doesn't displace **N** and so is less reactive than **N** ; [max 3]

iGda 13w31 Q4

(c) (i) carbon monoxide ; [1]

(ii) carbon + oxygen → carbon dioxide ;
iron oxide + carbon monoxide → iron + carbon dioxide ;
calcium carbonate → carbon dioxide + calcium oxide ; [max 2]

(iii) carbon dioxide reacts with (hot) carbon/carbon dioxide + carbon → carbon monoxide ; [1]

iGda 13s31 Q1

(c) pop (test) indicates hydrogen (given off)/hydrogen is given off ;
zinc displaces hydrogen/reacts with HC/ to produce hydrogen/silver does not react with HC/ to produce hydrogen ;
zinc more reactive than hydrogen ;
silver less reactive than hydrogen (so no reaction) ; [max 3]

iGda 13s31

7 (a) (i) vanadium oxide + magnesium → vanadium + magnesium oxide ; [1]

(ii) vanadium has higher density ;
vanadium has higher melting point ;
vanadium can act as catalyst ;
vanadium forms coloured compounds ; [max 2]

iGda 12s31 Q8

(b) (i) limestone/ calcium carbonate ;
forms slag/ removes impurities/removes silicon dioxide ; [2]

(ii) iron oxide + carbon monoxide → iron + carbon dioxide ;; [2]
[LHS + RHS]

(c) (i) question withdrawn [2]

(ii) zinc more reactive than iron ;
so zinc reacts (with water/oxygen) before/instead of iron ;
so zinc corrodes leaving the iron/steel unaffected/ owtte ; [max 2]

iGda 11w31

8 (a) (C) high density and (high) electrical conductivity ; [1]

(b) (i) delocalised electrons/sea of electrons/the outer shell electrons ; [1]

(ii) diagram shows atoms of two different sizes ;
words or diagram imply layer structure disrupted ;
atoms of different size prevent layers of the other atoms from sliding ;
the idea that more force needed to move layers/atoms ; [max 3]

(c) (X) the idea that cell voltage is related to relative metal reactivity ;
the idea that the greater the difference in reactivity the greater the voltage/the reactivity difference between Cu and Zn is greater than between Cu and Sn ; [2]

iGda 11s31 Q5

(b) (i) carbon ; [1]

(ii) regular structure (of iron) disrupted/ atoms are of different sizes ;
(iron) atoms do not so easily slip past one another ; [2]

iGda 10w31 Q4

(c) (i) high strength, for safety/ resist breakage/ because high forces on airframe in flight ;
low density, to reduce weight/ reduce fuel cost ; [max 2]

iGda 09s31 Q9

(c) *metal diagram shows*
regular lattice ;
all atoms same diameter ;

alloy diagram shows
atoms of different diameters ;
reference to the disrupted lattice in alloy resisting movement of atoms ; [4]

iGda 08w31 Q9

(b) **(i)** X (most)
Y
zinc
(copper)
Z (least ;; (all correct for [2] two correct for [1]) [2]

(ii) X ;
it is the most reactive ; [2]

(c) evidence of balancing charge to find copper ion charge ;
deduces Cu^{+} in Cu_2O ;
deduces Cu^{2+} in CuO ;
statement to effect that Cu^{2+} has one less electron than Cu^{+} / or similar ; [max 3]
$2Cu^{+} + O^{2-}$ *arrow* Cu_2O gets mp 1 and 2 because it implies charge neutralised

Topic 11

iGda 15s31 Q7

(b) Fig. 7.2 shows a simplified diagram of waste gases from a car engine passing over a catalyst.

Mixtures of hydrocarbons, such as diesel, are used as car fuel.

The waste gases from car engines contain many substances that cause air pollution.

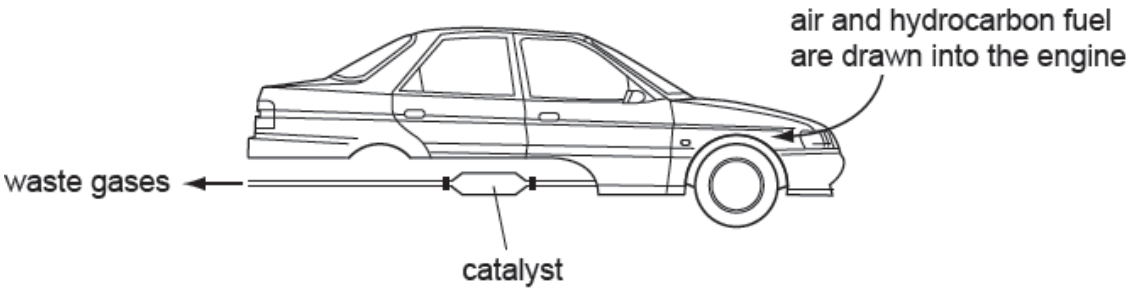


Fig. 7.2

Chemical reactions on the catalyst remove nitrous oxide, N_2O, and carbon monoxide, CO, from the waste gases.

(ii) Use information from Fig. 7.2 to suggest how nitrous oxide and carbon monoxide are formed inside the car's engine.

nitrous oxide

.....

.....

.....

carbon monoxide

.....

.....

.....

[4]

iGda 14s31 Q4

(b) When some fuels are burned, the mixture of combustion products contains sulfur dioxide and oxides of nitrogen.

State **two** harmful effects of these gases in the environment.

1 .....

.....

2 .....

..... [2]

iGda 14s31 Q12

(c) Rust is a type of iron oxide.

Fig. 12.1 shows four test-tubes, **1**, **2**, **3** and **4**, that a student set up to investigate the rusting of iron.

Each test-tube contained an iron nail and different combinations of a liquid and a gas.

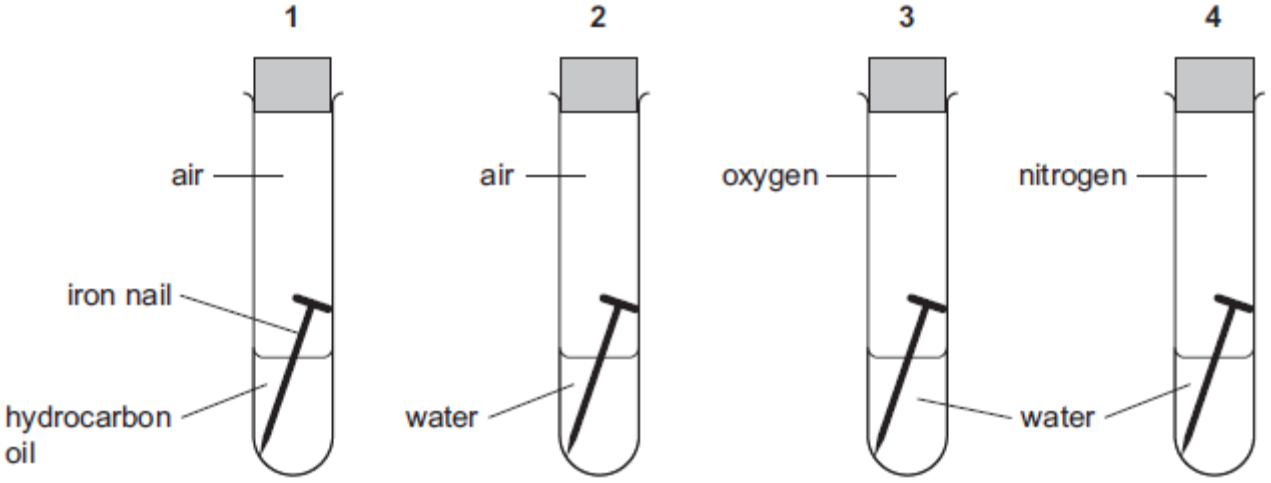


Fig. 12.1

The test-tubes and their contents were left for a week and then observed. Table 12.2 shows the observations the student made.

Table 12.2

test-tube	observation
1	no rust
2	rust formed
3	rust formed
4	no rust

Explain how the results in each test-tube lead to a conclusion about what is needed for rust to form.

.....

.....

.....

.....

.....

.....

..... [3]

12 About one tenth of the Earth's surface is covered by forests in which much photosynthesis takes place.

(a) Describe how photosynthesis transforms energy from sunlight to chemical energy.

.....

.....

.....

.....

.....

..... [3]

(b) Explain how extensive deforestation could lead to an increase in the rate of global warming.

.....

.....

.....

.....

.....

..... [3]

8 The addition of a harmful substance to the environment is called pollution. Three examples of pollution caused by human activities are

- acid rain,
- fertilisers entering rivers and lakes,
- the release of too much carbon dioxide into the atmosphere.

(a) Describe how acid rain is caused.

.....

.....

.....

..... [2]

(b) Explain what happens in a lake after large quantities of fertilisers are washed into it.

.....

.....

.....

.....

.....

.....

..... [4]

(c) Explain how cutting down forests can result in an increase in the carbon dioxide concentration in the atmosphere.

.....

.....

.....

..... [2]

iGda 12s31 Q12

(b) The combustion of hydrocarbons is believed to be increasing the level of carbon dioxide in the atmosphere.

Electric vehicles are powered by batteries which are recharged from the mains electricity supply.

Some people have suggested that the build-up of carbon dioxide in the atmosphere would be greatly reduced if all gasoline and diesel vehicles were replaced by electric vehicles.

Suggest why this might **not** achieve the predicted reduction in carbon dioxide build-up.

.....

.....

..... [2]

iGda 11w31 Q8

(d) Catalytic converters are used in the exhaust systems of modern cars to reduce air pollution.

Fig. 8.3 shows where the catalytic converter is located in a car.

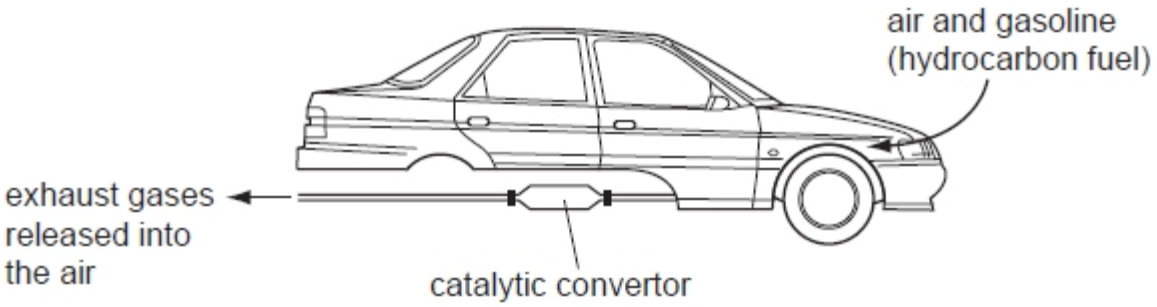


Fig. 8.3

When the fuel burns in the engine, a mixture of exhaust gases is produced. This mixture passes through the converter before being released into the air.

(i) The following word equation shows how two polluting gases, carbon monoxide, CO, and nitrogen monoxide, NO, react together on the surface of the catalyst inside the converter.

carbon monoxide	+	nitrogen monoxide	→	carbon dioxide	+	nitrogen

Construct a balanced, symbolic equation for this reaction.

.....

[2]

(ii) Suggest why polluting gases are removed more efficiently when the catalytic converter is hot.

.....

.....

[1]

(iii) Suggest and explain **one** type of atmospheric pollution, caused by car exhaust gases, which is **not** reduced by the use of catalytic converters.

.....

.....

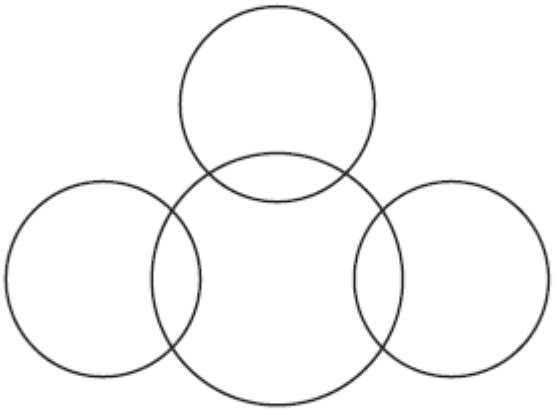
.....

[2]

iGda 11w31 Q3

(b) Complete the bonding diagram below to show

- the chemical symbols of the elements in a molecule of ammonia,
- the arrangement of the outer electrons of each atom.



[3]

iGda 11s31

5 A student carried out an experiment to find which substances in the environment caused nails made of mild steel to become rusty.

She selected three identical nails and placed them in sealed test-tubes, **A**, **B** and **C**, as shown in Fig. 5.1.

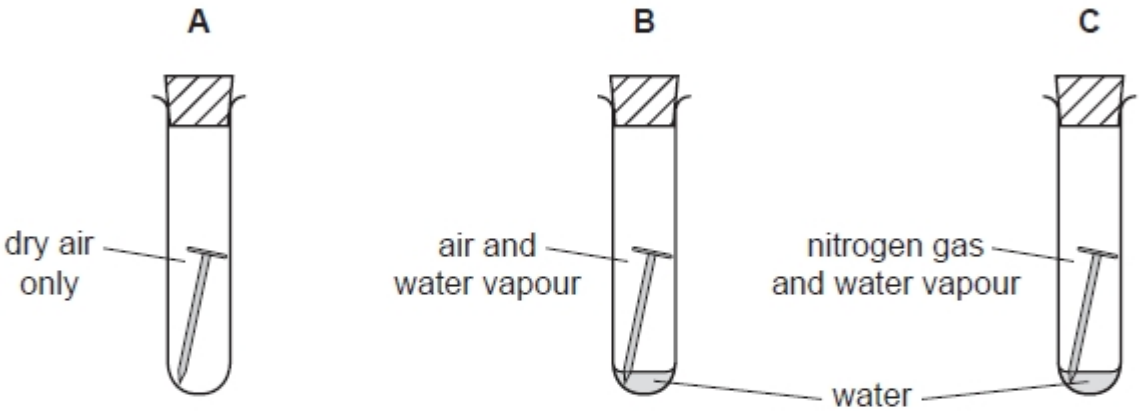


Fig. 5.1

(a) Predict in which tube, **A**, **B** or **C**, the nail became rusty, and explain why the nail did **not** rust in either of the other two tubes.

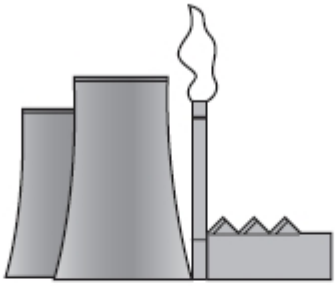
.....

.....

..... [2]

iGda 09w31 Q9

(e) Fuel oil is used as an energy source in some power stations. Fuel oil which is obtained from petroleum contains sulfur compounds.



In some power stations, the combustion products from the burning of fuel oil are treated with calcium hydroxide, an alkali, before release into the atmosphere.

Suggest and explain why this is done.

.....

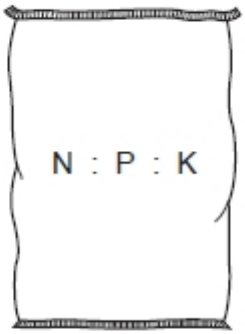
.....

.....

..... [3]

iGda 09w31

3 Some types of fertiliser have the letters NPK on the package label, indicating the chemical symbols of three elements contained in the fertiliser.



(a) State and explain which of the elements shown in the name NPK contains atoms that have their electrons arranged as shown in Fig. 3.1.

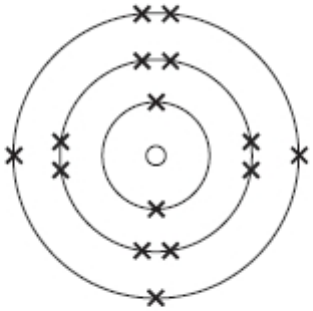


Fig. 3.1

element .....

explanation .....

.....

..... [2]

(b) Plants need nitrogen in order to produce amino acids.

Name the **three** elements, other than nitrogen, which are present in all amino acid molecules.

.....

.....

..... [1]

(c) Ammonia is an important compound that is used in the manufacture of fertilisers.

Fig. 3.2 shows a simplified diagram of the type of reaction vessel that is used in the production of ammonia.

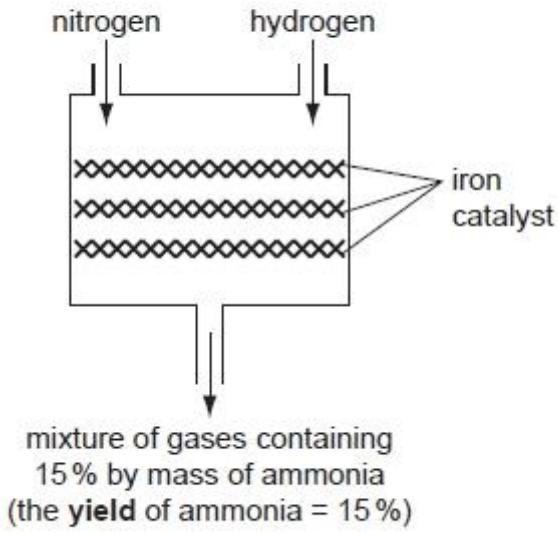


Fig. 3.2

(i) The equation below shows what happens on the surface of the iron catalyst.

The equation is not balanced.

Balance the equation.

$$N_2 + H_2 \rightleftharpoons NH_3$$

[1]

(ii) The yield of ammonia in this reaction vessel is 15%. This means that the mixture of gases coming out of the reaction vessel contains 15% by mass of ammonia.

State and explain which gases account for most of the remaining 85% of the gas mixture.

.....

.....

..... [2]

(iii) Research chemists and engineers have investigated the effects of temperature and pressure on the yield of ammonia.

Fig 3.3 shows the results of their investigations.

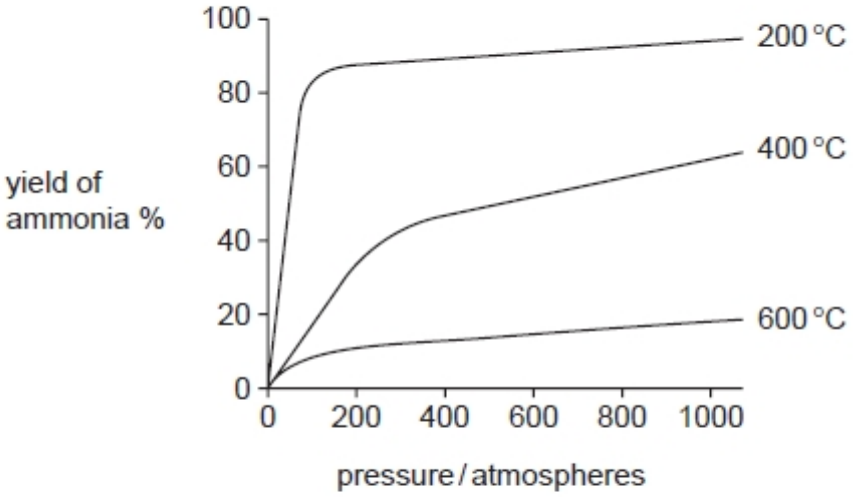


Fig. 3.3

The engineers running the factory want to increase the yield of ammonia.

Use the information in Fig. 3.3 to suggest two ways in which this could be done.

1 .....

2 ..... [2]

(d) In an ammonia factory, 1000 kg of gas mixture leave the reaction vessel every minute. In this factory the yield of ammonia is 17%.

Calculate the number of moles of ammonia which leave the reaction vessel every minute.

Show your working.

[relative atomic masses, A_r: N=14; H=1]
1 kg = 1000 g

.....

.....

.....

.....

.....

..... [4]

(iii) Use the data in Table 8.1 and information in (ii) to suggest and explain **one** advantage and **one** disadvantage of burning biogas from a digester rather than from landfill.

advantage

.....

.....

.....

disadvantage

.....

.....

..... [3]

iGda 08s31

2 Starch, cellulose and proteins are compounds found in plants.

(a) (i) State the **chemical symbols** of the three elements which are combined together in starch.

..... [1]

(ii) Plants contain proteins which are compounds containing nitrogen atoms. These atoms have been obtained from gaseous nitrogen in the air by nitrogen fixation.

Explain the meaning of the term *nitrogen fixation*.

.....

.....

..... [2]

Topic 11 MS

iGda 15s31 Q7 (b)

(ii) air (taken into the engine) contains nitrogen and oxygen ;
nitrous oxide formed from (direct) combination / reaction of nitrogen and oxygen ;
(very) hot (and pressurised) in engine so (direct) combination / reaction possible ;
carbon monoxide from reaction between the fuel / hydrocarbons and oxygen ;
reference to incomplete combustion ; [max 4]

iGda 14s31 Q4

(b) reference to acid rain which damages building material/plants/aquatic life;
reference to damage to respiratory system ;
other correct e.g. acidity of soil ; [max 2]

iGda 14s31 Q12

(c) no rust in tube **1** because water absent ;
no rust in tube **4** because air/oxygen absent ;
tubes **2** and **3** show that it is the oxygen from the air that is needed for rusting ;
rust formed in tubes **2** and **3** because both contained, air/oxygen, and water present together/general statement that rusting requires, air/oxygen, and water present together ;

[max 3]

iGda 13w31

12 **(a)** energy in sunlight absorbed/trapped by chlorophyll ;
plus any two of:
carbon dioxide and water react together ;
to produce glucose ;
glucose contains chemical energy ; [max 3]

(b) CO_2 levels in the atmosphere increase ;
due to fewer trees to photosynthesise/less photosynthesis to remove carbon dioxide ;
also due to burning trees produce CO_2/rotting trees produce CO_2 by respiration of microbes ;
carbon dioxide, traps long-wave radiation/infra-red/heat/thermal energy/is a greenhouse gas ;
reduces rate of loss of heat from the Earth's surface ; [max 3]

[Total: 6]

iGda 13s31

8 **(a)** combustion/burning, of (fossil) fuels ;
sulfur dioxide produced ;
(sulfur dioxide), reacts with/dissolves in/mixes with, water (in atmosphere) ; [max 2]

(b) eutrophication ;
increased growth of algae/surface plants ;
blocks light to plants (deeper down) ;
algae/plants die ;
bacteria feed on them/population increases ;
bacteria etc. use oxygen ;
removal of oxygen kills fish ; [max 4]

(c) less photosynthesis ;
so less carbon dioxide removed ;
OR
trees burned ;
producing carbon dioxide ; [max 2]

[Total: 8]

iGda 12s31 Q12

(b) idea that electricity comes from, power station/burning fuel ;
where greenhouse gases/carbon dioxide may still have to be produced/owtte ; [2]

iGda 11w31 Q8

(d) (i) $2CO + 2NO \longrightarrow 2CO_2 + N_2$ (formulae + balanced) ;; [2]
(allow one mark for $CO + NO \rightarrow CO_2 + N$)

(ii) reference to increased rate of reaction ; [1]

(iii) greenhouse effect/global warming/climate change ;
much carbon dioxide (in exhausts)/carbon dioxide not reduced by converters/carbon dioxide made in converter ; [2]

iGda 11w31 Q3

(b) symbols shown in correct atoms ;
three bond pairs around central atom ;
lone pair correctly shown and no others ; [3]

iGda 11s31

5 (a) in **B**/not in **A** or **C**, because air/oxygen and water are present **or** air and water are needed for rusting ;
no water in **A** **and** no air/oxygen in **C** ; [2]

iGda 09w31 Q9

(e) sulfur dioxide is produced (when sulfur compounds burn) ;
ref. acid rain ;
acidic gases / sulfur compounds, react with calcium hydroxide ;
ref. neutralisation ; [max 3]

iGda 09w31

3 (a) phosphorus / P ;
(15 electrons so) 15 protons so atomic number 15 / proton number is 15 *or*
5 electrons in outer shell / in group 5, and, three shells / period 3 ; [2]

(b) carbon hydrogen oxygen / C H O ; [1]

(c) (i) $N_2 + 3H_2 \rightleftharpoons 2NH_3$; [1]

(ii) nitrogen and hydrogen ;
reversible reaction / have not reacted ; [2]

(iii) use high pressure / at *or* above 200 ;
use low temperature / 200 °C ; [2]

iGda 08s31 Q8 (b)

(iii) **advantage**
greater % of methane ;
so more efficient fuel/more heat from a unit mass ;

disadvantage
greater amount of hydrogen sulphide ;
so more atmospheric pollution/reference to consequences of SO_2 ; [3]

iGda 08s31

2 (a) (i) C H O ; (all three required) [1]

(ii) changing (the element) nitrogen in the air into nitrogen compounds ;
extra detail e.g. one way it occurs/reference to inert nitrogen being converted into useful compounds ; [2]

Topic 12 and 13

iGda 13s31 Q7

(b) Sulfuric acid is made in industry by the Contact Process.

Fig. 7.1 shows a simplified flow diagram of part of the Contact Process.

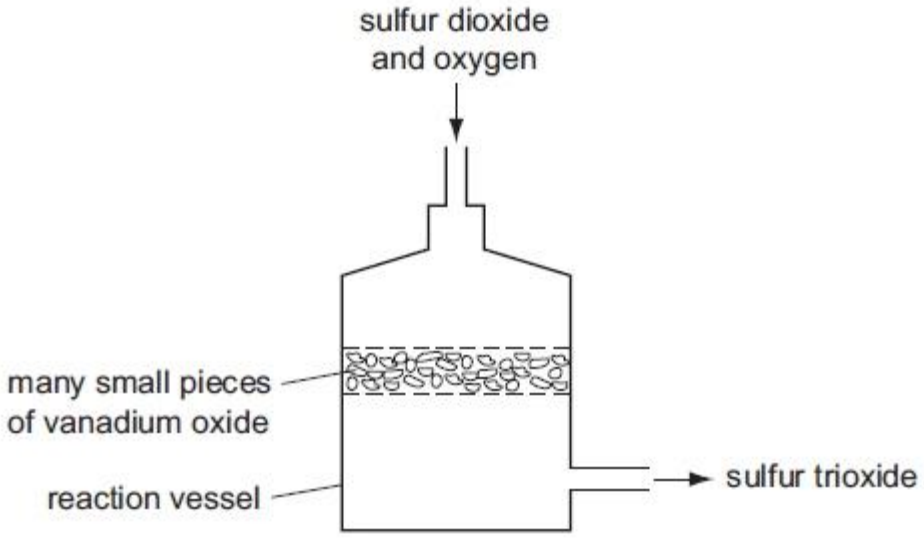


Fig. 7.1

A mixture of the gases sulfur dioxide and oxygen passes over the surface of solid vanadium oxide inside the reaction vessel.

The unbalanced equation for the reaction that occurs in the reaction vessel is shown below.

Balance the equation and explain why it does **not** contain the formula of vanadium oxide.

$$SO_2 \quad + \quad O_2 \longrightarrow \quad SO_3$$

explanation .....

.....

..... [2]

iGda 09s31 Q3

(c) Some water supplied to houses contains calcium hydrogencarbonate, $Ca(HCO_3)_2$. When heated, calcium hydrogencarbonate undergoes thermal decomposition.

(i) Complete the symbolic equation below which describes the thermal decomposition of calcium hydrogencarbonate.

$Ca(HCO_3)_2 \rightarrow$

[2]

Topic 12 and 13 MS

iGda 13s31 Q7

(b) $\underline{2}SO_2 + O_2 \rightarrow \underline{2}SO_3$;
vanadium oxide is a catalyst/is not (permanently) changed ; [2]

iGda 09s31 Q3

(c) (i) $(Ca(HCO_3)_2 \rightarrow CaCO_3 + CO_2 + H_2O$;;
[$CaCO_3$ + both for 2 marks]
[$CaCO_3$ + one for 1 mark] [2]

Topic 14

iGda 15s31

12 (a) Give an example of a fossil fuel.

..... [1]

(b) Fossil fuels are non-renewable. Explain what is meant by *non-renewable*.

.....

..... [1]

(c) Many governments are making efforts to reduce the use of fossil fuels.

Suggest **two** ways in which the use of fossil fuels can be reduced.

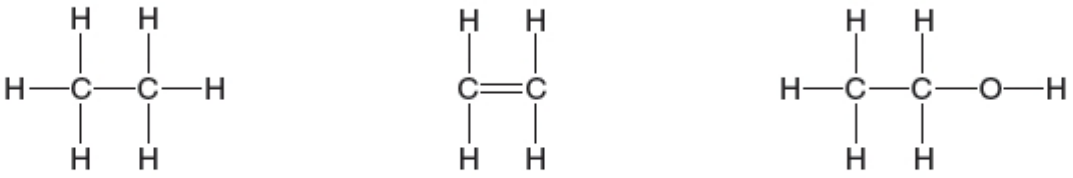
1 .....

2 .....

[2]

iGda 14w31

9 Fig. 9.1 shows molecules of ethane, ethene and ethanol.



ethane ethene ethanol

Fig. 9.1

(a) (i) State and explain which of these compounds are hydrocarbons.

compounds .....

explanation .....

.....[2]

(ii) State and explain which **one** of the three compounds named above is an unsaturated compound.

compound .....

explanation .....

.....[1]

(iii) Describe what is observed when the compound in **(a)(ii)** reacts with a solution of bromine.

.....

.....[1]

(b) (i) State **two** uses of ethanol.

1 .....

2 .....

[2]

(ii) In industry, ethanol is made in a chemical reaction involving ethene.

Name the substance that reacts with ethene to produce ethanol.

.....[1]

(iii) State **two** of the reaction conditions needed for the reaction in **(b)(ii)**.

1 .....

2 .....

[2]

(iv) Name the type of reaction in **(b)(ii)**.

.....[1]

(c) Ethanol, C_2H_6O, reacts with a compound **X** to produce a mixture containing ethanoic acid, $C_2H_4O_2$, which is a compound found in vinegar.

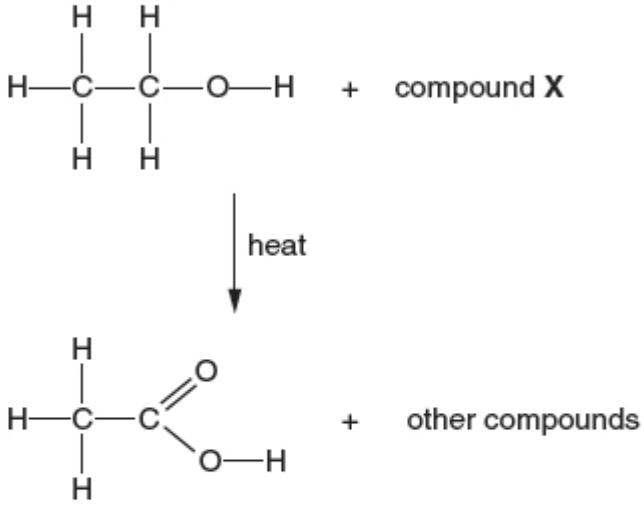


Fig. 9.2

The reaction between ethanol and compound **X** is a redox reaction.

