**Name: /**Out of 50

**AS Amount of Substance – Test**

**Section A**

**1.** (a) Define the term *relative atomic mass*.

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(2)

(b) How would you calculate the mass of one mole of atoms from the mass of a single atom?

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(1)

(c) Sodium hydride reacts with water according to the following equation.

 NaH(s) + H2O(l)  NaOH(aq) + H2(g)

 A 1.00 g sample of sodium hydride was added to water and the resulting solution was diluted to a volume of exactly 250 cm3.

(i) Calculate the concentration, in mol dm–3, of the sodium hydroxide solution formed.

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(ii) Calculate the volume of hydrogen gas evolved, measured at 293 K and 100 kPa.

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 (iii) Calculate the volume of 0.112 M hydrochloric acid which would react exactly with a 25.0 cm3 sample of the sodium hydroxide solution.

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(8)

(Total 11 marks)

**2.** (a) Give the meaning of the term *empirical formula.*

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(1)

(b) Analysis of 3.150 g of compound **X** showed that it contained 0.769 g of calcium and 0.539 g of nitrogen; the remainder was oxygen. Calculate the empirical formula of **X**.

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(3)

(c) What additional information is required in order to deduce the molecular formula of **X**?

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(1)

(d) A sample of **X** when heated in alkaline solution with an aluminium-zinc alloy produced ammonia gas. After cooling to 293 K, the ammonia occupied a volume of 1.53 × 10–3 m3 at a pressure of 95.0 kPa. The ammonia was dissolved in water and made up to 250 cm3 of aqueous solution. A 25.0 cm3 sample of this solution was then titrated with 0.150 M hydrochloric acid.

(i) Calculate the number of moles of ammonia gas in 1.53 × 10–3 m3 at a pressure of 95.0 kPa and a temperature of 293 K.

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(ii) Calculate the concentration, in mol dm–3, of ammonia in the aqueous solution.

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(iii) Calculate the volume of 0.150 M hydrochloric acid required to neutralise the
25.0 cm3 sample of ammonia solution.

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(6)

(Total 11 marks)

**3.** (a) Calculate the concentration, in mol dm–3, of the solution formed when 19.6 g of hydrogen chloride, HCl, are dissolved in water and the volume made up to 250 cm3.

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(3)

(b) The carbonate of metal **M** has the formula M2CO3. The equation for the reaction of this carbonate with hydrochloric acid is given below.

M2CO3 + 2HCl  2MCl + CO2 + H2O

 A sample of M2CO3, of mass 0.394 g, required the addition of 21.7 cm3 of a
0.263 mol dm–3 solution of hydrochloric acid for complete reaction.

(i) Calculate the number of moles of hydrochloric acid used.

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(ii) Calculate the number of moles of M2CO3 in 0.394 g.

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(iii) Calculate the relative molecular mass of M2CO3

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(iv) Deduce the relative atomic mass of **M** and hence suggest its identity.

*Relative atomic mass of* ***M*** ........................................................................

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*Identity of* ***M*** ..............................................................................................

(6)

(Total 9 marks)

**4.** Nitroglycerine, C3H5N3O9, is an explosive which, on detonation, decomposes rapidly to form a large number of gaseous molecules. The equation for this decomposition is given below.

4C3H5N3O9(l) → 12CO2(g) + 10H2O(g) + 6N2(g) + O2(g)

(a) A sample of nitroglycerine was detonated and produced 0.350 g of oxygen gas.

(i) State what is meant by the term *one mole* of molecules.

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(ii) Calculate the number of moles of oxygen gas produced in this reaction, and hence deduce the total number of moles of gas formed.

*Moles of oxygen gas* .........................................................................................

*Total moles of gas* ............................................................................................

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(iii) Calculate the number of moles, and the mass, of nitroglycerine detonated.

*Moles of nitroglycerine* ....................................................................................

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*Mass of nitroglycerine* .....................................................................................

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(7)

(b) A second sample of nitroglycerine was placed in a strong sealed container and detonated. The volume of this container was 1.00 × 10–3 m3. The resulting decomposition produced a total of 0.873 mol of gaseous products at a temperature of 1100 K.

 State the ideal gas equation and use it to calculate the pressure in the container after detonation.

(The gas constant *R* = 8.31 J K–1mol–1)

*Ideal gas equation* ......................................................................................................

*Pressure* .....................................................................................................................

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(4)

(Total 11 marks)

**Section B**

**5.** Potassium nitrate, KNO3, decomposes on strong heating, forming oxygen and solid **Y** as the only products.

(a) A 1.00 g sample of KNO3 (*M*r = 101.1) was heated strongly until fully decomposed into **Y**.

(i) Calculate the number of moles of KNO3 in the 1.00 g sample.

(ii) At 298 K and 100 kPa, the oxygen gas produced in this decomposition occupied a volume of 1.22 × 10–4 m3.

 Calculate the number of moles of oxygen produced in this decomposition.

(The gas constant *R* = 8.31 J K–1 mol–1)

(4)

(b) Compound **Y** contains 45.9% of potassium and 16.5% of nitrogen by mass, the remainder being oxygen.

 Use the data above to calculate the empirical formula of **Y**.

 (3)

(c) Deduce an equation for the decomposition of KNO3 into **Y** and oxygen.

 (1)

(Total 10 marks)