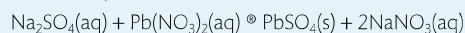


71 Sodium sulfate, Na_2SO_4 , reacts in aqueous solution with lead nitrate, $\text{Pb}(\text{NO}_3)_2$, as follows:

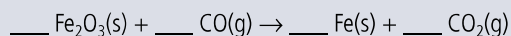


In an experiment, 35.30 cm^3 of a solution of sodium sulfate reacted exactly with 32.50 cm^3 of a solution of lead nitrate. The precipitated lead sulfate was dried and found to have a mass of 1.13 g . Determine the concentrations of the original solutions of lead nitrate and sodium sulfate. State what assumptions are made.

Practice questions

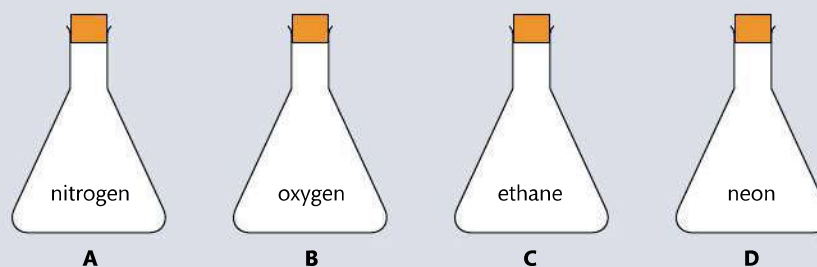
1 How many oxygen atoms are in 0.100 mol of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$?
A 5.42×10^{22} **B** 6.02×10^{22} **C** 2.41×10^{23} **D** 5.42×10^{23}

2 What is the sum of the coefficients when the following equation is balanced using whole numbers?



A 5 **B** 6 **C** 8 **D** 9

3 Four identical containers under the same conditions are filled with gases as shown below. Which container and contents will have the highest mass?



4 1.0 dm^3 of an ideal gas at 100 kPa and $25 \text{ }^\circ\text{C}$ is heated to $50 \text{ }^\circ\text{C}$ at constant pressure. What is the new volume in dm^3 ?

A 0.50 **B** 0.90 **C** 1.1 **D** 2.0

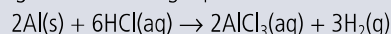
5 What is the amount, in moles, of sulfate ions in 100 cm^3 of $0.020 \text{ mol dm}^{-3} \text{ FeSO}_4(\text{aq})$?

A 2.0×10^{-3} **B** 2.0×10^{-2} **C** 2.0×10^{-1} **D** 2.0

6 1.7 g of NaNO_3 ($M_r = 85$) is dissolved in water to prepare 0.20 dm^3 of solution. What is the concentration of the resulting solution in mol dm^{-3} ?

A 0.01 **B** 0.1 **C** 0.2 **D** 1.0

7 What mass, in g , of hydrogen is formed when 3 mol of aluminium react with excess hydrochloric acid according to the following equation?

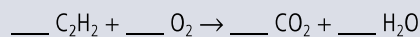


A 3.0 **B** 4.5 **C** 6.0 **D** 9.0

8 The relative molecular mass of a gas is 56 and its empirical formula is CH_2 . What is the molecular formula of the gas?

A CH_2 **B** C_2H_4 **C** C_3H_6 **D** C_4H_8

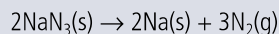
- 9 What is the sum of all coefficients when the following equation is balanced using the smallest possible whole numbers?



- A 5 B 7 C 11 D 13
- 10 What is the total number of hydrogen atoms in 1.0 mol of benzamide, $\text{C}_6\text{H}_5\text{CONH}_2$?
- A 7 B 6.0×10^{23} C 3.0×10^{24} D 4.2×10^{24}
- 11 Chloroethene, $\text{C}_2\text{H}_3\text{Cl}$, reacts with oxygen according to the equation below:
- $$2\text{C}_2\text{H}_3\text{Cl}(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g}) + 2\text{HCl}(\text{g})$$
- What is the amount, in mol, of H_2O produced when 10.0 mol of $\text{C}_2\text{H}_3\text{Cl}$ and 10.0 mol of O_2 are mixed together, and the above reaction goes to completion?
- A 4.00 B 8.00 C 10.0 D 20.0
- 12 What is the concentration of NaCl, in mol dm^{-3} , when 10.0 cm^3 of 0.200 mol dm^{-3} NaCl solution is added to 30.0 cm^3 of 0.600 mol dm^{-3} NaCl solution?
- A 0.450 B 0.300 C 0.500 D 0.800
- 13 On analysis, a compound with molar mass 60 g mol^{-1} was found to contain 12 g of carbon, 2 g of hydrogen, and 16 g of oxygen. What is the molecular formula of the compound?
- A CH_2O B CH_4O C $\text{C}_2\text{H}_4\text{O}$ D $\text{C}_2\text{H}_4\text{O}_2$
- 14 300 cm^3 of water is added to a solution of 200 cm^3 of 0.5 mol dm^{-3} sodium chloride. What is the concentration of sodium chloride in the new solution?
- A 0.05 mol dm^{-3} B 0.1 mol dm^{-3} C 0.2 mol dm^{-3} D 0.3 mol dm^{-3}
- 15 What is the approximate molar mass, in g mol^{-1} , of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$?
- A 120 B 130 C 138 D 246
- 16 Which is both an empirical and a molecular formula?
- A C_5H_{12} B C_5H_{10} C C_4H_8 D C_4H_{10}
- 17 Airbags are an important safety feature in vehicles. Sodium azide, potassium nitrate, and silicon dioxide have been used in one design of airbag.