Use the information in Fig. 9.2 to explain why **X** is reduced.

.....

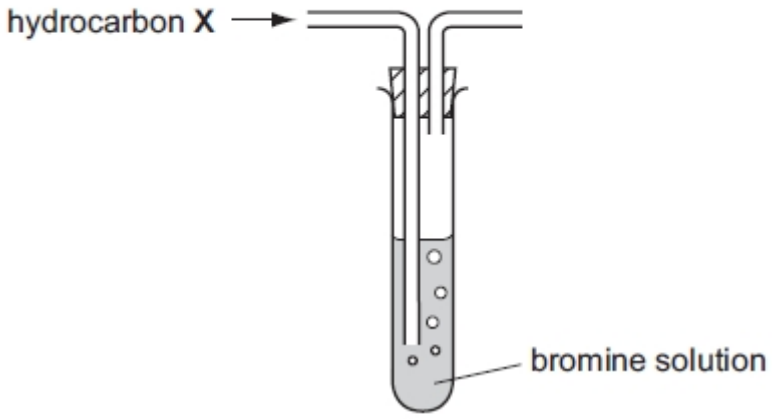
.....

.....[2]

iGda 13w31

10 (a) A gaseous hydrocarbon **X** contains 4 carbon atoms in each of its molecules.

A sample of **X** was bubbled through some bromine solution.



Bromine did **not** react quickly with **X** at room temperature.

Name hydrocarbon **X** and the homologous series to which **X** belongs.

name of **X** .....

name of homologous series ..... [2]

(b) Ethene, C_2H_4, is an unsaturated hydrocarbon.

Fig. 10.1 shows structures of the molecules involved when ethene reacts with bromine.

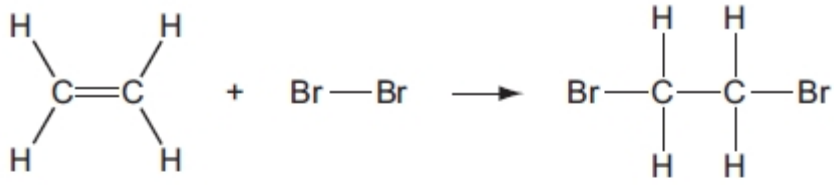


Fig. 10.1

(i) Describe the colour change that is observed when ethene reacts with bromine.

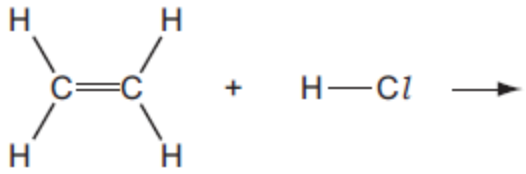
from ..... to ..... [1]

(ii) Name the type of chemical reaction shown in Fig. 10.1.

..... [1]

(iii) The reaction between ethene and hydrogen chloride, $HCl(g)$, is similar to the reaction shown in Fig. 10.1.

Complete the equation below to suggest the structure of the molecule that is produced.



[2]

(iv) Name the compound that is made when ethene reacts with steam.

..... [1]

(c) Methane, CH_4, reacts with steam in the presence of a catalyst to produce carbon monoxide, CO, and hydrogen gas.

Construct a balanced symbol chemical equation for this reaction.

..... [3]

iGda 13s31

4 Petroleum (crude oil) and rock salt occur naturally in the Earth's crust.

(a) Petroleum is a mixture that contains thousands of different compounds. Many of these compounds are alkanes.

Draw the structure of the alkane molecule that contains eight hydrogen atoms. Use short lines to represent covalent bonds.

[2]

(b) When petroleum is refined, it is separated into simpler mixtures.

Fig. 4.1 shows a simplified diagram of a distillation column that is used to refine petroleum.

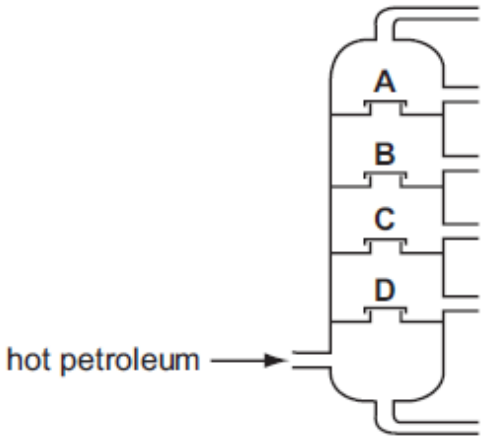


Fig. 4.1

(i) Describe how the temperature inside the apparatus changes from position **D** to position **A**.

.....

[1]

(ii) Explain, in terms of intermolecular forces and the size of molecules, why the average boiling point of the fraction at **B** differs from the average boiling point of the fraction at **C**.

.....

.....

.....

.....

.....

..... [3]

iGda 12w31

12 (a) (i) Name the **two** elements which are combined together in most of the compounds found in petroleum (crude oil).

1 .....

2 ..... [1]

(ii) Draw **four** straight lines to connect each process or reaction in the left hand column with its meaning in the right hand column.

type of process or reaction	process or reaction
reaction that produces ethane from ethene and hydrogen	addition
reaction that causes protein molecules to break up into amino acids	catalytic cracking
reaction that produces unsaturated compounds	fractional distillation
process that simplifies a complex mixture	hydrolysis

[2]

(b) Fig. 12.1 shows apparatus that a student uses to investigate what happens when gaseous decane, $C_{10}H_{22}$, is heated in the presence of a catalyst.

The catalyst is made of small pieces of aluminium oxide which are heated strongly.

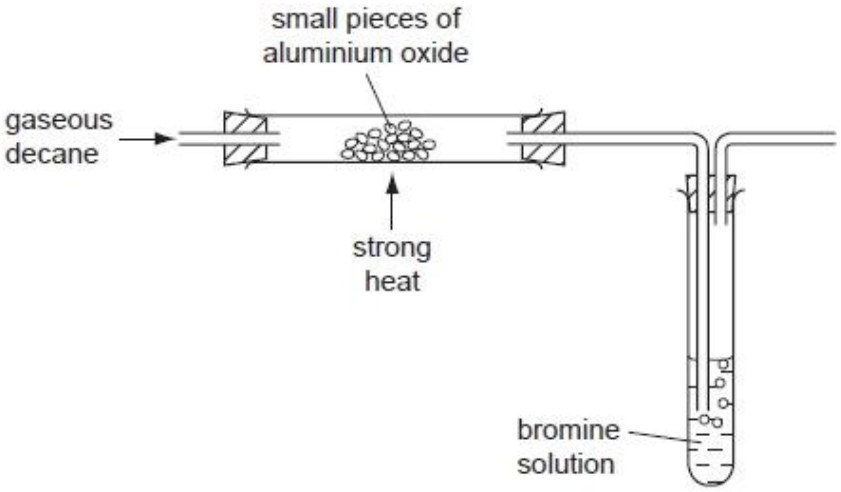


Fig. 12.1

When the gaseous decane passes through the heated catalyst, the solution of bromine rapidly changes colour from orange to colourless.

(i) Explain why this observation shows that decane has undergone a chemical reaction.

.....

.....

.....

.....

..... [3]

(ii) Explain why the products of the reaction do not include any aluminium compounds.

.....

..... [1]

(iii) Suggest why the catalyst needs to be heated.

.....

..... [1]

(c) When ethene, C_2H_4, is heated and pressurised in the presence of a catalyst, it is converted into a white compound which becomes solid when it cools.

(i) Complete the diagram below to show a small section of one of the molecules in the white solid.

[2]

(ii) Suggest why it is **not** possible to state an exact value of the relative molecular mass of the molecules in the white solid.

.....

..... [1]

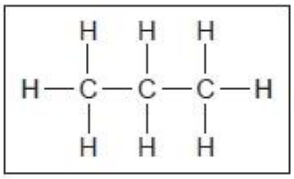
iGda 12s31

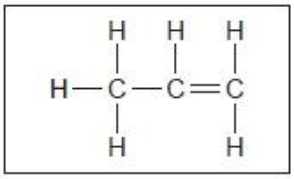
12 The element carbon is combined with other elements in millions of different compounds.

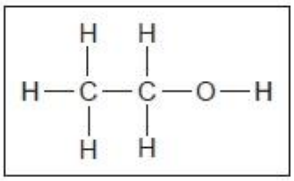
Chemists have organised carbon compounds into families which have similar chemical properties to one another.

(a) (i) The structures of three molecules together with the names of three families of carbon compounds are shown below.

Draw straight lines to connect the molecules with the family to which they belong.







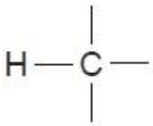
alkene

alcohol

alkane

[2]

(ii) Complete the molecular structure below to show a hydrocarbon molecule which contains four carbon atoms and eight hydrogen atoms combined together.



[2]

(c) In many countries, ethanol, C_2H_6O , is added to hydrocarbon fuels such as gasoline.

(i) Describe briefly how the compound ethene, C_2H_4, is converted into ethanol.

.....

.....

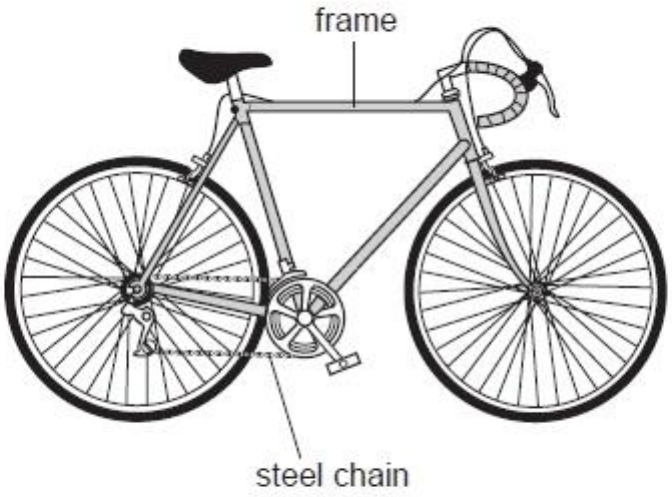
.....

..... [3]

(ii) State **one** use of ethanol other than as a fuel.

..... [1]

(c) Steel is used to make both the frames and the chains of bicycles. In order to prevent rusting, the frames are painted and the chains are covered in an oil made of hydrocarbon molecules.



(i) The oil used to protect the bicycle chain contains mainly alkanes. Alkane molecules are described as being saturated.

Explain, in terms of chemical bonding, the difference between saturated and unsaturated hydrocarbon molecules.

You may draw a diagram to help your explanation.

.....

.....

..... [2]

(i) Explain why this observation shows that decane has undergone a chemical reaction.

.....

.....

.....

.....

..... [3]

(ii) Explain why the products of the reaction do not include any aluminium compounds.

.....

..... [1]

(iii) Suggest why the catalyst needs to be heated.

.....

..... [1]

(c) When ethene, C_2H_4, is heated and pressurised in the presence of a catalyst, it is converted into a white compound which becomes solid when it cools.

(i) Complete the diagram below to show a small section of one of the molecules in the white solid.

[2]

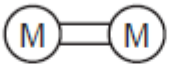
(ii) Suggest why it is **not** possible to state an exact value of the relative molecular mass of the molecules in the white solid.

.....

..... [1]

(ii) The paint used to protect the bicycle frame from rusting often contains substances made by addition polymerisation of suitable monomers.

Use the simplified diagram of a monomer molecule below to explain what happens in addition polymerisation.

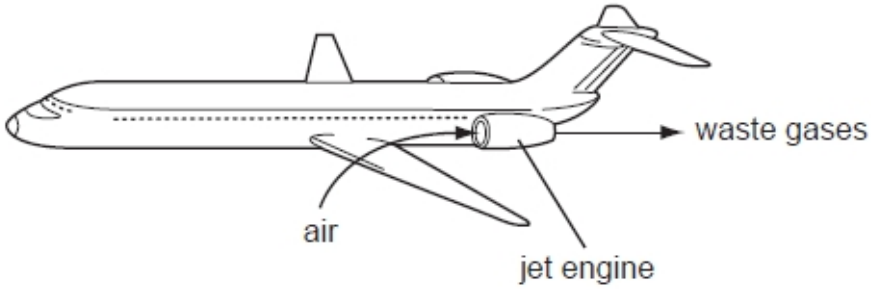


.....

..... [2]

iGda 10w31

4 In jet engines, hydrocarbon molecules from the jet fuel mix with air and burn. This releases a large amount of energy and produces a mixture of waste gases. These waste gases pass out through the back of the jet engine into the atmosphere.



(a) Fig. 4.1 shows a molecule of octane, which is a typical hydrocarbon molecule in jet fuel.

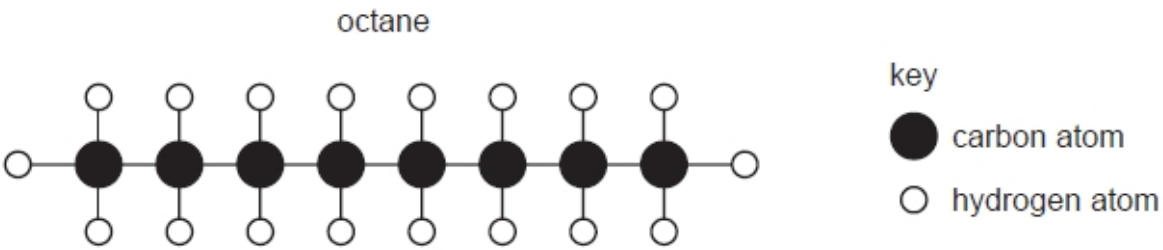


Fig. 4.1

(i) State the chemical formula of octane.

..... [1]

(ii) Complete the word equation below for the complete combustion of octane.

octane	+		→		+	

[2]

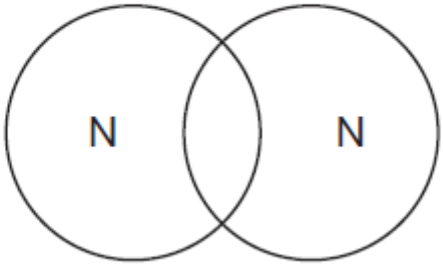
(b) The mixture of waste gases coming from the jet engine contains a large amount of the free element nitrogen, N_2, which exists naturally in the air.
The atoms in a nitrogen molecule are held together by a triple covalent bond as shown in the displayed formula below.

$$N \equiv N$$

(i) State the number of outer electrons in a single nitrogen atom.

..... [1]

(ii) Complete the bonding diagram below to show how the outer electrons are arranged around the atoms in a nitrogen molecule.



[2]

(iii) The temperature inside the jet engine is very high.

Suggest why most of the nitrogen molecules which pass through the engine do **not** break up into individual atoms.

.....

.....

..... [2]

7 Polymer molecules exist in both natural substances and in materials which have been made in industry.

(a) Starch, cellulose and protein are all natural substances made of polymer molecules.

(i) State the name of the monomer which forms starch.

..... [1]

(ii) A sample of one of the natural substances was burned in pure oxygen. The mixture of gases which was formed was analysed and found to contain carbon dioxide, water vapour, nitrogen dioxide and sulfur dioxide.

Which one of the three natural substances had been burned?

Explain your answer.

.....

.....

.....

..... [3]

(b) Nylon and melamine resin are polymers produced industrially. Nylon is a **thermoplastic** and melamine resin is a **thermoset**.

(i) Nylon is often formed into fibres which are used to make clothing, rope and guitar strings. Fig. 7.1 shows a simplified diagram of an industrial process which is used to produce nylon fibres.

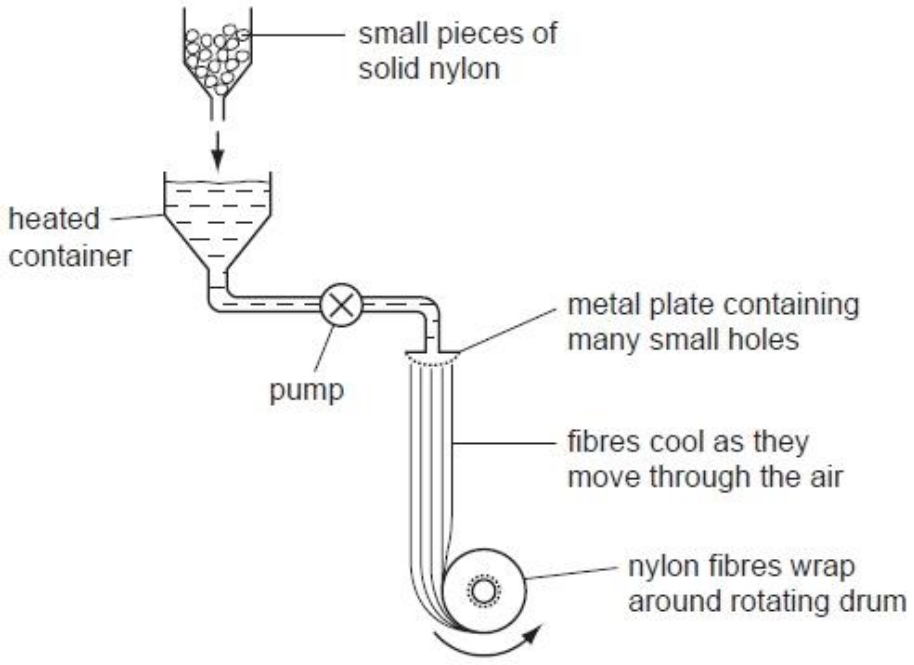


Fig. 7.1

Explain, in terms of the forces between molecules, why it is possible to form nylon fibres from solid nylon using the process in Fig. 7.1.

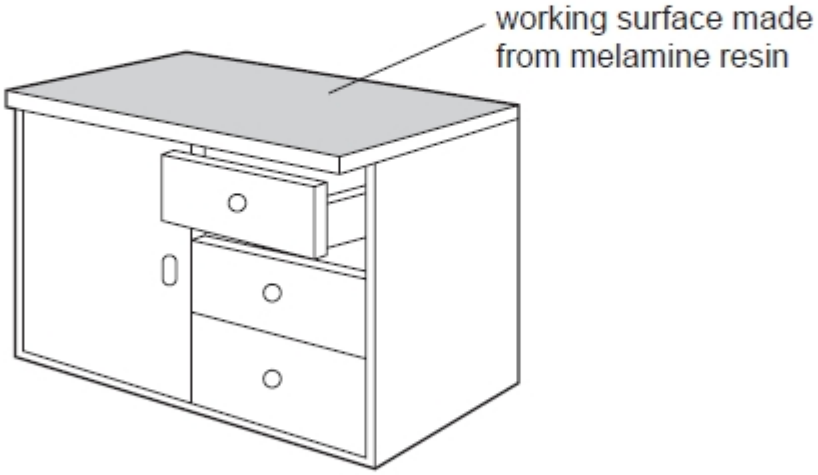
.....

.....

.....

..... [3]

(ii) Melamine resin is made into flat sheets for use as working surfaces in kitchens, where hot saucepans may come into contact with the surface.



Explain, in terms of molecules, why melamine resin is a suitable material for working surfaces.

.....

.....

.....

..... [2]

9 Fig. 9.1 shows a process carried out at an oil refinery.

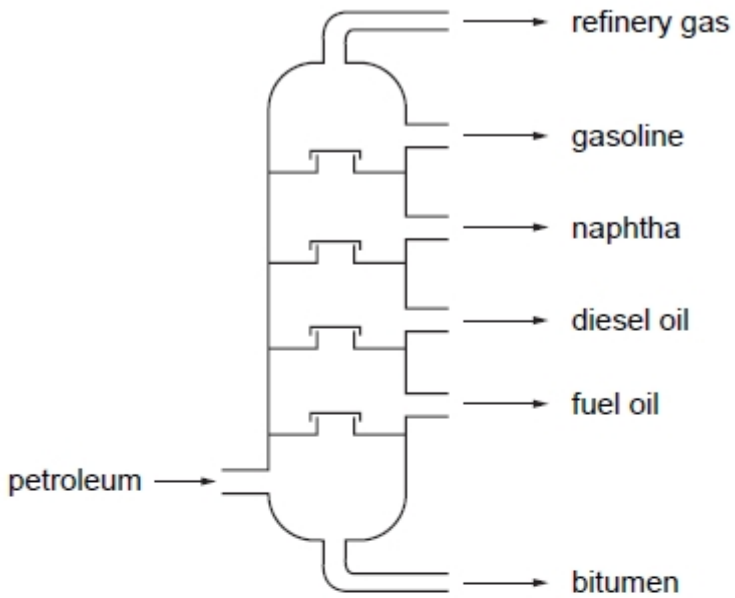


Fig. 9.1

(a) State **one** way in which the properties of gasoline are different from those of diesel oil.

.....

..... [1]

(b) Gasoline (petrol) is used as car fuel.

(i) Name a poisonous carbon compound which is found in the exhaust gases from cars.

..... [1]

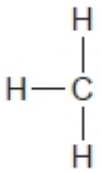
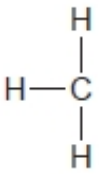
(ii) Describe briefly how the amount of this gas entering the air is reduced in modern cars.

.....

..... [1]

(c) Alkenes are unsaturated hydrocarbons produced by the catalytic cracking of alkanes from petroleum (crude oil).

(i) Complete the graphic (displayed) formulae for the alkane and the alkene which have three carbon atoms per molecule.

ALKANE	ALKENE
	

[2]

(ii) The apparatus in Fig. 9.2 can be used to test a gaseous hydrocarbon to discover whether it is an alkane or an alkene.

Name solution **X** and describe what would be observed if the gaseous hydrocarbon is an alkene.

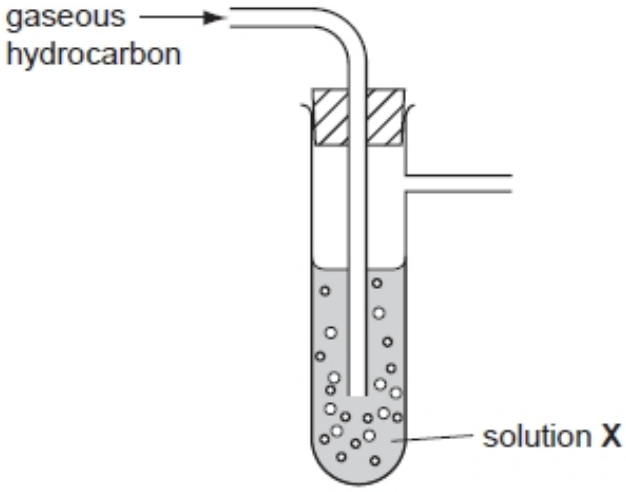


Fig. 9.2

.....

.....

.....

..... [2]

(d) Ethanol, C_2H_6O, is an important chemical which is made from ethene, C_2H_4, in the presence of a catalyst.

Write a balanced symbolic equation for the conversion of ethene to ethanol.

..... [1]

iGda 09s31 Q6 (c)

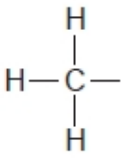
(iii) Describe how bromine is used to test hydrocarbons to find out whether or not they are unsaturated.

.....

.....

..... [2]

(iv) Complete the displayed formula to show the **alkene** which contains four carbon atoms in each of its molecules.



[2]

iGda 08w31

6 Fig. 6.1 shows crude oil (petroleum) being extracted from sedimentary rock under the sea.

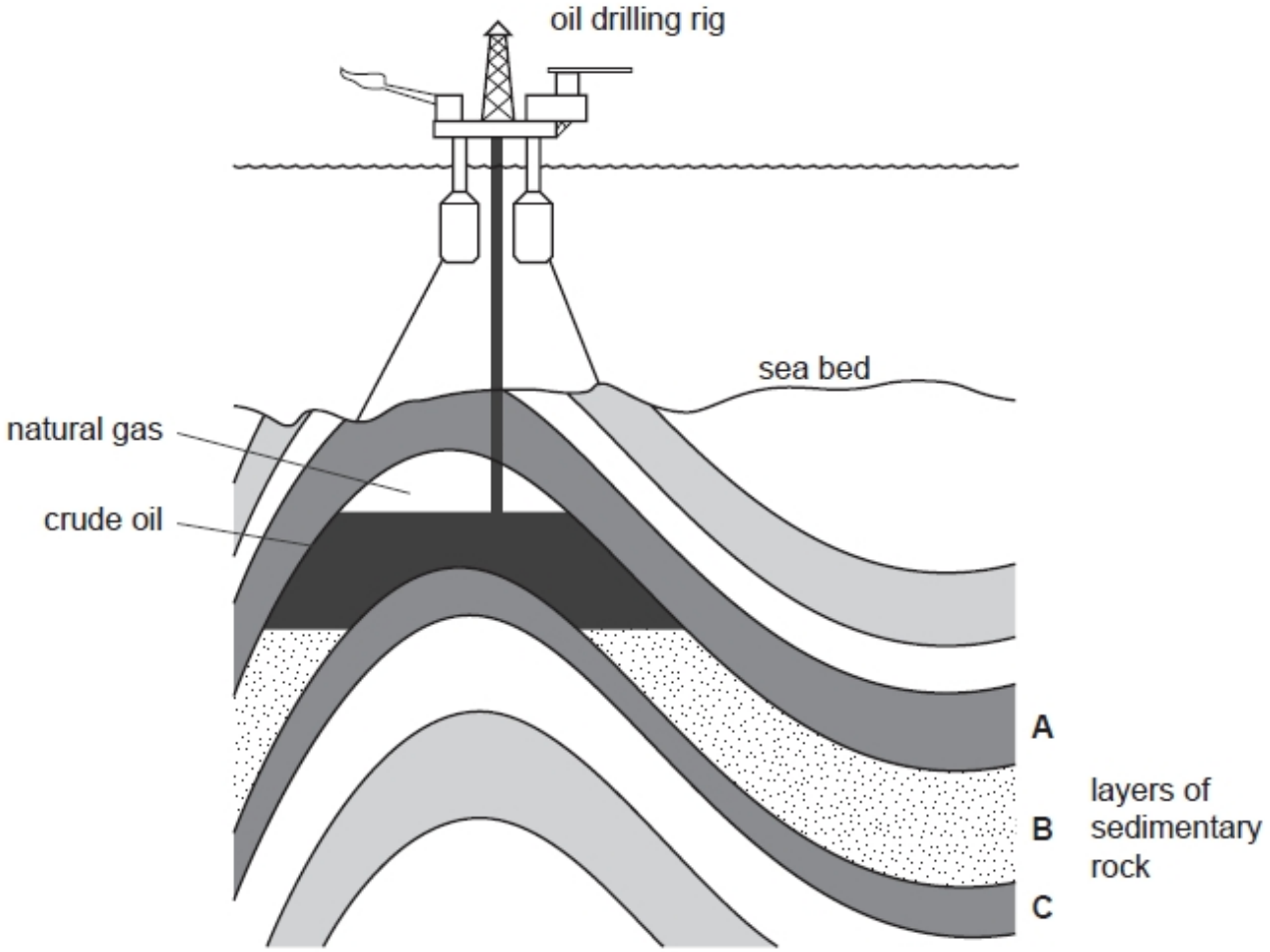


Fig. 6.1

(a) The oil shown in Fig. 6.1 is found only in rock layer **B** and not in layers **A** or **C**.

Suggest the property of rock **B** which is different from rocks **A** and **C**, and which allows it to contain oil.

.....

..... [1]

(b) Crude oil is a mixture of different hydrocarbon molecules. A typical hydrocarbon molecule is shown in Fig. 6.2.

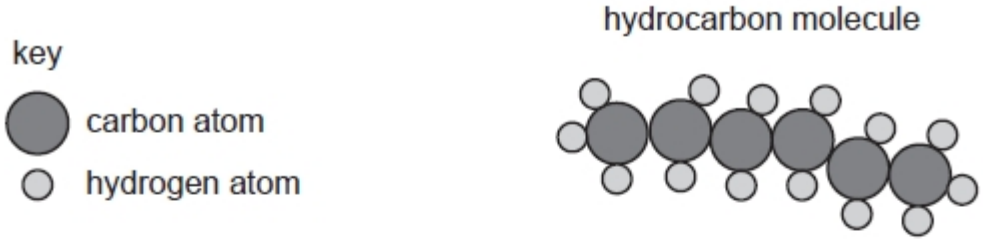


Fig. 6.2

Write the graphical (displayed) formula of the hydrocarbon shown in Fig. 6.2, and explain whether it is an alkane or an alkene.

.....

..... [2]

(c) Fig. 6.3 shows a simplified diagram of an important industrial process involving hydrocarbons.

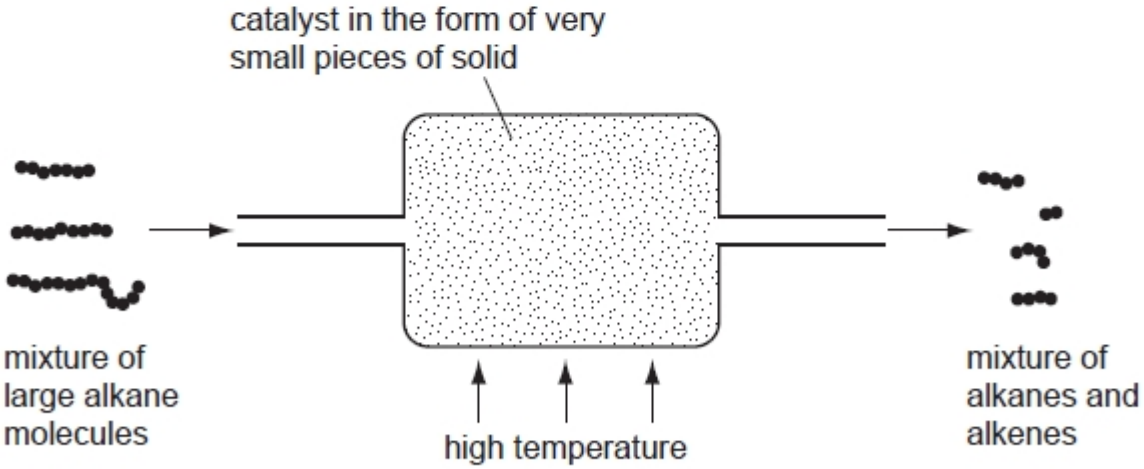


Fig. 6.3

(i) Name the process shown in Fig. 6.3.

