

Q1. (a) One isotope of sodium has a relative mass of 23.

(i) Define, in terms of the fundamental particles present, the meaning of the term *isotopes*.

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(ii) Explain why isotopes of the same element have the same chemical properties.

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(iii) Calculate the mass, in grams, of a single atom of this isotope of sodium.
(The Avogadro constant, L , is $6.023 \times 10^{23} \text{ mol}^{-1}$)

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(5)

(b) Give the electronic configuration, showing all sub-levels, for a sodium atom.

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(1)

(c) Explain why chromium is placed in the d block in the Periodic Table.

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(1)

- (d) An atom has half as many protons as an atom of ^{28}Si and also has six fewer neutrons than an atom of ^{28}Si . Give the symbol, including the mass number and the atomic number, of this atom.

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(2)
(Total 9 marks)

- Q2.** (a) The equation for the reaction between magnesium carbonate and hydrochloric acid is given below.



When 75.0 cm^3 of $0.500 \text{ mol dm}^{-3}$ hydrochloric acid were added to 1.25 g of impure MgCO_3 some acid was left unreacted. This unreacted acid required 21.6 cm^3 of a $0.500 \text{ mol dm}^{-3}$ solution of sodium hydroxide for complete reaction.

- (i) Calculate the number of moles of HCl in 75.0 cm^3 of $0.500 \text{ mol dm}^{-3}$ hydrochloric acid.

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- (ii) Calculate the number of moles of NaOH used to neutralise the unreacted HCl.

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- (iii) Show that the number of moles of HCl which reacted with the MgCO_3 in the sample was 0.0267

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- (iv) Calculate the number of moles and the mass of MgCO_3 in the sample, and hence deduce the percentage by mass of MgCO_3 in the sample.

Moles of $MgCO_3$

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Mass of $MgCO_3$

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Percentage of $MgCO_3$

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(8)

(b) A compound contains 36.5% of sodium and 25.5% of sulphur by mass, the rest being oxygen.

(i) Use this information to show that the empirical formula of the compound is Na_2SO_3

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(ii) When Na_2SO_3 is treated with an excess of hydrochloric acid, aqueous sodium chloride is formed and sulphur dioxide gas is evolved. Write an equation to represent this reaction.

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(Total 12 marks)

Q3. Which one of the following contains the greatest number of moles of methanol? (The Avogadro number (L) is 6.02×10^{23} , the relative molecular mass (M_r) of methanol is 32.)

- A** 6.6×10^{22} molecules
- B** 3.3 g of methanol
- C** $2.5 \times 10^{-3} \text{ m}^3$ of methanol vapour at 300 K and 100 kPa
- D** 70 cm^3 of 1.5 M aqueous methanol

(Total 1 mark)

Q4. Use the information below to answer this question.

A saturated solution of magnesium hydroxide, $\text{Mg}(\text{OH})_2$, contains 0.1166 g of $\text{Mg}(\text{OH})_2$ in 10.00 dm^3 of solution. In this solution the magnesium hydroxide is fully dissociated into ions.

Which one of the following is the concentration of $\text{Mg}^{2+}(\text{aq})$ ions in the saturated solution?

- A** $2.82 \times 10^{-2} \text{ mol dm}^{-3}$
- B** $2.00 \times 10^{-3} \text{ mol dm}^{-3}$
- C** $2.82 \times 10^{-3} \text{ mol dm}^{-3}$
- D** $2.00 \times 10^{-4} \text{ mol dm}^{-3}$

(Total 1 mark)

Q5. (a) A sample of ethanol vapour, $\text{C}_2\text{H}_5\text{OH}$ ($M_r = 46.0$), was maintained at a pressure of 100 kPa and at a temperature of 366K.

(i) State the ideal gas equation.

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(ii) Use the ideal gas equation to calculate the volume, in cm^3 , that 1.36 g of ethanol vapour would occupy under these conditions. (The gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$)

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(5)

(b) Magnesium nitride reacts with water to form magnesium hydroxide and ammonia.

(i) Balance the equation, given below, for the reaction between magnesium nitride and water.

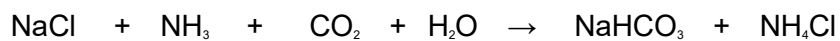


(ii) Calculate the number of moles, and hence the number of molecules, of NH_3 in 0.263 g of ammonia gas.
(The Avogadro constant $L = 6.02 \times 10^{23} \text{ mol}^{-1}$)

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(c) Sodium carbonate is manufactured in a two-stage process as shown by the equations below.



Calculate the maximum mass of sodium carbonate which could be obtained from 800 g of sodium chloride.

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(4)
(Total 13 marks)