Two students looked at data in a simulated computer-based experiment to determine the volume of nitrogen generated in an airbag.

Sodium azide, a toxic compound, undergoes the following decomposition reaction under certain conditions.



Using the simulation program, the students entered the following data into the computer.

Temperature (T) / °C	Mass of $\text{NaN}_3(\text{s})$ (m) / kg	Pressure (p) / atm
25.00	0.0650	1.08

- (a) State the number of significant figures for the temperature, mass, and pressure data. (1)
- (b) Calculate the amount, in mol, of sodium azide present. (1)
- (c) Determine the volume of nitrogen gas, in dm^3 , produced under these conditions based on this reaction. (4)

(Total 6 marks)

18 An important environmental consideration is the appropriate disposal of cleaning solvents. An environmental waste treatment company analysed a cleaning solvent, **J**, and found it to contain the elements carbon, hydrogen, and chlorine only. The chemical composition of **J** was determined using different analytical chemistry techniques.

Combustion reaction:

Combustion of 1.30 g of **J** gave 0.872 g CO₂ and 0.089 g H₂O.

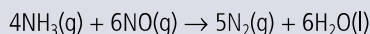
Precipitation reaction with AgNO₃(aq):

0.535 g of **J** gave 1.75 g AgCl precipitate.

- (a) Determine the percentage by mass of carbon and hydrogen in **J**, using the combustion data. (3)
 (b) Determine the percentage by mass of chlorine in **J**, using the precipitation data. (1)
 (c) The molar mass was determined to be 131.38 g mol⁻¹. Deduce the molecular formula of **J**. (3)

(Total 7 marks)

19 Nitrogen monoxide may be removed from industrial emissions via a reaction with ammonia as shown by the equation below:



30.0 dm³ of ammonia reacts with 30.0 dm³ of nitrogen monoxide at 100 °C. Identify which gas is in excess and by how much and calculate the volume of nitrogen produced. (2)

20 The percentage by mass of calcium carbonate in eggshell was determined by adding excess hydrochloric acid to ensure that all the calcium carbonate had reacted. The excess acid left was then titrated with aqueous sodium hydroxide.

- (a) A student added 27.20 cm³ of 0.200 mol dm⁻³ HCl to 0.188 g of eggshell. Calculate the amount, in mol, of HCl added. (1)
 (b) The excess acid requires 23.80 cm³ of 0.100 mol dm⁻³ NaOH for neutralization. Calculate the amount, in mol, of acid that is in excess. (1)
 (c) Determine the amount, in mol, of HCl that reacted with the calcium carbonate in the eggshell. (1)
 (d) State the equation for the reaction of HCl with the calcium carbonate in the eggshell. (2)
 (e) Determine the amount, in mol, of calcium carbonate in the sample of the eggshell. (2)
 (f) Calculate the mass and the percentage by mass of calcium carbonate in the eggshell sample. (3)
 (g) Deduce one assumption made in arriving at the percentage of calcium carbonate in the eggshell sample. (1)

(Total 11 marks)

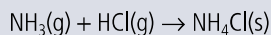
21 A 2.450 g sample of a mixture of sodium chloride and calcium chloride was dissolved in distilled water. The chloride solution was treated with excess silver nitrate solution, AgNO₃(aq). The precipitated silver chloride, AgCl(s), was collected, washed, and dried. The mass of the dried silver chloride was 6.127 g. Calculate the per cent by mass of the sodium chloride and calcium chloride in the original mixture. (2)

22 A hydrate of potassium carbonate has the formula K₂CO₃·xH₂O. A 10.00 g sample of the hydrated solid is heated, and forms 7.93 g of anhydrous salt.

- (a) Calculate the number of moles of water in the hydrated sample. (1)
 (b) Calculate the number of moles of anhydrous salt that form. (1)
 (c) Determine the formula of the hydrate. (1)
 (d) How could you determine when all the hydrated salt has been converted into anhydrous form? (1)

(Total 4 marks)

23 625 cm³ of ammonia, NH₃, at 42 °C and 160 kPa is combined with 740 cm³ of hydrogen chloride at 57 °C and 113.3 kPa. The reaction produces ammonium chloride as follows:



- (a) Which reactant is in excess? (1)
(b) Which reactant is limiting? (1)
(c) What mass of ammonium chloride forms? (1)

(Total 3 marks)

24 Sulfur dioxide, SO₂, is one of the gases associated with the formation of acidic deposition. It is released during the process of extracting lead from lead ore, when lead sulfide, PbS, is roasted to form lead oxide, PbO.

- (a) Write an equation for the reaction of roasting lead sulfide. (1)
(b) What mass of sulfur dioxide is produced when one tonne of lead sulfide is used in this reaction? (2)
(c) What assumption have you made in this calculation? (2)

(Total 5 marks)

25 Aluminium metal reacts with copper(II) sulfate solution, CuSO₄(aq), to produce aluminium sulfate solution, Al₂(SO₄)₃(aq), and copper metal.

- (a) Write an equation for this reaction. (1)
(b) How many moles of aluminium are needed to react with 10.38 moles of copper(II) sulfate? (1)
(c) How many moles of copper are produced if 3.95 moles of copper(II) sulfate react with aluminium? (1)
(d) What changes might be observed during this reaction? (2)

(Total 5 marks)



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