..... [1]

(ii) Suggest a process which could be used to separate the mixture of alkanes and alkenes.

..... [1]

(iii) A research chemist is investigating two catalysts, **P** and **Q**, for use in the process shown in Fig. 6.3.

Describe a simple chemical test for alkenes. Suggest how the chemist could use this test to discover which catalyst, **P** or **Q**, produces a mixture containing the larger amount of alkenes.

.....

.....

.....

.....

..... [3]

Topic 14 MS

iGda 15s31

12 (a) coal/petroleum/natural gas ; [1]

(b) cannot be replaced once used ; [1]

(c) (one named) alternative energy sources ;
insulation ;
low-energy appliances/ equipment ;
more public transport/less use of cars ;
less use of/ recycling of plastics ;
AVP ; [max 2]

[Total: 4]

iGda 14w31

9 (a) (i) ethane and ethene ;
contain only hydrogen and carbon ; [2]

(ii) (ethene)
contains (C to C) double bond / does not contain maximum possible hydrogen ; [1]

(iii) orange / brown solution decolourised ; (reject red) [1]

(b) (i) *any two from:* solvent / fuel / in drinks / other correct ;; [max 2]

(ii) water ; (allow water vapour / steam) [1]

(iii) moderate / high temperature / 300 – 350 °C ;
high pressure / 60 – 70 (atmospheres) ;
catalyst / phosphoric(V) acid ; [max 2]

(iv) addition (reaction) ; [1]

(c) **X**, loses oxygen / gains hydrogen, (and so is reduced) ;
ethanol gains oxygen / loses hydrogen, (and so is oxidised) ;
idea of, if one reactant is oxidised the other must be reduced ; [max 2]

[Total: 12]

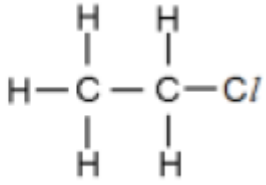
iGda 13w31

10 (a) butane ;
alkanes ; [2]

(b) (i) orange / yellow to colourless ; [1]

(ii) addition ; [1]

(iii)



;; [2]

(2 carbons connected by a single bond 1 mark, all else correct 1 mark)

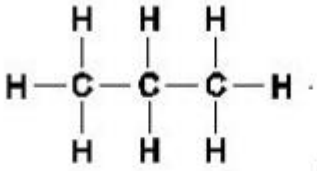
(iv) ethanol ; [1]

(c) $CH_4 + H_2O \rightarrow CO + 3\ H_2$;;; [3]
(LHS formulae 1 mark, RHS formulae 1 mark, balanced 1 mark)

[Total: 10]

iGda 13s31

4 (a) chain of three carbon atoms joined by single bonds ;
eight hydrogen atoms correctly bonded to carbon ;
i.e.



;;

[max 2]

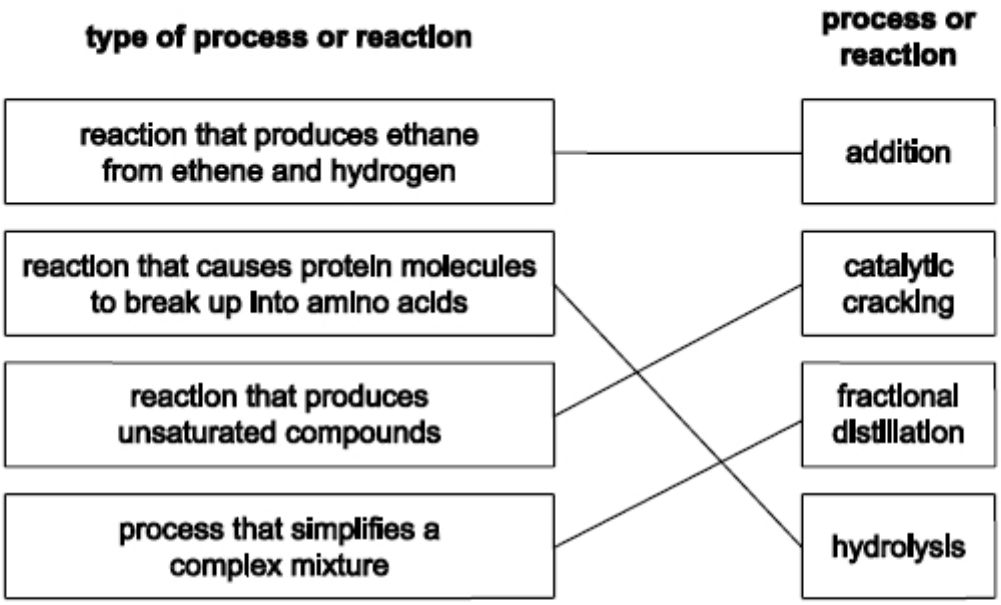
(b) (i) decreases (from **D** to **A**) ; [1]

(ii) (boiling range)/boiling point, is lower at **B** than **C** ;
(average) molecular size is lower at **B**/the smaller the molecular size the lower the boiling point.;
(mean) intermolecular attraction lower at **B**/the lower the intermolecular force the lower the boiling point.;
so less (heat) energy needed to separate molecules/boil the mixture ;
intermolecular attraction is lower for smaller molecules ; [max 3]

iGda 12w31

12 (a) (i) carbon and hydrogen ; [1]

(ii)



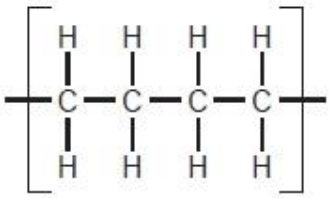
(all correct for 2 marks, 3 or 2 correct for 1 mark) ;; [2]

(b) (i) decane/alkanes does not decolorise bromine solution/bromine is only decolorised by an unsaturated substance/alkene ;
so a new product (which does) has been produced ;
new product must be unsaturated/reference to ethene/alkene ; [3]

(ii) catalysts do not undergo chemical changes/catalyst remains unchanged ; [1]

(iii) makes catalyst more efficient/work better/increases reaction rate ; [1]

(c) (i)



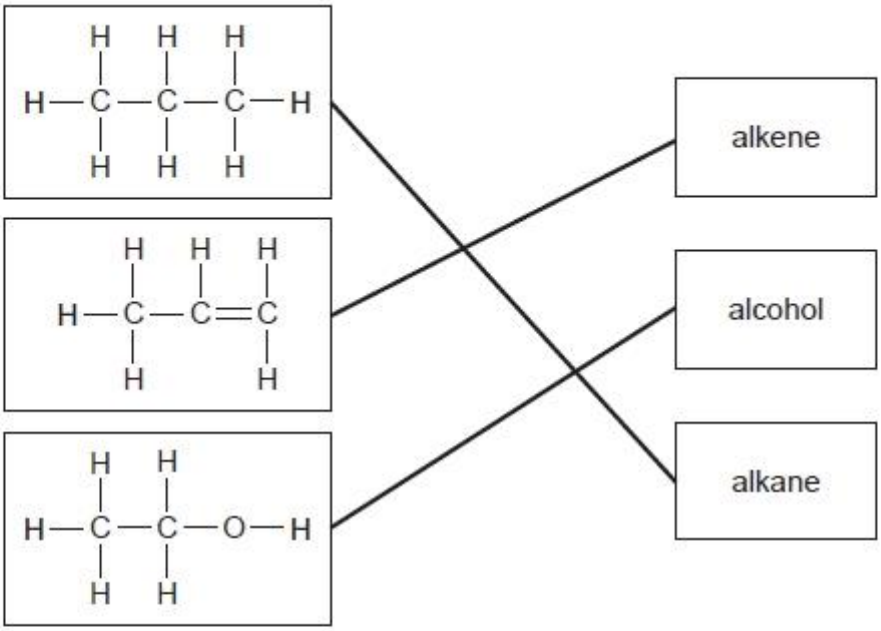
at least one more carbon atom with single C–C bonds ;
two H atoms bonded to each carbon ; [2]

(ii) size of molecules varies / variable chain length / owtte ; [1]

[Total: 11]

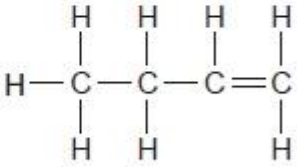
iGda 12s31

12 (a) (i)



(all correct = 2 one correct = 1) ;; [2]

(ii)



(double bond could be in middle) ;;
[credit cyclobutane with both marks] [2]

(c) (i) heated ;
mixed / reacted with water ;
requires catalyst ; [3]

(ii) solvent / in foods / sterilisation ; [1]

iGda 11s31 Q5

(c) (i) saturated – only single bonds **and** unsaturated – contain double/multiple bonds;
double bonds are between carbon atoms ; [2]

(ii) double bonds become single and monomers link together ;
to form chains ; [2]
(diagram showing at least three symbols linked by single bonds scores both marks)

iGda 10w31

4 (a) (i) C_8H_{18} ; [1]

(ii)

LHS ;
RHS ;
must be words – but allow one mark for completely correct balanced equation [2]

(b) (i) 5 ; [1]

(ii) three shared pairs ;
one non-bonding pair on both atoms ; [2]

(iii) very strong bond (between the atoms) ;
much energy needed to break bond / insufficient energy to break the bond ; [2]

iGda 10w31

4 (a) (i) C_8H_{18} ; [1]

(ii)

LHS ;
RHS ;
must be words – but allow one mark for completely correct balanced equation [2]

iGda 10s31

7 (a) (i) glucose ; [1]

(ii) protein;
only proteins contain, S/sulfur ;
only proteins contain, N/nitrogen ; [3]

(b) (i) molecules have only weak forces between them ;
molecules/particles, can move past one another easily ;
therefore (solid) nylon, melts / becomes a liquid, when heated / it enters the hot container ;
molten nylon can be pumped (through small holes) ;
molten threads solidify when cooled ;
strong forces between molecules when solid ; [max 3]

(ii) doesn't melt (on contact with hot containers) ;
molecules cannot move past one another ;
because strong bonds hold polymer chains/crosslinks ; [max 2]
[clear diagram could score crosslink mark]

[Total: 9]

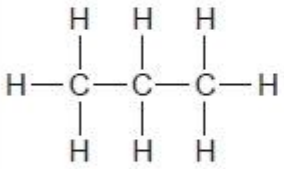
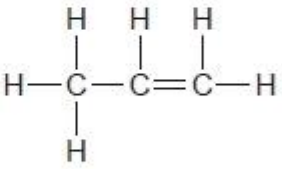
iGda 09w31

9 (a) *gasoline has:*
lower viscosity / lower boiling point / lower melting point / less coloured / higher flammability / less dense / more volatile ; [1]

(b) (i) carbon monoxide ; [1]

(ii) use of catalytic (converter) ; [1]

(c) (i)

ALKANE	ALKENE
	

[2]

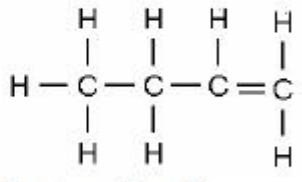
(ii) **X** is bromine / bromine solution / bromine water /
potassium manganate(**VII**) solution ;
if hydrocarbon is an alkene then bromine changes from orange to colourless / manganate(**VII**) from purple to colourless ; [2]

(d) $C_2H_4 + H_2O \rightarrow C_2H_6O$; [1]

iGda 09s31 Q6 (c)

(iii) bromine colour change from orange to colourless ;
if hydrocarbon is unsaturated ; [max 2]

(iv)

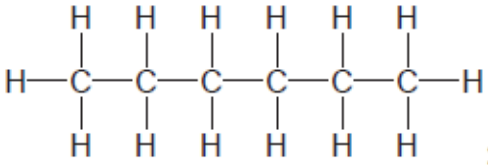


;; (or correct isomer)
4 x C and 8 x H ;
correct bonds between carbons ; [2 single and one double] [2]

iGda 08w31

6 (a) it is porous / permeable / description of porosity ; [1]

(b)



; 1

(alkane)
contains only single bonds (between carbon atoms) / is saturated /
contains maximum possible number of H atoms / fits formula C_nH_{2n+2} ; [1]

(c) (i) (catalytic) cracking ; [1]

(ii) fractional distillation ; [1]

(iii) bromine (solution) ;
orange to colourless / decolourised, with alkenes ;
take equal amounts of product mixture for both catalysts ;
the mixture which decolourises, the greater amount of bromine / faster /
produces lightest colour, has the more alkenes ; [max 3]

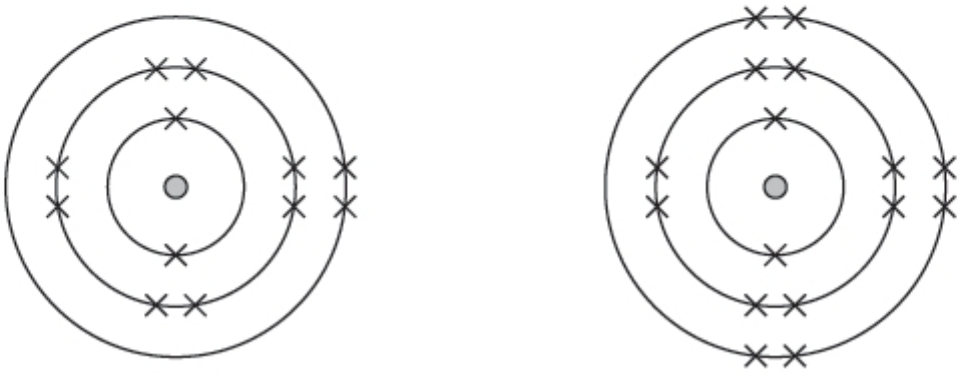
[Total: 8]

iGda 14w31 Q1

(c) Molten iron produced by the apparatus in **(a)** contains sulfur as an impurity.

Sulfur is removed from the molten iron by adding magnesium powder to form magnesium sulfide.

Fig. 1.1 shows diagrams of a magnesium atom and a sulfur atom.



magnesium sulfur

Fig. 1.1

Describe the changes to the electron configurations of these atoms when magnesium sulfide is formed.

.....

.....

.....[2]

(d) Suggest the balanced equation for the formation of magnesium sulfide.

.....[1]

(e) Magnesium sulfide has a very high melting point.

Suggest why magnesium sulfide has a very high melting point.

.....

.....

.....

.....[2]

12 **(a)** The Periodic Table lists the elements in order of their proton numbers.

Fig. 12.1 shows the positions of the first eighteen elements.

The letters are **not** the chemical symbols of the elements.

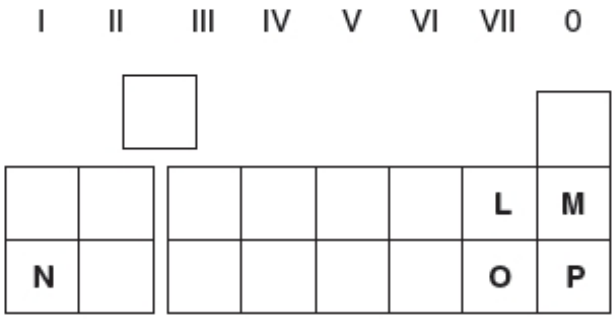


Fig. 12.1

(i) State the meaning of the term *proton number*.

.....

.....[1]

(ii) Element **L** has similar chemical properties to element **O** but different chemical properties from element **M**.

Explain this in terms of atomic structure.

.....

.....

.....[2]

(b) A student attempted to draw a dot-and-cross diagram for a molecule of carbon dioxide.

Fig. 12.2 shows the diagram he produced, but it is **incorrect**.

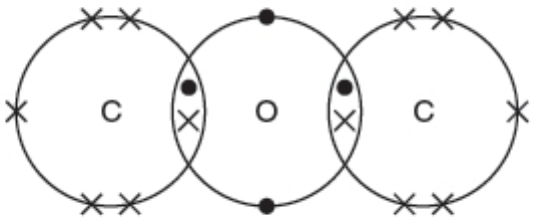


Fig. 12.2

[3]

iGda 14s31

7 **(a)** Fig. 7.1 shows a chlorine atom that has a nucleon number (mass number) of 35.

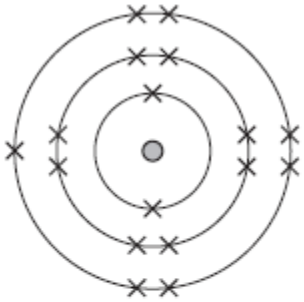


Fig. 7.1

Two types of particle are found in the nucleus of this atom.

Complete Table 7.1 with the names and numbers of these particles in the nucleus of this chlorine atom.

Table 7.1

name of particle	number in the nucleus

[2]

iGda 14s31

1 **(a)** Complete the following sentences about chemical bonding choosing words from the list below.

Each word may be used once, more than once or not at all.

electrons	**ions**	**lost**	**molecules**
neutralised	**nucleons**	**shared**	**transferred**

When a covalent bond forms, ... are .....

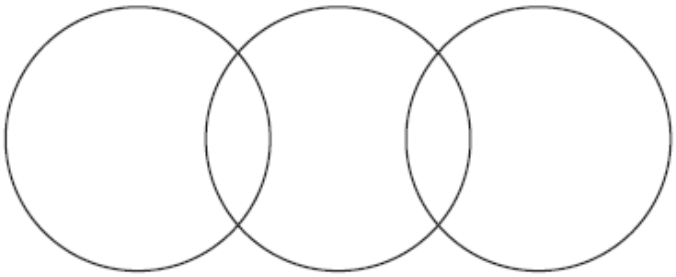
between atoms.

When an ionic bond forms, ... are .....

between atoms. [2]

(b) Complete the dot-and-cross diagram of one molecule of carbon dioxide.

The diagram should show the chemical symbols of the elements and the arrangement of only the outer electrons of the atoms.



[3]

iGda 14s31

(b) (i) Explain why chlorine is added to water that will be used for drinking.

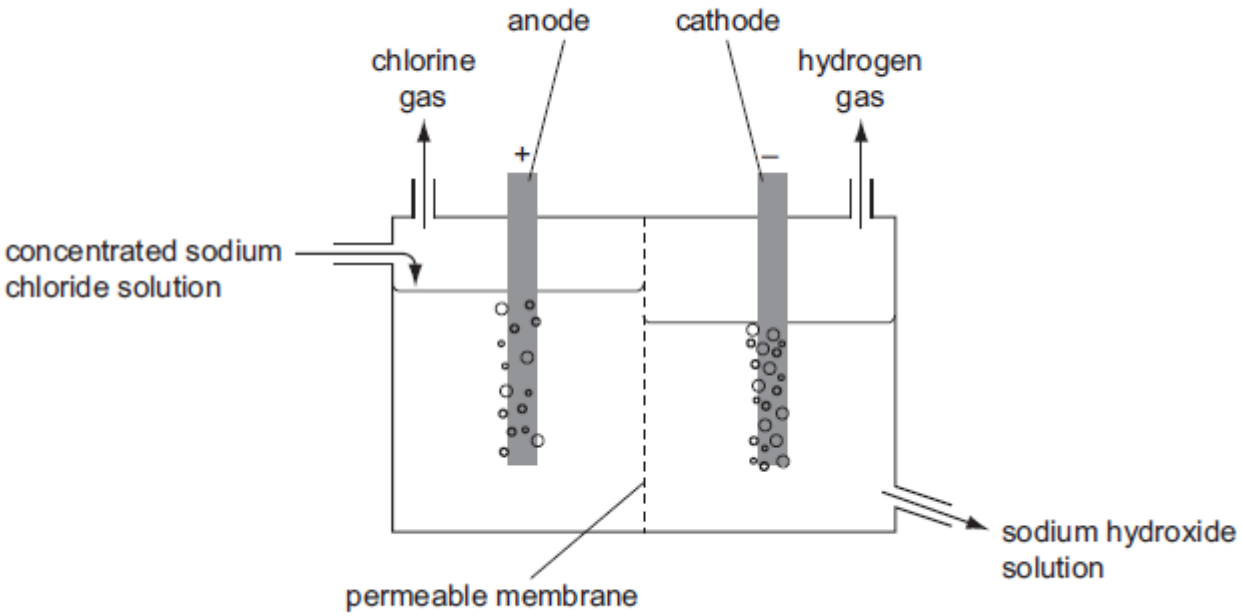
.....

..... [1]

(ii) Suggest the **word** chemical equation for the reaction that occurs when chlorine is mixed with sodium iodide solution.

..... [1]

(c) Fig. 7.2 shows a simplified diagram of the electrolysis of sodium chloride solution, used to produce chlorine in industry.



(iv) Explain why chlorine is given off at the anode in this process.

Your answer should refer to

- the movement of ions, atoms and electrons,
- the reactions involving ions, atoms and electrons.

.....

.....

.....

..... [3]

iGda 13w31

1 Sodium chloride (common salt) is obtained from underground deposits in the Earth's crust.

Low-sodium salt is a mixture containing both sodium chloride (melting point 801 °C) and potassium chloride (melting point 770 °C).

(a) (i) Explain why the Earth's crust contains the compound sodium chloride and not the uncombined elements sodium and chlorine.

.....

..... [1]

(ii) State **one** difference between a compound, such as potassium chloride, and a mixture, such as low-sodium salt.

.....

.....

..... [2]

(b) Table 1.1 contains the names and symbols of some positive and negative ions.

Table 1.1

positive ions	
name	symbol
potassium	K^+
ammonium	NH_4^+
calcium	Ca^{2+}
aluminium	Al^{3+}

negative ions	
name	symbol
fluoride	F^-
oxide	O^{2-}
nitride	N^{3-}
sulfate	SO_4^{2-}

(i) Use the information shown in Table 1.1 and the Periodic Table on page 36 to determine the ions that have an electron configuration of 2, 8, 8.

..... [1]

iGda 13s31 Q4

(c) Rock salt contains mainly sodium chloride which is a compound of the alkali metal, sodium, and the halogen, chlorine.

(i) Explain why the uncombined elements sodium and chlorine are **not** found in the Earth's crust.

.....

..... [1]

(ii) Describe the changes in electron configuration when sodium atoms (2,8,1) react with chlorine atoms (2,8,7) to form sodium chloride.

.....

.....

.....

..... [2]

(iii) Explain, in terms of its structure, why sodium chloride forms crystals which have a regular shape.

You should draw a simple diagram of the structure to help you to answer this question.

.....

..... [3]

iGda 13s31

1 (a) Table 1.1 shows the numbers of protons, neutrons and electrons in four atoms, **A**, **B**, **C** and **D**.

Table 1.1

atom	protons	neutrons	electrons
A	2	2	2
B	1	1	1
C	1	0	1
D	2	1	2

(i) Explain which one of the atoms, **A**, **B**, **C** or **D**, has the highest nucleon number (mass number).

atom .....

explanation .....

..... [1]

(ii) Explain which pair of atoms chosen from **A**, **B**, **C** and **D** are isotopes of helium.

atom ..... and atom .....

explanation .....

..... [2]

(b) Fig. 1.1 shows containers of hydrogen and helium.

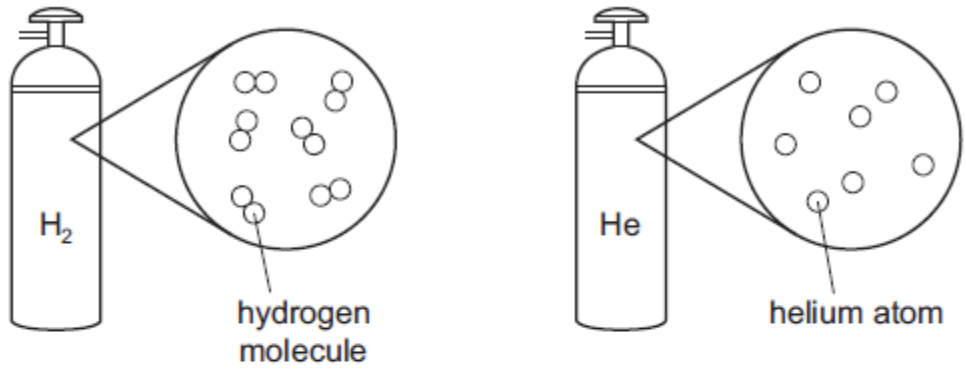


Fig. 1.1

(i) Describe, in terms of electrons, how a chemical bond forms between two hydrogen atoms.

You may draw a diagram of a hydrogen molecule if it helps you to answer this question.

.....

.....

..... [2]

(ii) Explain why helium exists as single atoms and **not** as molecules.

.....

..... [1]

iGda 12w31 Q6

(b) Some firework mixtures contain aluminium which is oxidised to produce aluminium oxide.

When aluminium is oxidised, aluminium atoms are converted into aluminium ions.

(i) The electron configuration of an aluminium **atom** is **2,8,3**.

Explain why the electrical charge of an aluminium **ion** is +3.

.....

.....

.....

..... [2]

iGda 12w31

9 In 1774 the chemist Carl Scheele reacted concentrated hydrochloric acid with manganese dioxide. One of the products of this reaction was a pale green gas which Scheele believed to be a compound containing oxygen.

All attempts by Scheele and other chemists to decompose this green gas were unsuccessful. In 1810 the green gas was named chlorine.

(a) Explain which information in the passage above suggests that chlorine is an element.

.....

.....

..... [2]

(b) Chlorine is produced in the chemical industry by electrolysis.

(ii) Fig. 9.2 shows how the electrons are arranged in a chlorine atom.

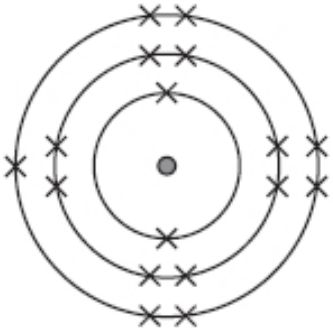


Fig. 9.2

In chlorine gas, the atoms form molecules which have the formula, Cl_2.

Draw a diagram to show how the **outer** electrons are arranged in a molecule of chlorine.

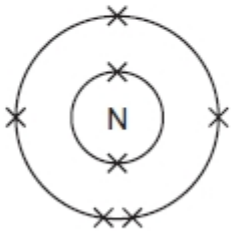
[2]

iGda 12s31

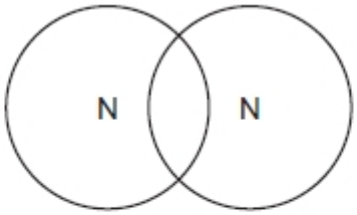
2 Magnesium is a reactive metal that combines with both oxygen and nitrogen when burnt in air. The white solid that remains after this combustion reaction contains mainly magnesium oxide mixed with a little magnesium nitride.

Nitrogen exists in the air in the form of diatomic molecules, N_2.

(a) A diagram of a nitrogen atom is shown below.



(i) Complete the bonding diagram below to show how all the **outer** electrons are arranged in a nitrogen molecule.



[2]

(ii) When magnesium reacts with nitrogen, the bonds in the nitrogen molecules are broken. Nitrogen atoms then combine with magnesium atoms to form the **ionic** compound magnesium nitride.

Draw a diagram of a nitride **ion**, N^{3-}, showing how **all** of the electrons are arranged.

[1]

(iii) Explain, in terms of protons and electrons, why the nitride ion carries an electrical charge of 3^-.

.....

.....

..... [2]

(iv) Magnesium ions have the formula Mg^{2+}.

Deduce the chemical formula of magnesium nitride.

Explain your answer briefly. ..... [2]

iGda 11w31

5 Diamonds, sapphires and rubies are found in the Earth's crust and are valuable as industrial materials and for making jewellery.

(a) (i) Name the substance from which diamonds are made and explain why this substance is an example of an element and **not** a compound.

substance .....

.....

.....

..... [3]

(ii) The main compound in sapphires and rubies is aluminium oxide.

Explain briefly, in terms of their structures and the energy needed to separate their atoms, why diamond and aluminium oxide are both very hard solids at room temperature.

.....

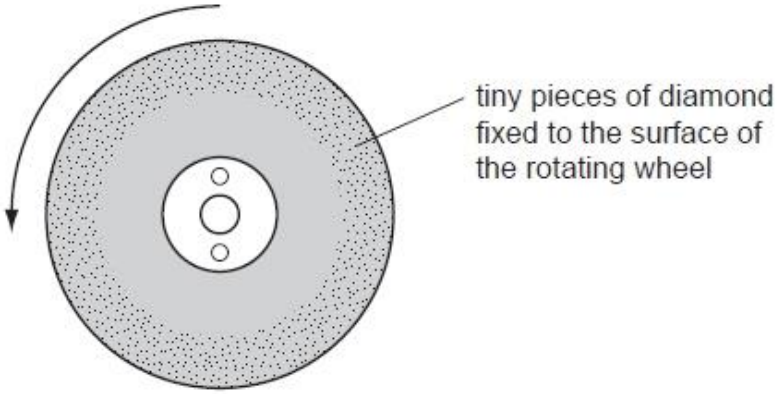
.....

.....

..... [2]

(iii) Sapphires and rubies for use in jewellery must be cut and polished by grinding them on a rotating wheel.

Suggest why the surface of the rotating wheel is covered with small pieces of diamond.



.....

..... [1]

iGda 11s31 Q2

(b) The way in which the atoms are arranged in a substance is often referred to as its structure.

Substances with different structures are listed below.

argon **copper** **glass** **sodium chloride**

(i) State the substances in the list that have a giant structure.

..... [1]

(ii) State the substances in the list whose atoms are arranged in a disorderly (irregular) manner.

..... [1]

(iii) Decane, $C_{10}H_{22}$, is a liquid at room temperature.

When decane is heated gently, a vapour made of unbroken decane molecules is released. Hydrogen gas and black soot made of carbon are **not** released.

Explain these findings in terms of attractive forces between molecules and chemical bonds within molecules.

.....

.....

.....

.....

..... [3]

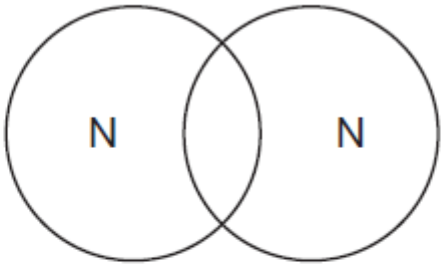
(b) The mixture of waste gases coming from the jet engine contains a large amount of the free element nitrogen, N_2, which exists naturally in the air.
The atoms in a nitrogen molecule are held together by a triple covalent bond as shown in the displayed formula below.

$$N \equiv N$$

(i) State the number of outer electrons in a single nitrogen atom.

..... [1]

(ii) Complete the bonding diagram below to show how the outer electrons are arranged around the atoms in a nitrogen molecule.



[2]

(iii) The temperature inside the jet engine is very high.

Suggest why most of the nitrogen molecules which pass through the engine do **not** break up into individual atoms.

.....

.....

..... [2]

iGda 10s31 Q9

(b) Metals have giant structures and are good conductors of electricity.

(i) Complete and label the diagram of the structure of a typical metal. Your diagram should show how the atoms are arranged.

[1]

(ii) Use your diagram to explain why metals are good conductors of electricity.

.....

.....

.....

..... [2]

iGda 09w31 Q6

(d) Table 6.1 shows some information about carbon dioxide and silicon dioxide.

Table 6.1

	carbon dioxide	silicon dioxide
chemical formula	CO_2	SiO_2
type of bonding	covalent	covalent
melting point/°C	– 57	1710

Explain, in terms of their internal structures, why much more energy is needed to melt silicon dioxide than to melt carbon dioxide.

.....

.....

.....

.....

..... [2]

iGda 09s31 Q9

(d) Table 9.1 shows information about the atomic structures of four particles **W**, **X**, **Y** and **Z**.

Table 9.1

	number of protons	number of neutrons	electrons in 1st shell	electrons in 2nd shell	electrons in 3rd shell
W	11	12	2	8	-
X	9	10	2	8	-
Y	12	12	2	8	2
Z	12	13	2	8	2

Explain which **two** particles from **W**, **X**, **Y** and **Z** in the table would attract one another very strongly.

.....

.....

.....

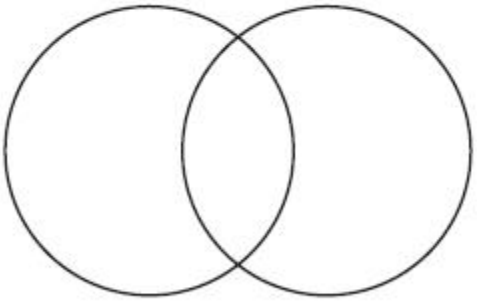
.....

.....

..... [3]

iGda 09s31 Q6 (c)

(ii) Complete the bonding diagram of a bromine molecule to show the arrangement of the outer electrons of each atom.



[2]

iGda 08w31 Q3

(b) Explain why a metal such as magnesium is a good conductor of electricity. You should draw a labelled diagram to help your explanation.

.....

.....

..... [3]

iGda 08s31 Q8

(b) Biogas is an alternative source of methane made from biodegradable materials. Biogas may be obtained from waste materials stored in landfill sites and from controlled reactions in vessels called digesters. Some information about two sources of biogas is shown in Table 8.1.

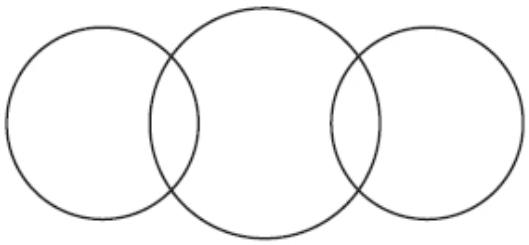
Table 8.1

	% of substances in the biogas mixture	
	biogas from a digester	biogas from landfill
methane	60 – 70	45 – 55
carbon dioxide	30 – 40	30 – 40
nitrogen	less than 1	5 – 15
hydrogen sulphide	0.2	0.03

(i) Hydrogen sulphide is made of molecules in which two hydrogen atoms are bonded to one sulphur atom.

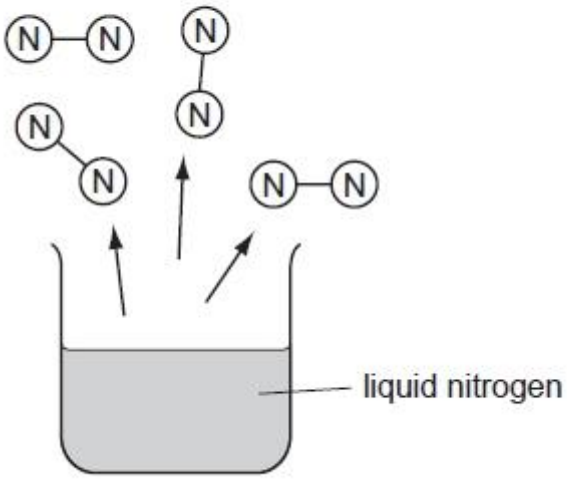
Complete the bonding diagram below to show

- the chemical symbols of the elements in a molecule of hydrogen sulphide,
- the arrangement of the outer electrons of each atom.



[2]

(c) When liquid nitrogen evaporates, nitrogen molecules, N_2, separate and form nitrogen gas.



Explain, in terms of forces of attraction, why **molecules** of nitrogen rather than individual **atoms** of nitrogen separate from each other when liquid nitrogen evaporates.

.....

.....

..... [2]

Topic 3 MS

iGda 14w31 Q1

(c) magnesium loses electrons and sulfur gains electrons ;
reference to loss or gain of two electrons ;
reference to acquisition of complete outer shells ; [max 2]

(d) $Mg + S \rightarrow MgS$; [1]

(e) it is an ionic compound ;
strong attraction between ions / opposite charges attract (strongly) ;
much (thermal) energy needed to separate ions ; [max 2]

iGda 14w31

12 (a) (i) number of protons in atom / nucleus ; [1]

(ii) idea that **L** and **O** in same group / properties similar within groups ;
atoms of **L** and **O** have same number of outer electrons / **L** and **M** have different numbers of outer electrons / or statement of number of electrons in outer shells ;
chemical properties related to number of outer electrons ; [max 2]

(b) symbols correct ;
have 8 electrons in all outer shells ;
two shared pairs in both bonds ; [3]

iGda 14s31

7 **(a)**

name of particle	*number in the nucleus*
proton	17
neutron	18

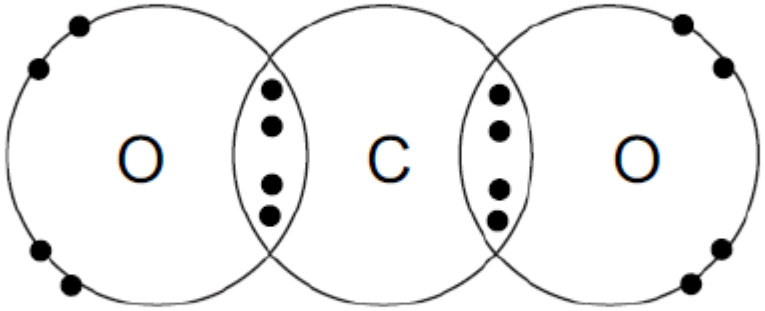
;;

(one for each correct row ;;) [2]

iGda 14s31

1 **(a)** electrons are shared ;
electrons are transferred ; [2]

(b)



bonding electrons shown as two sets of two shared pairs ;
two lone pairs shown on both oxygen atoms ;
chemical symbols correctly indicated ; [3]

iGda 14s31 Q7

(b) **(i)** kill microorganisms / prevent water-borne disease ; [1]

(ii) chlorine + sodium iodide → sodium chloride + iodine ; [1]

(c)

(iv) non-metals (other than H) appear at the positive electrode / anode ;
chloride ions are negative / are Cl^- / are anions ;
chloride ions are attracted to the positive electrode / anode ;
chloride ions are discharged / lose electrons (at the anode) ; [max 3]
[electrode equation $2\,Cl \rightarrow Cl_2 + 2\,e^-$ *award 2 marks]*

iGda 13w31

1 (a) (i) reference to reactivity of elements / compound is more stable ; [1]

(ii) compound has elements in fixed proportions / has a formula ;
mixture has no fixed proportions ;
compound has a unique set of properties ;
constituents of a mixture retain individual properties ;
compound cannot / can only be separated by chemical means ;
mixture can be separated by physical means ;
compound has all constituents chemically bonded / formed by a chemical reaction ;
mixture does not have chemical bonds between all constituents / is not formed by a chemical reaction ; [max 2]

(iii) (try to) find melting point ;
sharp m.pt. / 801 °C indicates sodium chloride ;
unclear m.pt. indicates mixture / low sodium salt ; [max 2]

(b) (i) potassium and calcium (both required) ; [1]

iGda 13s31 Q4

(c) (i) too reactive / elements unstable / they would react / compounds (much) more stable ; [1]

(ii) sodium atoms lose one electron / outer shell electron / become 2.8 ;
chlorine atoms gain one electron / complete their outer shell / become 2.8.8 ; [2]

(iii) particles shown as positively and negatively charged ;
ions shown alternating in ratio 1:1 ;
shape shown as square / cube ; [3]

iGda 13s31

1 (a) (i) (**A**)
sum of protons and neutrons is greatest / nucleon number is sum of protons and neutrons / most protons and neutrons ; [1]

(ii) **A** and **D** ;
proton number 2 shows helium ;
(isotopes) have same number of protons but different, numbers of neutrons / (atomic) mass ; [max 2]

(b) (i) atoms share electrons ;
electron pair (is shared) ;
electron pair lies between nuclei / shields nuclear repulsion ; [max 2]

(ii) helium (atoms) inert / stable / unreactive / do not (need to) bond ;
reference to complete (outer) shell ; [max 1]

iGda 12w31 Q6

(b) (i) 3 / outer electrons / shell is lost ;
so now three more positive charges (protons) than negative charges / electrons ; [2]

iGda 12w31

9 (a) failure to decompose the green gas ;
elements cannot be simplified/owtte ; [2]

(b) (i) **X** – sodium chloride ;
Y – hydrogen ;
Z – sodium hydroxide ; [3]

(ii) two atoms with shared pair of electrons between them ;
all other electrons correct/6 unshared electrons each ; [2]

iGda 12s31

2 (a) (i) three shared pairs ;
one lone pair on both atoms ; [2]

(ii) two shells showing 2,8 configuration ; [1]

(iii) reference to positive protons and negative electrons ;
reference to 7 protons and 10 electrons/3 more electrons than protons ; [2]

(iv) Mg_3N_2 ;
working/statement to show need for charge balance ; [2]

iGda 11w31

5 (a) (i) carbon ;
elements contain one type of atom/carbon is listed in the Periodic Table ;
compounds contain more than one, type of atom/element (bonded) ; (reject 'mixed') [3]

(ii) (both have a) giant structure/or good attempt to describe ;
so large numbers of bonds to break (which needs energy) ;
(all these) bonds are strong ; [max 2]

(iii) diamond is harder/has stronger bonds, than sapphires/rubies ; [1]

iGda 11s31 Q2

(b) (i) *any two of:* copper, sodium chloride, glass ; [1]

(ii) argon **and** glass ; [1]

(iii) attractions between molecules, are weak/require little energy to break ;
bonds within molecules, are strong/require much energy to break ;

(energy from) heating sufficient to separate molecules ;
(energy from) heating insufficient to break chemical bonds ;

evaporation requires (only) weak forces between molecules to be overcome ;
appearance of, hydrogen/carbon, requires chemical bonds to be broken ; [max 3]

iGda 10w31 Q4

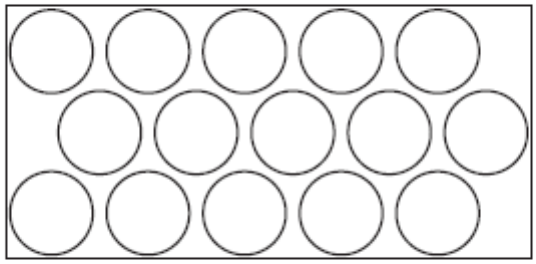
(b) (i) 5 ; [1]

(ii) three shared pairs ;
one non-bonding pair on both atoms ; [2]

(iii) very strong bond (between the atoms) ;
much energy needed to break bond / insufficient energy to break the bond ; [2]

iGda 10s31 Q9

(b) **(i)** atoms all same size arranged in regular lattice ; [1]
e.g.



(ii) reference to delocalised electrons ;
movement of charge/electrons ; [2]

iGda 09w31 Q6

(d) carbon dioxide is simple molecular ;
melting involves breaking weak forces between molecules ; (max 1)
silicon dioxide is giant (lattice) ;
melting involves breaking very many strong bonds between atoms ; (max 1)
[2]

iGda 09s31 Q9

(d) **W** is a positive ion/positively charged ;
because it contains more protons than electrons ;
X is a negative ion/negatively charged ;
because it has more electrons than protons ;
opposite charges attract ; [max 3]

iGda 09s31 Q6 (c)

(ii) 1 shared pair ;
all other outer shell electrons on both atoms ; [2]

iGda 08w31 Q3

(b) *diagram shows*
lattice of, atoms / ions ;
delocalised electrons ;
ref to electrical conductivity explained in terms of ease of electron movement / energy transfer between electrons ; [3]

iGda 08s31 Q8

(b) **(i)** correct bonding electrons ;
lone pairs on sulphur ; [2]

(c) attractive forces within molecules are very strong/chemical bonds holding atoms together are very strong ;
forces between nitrogen molecules are very weak/much less energy needed for molecules to separate than to break ; [2]

Topic 4

iGda 15s31 Q11

(b) Fig. 11.2 shows the electrolysis of copper sulfate solution using copper electrodes.

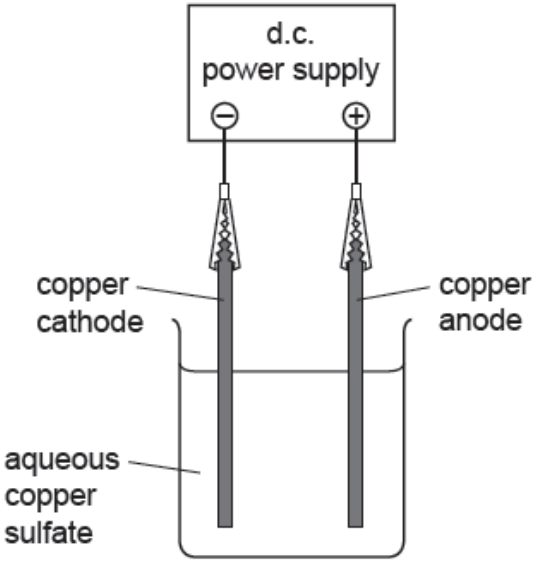


Fig. 11.2

During this electrolysis reaction the masses of the electrodes slowly change.

Table 11.1 shows the mass of the cathode at the start and end of the process.

Table 11.1

cathode mass at the start/g	cathode mass at the end/g
177.42	178.38

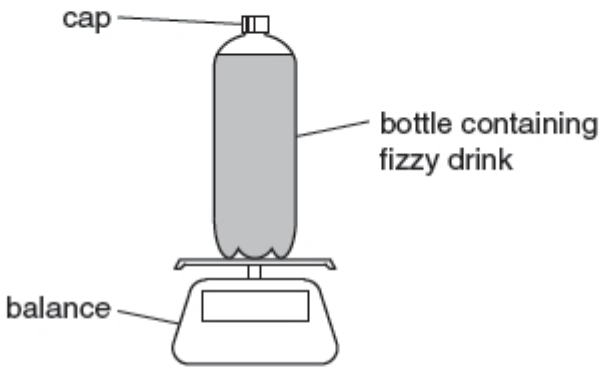
(i) Calculate the number of moles of copper deposited on the cathode during the electrolysis. The relative atomic mass of copper is 64.

Show your working.

number of moles of copper = ... [2]

(c) A student investigates how much carbon dioxide gas is contained in a carbonated (fizzy) drink.

He measures the mass of a full bottle of fizzy drink.



He shakes the bottle. He releases the carbon dioxide by carefully unscrewing the cap.

He measures the mass of the bottle and cap, and liquid without the carbon dioxide.

His results are shown in Table 12.1.

Table 12.1

mass of bottle filled with fizzy drink /g	mass of bottle and cap, and liquid without carbon dioxide /g	volume of the liquid /cm^3
476.2	474.0	454.0

(i) State the mass of carbon dioxide that is released from the fizzy drink.

.....[1]

(ii) Calculate the number of moles of carbon dioxide released from the fizzy drink.

Show your working.

.....[2]

(iii) Calculate the concentration of carbon dioxide in the original fizzy drink.

State your answer in units of mol/dm^3.

Show your working.

..... mol/dm^3 [2]

iGda 14s31 Q7

(c) Fig. 7.2 shows a simplified diagram of the electrolysis of sodium chloride solution, used to produce chlorine in industry.

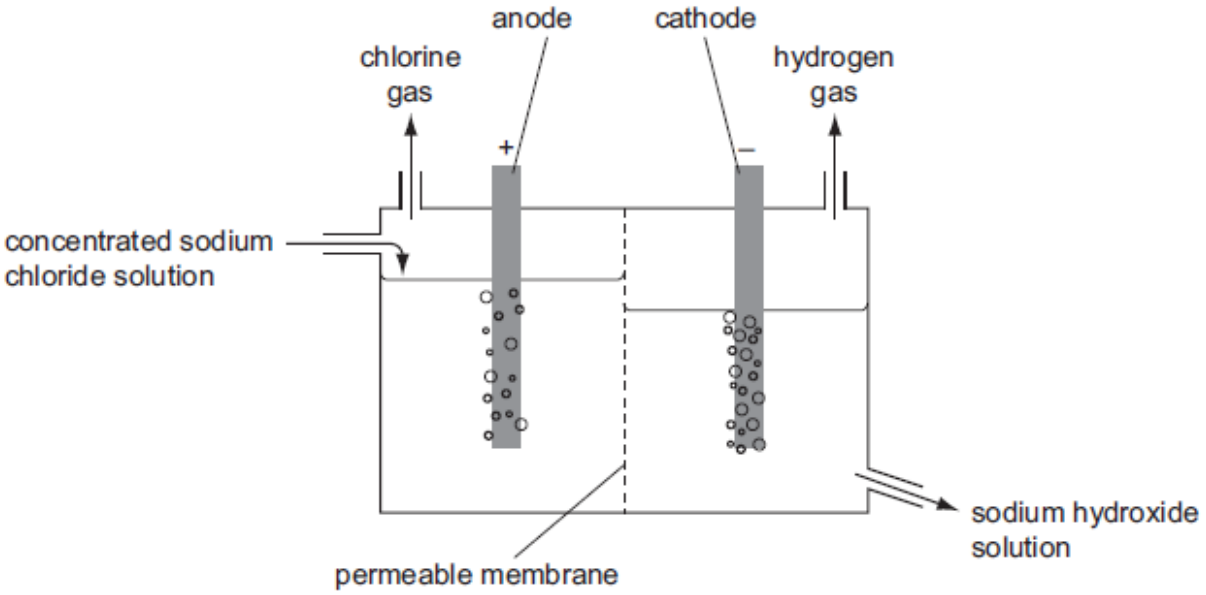


Fig. 7.2

The balanced equation for the overall chemical change that occurs in the process shown in Fig. 7.2 is

$$2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$$

(i) Show that the relative formula mass of sodium chloride is 58.5.

[1]

(ii) Calculate the number of moles in 234 g of sodium chloride.

Show your working.

number of moles = ... [1]

(iii) Calculate the volume of chlorine molecules produced at room temperature and pressure, when 234 g of sodium chloride are electrolysed.
(1 mole of chlorine molecules has a volume of 24 dm^3 at room temperature and pressure.)

Show your working.

volume = ... [2]

iGda 13w31 Q7

(b) Zirconium is produced in a reaction between zirconium chloride and magnesium.

The balanced equation for the reaction is

$$ZrCl_4 + 2Mg \longrightarrow Zr + 2MgCl_2$$

(i) A chemical company makes 182 kg of zirconium.

Calculate the number of moles in 182 kg of zirconium.

Show your working.

..... [2]

(ii) Calculate the mass of magnesium chloride that will be made when 182 kg of zirconium are made.

Show your working.

..... [2]

iGda 13w31 Q1

(b) Table 1.1 contains the names and symbols of some positive and negative ions.

Table 1.1

positive ions	
name	symbol
potassium	K^+
ammonium	NH_4^+
calcium	Ca^{2+}
aluminium	Al^{3+}

negative ions	
name	symbol
fluoride	F^-
oxide	O^{2-}
nitride	N^{3-}
sulfate	SO_4^{2-}

(ii) Deduce the chemical formula of the compound calcium nitride.

Show how you obtained your answer.

..... [2]

iGda 13w31

7 Zirconium, Zr, is a metallic element found in Period 5 of the Periodic Table.

(a) Fig. 7.1 shows information about isotopes of zirconium.

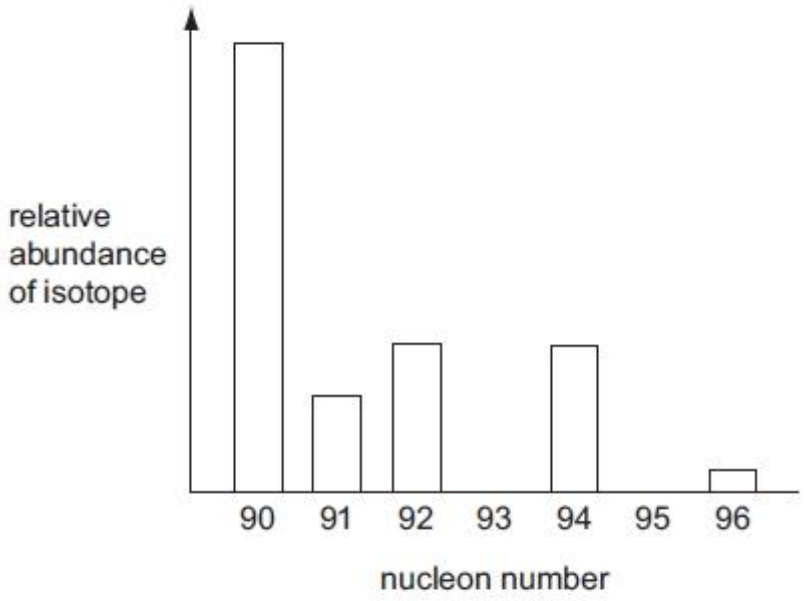


Fig. 7.1

(i) Complete Table 7.1 to show the numbers of nucleons and electrons in two of the zirconium isotopes.

Table 7.1

isotope	number of protons	number of neutrons	number of electrons
Zr-90			
Zr-96			

[2]

(ii) The relative atomic mass of zirconium is 91 (to the nearest whole number).

State the meaning of the term *relative atomic mass*.

.....

.....

..... [2]

iGda 13s31 Q7

(c) 1.00 kg of a sample of concentrated sulfuric acid contains 98% by mass of H_2SO_4 molecules.

Calculate the number of moles of H_2SO_4 molecules in 1.00 kg of this sample of concentrated sulfuric acid.

Show your working.

..... [3]

iGda 13s31 Q10

(c) The student's teacher then set up the apparatus shown in Fig. 10.4 in a fume cupboard.

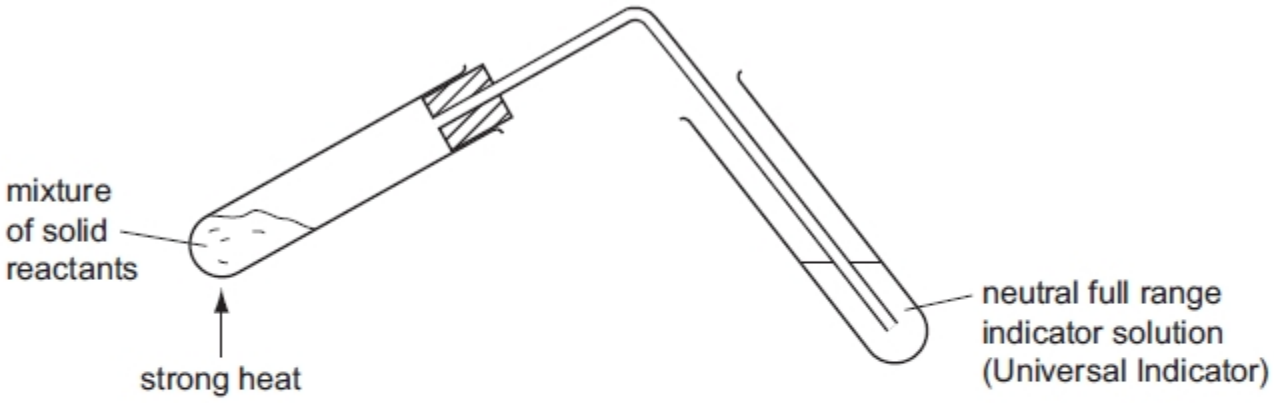


Fig. 10.4

The teacher heated the mixture of reactants. A gas was given off which did **not** change the colour of the indicator.

The teacher told the student

- that the gas was an oxide of carbon,
- that the relative formula mass of the gas molecules was 28.

The gas was not carbon dioxide

(ii) Use the value of the relative formula mass to deduce the chemical formula of the gas produced in this experiment.

.....

.....

..... [2]

iGda 12w31 Q9

(c) A student plans to produce some chlorine gas by repeating the reaction used by Scheele. She researches the balanced symbolic equation for the reaction and finds that it is

$$4HCl(aq) + MnO_2(s) \longrightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g).$$

The student decides to react 1.74 g of manganese dioxide with excess hydrochloric acid.

(i) Calculate the number of moles of manganese dioxide in 1.74 g.

Show your working.

..... [2]

(ii) Calculate the volume of chlorine gas, measured at room temperature and pressure, which the student might expect to be produced in her experiment.

The volume of one mole of chlorine, measured at room temperature and pressure, is 24 dm^3.

Show your working.

..... [3]

iGda 12w31 Q6 (b)

(ii) A student suggested the symbolic equation below for the formation of aluminium oxide.

$$2Al + 3O_2 \longrightarrow Al_2O_3$$

State and explain whether or not this equation is balanced.

.....

.....

..... [2]

iGda 12w31

2 **(a)** Fig. 2.1 shows part of the carbon cycle.

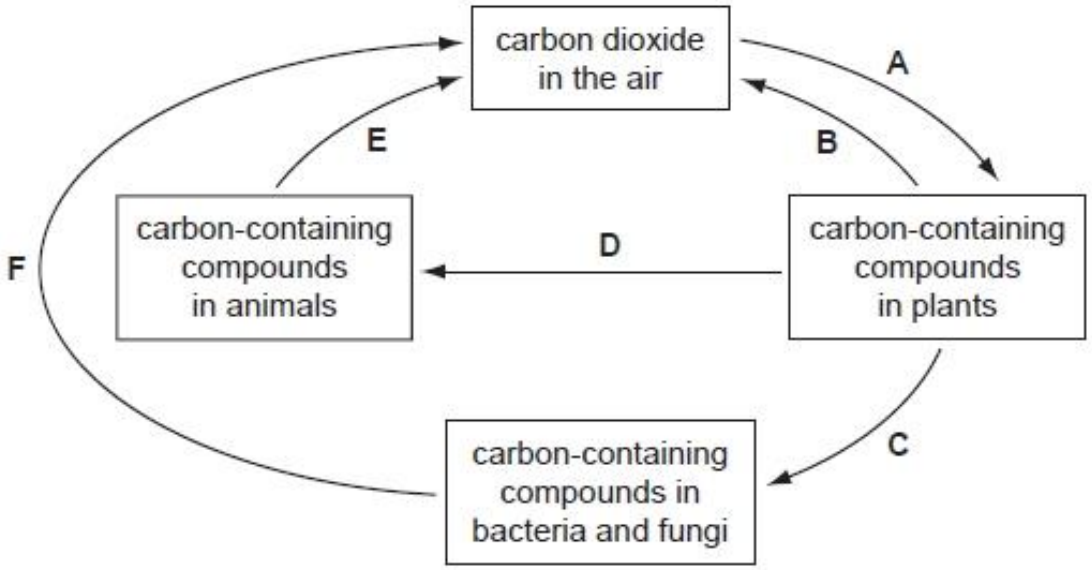


Fig. 2.1

(i) State the letter or letters, **A**, **B**, **C**, **D**, **E** or **F**, that represent

photosynthesis, ...

respiration. ..... [2]

(ii) Name **one** carbon-containing compound in plants.

..... [1]

(iii) State the approximate percentage of carbon dioxide in the air.

..... [1]

(b) Earthworms play an important part in the carbon cycle. They are decomposers.

Describe the role of decomposers in the carbon cycle.

.....

.....

.....

..... [2]

(c) The balanced symbol equation for the reaction between hydrochloric acid and magnesium is shown below.

$$Mg\,(s) + 2HCl\,(aq) \rightarrow MgCl_2\,(aq) + H_2\,(g)$$

(i) What is meant by the state symbol (aq) in this equation?

.....

[1]

(ii) Calculate the number of moles of magnesium atoms contained in 6.0g of magnesium metal.

Show your working.

.....

[2]

iGda 11w31 Q3

(c) Ammonia reacts with dilute nitric acid to make the salt ammonium nitrate.

$$NH_3 + HNO_3 \longrightarrow NH_4NO_3$$

A student makes a solution containing ammonium nitrate by mixing solutions **A** and **B** as shown in Fig. 3.2.

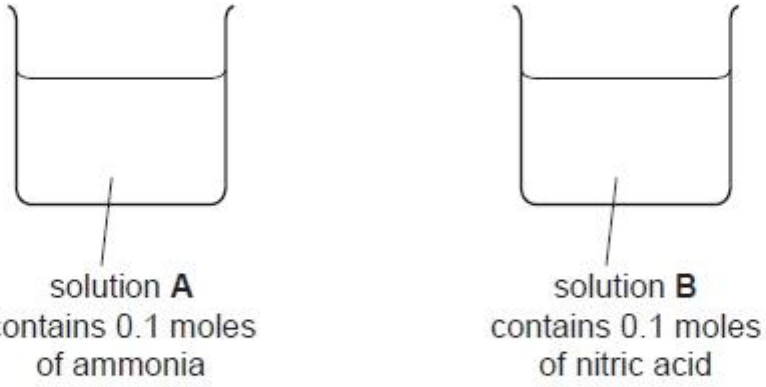


Fig. 3.2

The student then leaves the solution of ammonium nitrate to evaporate completely.

(i) Calculate the mass in grams of ammonium nitrate crystals that she will obtain.

Show your working. [relative atomic masses, A_r: N=14; O=16; H=1]

..... [2]

(ii) The formula of the ammonium ion is NH_4^+.

Deduce the formula of the nitrate ion.

Show how you obtained your answer.

..... [2]

8 The chemical formulae for some compounds (minerals) found in rocks are shown below.

$CaMg(CO_3)_2$	dolomite
$KAlSi_3O_8$	potassium feldspar
$NaAlSi_3O_8$	sodium feldspar
SiO_2	quartz

(b) Dolomite contains three ions, calcium, magnesium and carbonate.

Calcium and magnesium ions are represented by Ca^{2+} and Mg^{2+} respectively.

Deduce the electrical charge carried by a carbonate ion.

Explain how you obtained your answer.

..... [2]

(c) When dolomite is strongly heated it undergoes thermal decomposition, giving off carbon dioxide gas and leaving a mixture of calcium oxide and magnesium oxide.

The balanced equation for this reaction is

$$CaMg(CO_3)_2 \longrightarrow CaO + MgO + 2CO_2$$

(i) Calculate the number of moles of dolomite in 1.84 g.

Show your working.

..... [3]

(ii) State the number of moles of carbon dioxide which is given off when 1.84 g of dolomite completely decomposes.

..... [1]

iGda 10w31 Q4 (c)

(c) Table 4.1 shows information about some metallic materials.

Table 4.1

material	strength	density
mild steel	very high	very high
aluminium	low	low
duralumin (an aluminium alloy)	very high	low

(ii) A sample of duralumin has a mass of 50.00 g and contains 1.73 moles of aluminium.

Calculate the percentage by mass of aluminium in this sample of duralumin.

Show your working.

..... [3]

iGda 10w31

7 Copper metal reacts with oxygen gas to form copper oxide.

(a) Table 7.1 shows information about two different types of copper oxide.

Table 7.1

name	colour	chemical formula
copper(II) oxide	black	CuO
copper(I) oxide	red	Cu_2O

(ii) The formula of the oxide ion is O^{2-}.

Use the formula of copper(I) oxide to deduce the charge of the copper ion in this compound.

Show your working.

.....

..... [2]

iGda 10s31 Q4

(b) In the experiment, the concentrations of acid **A** and the potassium hydroxide solution were 0.2 mol/dm^3 and 0.5 mol/dm^3 respectively.

(i) Use the equation

moles (dissolved) = volume (dm^3) x concentration (mol/dm^3)

to calculate the number of moles of both acid **A** and potassium hydroxide which neutralised each other in this reaction.

moles of acid **A**

.....

moles of potassium hydroxide

..... [2]

(ii) State the number of moles of acid **A** which would be needed to neutralise **one** mole of potassium hydroxide.

Explain your answer briefly.

moles of acid **A** .....

explanation .....

..... [1]

iGda 09w31

Ammonia has a chemical formula of NH_3 and can be made in a factory where 17% of the total mass leaving the reaction vessel is ammonia, the rest is not important.

(d) In an ammonia factory, 1000 kg of gas mixture leave the reaction vessel every minute. In this factory the yield of ammonia is 17%.

Calculate the number of moles of ammonia which leave the reaction vessel every minute.

Show your working.

[relative atomic masses, A_r: N=14; H=1]
1 kg = 1000 g

.....

.....

.....

.....

.....

..... [4]

iGda 09s31 Q3

(c) Some water supplied to houses contains calcium hydrogencarbonate, $Ca(HCO_3)_2$. When heated, calcium hydrogencarbonate undergoes thermal decomposition.

(ii) The ionic charge of a calcium ion is 2+. Deduce the ionic charge of a hydrogencarbonate ion.

Show how you obtained your answer.

.....

.....

..... [2]

6 Fig. 6.1 shows apparatus a student used to investigate electrolysis using concentrated sodium chloride solution as the electrolyte.

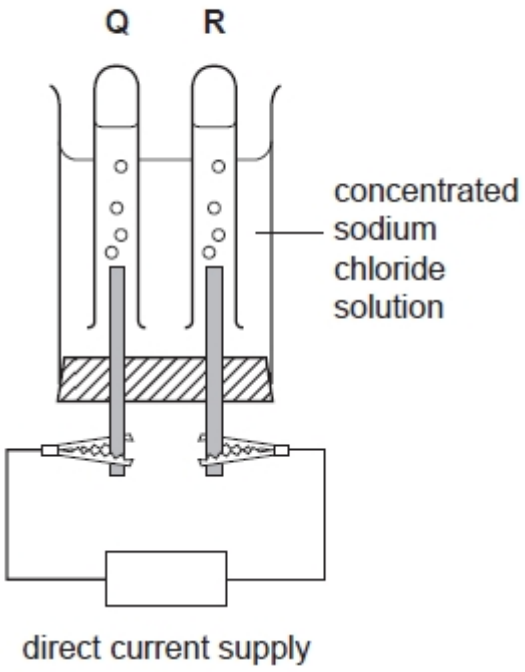


Fig. 6.1

When an electric current flowed through the circuit, chlorine gas collected in tube **Q** and hydrogen gas collected in tube **R**.

The balanced equation below describes the overall chemical change which takes place.

$$2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$$

(b) The student allowed the current to flow through the apparatus until 0.01 moles of hydrogen gas had been produced.

(i) State the number of moles of chlorine which were produced during the experiment.

..... [1]

(ii) Calculate the mass of sodium hydroxide which was produced during the experiment. (Relative atomic masses Na = 23, O = 16, H = 1)

Show your working.

..... [3]

(c) Copper is a transition metal which forms two oxides. The chemical formulae of these oxides are:

Cu_2O	copper(I) oxide
CuO	copper(II) oxide

The formula and electrical charge of an oxide ion is O^{2-}.

Deduce the difference between the copper ion in copper(I) oxide and that in copper(II) oxide. Show how you obtained your answer.

.....

.....

.....

..... [3]

iGda 08w31 Q3

(c) Magnesium alloys are widely used in making parts for aircraft and racing car engines.

Table 3.1 shows some incomplete data about one type of magnesium alloy.

Table 3.1

element	moles in 100 g of alloy	mass in 100 g of alloy /g
magnesium		
zinc	0.055	3.575
zirconium	0.011	

(i) Calculate the mass of zirconium in 100 g of the alloy. Zirconium is in Period 5 of the Periodic Table.

Show your working.

..... [2]

(ii) Calculate the mass and hence the number of moles of magnesium in 100 g of the alloy.

Show your working.

..... [3]

iGda 08s31 Q8 (b)

(ii) When biogas is burned, any hydrogen sulphide present is oxidised.

The symbolic equation below for this reaction is incomplete.

State how many molecules of oxygen are required to oxidise two molecules of hydrogen sulphide and explain your answer.

$$2H_2S + ...O_2 \rightarrow 2H_2O + 2SO_2$$

number of oxygen molecules .....

explanation .....

.....

..... [2]

iGda 08s31

(b) Ammonium sulphate is a fertiliser which is produced in a reaction between sulphuric acid and ammonia solution. The balanced equation for this reaction is shown below.

$$2\,NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

In an attempt to produce a solution containing only ammonium sulphate, a student used the following method.

1 50.0 cm^3 of a solution containing 2.0 mol / dm^3 of ammonia were placed into a glass beaker.

2 50.0 cm^3 of a solution containing 2.0 mol / dm^3 of sulphuric acid were added to the ammonia solution.

(i) Calculate the number of moles of ammonia which the student used.
(There are 1000 cm^3 in 1 dm^3.)

Show your working.

..... [2]

(iii) The formula of the sulphate ion is SO_4^{2-}. Explain why the formula of ammonium sulphate is $(NH_4)_2SO_4$.

.....

.....

..... [2]

Topic 4 MS

iGda 15s31 Q11

(b) (i) mass of copper deposited = 178.38 – 177.42 = 0.96 (g) ;
moles of copper = 0.96 ÷ 64 = 0.015 ; [2]

iGda 14w31

(c) (i) 476.2 – 474.0 **or** 2.2 g (unit required) ; [1]

(ii) M_r CO_2 = 44 ;
number of moles = 2.2 ÷ 44 = 0.05 ; (*allow ecf from* **(i)**) ; [2]

(iii) (express volume of drink in dm^3 =) 0.454 (dm^3) ;
concentration = 0.05 ÷ 0.454 = 0.11 (mol/dm^3) ; (allow ecf) [2]

iGda 14s31 Q7

(c) (i) look for 23 + 35.5 (= 58.5) ; [1]

(ii) look for 234 ÷ 58.5 = 4 ; [1]

(iii) (look for any reference to 2:1 stoichiometry of NaCl : Cl_2)
2 moles of Cl_2 are produced ;
so volume produced is 2 × 24 = 48 dm^3 (unit required) ; [2]

iGda 13w31 Q7

(b) (i) A_r of zirconium = 91 ;
182000 (÷ 91) = 2000 (moles) ; [2]

(ii) M_r magnesium chloride = 95 ;
4000 × 95 = 380000 g / 380 kg ; [2]

iGda 13w31 Q1 (b)

(ii) reference to charge balance / correct electron transfer shown ;
Ca_3N_2 ; [2]

iGda 13w31

7 (a) (i)

isotope	*protons*	*neutrons*	*electrons*
Zr – 90	40	50	40
Zr – 96	40	56	40

1 mark for a correct row ;; [2]

(ii) (weighted) mean mass ;
of isotopes / compared to mass of a hydrogen atom / carbon – 12 isotope ; [2]

iGda 13s31 Q7

(c) M_r of H_2SO_4 = 98 ;
98% of 1 kg = 0.98 (kg) = 980 (g) ;
number of moles = mass ÷ molar mass 980 ÷ 98 = **10** (moles) ; [3]

iGda 13s31 Q10

(ii) formula is CO ;
logical statement(s) ;
e.g. (must be at least one O, so) 28 – 16 = 12 (which can only be one C)
OR
(both carbon oxides have only one carbon atom so) 28 – 12 = 16
(so only one oxygen also) [max 2]

iGda 12w31 Q9

(c) (i) calculates M_r as 55 + (16 × 2) = 87 ;
calculates number of moles as 1.74 ÷ 87 = 0.02 ; [2]

(ii) use of equation to establish 1 : 1 molar ratio MnO_2 : Cl_2 / states that 0.02 moles chlorine will be produced ;
does the proportion sum to arrive at 24 × 0.02 ;
states answer with unit i.e. 0.48 dm^3 / 480 cm^3 ; [3]

iGda 12w31 Q6 (b)

(ii) (not balanced)
balanced requires same number of each type of atom on both sides ;
reference to the oxygen imbalance / correct detail ;
correctly balances the equation ; [max 2]

iGda 12w31

2 (a) (i) **A** ;
B, **E**, **F** ; [2]

(ii) starch / cellulose / sugar / chlorophyll / any other correct ; [1]

(iii) 0.04 ; (accept 0.03) [1]

(b) feed / digest / breakdown on dead (plant or animal) material / organic matter / waste products (from plants or animals) ;
use carbon-containing substances / sugar ;
for respiration ;
return carbon dioxide to the air ; [max 2]

iGda 12s31 Q6

(c) (i) aqueous (solution)/dissolved in water/in solution ; [1]

(ii) A_r Mg = 24 ;
moles Mg = 6 ÷ 24/0.25 ; [2]

iGda 11w31 Q3

(b) symbols shown in correct atoms ;
three bond pairs around central atom ;
lone pair correctly shown and no others ; [3]

(c) (i) calculate M_r of ammonium nitrate = (14 × 2) + (1 × 4) + (16 × 3)/80 ;
calculate mass of 0.1 moles = 0.1 × 80 = 8 g ; [2]

(ii) NO_3^- ;
reference to charge balance given 1:1 ratio of ions ; [2]

iGda 11s31 Q8

(b) total charge of positive ions = total charge of negative/total negative needs to be 4 – ;
so each carbonate must be 2 – ; [2]

(c) (i) (M_r dolomite is) 40 + 24 + (12 + 16 × 3) / 184 ;
moles = mass ÷ M_r/moles = 1.84 ÷ 184 ; (allow ecf)
= 0.01 ; [3]

(ii) 0.02 ; (allow ecf from **(i)**) [1]

iGda 10w31 Q4 (c)

(ii) A_r of aluminium = 27 ;
mass of aluminium = 1.73 × 27 = 46.74(g) ; *allow other methods of working*
percentage in duralumin = (46.74 ÷ 50.00) × 100 = 93.4(2)% [3]

iGda 10w31 (a)

(ii) Cu^+ ;
working shows (or heavy implication of) need for charge balance ;
[reject unexplained "criss-cross" diagrams] [2]

iGda 10s31 Q4

(b) (i) *moles of A*
((25.0/1000) × 0.2 =) 0.005 ;

moles KOH
((20.0/1000) × 0.5 =) 0.01 ; [2]
(allow 1 mark if the same error in converting to dm^3 is made in each calculation, e.g. if left in cm^3 answers are 5 and 10)

(ii) (0.5) (no mark)
[e.c.f. from **(i)** provided answer is <u>half</u> the KOH moles] because the number of moles of acid must be half the number of moles of KOH / owtte / or relevant working ; [1]

iGda 09w31

(d) M_r of ammonia = 17 ;
mass of ammonia exiting reactor per minute = 1000 × 17/100 = 170 kg ;
= 170000 g ;
moles of ammonia = 170000 / 17 = 10000 ; [4]

iGda 09s31 Q3

(c) (i) $(Ca(HCO_3)_2 \rightarrow CaCO_3 + CO_2 + H_2O$;;
[$CaCO_3$ + both for 2 marks]
[$CaCO_3$ + one for 1 mark] [2]

iGda 09s31 Q6

(b) (i) 0.01 ; [1]

(ii) 2 x 0.01 moles of sodium hydroxide produced (use of equation) ; [allow ecf]
M_r of sodium hydroxide 23 + 16 + 1 = 40 ;
mass of sodium hydroxide = 40 x 0.02 = 0.8g ; [unit required] [3]

iGda 08w31 Q9

(c) evidence of balancing charge to find copper ion charge ;
deduces Cu^+ in Cu_2O ;
deduces Cu^{2+} in CuO ;
statement to effect that Cu^{2+} has one less electron than Cu^+ / or similar ; [max 3]
$2Cu^+ + O^{2-}$ *arrow* Cu_2O gets mp 1 and 2 because it implies charge neutralised

iGda 08w31 Q3

(c) (i) evidence of use of mass = molar mass x number of moles / Ar ;
Ar of Zr = 91 ; give this if 91 appears anywhere
mass = 0.011 x 91 = 1.00(1) ; [max 2]

(ii) mass of Mg = 100 – (3.575 + 1.001) = 95.424g ;
Ar Mg = 24 ; give this if 24 appears anywhere
moles of Mg = 95.424 ÷ 24 = 3.976 ; [3]

iGda 08s31 Q8 (b)

(ii) 3 ;
must be the same number of each type of atom on both sides ; [2]

iGda 08s31

(b) (i) obvious use of formula moles = volume × concentration ;
(50.0 ÷ 1000) × 2.0 / **0.1** (moles) ; [2]

(iii) ammonium ion must be NH_4^+ ;
two positive charges required to balance the double negative of sulphate ; [2]

iGda 15s31

11 Fig. 11.1 shows two electrolysis reactions in beakers **A** and **B**. Gases are produced at three of the four electrodes.

In one of the beakers, the electrolyte is aqueous copper chloride and in the other the electrolyte is dilute sulfuric acid.

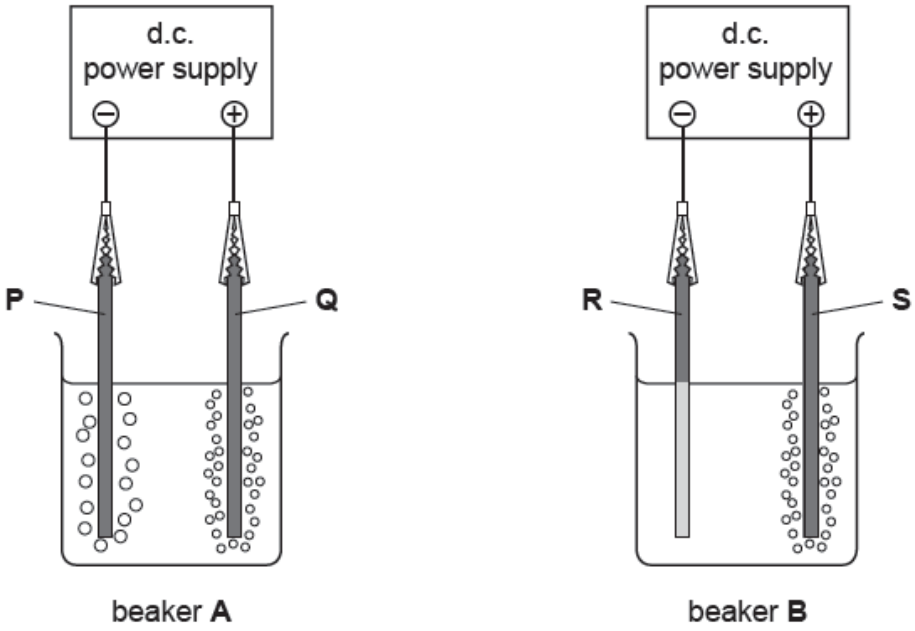


Fig. 11.1

(a) (i) State and explain in which beaker, **A** or **B**, the electrolysis of copper chloride is taking place.

beaker .....

explanation .....

..... [1]

(ii) Name the gaseous element produced on the surface of electrode **Q** in beaker **A**.

Explain your answer.

gas .....

explanation .....

..... [2]

(iii) Name the gas produced on the surface of electrode **P** in beaker **A**.

..... [1]

(b) Fig. 11.2 shows the electrolysis of copper sulfate solution using copper electrodes.

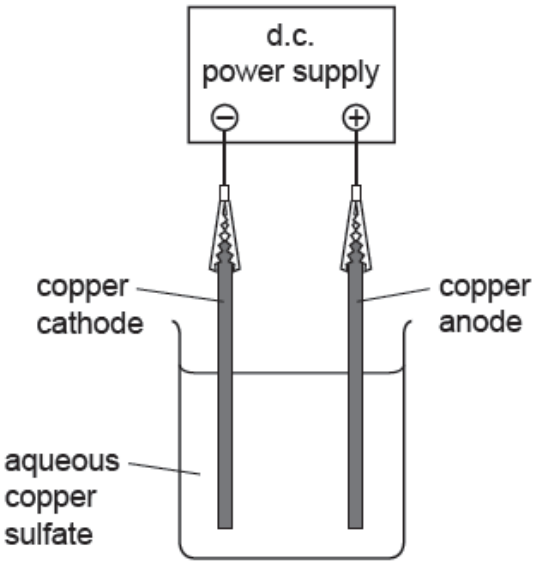


Fig. 11.2

During this electrolysis reaction the masses of the electrodes slowly change.

Table 11.1 shows the mass of the cathode at the start and end of the process.

Table 11.1

cathode mass at the start/g	cathode mass at the end/g
177.42	178.38

(ii) State and explain what happens to the mass of the anode during the electrolysis.

.....

.....

..... [2]

iGda 12w31 Q9

(b) Chlorine is produced in the chemical industry by electrolysis.

A simplified diagram of one type of electrolysis cell used to produce chlorine is shown in Fig. 9.1.

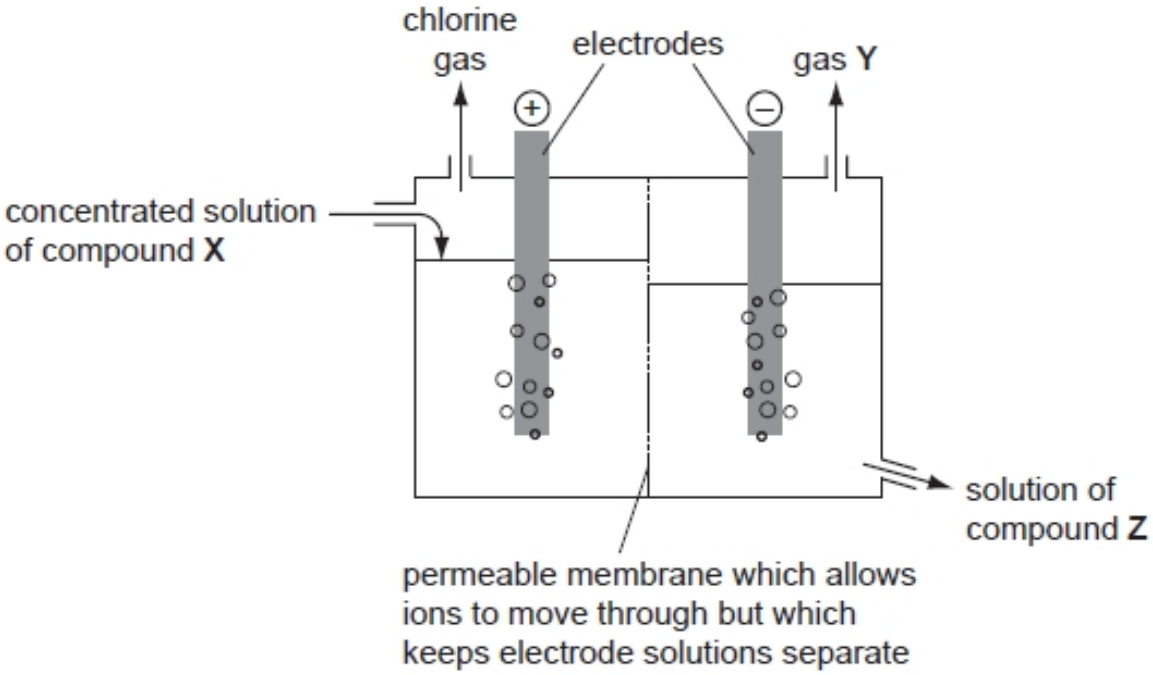


Fig. 9.1

(i) Name substances **X**, **Y** and **Z** in Fig. 9.1.

X .....

Y .....

Z ..... [3]

iGda 12s31 Q2

(b) Metallic magnesium may be obtained by the electrolysis of an electrolyte which contains molten magnesium chloride.

Fig. 2.1 shows a simplified diagram of this process.

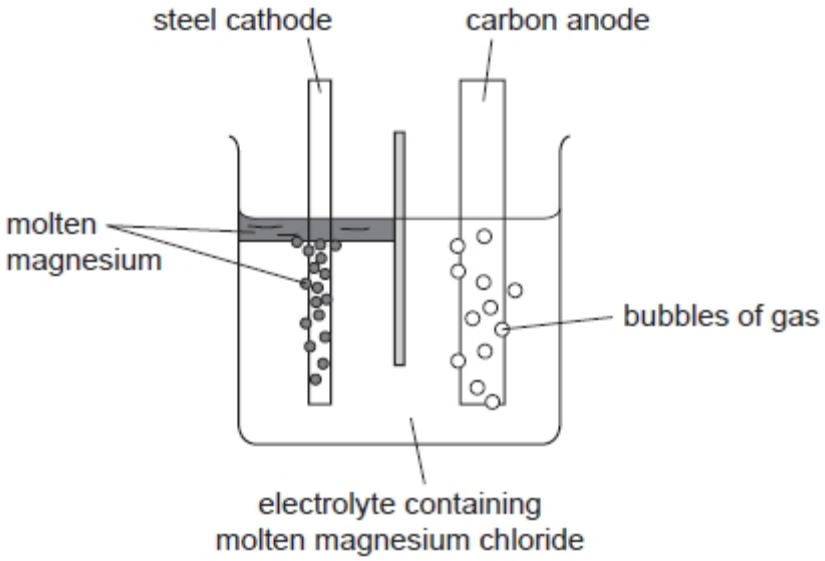


Fig. 2.1

(i) Suggest the name of the gaseous element which forms on the surface of the anode in Fig. 2.1.

..... [1]

(ii) If an aqueous solution of magnesium chloride is used as the electrolyte instead of the molten salt, a colourless gas forms on the cathode instead of magnesium.

Suggest the name of this gas and describe a simple test which would confirm its identity.

gas .....

test .....

..... [2]

iGda 11w31 Q5

(b) Aluminium may be obtained by the electrolysis of a molten mixture containing aluminium ions, Al^{3+}, and oxide ions, O^{2-}.

Fig. 5.1 shows a simplified diagram of this process.

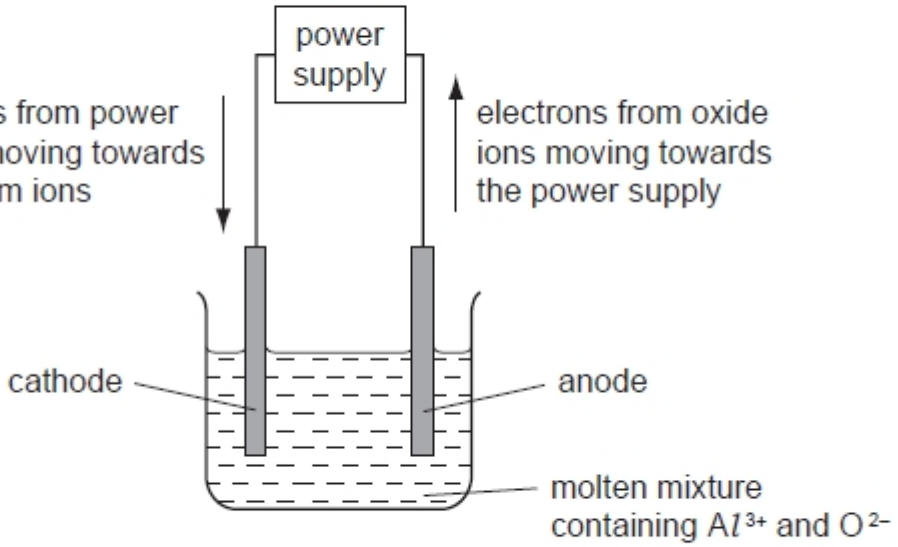


Fig. 5.1

When the circuit is completed, electrons move in the directions shown in Fig. 5.1 and ions are converted into uncharged atoms at the surfaces of the electrodes.

(i) Explain briefly why oxygen atoms are formed at the anode and **not** the cathode.

.....

..... [1]

(ii) Explain why, when **six** electrons move around the circuit, **two** aluminium atoms and **three** oxygen atoms are formed.

.....

.....

.....

.....

.....

..... [3]

iGda 11s31

2 The Earth provides raw materials which are processed into useful products.

(a) Choose products from the list to complete the right hand column of Table 2.1.

aluminium **ceramics** **chlorine** **glass** **steel**

Table 2.1

raw material	useful product
rock salt	
sand and metal oxides	

[2]

iGda 10w31 Q7

(b) Fig. 7.1 shows apparatus and materials needed for the electrolysis of aqueous solutions of ionic compounds, using graphite electrodes.

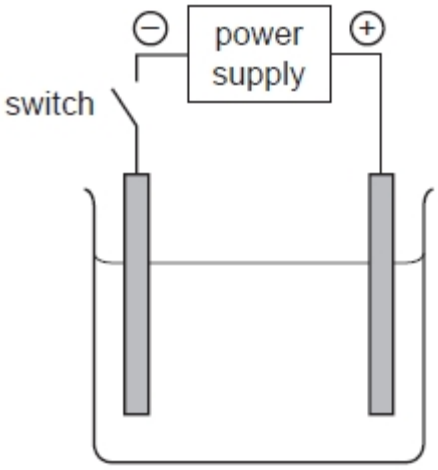


Fig. 7.1

Table 7.2 shows the observations made when solutions of three compounds, **W**, **X** and **Y**, were each electrolysed.

Table 7.2

compound in solution	observation at the cathode	observation at the anode
W	bubbles of gas	bubbles of gas which bleach damp litmus paper
X	orange / pink solid layer forms	bubbles of gas which bleach damp litmus paper
Y	bubbles of gas	orange solution produced

(i) On Fig 7.1, clearly label the **anode** and the **electrolyte**. [2]

(ii) Suggest the name of compound **X**. ..... [1]

(iii) Name the gas produced at the cathode when compound **W** is electrolysed.

..... [1]

(iv) Explain which compound, **W**, **X** or **Y**, could be potassium bromide.

compound .....

.....

.....

..... [2]

iGda 09s31

6 Fig. 6.1 shows apparatus a student used to investigate electrolysis using concentrated sodium chloride solution as the electrolyte.

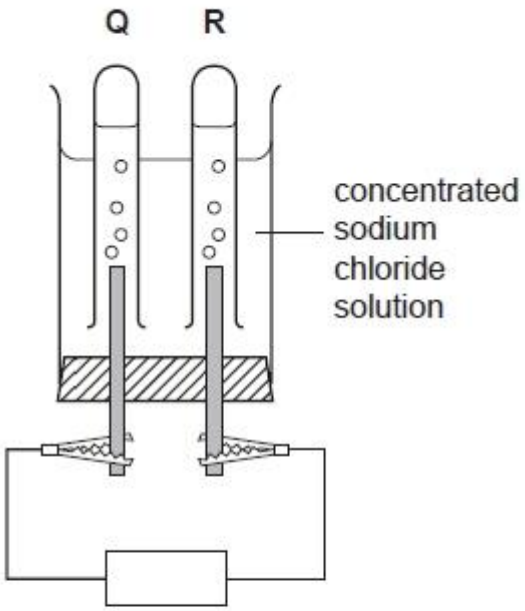


Fig. 6.1

When an electric current flowed through the circuit, chlorine gas collected in tube **Q** and hydrogen gas collected in tube **R**.

The balanced equation below describes the overall chemical change which takes place.

$$2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$$

(a) On Fig. 6.1 label the anode.

Give a reason for your choice.

.....

.....

..... [2]

iGda 08w31

9 Fig. 9.1 shows the apparatus and substances used by a student to make an electrical cell.

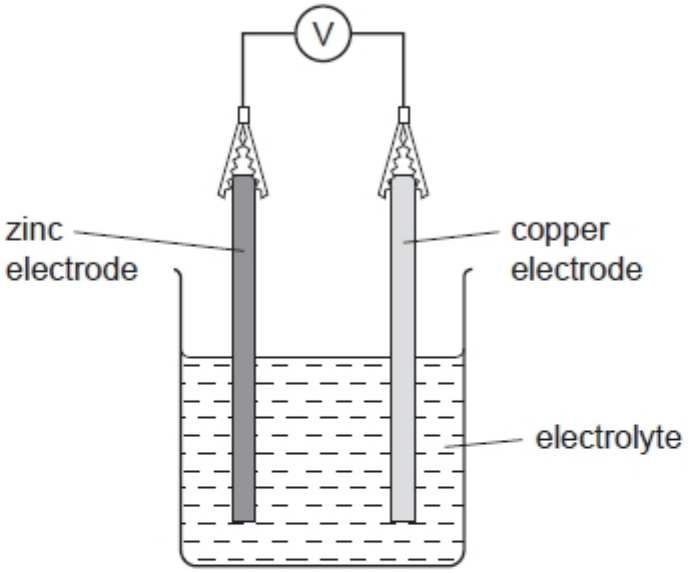


Fig. 9.1

(a) Suggest a compound which the student could dissolve in water to make the electrolyte.

Explain your answer briefly.

.....

..... [2]

iGda 08w31

9 Fig. 9.1 shows the apparatus and substances used by a student to make an electrical cell.

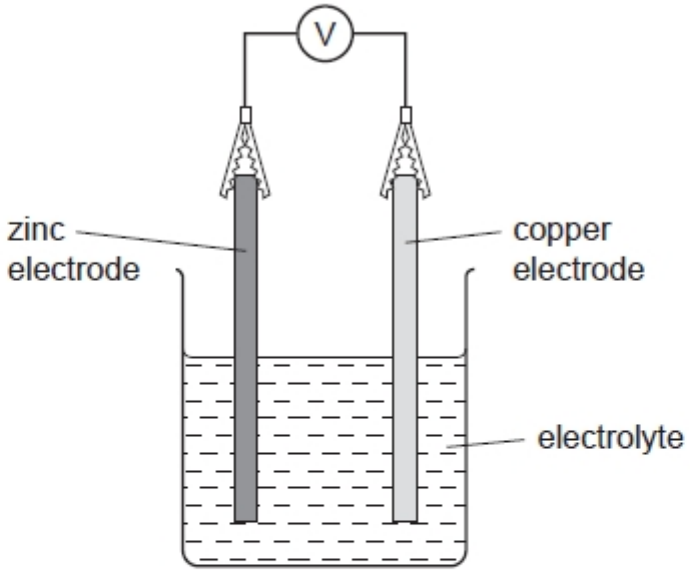


Fig. 9.1

(a) Suggest a compound which the student could dissolve in water to make the electrolyte.

Explain your answer briefly.

.....

..... [2]

(d) Zinc can be obtained industrially by the electrolysis of concentrated zinc sulphate solution which contains zinc ions, Zn^{2+}.

Describe and explain what happens to zinc ions in the solution in order to convert them into zinc atoms.

.....

.....

.....

..... [3]

iGda 15s31

11 (a) (i) (**B**) no mark
the idea that the electrolysis of copper chloride does not produce gas at the cathode / **R** / negative / does not produce two gases / produces gas only at the anode / **S** / positive / produces copper (a solid) and chlorine (a gas) ; [1]

(ii) oxygen ;
oxygen is evolved from the anode / positive electrode (when dilute sulfuric acid is electrolysed) ; [2]

(iii) hydrogen ; [1]

(b) (i) mass of copper deposited = 178.38 – 177.42 = 0.96 (g) ;
moles of copper = 0.96 ÷ 64 = 0.015 ; [2]

(ii) anode mass decreases ;
anode dissolves / atoms break away as ions /
$Cu \rightarrow Cu^{2+} + 2e^-$; [max 2]

[Total: 8]

iGda 12w31 Q9

(b) (i) **X** – sodium chloride ;
Y – hydrogen ;
Z – sodium hydroxide ; [3]

iGda 12s31 Q2

(b) (i) chlorine ; [1]

(ii) hydrogen ;
pops on ignition ; [2]

iGda 11w31 Q5

(b) (i) the idea of attraction between opposite charges ; [1]

(ii) Al^{3+} gain and O^{2-} lose electrons;
Al^{3+} gains three and O^{2-} loses two electrons ;
some relevant maths ; [3]
(e.g. so if six electrons then number of Al atoms is 6 ÷ 3 = 2)

iGda 11s31

2 (a) chlorine ;
glass ; [2]

iGda 10w31 Q7

(b) (i) anode labelled ;
electrolyte labelled ; [2]

(ii) copper chloride ; *must be name, not formula* [1]

(iii) hydrogen ; *must be name, not formula* [1]

(iv) (**Y**)
cathode gas is hydrogen ;
so reactive metal present could be potassium ;
bromide ions negative so go to anode ;
bromine is orange (and would form from bromide and anode) ; [max 2]

iGda 09s31

6 (a) Q labelled as anode ;
chloride ions are negative/are Cl^-, and attracted to positive electrode ; [2]

iGda 08w31

9 (a) any ionic (ignore solubility issues) ;
must contain ions / it is ionic / must be able to conduct ; [2]

iGda 08w31

9 (a) any ionic (ignore solubility issues) ;
must contain ions / it is ionic / must be able to conduct ; [2]

(d) zinc ions / they, move to cathode / negative electrode ;
reference to Zn ions positive and attracted to negative electrode ;
zinc ions gain electrons ;
two electrons each / are discharged ;
$Zn^{2+} + 2e^-$ *arrow* Zn gets mp 3 and 4 [max 3]

iGda 15s31

2 Fig. 2.1 shows apparatus a student uses to study the change in temperature when some metallic zinc is added to copper sulfate solution.

The student checks that the temperature of the copper sulfate solution is steady and then adds powdered zinc.

Data from the experiment are shown in the graph below the apparatus.

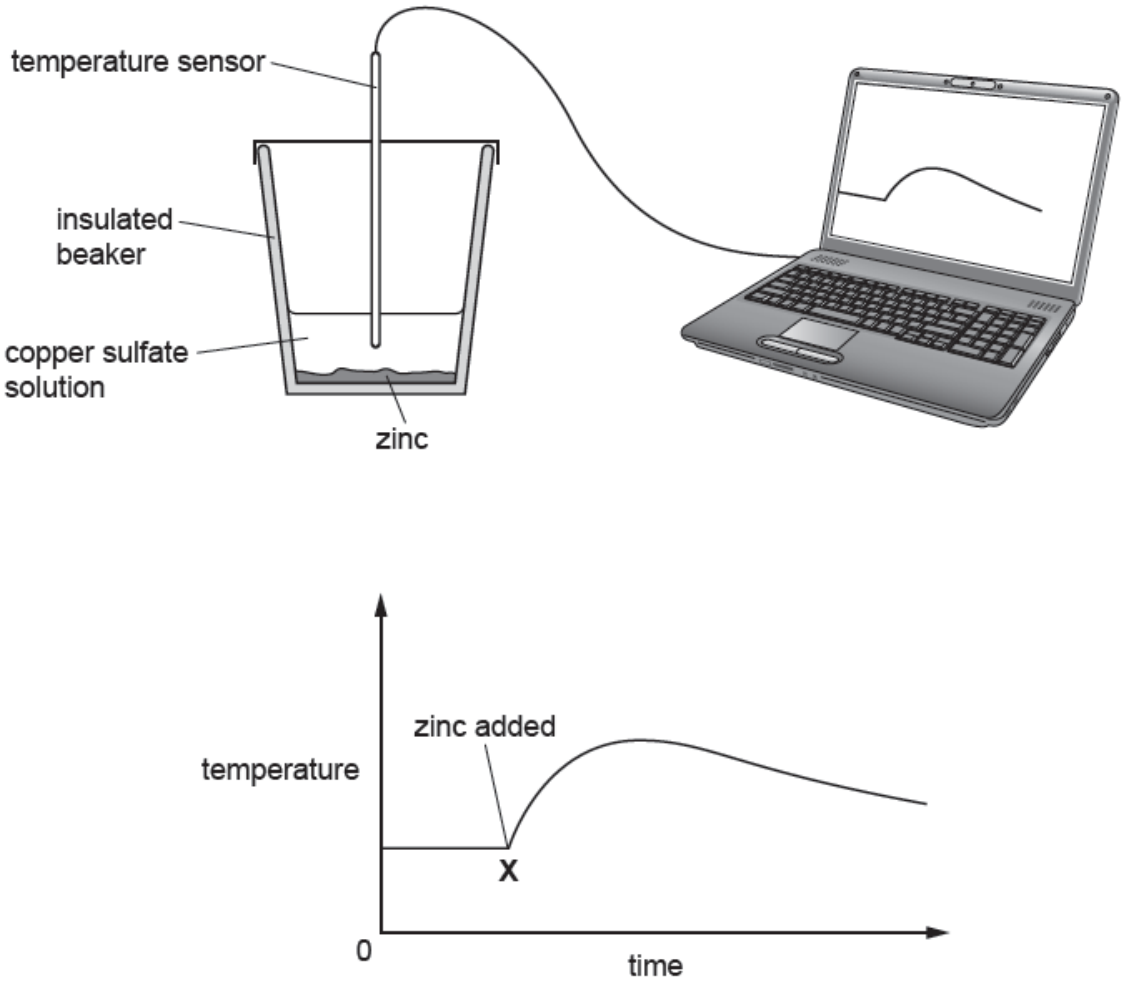


Fig. 2.1

(a) (i) State the word that is used to describe a chemical reaction that causes an increase in temperature.

..... [1]

(ii) Suggest why the temperature after **X** in Fig. 2.1 rises to a maximum and then decreases.

.....

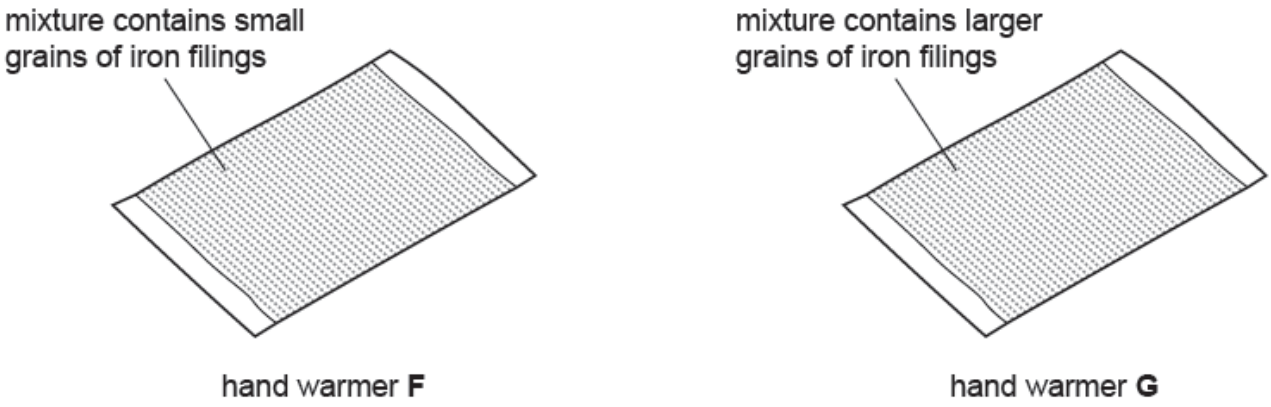
.....

..... [2]

(c) Hand warmers like the one in Fig. 2.2 may release thermal energy for up to seven hours.

The total surface area of the iron filings used in the hand warmer affects the rate of oxidation.

A scientist compares two hand warmers, **F** and **G**.



hand warmer **F** hand warmer **G**

The only difference between these hand warmers is that the size of the grains of iron in **F** is smaller than those in **G**.

(ii) State and explain whether the chemical potential energy of the contents of the hand warmer increases, decreases or remains unchanged when it is used.

.....

.....

..... [2]

iGda 14s31

4 Fuels react with oxygen in combustion reactions. During these reactions, heat energy is released.

(a) (i) Name and state a use for a gaseous fuel.

name .....

use ..... [2]

(ii) State the word used to describe chemical reactions that release heat energy.

..... [1]

(c)

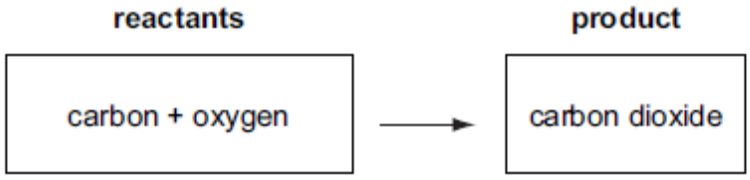


Fig. 4.1

(ii) The reactants and the product for the complete combustion of carbon are shown in Fig. 4.1.

Predict and explain whether the product contains a greater, smaller or the same total amount of chemical potential energy compared to the reactants.

prediction .....

explanation .....

.....

..... [2]

iGda 13w31 Q7 9(c)

(ii) The word equation for the combustion of zirconium is

zirconium + oxygen ⟶ zirconium oxide.

State and explain whether the reactants or the product of this reaction contains the greater amount of chemical potential energy.

.....

.....

..... [2]

iGda 13s31 Q10

(b) The student investigated the temperature change when sodium hydrogencarbonate was added to excess dilute hydrochloric acid.

Fig. 10.2 shows the apparatus she used.

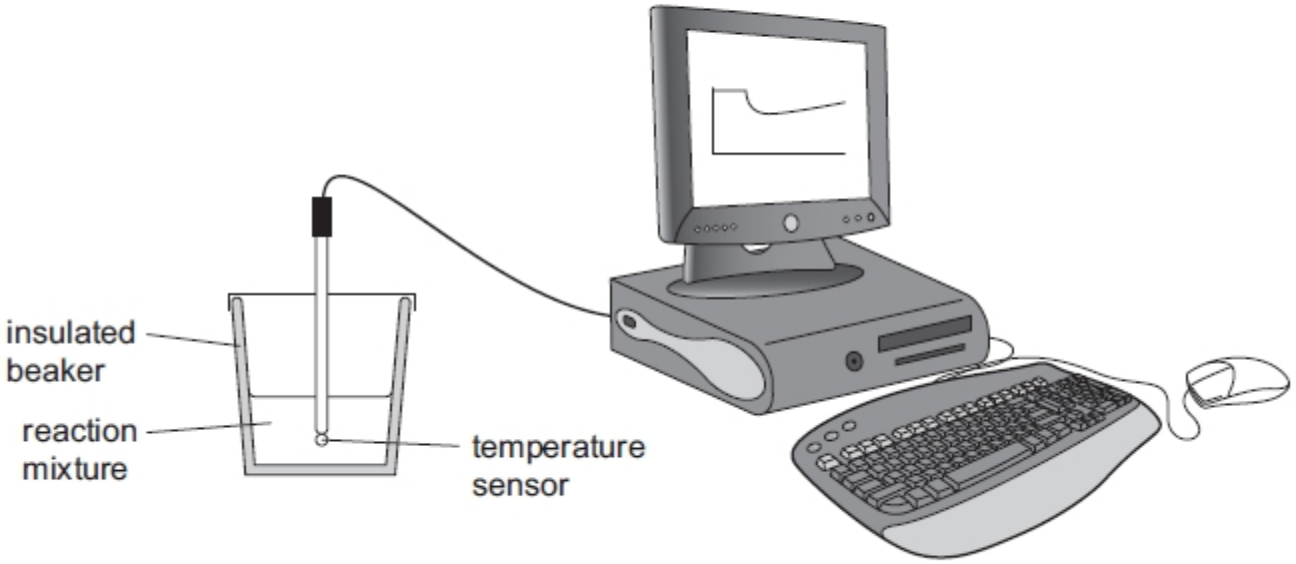


Fig. 10.2

Temperature measurements were displayed on the computer screen as a graph of temperature against time.

This graph is shown in Fig. 10.3.

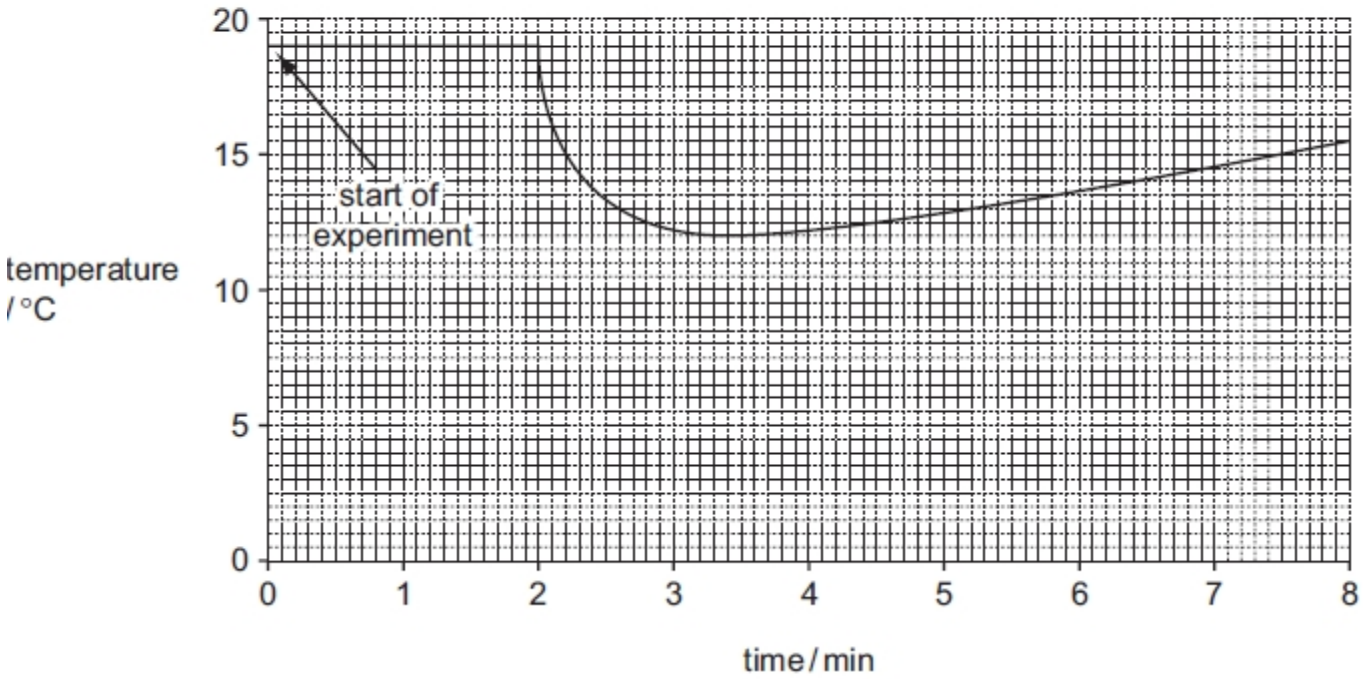


Fig. 10.3

(i) On the graph, mark with an **X** the point where sodium hydrogencarbonate was added to the dilute hydrochloric acid. [1]

(ii) Calculate the temperature change shown in Fig. 10.3 that occurred during the reaction.

.....

[2]

(iii) Use the results shown in Fig. 10.3 to explain, in terms of chemical energy and heat energy, the energy transformation that occurred during the reaction.

.....

.....

.....

..... [2]

iGda 12w31 Q6

(c) The firework mixture contained in the firework in Fig. 6.1 contains the compound potassium perchlorate, $KClO_4$.

When potassium perchlorate is heated, a colourless gas is given off which re-lights a glowing splint.

Suggest why the firework mixture needs to contain potassium perchlorate.

.....

.....

..... [2]

iGda 10s31

4 A student used the apparatus shown in Fig. 4.1 to investigate the reaction between a solution of an acid **A** and 20.0 cm^3 of a solution of the alkali, potassium hydroxide.

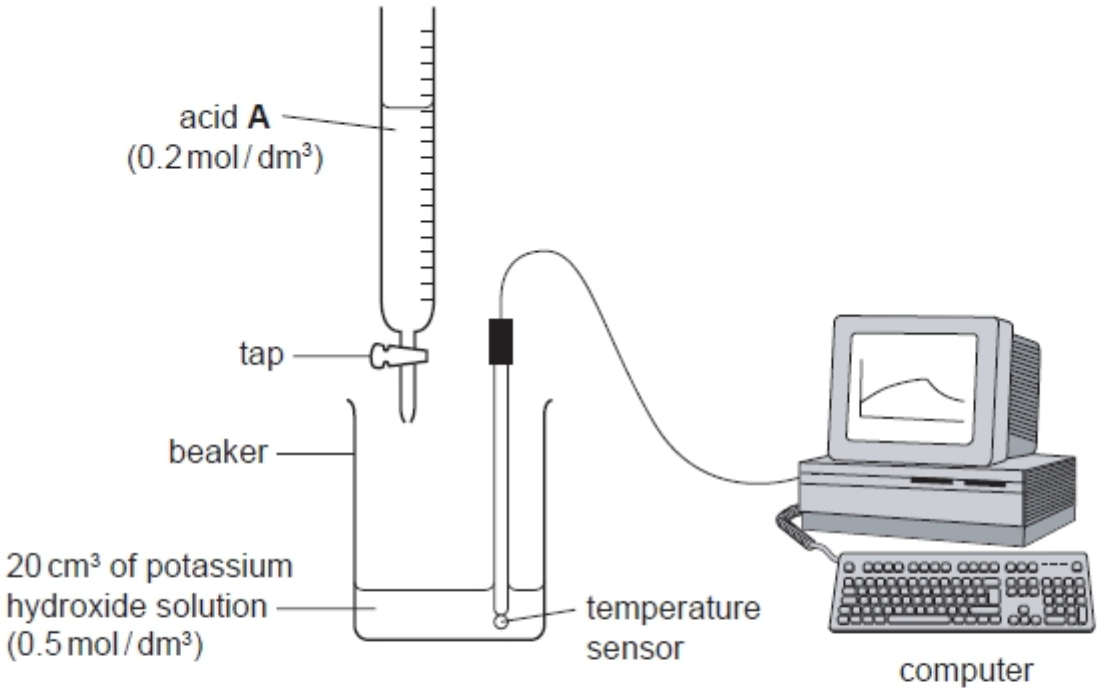


Fig. 4.1

Fig. 4.2 shows how the temperature of the mixture changed as the acid was added to the alkali in the beaker.

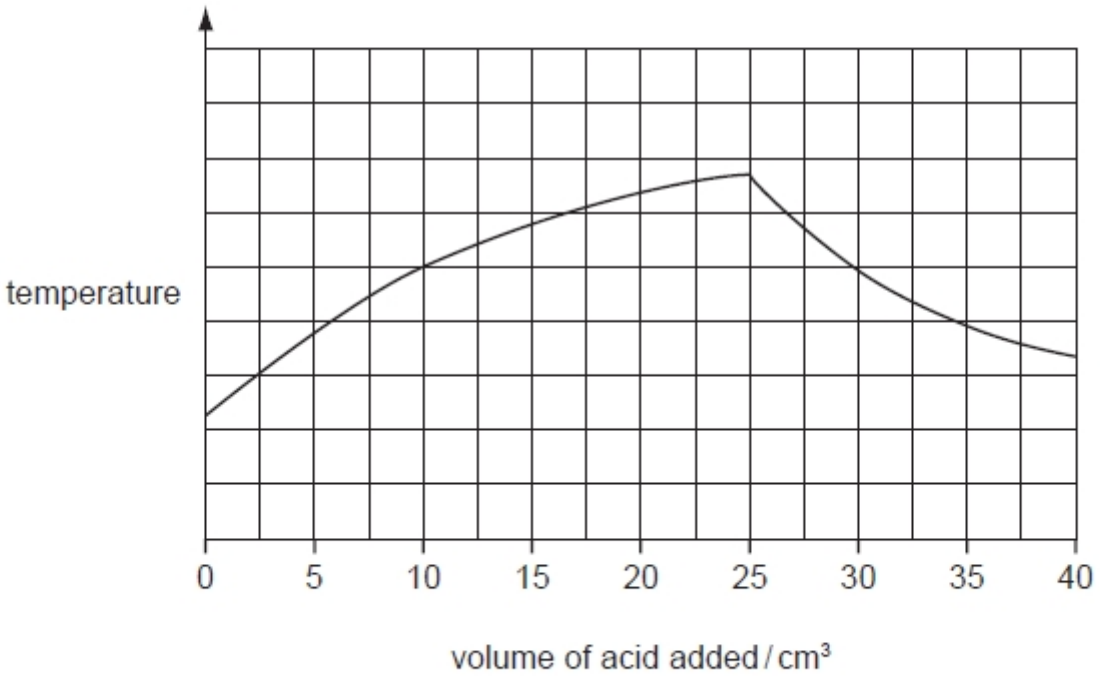


Fig. 4.2

(a) (i) State why the temperature of the mixture increased when the acid was first added to the alkali.

.....

[1]

(ii) Explain how the information in Fig. 4.2 shows that it took 25.0 cm^3 of the acid to neutralise 20.0 cm^3 of the potassium hydroxide solution.

.....

.....

.....

[2]

Topic 6 MS

iGda 15s31

2 (a) (i) exothermic ; [1]

(ii) the idea that thermal energy given out until (one of) the reactants is used up / thermal energy is only released while reaction occurs ;

the idea that when reactants used up / reaction stops, the mixture cools / starts to return to room temperature / energy leaves beaker / temperature increases until reactants used up ; [2]

(C)

(ii) decreases ;
(chemical potential) energy is transferred (out of the mixture) as thermal energy / heat ; [2]

iGda 14s31

4 (a) (i) natural gas / methane / propane / butane / biogas / refinery gas / petroleum gas ;
used for heating / cooking / lighting / vehicle fuel / burners ; [2]

(ii) exothermic ; [1]

(ii) smaller / less chemical potential energy in products / owtte ;
chemical potential energy (in reactants) is converted to heat energy ;
heat (and light) energy is lost / reaction is exothermic ; [max 2]

iGda 13w31 Q7 (c)

(ii) (reactants)
reaction is exothermic / gives out heat / gives out thermal energy ;
so chemical potential energy has transferred into surroundings ; [2]

iGda 13s31 Q10

(b) (i) **X** shown clearly on graph at 2 min ; [1]

(ii) decrease of / or negative value indicated ;
7 °C ; [2]

(iii) (reaction is) endothermic / heat energy is, removed from mixture / taken in ;
thermal / heat / kinetic energy converted to (internal) chemical energy ;
products have more chemical energy than reactant / owtte ; [max 2]

iGda 12w31 Q6

(c) (components in) firework mixture must burn / require oxygen to burn / need to be oxidised ;
potassium perchlorate produces oxygen (when heated) ;
idea that oxygen needs to be produced in situ / air cannot easily get into firework mixture ; [max 2]

iGda 10s31

4 (a) (i) reaction is exothermic / heat was given off ; [1]

(ii) temperature falls (after 25 cm^3 of acid added) ;
so no further (exothermic) reaction / all alkali used up ; [2]

Topic 7

iGda 15s31 Q7

(b) Fig. 7.2 shows a simplified diagram of waste gases from a car engine passing over a catalyst.

Mixtures of hydrocarbons, such as diesel, are used as car fuel.

The waste gases from car engines contain many substances that cause air pollution.

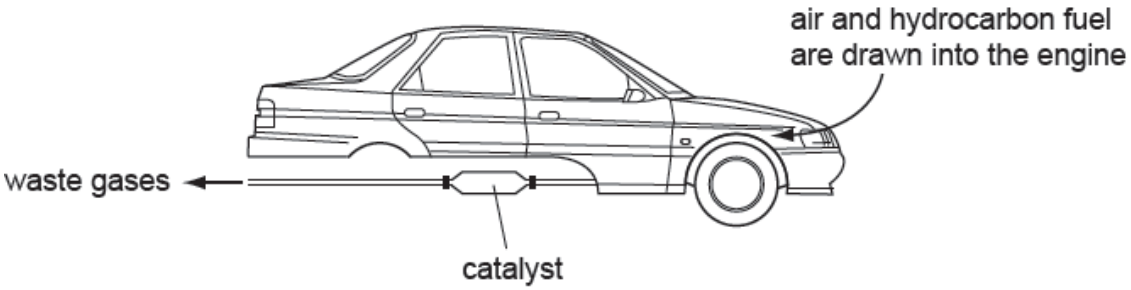


Fig. 7.2

Chemical reactions on the catalyst remove nitrous oxide, N_2O, and carbon monoxide, CO, from the waste gases.

(i) State the meaning of the term *catalyst*.

.....

.....

..... [2]

(b) Hand warmers are used by people who may be out of doors in cold weather.

Fig. 2.2 shows one type of hand warmer.

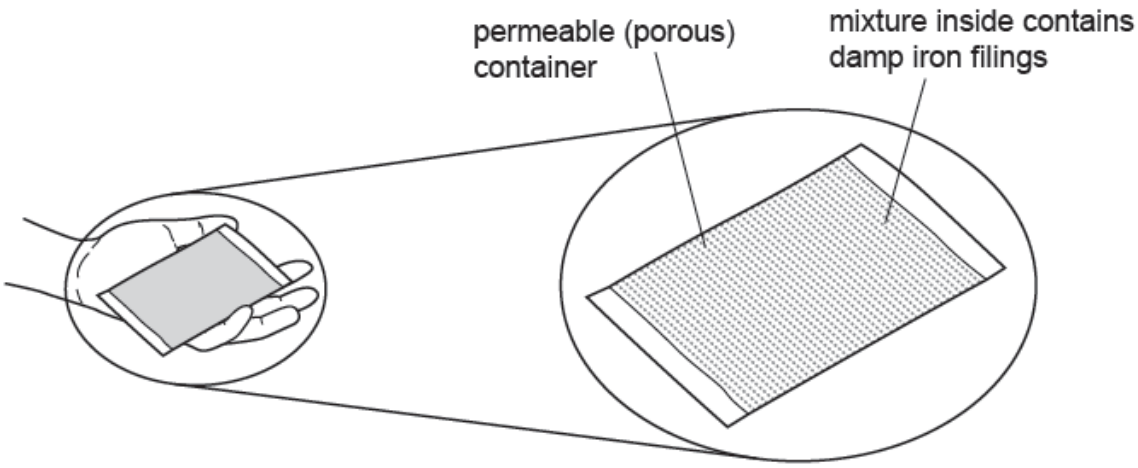


Fig. 2.2

When the hand warmer is exposed to the air, the air diffuses through the permeable (porous) container and causes a chemical reaction that releases thermal energy (heat).

During the reaction that occurs inside the hand warmer, iron is oxidised by oxygen gas to iron oxide, Fe_2O_3.

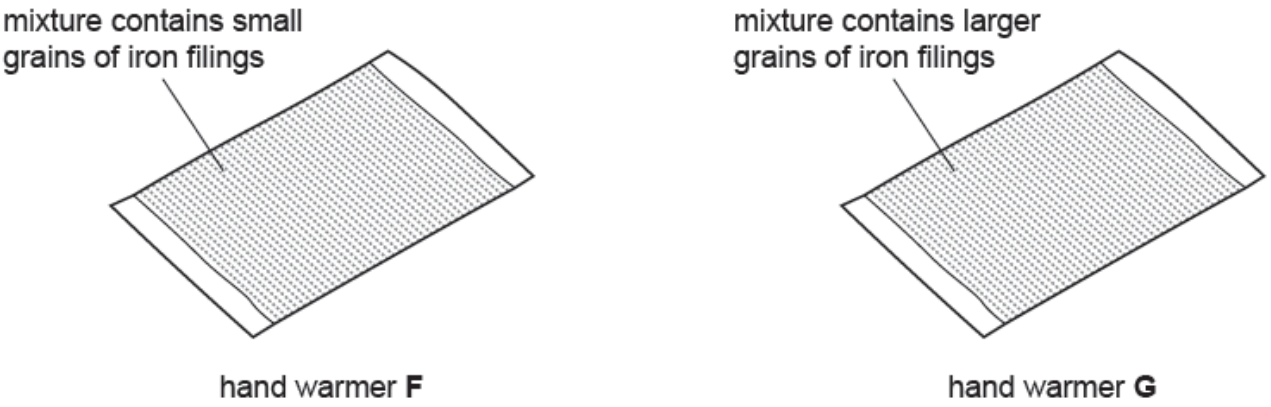
Suggest a balanced symbol equation for this oxidation reaction.

..... [2]

(c) Hand warmers like the one in Fig. 2.2 may release thermal energy for up to seven hours.

The total surface area of the iron filings used in the hand warmer affects the rate of oxidation.

A scientist compares two hand warmers, **F** and **G**.



hand warmer **F** hand warmer **G**

The only difference between these hand warmers is that the size of the grains of iron in **F** is smaller than those in **G**.

(i) Predict and explain which hand warmer, **F** or **G**, releases thermal energy for the longer time period.

hand warmer .....

explanation .....

.....

.....

..... [3]

iGda 14s31 Q4

(c) Charcoal is a solid fuel that contains mainly the element carbon.

Large pieces of charcoal burn slowly. Charcoal in the form of a fine powder burns very quickly.

(i) Explain, in terms of the collision theory of rate of reaction, why charcoal powder burns more quickly than large pieces of charcoal.

.....

.....

..... [2]

iGda 13w31 Q7

(c) A large piece of zirconium does not burn in air but zirconium powder burns rapidly, forming zirconium oxide.

(i) Suggest why zirconium powder burns rapidly but a large piece of zirconium does not.

.....

.....

..... [2]

(ii) The word equation for the combustion of zirconium is

zirconium + oxygen ⟶ zirconium oxide.

State and explain whether the reactants or the product of this reaction contains the greater amount of chemical potential energy.

.....

.....

..... [2]

iGda 12w31 Q3

(b) When a reactive metal is added to a dilute acid, the metal reacts and dissolves and hydrogen gas is given off.

(i) When magnesium reacts with dilute hydrochloric acid, magnesium **atoms** are oxidised by hydrogen **ions**.

The balanced ionic equation for this redox reaction is shown below.

$$Mg(s) + 2H^+(aq) \longrightarrow Mg^{2+}(aq) + H_2(g)$$

Explain, in terms of the transfer of electrons, why this reaction is described as redox.

.....

.....

..... [2]

iGda 12w31

6 Some types of firework are made by filling a cardboard tube with firework mixture. Firework mixture is made from several solid substances which have been powdered and mixed together.

Fig. 6.1 shows a typical firework.

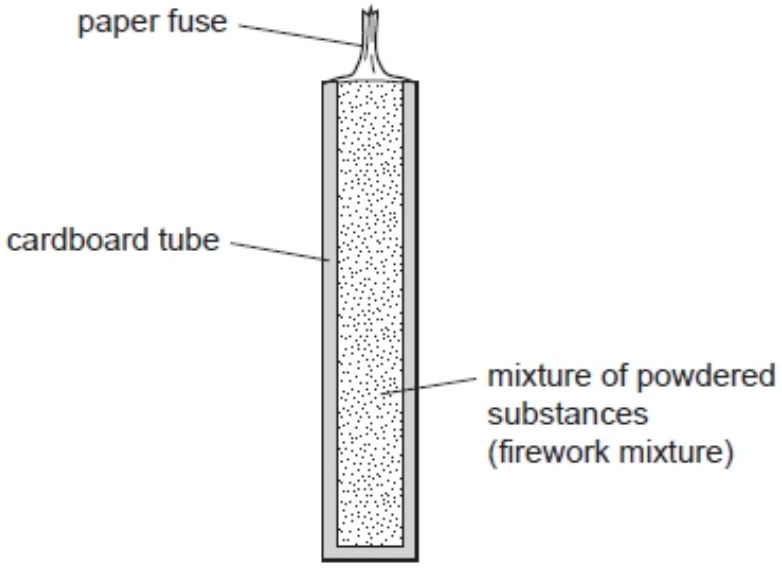


Fig. 6.1

When the paper fuse is lit, exothermic chemical reactions occur inside the firework.

(a) Explain, in terms of rate of reaction, why firework mixture is a powder.

.....

.....

..... [2]

iGda 12s31

6 Fig. 6.1 shows the apparatus a student used to investigate the effect of changing the acid concentration on the rate of reaction between dilute hydrochloric acid and magnesium. At the start of the experiment the measuring cylinder contained no gas and was full of water.

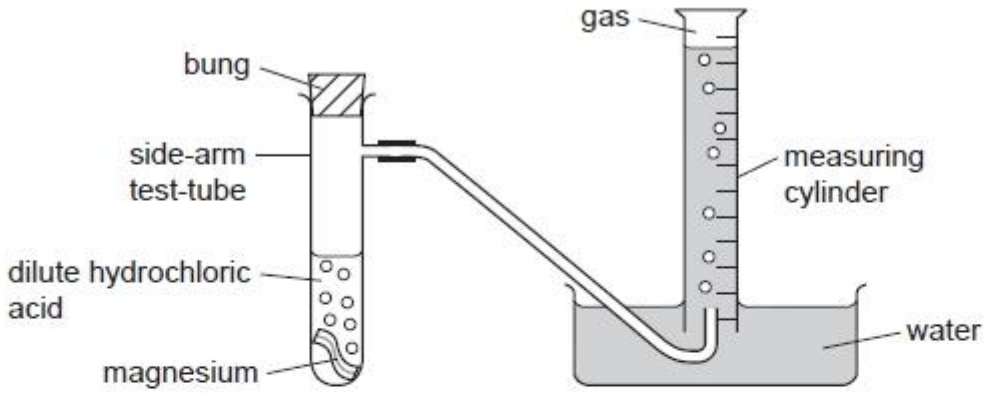


Fig. 6.1

To carry out his investigation the student used the following method.

- He dropped the magnesium into the dilute acid.
- He immediately placed the bung into the side-arm test-tube and started a stopclock.
- He measured the volume of gas in the measuring cylinder every half minute for eight minutes.

He carried out two experiments, **A** and **B**, in which the only variable that he changed was the concentration of the hydrochloric acid.

(a) State **two** other variables (factors) that the student needed to keep the same in experiments **A** and **B**.

1 .....

2 ..... [1]

(b) Fig. 6.2 shows the results the student obtained for experiments **A** and **B**.

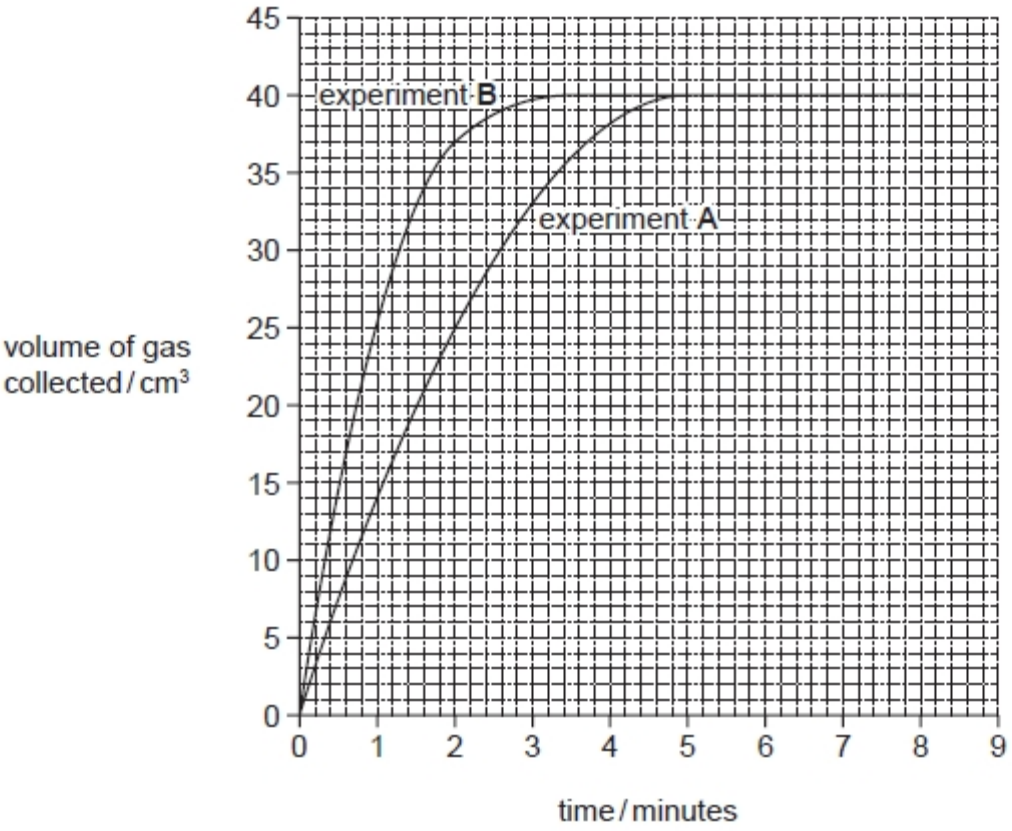


Fig. 6.2

(i) In which experiment, **A** or **B**, did the student use hydrochloric acid which had the higher concentration?

Explain your answer.

experiment .....

explanation .....

.....

..... [1]

(ii) The student was told that he could calculate the average rate of reaction using:

$$\text{average rate of reaction} = \frac{\text{maximum volume of gas collected}}{\text{minimum time taken to collect maximum volume}}$$

Use the information in Fig. 6.2 to calculate the average rate of reaction for experiment **A**.

Show your working and state the units.

..... [3]

iGda 11w31

3 The manufacture of ammonia and of sulfuric acid are two important industrial processes.

Fig. 3.1 is a simplified diagram of the type of reaction vessel which is used in both processes.

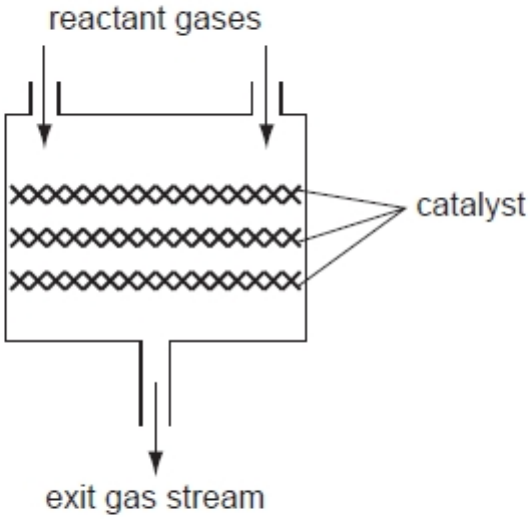


Fig. 3.1

(a) The manufacture of ammonia and of sulfuric acid both involve reversible redox reactions which require a catalyst.

(i) State the purpose of a catalyst.

.....

[1]

(ii) The reactant gases required to make ammonia are nitrogen and hydrogen.

Explain why the exit gas stream contains all three of these gases.

.....

.....

.....

[2]

(iii) The equation below shows one of the reactions involved in the manufacture of sulfuric acid. The equation is not balanced.

Balance the equation.

$$SO_2 + O_2 \rightleftharpoons SO_3$$

[1]

(iv) **Name** the substance which is oxidised in the reaction in **(iii)**.

.....

[1]

iGda 11s31 Q2

(c) Nitrogen and hydrogen react together to form ammonia.

The balanced equation for this reaction is

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

This reaction requires high temperature and pressure, and an iron catalyst which is present in the form of a large number of small pieces.

(i) Suggest the meaning of the symbol $\rightleftharpoons$ in the equation.

.....

..... [1]

(ii) Describe the advantage of using a catalyst broken into a large number of small pieces in this reaction.

.....

.....

.....

.....

..... [3]

(iii) The reaction described above involves breaking the bond between the atoms in nitrogen molecules.

Suggest why high temperature and pressure are needed for this reaction to take place.

.....

.....

.....

..... [3]

iGda 10w31

1 Fig. 1.1 shows the apparatus a student used to study the rate of reaction between 1.0 g of powdered metal and dilute hydrochloric acid.

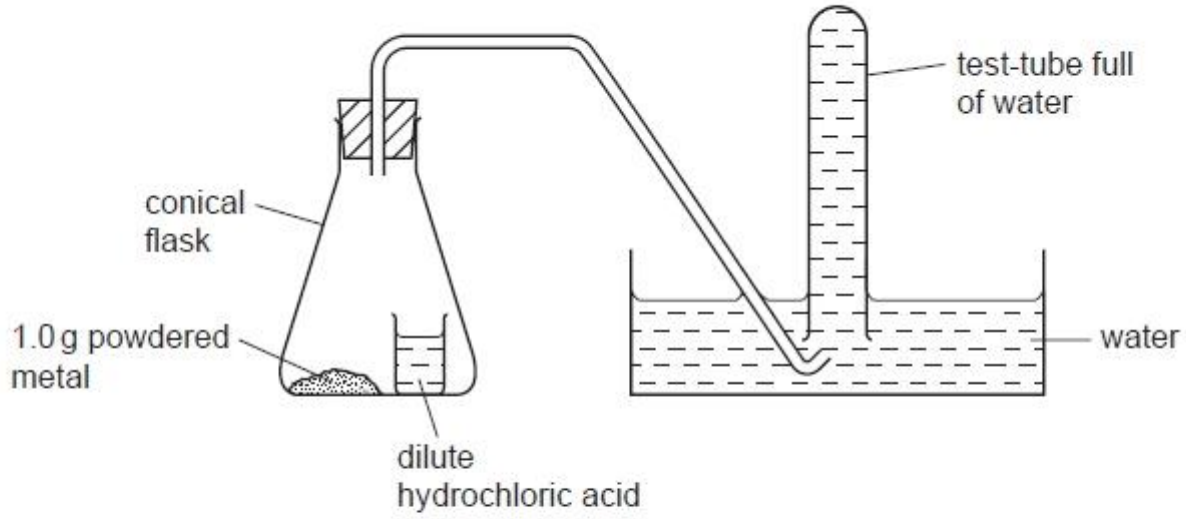


Fig. 1.1

When the student tilted the conical flask, the acid mixed with the powdered metal. If a reaction occurred, any gas which was produced collected in the test-tube, pushing the water out. The student measured the time taken for the test-tube to fill with gas.

(b) The student used the apparatus and method described above to compare the rates of reaction between dilute hydrochloric acid and three powdered metals, **X**, **Y** and **Z**.

The results the student obtained are shown in Table 1.1.

Table 1.1

metal	mass of metal / g	time for gas to fill the test-tube / seconds
X	1.0	154
Y	1.0	28
Z	1.0	76

(i) The student was careful to ensure that the only variable (factor) which differed between the experiments was the type of metal.

State **two** variables, other than the mass and surface area of the metals, which the student must keep the same in each experiment.

1 .....

2 ..... [2]

(ii) Explain how the results show that the rate of reaction was the lowest when metal **X** was used.

.....

..... [1]

(iii) The student repeated the experiment with metal **Y** but this time he used a single piece of metal which had a mass of 1.0 g.

State how the rate of reaction would differ from the experiment in which 1.0 g of powdered metal was used.

Explain your answer in terms of the collisions between atoms in the surface of the metal and ions in the solution.

.....

.....

.....

.....

..... [3]

iGda 09w31

6 The Earth's crust contains very large amounts of the elements silicon and aluminium.

These elements are found combined in compounds such as silicon dioxide and aluminium oxide.

(a) Pure silicon is used in the manufacture of many types of electronic devices.

Silicon can be obtained by heating a mixture of silicon dioxide and carbon.

A symbolic equation for this reaction is shown below.

$$SiO_2 + C \rightarrow Si + CO_2$$

State the type of chemical reaction shown above.

Explain your answer briefly.

.....

.....

..... [2]

iGda 09s31 Q9

(b) A student used the apparatus shown in Fig. 9.1 to investigate the rate of reaction between sulfuric acid and magnesium.

To start the reaction, she tilted the flask to mix the reactants.

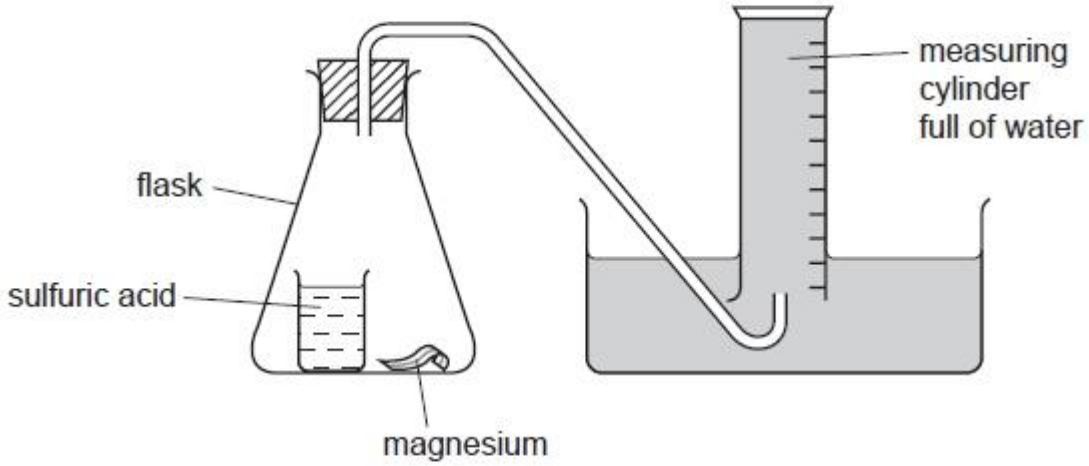


Fig. 9.1

She measured the volume of gas which had collected in the measuring cylinder every minute for several minutes.

Her results are shown in Fig. 9.2.

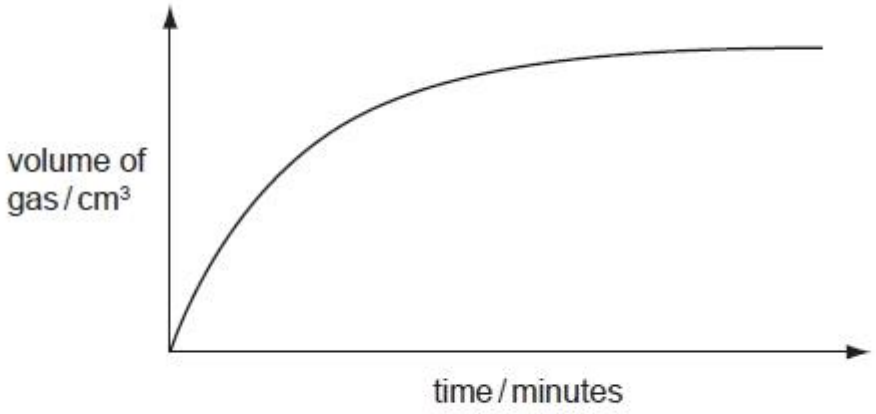


Fig. 9.2

Explain these results in terms of the collisions between particles in the reacting mixture.

.....

.....

.....

.....

..... [3]

iGda 15s31 Q7

(b) (i) ref. to increasing the speed of a reaction ;
remaining unchanged itself ; [2]

iGda 15s31 Q2

(b) $4Fe + 3O_2 \rightarrow 2Fe_2O_3$
all formulae ;
and then look for balanced ; [2]

(c) (i) (**G**) no mark
G / larger grains have smaller surface area ;
smaller surface area causes lower speed of reaction / longer reaction time / time to use up reactants ;
lower speed of reaction causes longer reaction time / time to use up reactants ;
extra detail, e.g. correct collision theory ideas ; [max 3]

iGda 14s31 Q4

(c) (i) powder has a greater surface area (mass for mass) ;
so greater chance of collision between (carbon and oxygen / air) particles ;
reference to higher collision frequency between (carbon and oxygen / air) particles ; [max 2]

iGda 13w31 Q7

(c) (i) powder has higher surface area ;
which increase reaction rate / allows efficient contact between oxygen and metal / increases particle collision frequency / owtte ; [2]

(ii) (reactants)
reaction is exothermic / gives out heat / gives out thermal energy ;
so chemical potential energy has transferred into surroundings ; [2]

iGda 12w31 Q3

(b) (i) correct transfer of electrons e.g. magnesium loses electrons / hydrogen gains electrons ;
correct linking of gain of electrons to reduction and loss of electrons to oxidation ; [2]

iGda 12w31

6 (a) high rate / fast reaction needed ;
powder has high surface area ;
high surface area (of solids) increases rate / collision frequency ; [max 2]

iGda 12s31

6 (a) temperature and surface area of magnesium ; [1]

(b) (i) (**B**)
higher concentration shown by higher rate / higher rate shown by steeper graph ; [1]

(ii) (maximum volume of gas is) 40 cm^3 **AND** (time of reaction is) 4.9 ± 0.1 minutes ;
average rate = 40 ÷ 4.9 = 8.2 / 8.0 to 8.3 ;
units: [cm^3 / minute] / [cm^3 / second] if consistent with calculation ; [3]

iGda 11w31

3 (a) (i) speeds up reactions/provides lower activation energy route ; [1]

(ii) reaction (to make gases) is reversible ;
so reactants can never be fully used up/some product changes back to reactants/some gases pass through without reacting ; [2]

(iii) $2\,SO_2 + O_2 \rightleftharpoons 2\,SO_3$; (or correct multiple) [1]

(iv) sulfur dioxide ; [1]

iGda 11s31 Q2

(c) (i) reaction is reversible ; (**not** 'the equation is reversible' or 'it is reversible') [1]

(ii) increases reaction rate ;
increases surface area (of catalyst) ;
greater collision frequency/less catalyst required/improves catalyst efficiency/avp ; [3]

(iii) nitrogen is, unreactive/stable/inert ;
nitrogen, is strongly bonded/has triple bond ;
much energy needed to break molecule/start reaction ;

link high temperature to kinetic energy of molecules ;
link, pressure/high temperature, to high collision frequency ; [max 3]

iGda 10w31 Q1

(b) (i) acid concentration ;
temperature ;
degree of agitation ; *allow* size of test-tube [max 2]

(ii) time taken for gas to fill test-tube was greatest ; [1]

(iii) rate is lower (with single piece) ;
surface area (of single piece) is lower ;
fewer collisions per second/lower collision frequency (between acid and (atoms in) metal (surface)) ; [3]

iGda 09w31

6 (a) reduction / oxidation / redox ;
Si / SiO_2 has lost oxygen and is reduced / carbon has gained oxygen and is oxidised ; [2]

iGda 09s31 Q9

(b) 1 reaction is fast at first/reaction is slowing down/reaction eventually stops ;
2 acid (concentration) is decreasing/reactants are being used up/magnesium surface area is decreasing ;
3 reactions occur when particles collide/ref. to successful collisions ;
4 frequency of collisions between particles is decreasing ; [3 max]

Topic 8

iGda 14s31 Q12

(b) Oxides are compounds of oxygen with other elements.

A student made four mixtures, **W**, **X**, **Y** and **Z**, by shaking four oxides in water. He measured the pH values of the mixtures, and his results are shown in Table 12.1.

Table 12.1

mixture	pH
W	3
X	2
Y	12
Z	7

(i) State and explain which mixture was the most acidic.

mixture .....

explanation .....

..... [1]

(ii) State and explain in which mixture the oxide had **not** changed the pH of the water.

mixture .....

explanation .....

..... [1]

(iii) State and explain which mixture had been made using the oxide of a metallic element.

mixture .....

explanation .....

..... [1]

iGda 13s31

10 (a) Fig. 10.1 shows apparatus a student used to investigate the reaction between a white powder and dilute hydrochloric acid.

The student predicted which gas would be given off in her experiment and chose to test the gas using limewater.

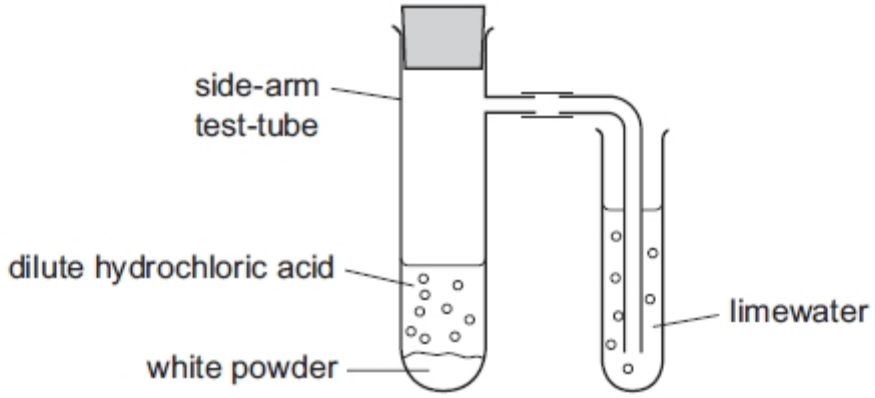


Fig. 10.1

State the gas that the student predicted would be given off.

Explain your answer.

name of gas .....

explanation .....

.....

..... [2]

(c) The student's teacher then set up the apparatus shown in Fig. 10.4 in a fume cupboard.

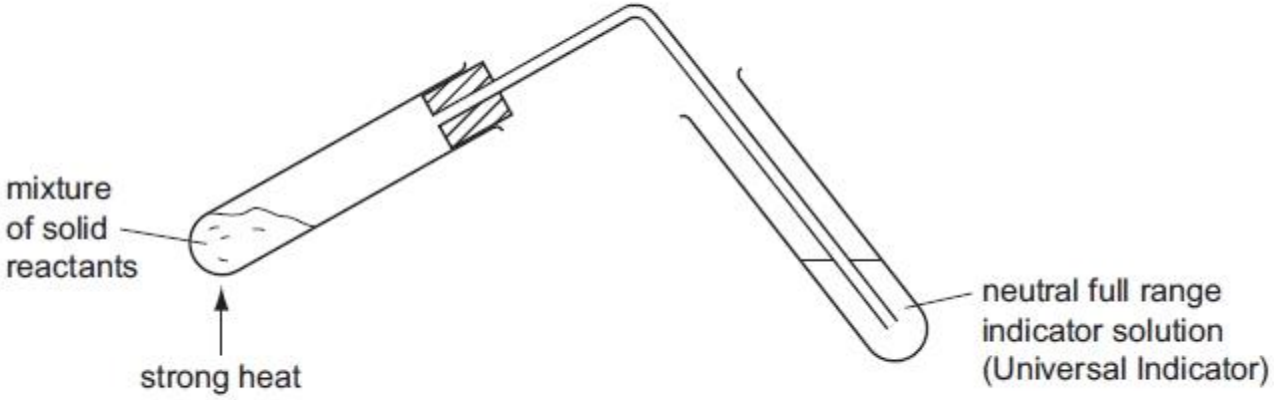


Fig. 10.4

The teacher heated the mixture of reactants. A gas was given off which did **not** change the colour of the indicator.

The teacher told the student

- that the gas was an oxide of carbon,
- that the relative formula mass of the gas molecules was 28.

(i) State and explain why the observation involving the indicator shows that the gas produced was **not** carbon dioxide.

.....

.....

..... [2]

iGda 12w31

3 (a) Fig. 3.1 shows how a digital pH meter is used to measure the pH of some liquids.

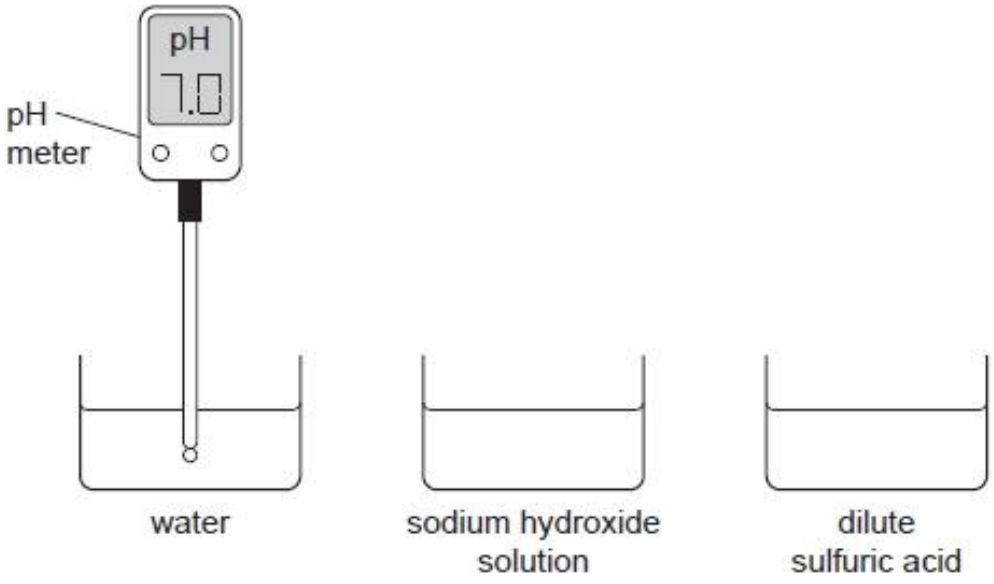


Fig. 3.1

(i) Complete Table 3.1 by suggesting suitable pH values for the different liquids.

Table 3.1

liquid	pH
water	7.0
sodium hydroxide solution	
dilute sulfuric acid	

[1]

(ii) Suggest **one** advantage of using a digital pH meter rather than a piece of litmus paper to assess the acidity of an aqueous solution.

.....

..... [1]

(iii) Dilute acids are aqueous solutions that contain dissolved ions.

Table 3.2 shows the names of the ions in two common acids.

Table 3.2

name of dilute acid	names of dissolved ions
hydrochloric acid	hydrogen ions and chloride ions
sulfuric acid	hydrogen ions and sulfate ions

A student is given an unlabelled beaker which is known to contain either dilute hydrochloric acid or dilute sulfuric acid.

Describe a chemical test that a student could use to find out which acid the beaker contains.

.....

.....

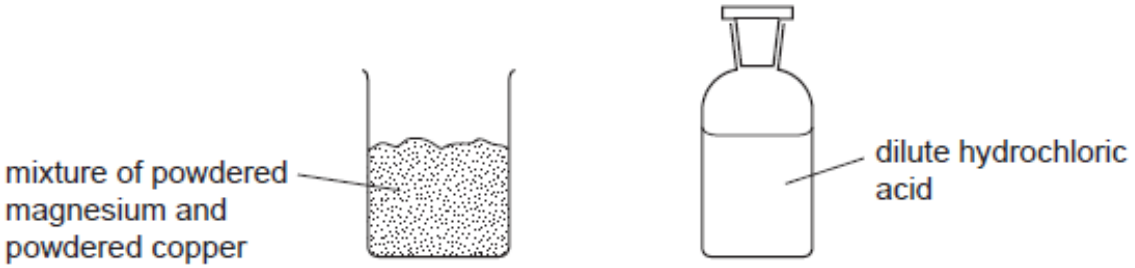
..... [2]

(b)

(ii) Unreactive metals do **not** react in dilute acid.

A student is given a mixture of powdered magnesium and powdered copper.

Describe and explain how the student could use dilute hydrochloric acid and usual laboratory apparatus to obtain a sample of copper from this mixture.



.....

.....

.....

.....

.....

..... [3]

iGda 11s31 Q8

(d) When excess dilute hydrochloric acid, HC*l*, is added to a mixture of calcium oxide and magnesium oxide, a highly exothermic neutralisation reaction occurs.

(i) Name **two** salts which are present in the mixture after the reaction.

1 .....

2 ..... [1]

(ii) Suggest the balanced symbolic equation for the reaction between magnesium oxide and dilute hydrochloric acid.

..... [3]

iGda 10w31

1 Fig. 1.1 shows the apparatus a student used to study the rate of reaction between 1.0 g of powdered metal and dilute hydrochloric acid.

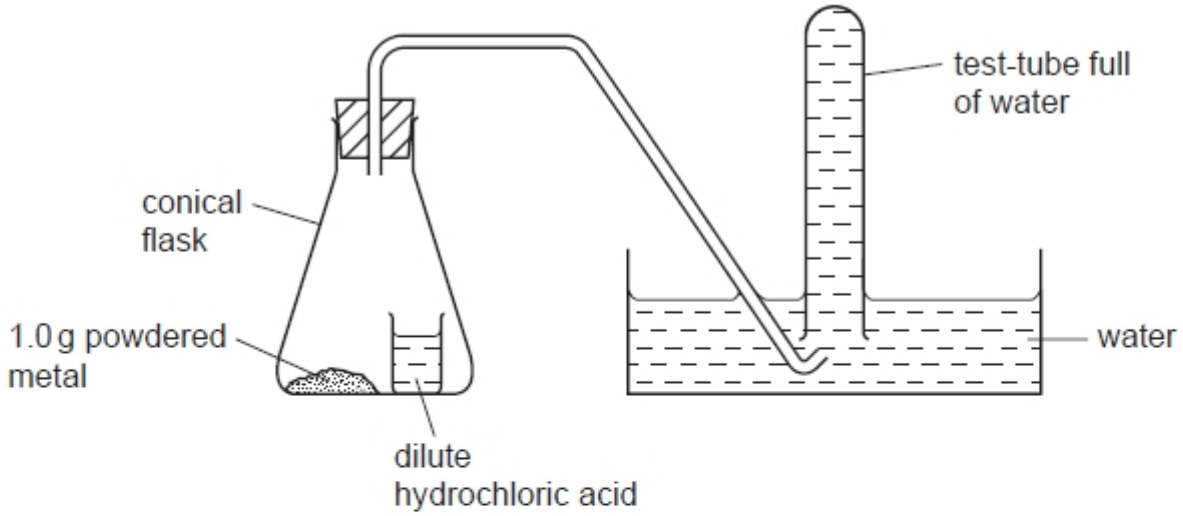


Fig. 1.1

When the student tilted the conical flask, the acid mixed with the powdered metal. If a reaction occurred, any gas which was produced collected in the test-tube, pushing the water out. The student measured the time taken for the test-tube to fill with gas.

(a) (i) Name the gas produced when metals react with dilute hydrochloric acid.

..... [1]

(ii) State the formula of the *ion* which is present in relatively high concentrations in all acids.

..... [1]

(c) When magnesium reacts with dilute hydrochloric acid, HC*l*, one of the products is magnesium chloride, $MgCl_2$.

(i) Construct a balanced symbolic equation for this reaction.

..... [2]

iGda 10s31 Q4 (b)

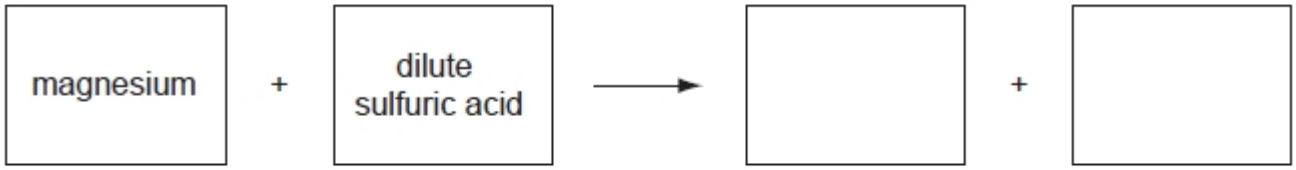
(iii) Write the **ionic** chemical equation which represents what happens when an aqueous acid reacts with aqueous alkali.

..... [2]

iGda 09s31

9 Many metals react with dilute acids.

(a) Complete the word equation for the reaction of magnesium with dilute sulfuric acid.



[1]

iGda 08w31

3 A student investigates the reaction between magnesium and dilute acid **Y**.
Fig. 3.1 shows the metal being added to the acid contained in a test-tube, and also the same tube some time later.

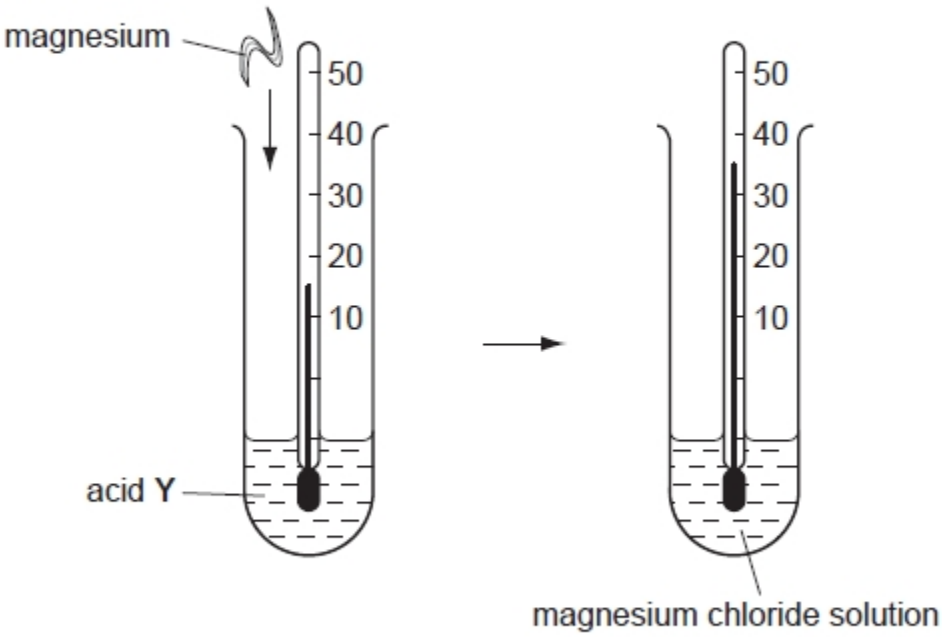


Fig. 3.1

(a) (i) Name acid **Y**.

.....

[1]

(ii) Describe and explain **one** observation which the student would have made during the reaction.

.....

.....

[2]

(iii) The student noticed that, within a short time, the piece of magnesium completely reacted.

Predict and explain what would be observed if another small piece of magnesium were added to the solution in the tube shown on the right of Fig. 3.1.

.....

.....

.....

[2]

(b) Ammonium sulphate is a fertiliser which is produced in a reaction between sulphuric acid and ammonia solution. The balanced equation for this reaction is shown below.

$$2\,NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

In an attempt to produce a solution containing only ammonium sulphate, a student used the following method.

1 50.0 cm^3 of a solution containing 2.0 mol / dm^3 of ammonia were placed into a glass beaker.

2 50.0 cm^3 of a solution containing 2.0 mol / dm^3 of sulphuric acid were added to the ammonia solution.

The amount of acid the student used is 0.1moles

(ii) Explain whether or not the student had calculated the correct amount of sulphuric acid to use.

Show your working.

..... [3]

Topic 8 MS

iGda 14s31 Q12

(b) (i) (**X**/2)
reference to lowest pH ; [1]

(ii) (**Z**/7)
pH is 7/water is pH 7/has a neutral pH ; [1]

(iii) (**Y**/12)
metal oxides are alkaline/have pH greater than 7 ; [1]

iGda 13s31

10 (a) carbon dioxide/CO_2 ;
limewater turns cloudy etc.(with carbon dioxide)/limewater reacts with carbon dioxide/limewater is the test reagent for CO_2 ; [2]

(c) (i) carbon dioxide would react with the water ;
producing an acidic solution/lowering pH/CO_2 is an acidic gas ;
which would change the indicator colour/turn indicator orange/red ; [max 2]

iGda 12w31

3 (a) (i) >7 to 14 ;
<7 to 0 ; [1]

(ii) meter is more accurate / precise / reference to quantitative ; [1]

(iii) add (acidified) silver nitrate / ethanoate (solution) ;
white precipitate / solid indicates hydrochloric acid / chloride (ions) ;
OR
add (acidified) barium chloride / ethanoate / nitrate (solution) ;
white precipitate / solid indicates sulfuric acid / sulfate (ions) ; [max 2]

(b)

(ii) add acid to the mixed metals ;
reference to adding excess acid e.g. until bubbling stops ;
magnesium (reacts) / dissolves ;
copper (does not react) / does not dissolve ;
filter off the copper ; [max 3]

iGda 11s31 Q8

(d) (i) calcium chloride **and** magnesium chloride ; [1]

(ii) $MgO + 2HCl \longrightarrow MgCl_2 + H_2O$;;;
(one mark for each correct *product* formula and one mark for balancing) [3]

iGda 10w31

1 (a) (i) hydrogen ; [1]

(ii) H^+ ; *allow* H_3O^+ [1]

(c) (i) $Mg + 2HCl \rightarrow MgCl_2 + H_2$;; (formulae then look for balanced) [2]

iGda 10s31 Q4 (b)

(iii) $H^+ + OH^- \rightarrow H_2O$ (all correct for 2 marks, two of the three for 1 mark) ;; [2]

iGda 09s31

9 (a) magnesium sulfate + hydrogen ; [1]

iGda 08w31

3 (a) (i) hydrochloric ; [1]

(ii) bubbles of gas / effervescence ;
hydrogen is a product ;

temperature increases / tube feels warm ;
reaction is exothermic / heat evolved ;

metal dissolves ;
metal reacts to form a soluble product ;

metal rises to surface ;
supported by bubbles of gas / made buoyant by gas ; [max 2]

(iii) it would react (like the first piece) / specific observation ;
because acid, remains / was in excess ; [2]

iGda 08s31 Q2 (b)

(ii) number of moles of acid used also = 0.1 ;
use of equation to show that acid will be in excess ;
so solution of ammonium sulphate will not be pure/owtte ; [3]

Topic 9

iGda 15s31

4 Table 4.1 shows information about five materials, **H** to **L**.

Table 4.1

	name	chemical formula
H	argon	Ar
I	aspirin (pain killer)	$C_9H_8O_4$
J	hydrogen	H_2
K	oxygen	O_2
L	sea water	–

(a) (i) State and explain which of the materials, **H** to **L**, are elements.

.....

.....

..... [2]

(ii) Explain why a chemical formula can be written for water but **cannot** be written for sea water.

.....

..... [1]

(b) Fig. 4.1 shows an incomplete diagram of the electron arrangement in an atom of argon, proton number 18.

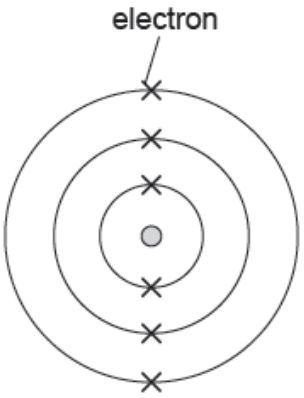


Fig. 4.1

(i) Complete Fig. 4.1 by adding the missing electrons. [2]

(ii) Most of the argon atoms in the Earth's atmosphere have a nucleon number of 40 (Ar-40).

Most of the argon atoms in space have a nucleon number of 36 (Ar-36).

Explain why both types of atoms are argon but can have different nucleon numbers.

.....

.....

..... [2]

iGda 14s31

12 **(a)** The elements are often described as being either metals or non-metals.

(i) Describe **two** differences in the **physical** properties of a typical metal and a typical non-metal.

1 .....

.....

2 .....

..... [2]

(ii) The element radium has a proton number of 88.

Predict and explain briefly whether radium is a metallic or non-metallic element.

You may wish to refer to the Periodic Table on page 32.

.....

..... [1]

4 Fig. 4.1 shows the nucleus and **outer** electron shell of an atom of an element from the **third** period of the Periodic Table .

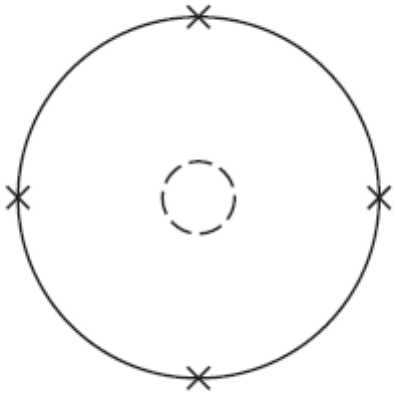


Fig. 4.1

(a) Deduce the name of the element and explain your answer briefly.

name of element .....

explanation .....

..... [2]

(b) Fig. 4.2 shows the melting points of four metallic elements from the same group of the Periodic Table.

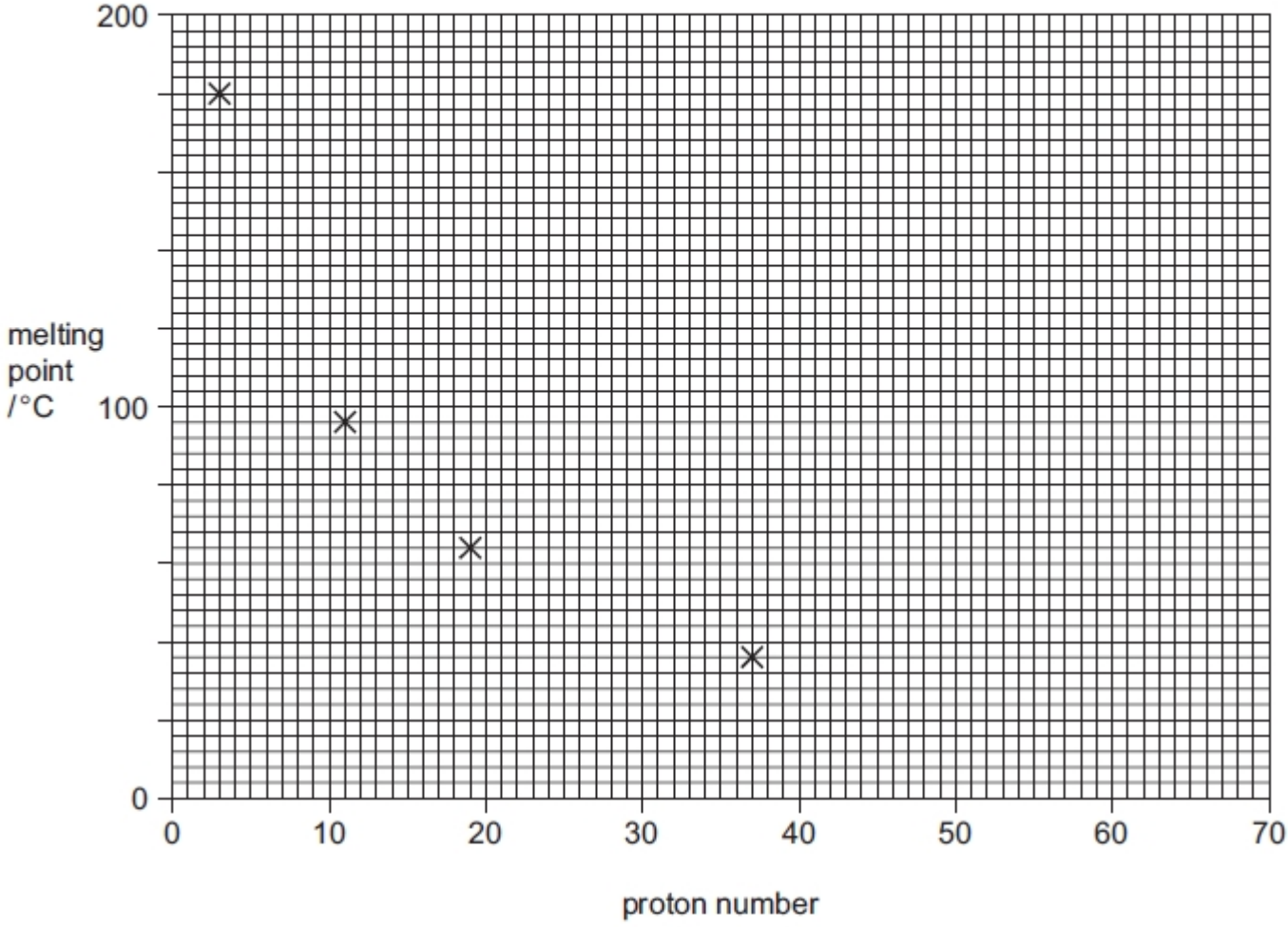


Fig. 4.2

(i) State the number of the group that contains the elements whose melting points are shown in Fig. 4.2.

Explain your answer briefly.

group number .....

explanation .....

..... [1]

(ii) Estimate the melting point of the next element in the same group of the Periodic Table.

Use the symbol **X** to mark your estimate on the grid in Fig. 4.2. [2]

iGda 12s31

8 An element is a substance that is made of atoms which have the same proton number. Most atoms contain protons, neutrons and electrons.

(a) The electronic structures (configurations) of atoms of three elements, **P**, **Q** and **R** are shown below. **P**, **Q** and **R** are **not** the chemical symbols of these elements.

P 2,8,1 **Q** 2,8 **R** 2,7

(i) Use the electronic structures to state and explain the group numbers in the Periodic Table that contain elements **P**, **Q** and **R**.

P Group .....

Q Group .....

R Group .....

explanation .....

..... [2]

(ii) State and explain which of the elements, **P**, **Q** or **R**, is the least reactive.

element .....

explanation .....

..... [1]

(iii) State and explain which **one** of the elements, **P**, **Q** or **R**, is a good conductor of electricity.

element .....

explanation .....

..... [1]

iGda 10w31

7 Copper metal reacts with oxygen gas to form copper oxide.

(a) Table 7.1 shows information about two different types of copper oxide.

Table 7.1

name	colour	chemical formula
copper(II) oxide	black	CuO
copper(I) oxide	red	Cu_2O

(i) Copper is a transition metal.

State **one** property, shown in Table 7.1, which is typical of transition metals.

.....

[1]

iGda 10w31

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State **one** property, shown in Table 7.1, which is typical of transition metals.

.....

[1]

iGda 10s31

9 (a) The grid in Fig. 9.1 shows the arrangement of the first twenty elements in the Periodic Table.

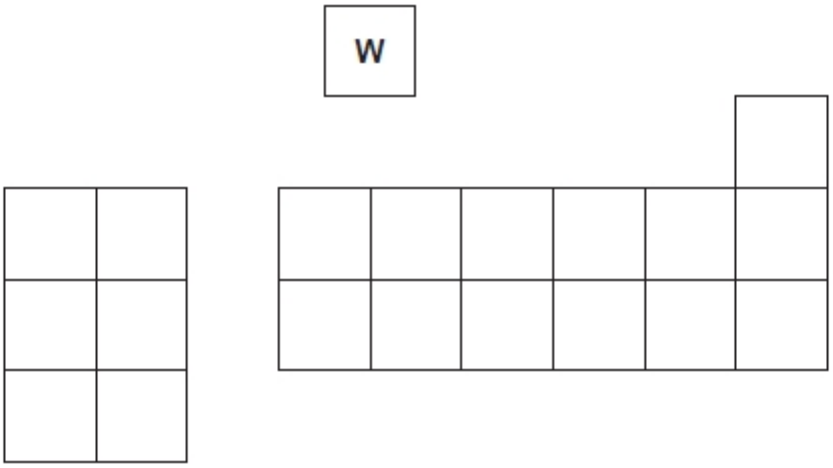


Fig. 9.1

For each of the elements described below, write the letter for each element in the correct box in Fig. 9.1. The first one has been done as an example.

Element **W** is made of the lightest atoms.

Element **X** is in Period 3 and atoms of **X** have 2 outer electrons.

Element **Y** is the most reactive in Group 7 (Group VII).

Element **Z** is made of atoms which have 10 protons in their nuclei.

[3]

(c) Welding is a process used to join pieces of metal together. Fig. 9.2 shows a simplified diagram of a method known as metal inert gas (MIG) welding. The metal wire and the pieces of metal to be joined are heated electrically, and melt together. When the molten metal cools, the pieces are permanently joined.

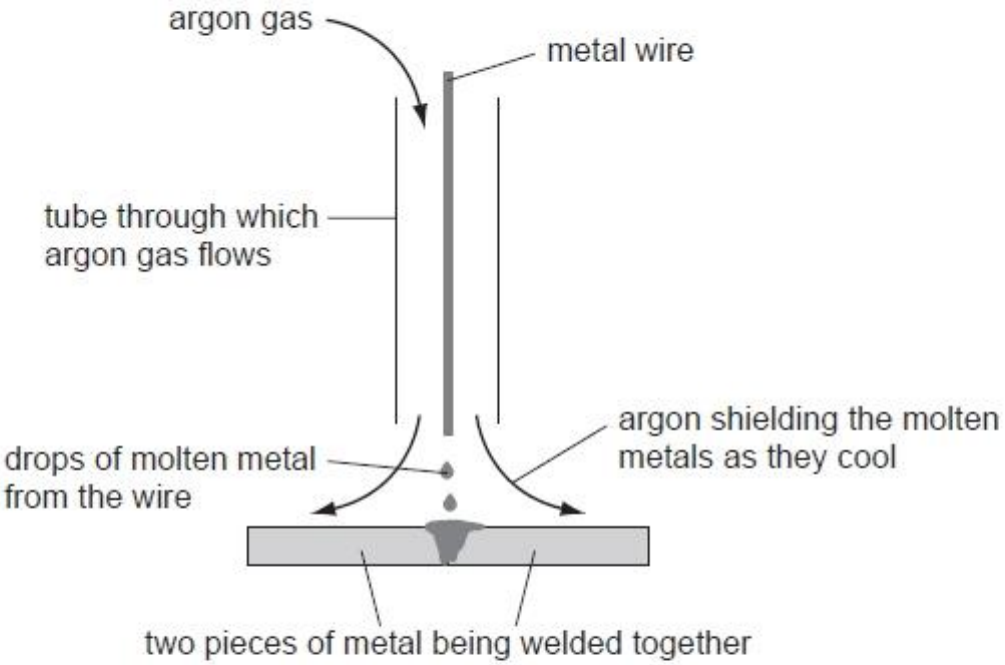


Fig. 9.2

(i) Argon is often used in MIG welding as shown in Fig. 9.2.

Suggest a chemical reaction which is being prevented by the presence of argon.

.....

.....

..... [2]

(ii) Draw a diagram of one atom of argon showing how all of its electrons are arranged.

[2]

(iii) Explain, in terms of their electron arrangement, why argon atoms do not react with the hot metals in MIG welding.

.....

.....

..... [2]

iGda 09s31 Q6

(c) When chlorine gas is bubbled through a colourless solution of potassium bromide, KBr, the solution turns orange because the element bromine is produced.

(i) Write a balanced equation for the reaction between chlorine and potassium bromide.

..... [2]

iGda 08s31 Q6

(d) A solution of bromine is used to discover whether a compound is a saturated or unsaturated hydrocarbon.

Explain the meanings of the words *saturated* and *unsaturated* hydrocarbon.

.....

.....

.....

..... [2]

iGda 08s31 Q6

(c) The element bromine is extracted from concentrated solutions of bromine compounds.

The reaction between chlorine and sodium bromide solution produces bromine.

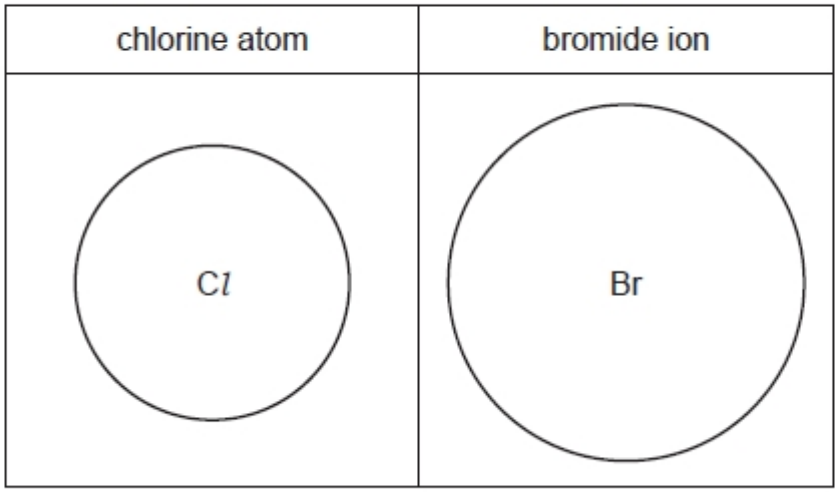
chlorine + sodium bromide → sodium chloride + bromine

(i) Explain why chlorine but **not** iodine reacts with sodium bromide.

.....

..... [1]

(ii) In the boxes below, draw diagrams of a chlorine atom and a bromide ion, showing only the electrons in the outer shells.



[2]

(iii) Describe how the numbers of outer electrons of the particles you have drawn in **(ii)** change during the reaction of chlorine with sodium bromide.

.....

.....

..... [2]

Topic 9 MS

iGda 15s31

4 (a) (i) **H J** and **K**/argon hydrogen oxygen ;
only one type of atom/in Periodic Table/cannot be simplified ; [2]

(ii) it is a mixture/owtte ; [1]

(b) (i) total of 18 electrons ;
arranged 2,8,8 ; [2]

(ii) both (argon) atoms have 18/same number of protons ;
Ar – 36 has 18 neutrons (per atom) and Ar – 40 has 22 neutrons (per atom)/different numbers of neutrons (per atom) ; [2]

[Total: 9]

iGda 14s31

12 (a) (i) *metal* malleable, *non-metal* not malleable / brittle ;
metal electrical conductor, *non-metal* insulator ;
metal heat conductor, *non-metal* insulator ;
metal ductile, *non-metal* not ductile ;
metal lustrous, *non-metal* not lustrous / dull ;
metal sonorous, *non-metal* not sonorous ;
metal high density, *non-metal* low density ; [max 2]

(ii) (metallic)
is in Group II / on left of Periodic Table / forms positive ions / 2 valence elections ; [1]

iGda 13w31

4 (a) silicon ;
in Group IV (and third period) / (atoms has) four outer electrons / calculation of proton number from 2, 8, 4 electronic configuration ; [2]

(b) (i) (Group 1)
reference to at least one of the proton numbers plotted on graph ; [1]

(ii) allow anywhere in range 20–34 °C ;
at proton number 55 ; [2]

iGda 12s31

8 (a) (i) **P** Group 1 **Q** Group 0 **R** Group 7 ;
outer electrons determine group number / answer based on identifying the elements and looking up on PT ; [2]

(ii) (**Q**)
it is a noble gas / references to full shells ; [1]

(iii) (**P**)
it is a metal ; [1]

iGda 10w31

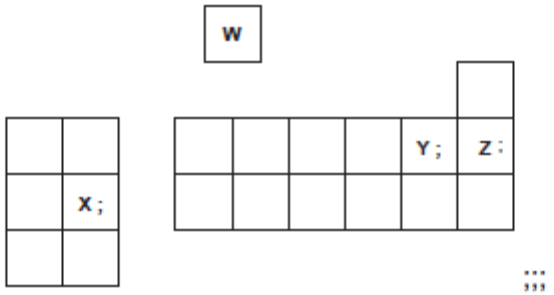
7 (a) (i) coloured compounds *or* variable, valency / ion charge / oxidation state ; [1]

iGda 10w31

7 (a) (i) coloured compounds *or* variable, valency / ion charge / oxidation state ; [1]

iGda 10s31

9 (a)



;;; [3]

(c) (i) oxidation/reaction with oxygen (from air)/formation of metal oxide ;
reference to the, hot/molten, metal ; [2]

(ii) three shells with 18 electrons ;
arranged 2,8,8 ; [2]

(iii) outer shell is complete ;
does not need to, lose/gain electrons, (by reaction)/owtte ; [2]

iGda 09s31 Q6

(c) (i) Cl_2 + 2KBr → 2KC*l* + Br_2 ;; [formulae then balanced] [2]

iGda 08s31 Q6

(d) saturated – only single bonds (between C atoms)/contains as much H as possible ;
unsaturated – contains double bond(s)/more H could be added ; [2]

iGda 08s31 Q6

(c) (i) chlorine more reactive than bromine/free halogen must be more reactive than halide in compound/iodine is less reactive than bromine ; [1]

(ii) 7 electrons on chlorine ;
8 electrons on bromide ; [2]

(iii) chlorine becomes 2,8,8/gains an electron/gains a full shell ;
bromide loses an electron/now has 7 electrons in outer shell ; [2]
(saying one electron transfers from bromide to chlorine gains both marks)