C3F Quantitative Chemistry: Foundation Tier Practice

Total Marks

AQA 8462 · Calculator allowed · about 75 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 State the meaning of the term 'relative atomic mass' (Ar).

(Total for Question 1 is 1 mark)

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2 Give the relative formula mass, Mr, of sodium chloride, NaCl. (Ar: Na = 23, Cl = 35.5)

(Total for Question 2 is 1 mark)

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3 A molecule of water is H2O. Use the Ar values H = 1, O = 16 to calculate the Mr of water.

(Total for Question 3 is 2 marks)

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4 A student has 36 g of water. Calculate how many moles of water this is. Use Mr of water = 18 and the equation moles = mass / Mr.

(Total for Question 4 is 2 marks)

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5 Magnesium oxide has formula MgO. A student reacts 24 g of magnesium with excess oxygen to form magnesium oxide. Calculate the mass of magnesium oxide produced. (Ar: Mg = 24, O = 16)

Note: assume all magnesium reacts and conservation of mass applies.

(Total for Question 5 is 3 marks)

6 State the meaning of 'concentration' of a solution in terms of amount of substance.

(Total for Question 6 is 2 marks)

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7 A pupil dissolves 0.50 mol of sodium chloride, NaCl, in water and makes the solution up to a total volume of 0.50 dm3. Calculate the concentration in mol per dm3. (Use moles / volume.)

(Total for Question 7 is 3 marks)

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8 Sulfuric acid, H2SO4, is used to make a 0.20 mol per dm3 solution. Calculate the number of moles of H2SO4 needed to make 250 cm3 of this solution. (Remember 1000 cm3 = 1 dm3.)

(Total for Question 8 is 3 marks)

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9 A reaction between zinc and hydrochloric acid produces hydrogen gas. Write the symbol equation for the reaction: zinc + hydrochloric acid -> zinc chloride + hydrogen.

(Total for Question 9 is 2 marks)

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10 A sample contains 0.25 mol of hydrogen gas. Calculate the number of molecules of hydrogen present. Use Avogadro constant = 6.0×10^{23} mol^{-1}. (Give your answer in standard form.)

(Total for Question 10 is 2 marks)

11 Masses are often conserved in chemical reactions. A student reacts 2.0 g of carbon with 5.5 g of oxygen to make carbon dioxide. Calculate the mass of carbon dioxide formed.

(Total for Question 11 is 2 marks)

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12 Dilution: A teacher has 1.0 mol per dm3 hydrochloric acid solution. She dilutes 40 cm3 of this solution to a total volume of 200 cm3. Calculate the new concentration in mol per dm3.

(Total for Question 12 is 3 marks)

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13 A student has a 0.10 mol per dm3 solution of sodium hydroxide, NaOH. How many moles of NaOH are in 100 cm3 of this solution?

(Total for Question 13 is 2 marks)

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14 A teacher asks pupils to find the mass of one mole of calcium carbonate, CaCO3. Calculate its Mr and then the mass of 2.5 mol of CaCO3. (Ar: Ca = 40, C = 12, O = 16.)

(Total for Question 14 is 4 marks)

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15 A simple titration gives the following results for the volume of acid used to neutralise a fixed volume of alkali: 23.4 cm3, 23.6 cm3, 23.2 cm3. Calculate the mean volume of acid used. Give the answer to 3 significant figures.

(Total for Question 15 is 3 marks)

16 Explain how you would carry out a titration to find the concentration of a hydrochloric acid solution using a standard 0.10 mol per dm3 sodium carbonate solution. In your answer describe the key steps, the measurements you would make, and two sources of error and how to reduce them.

(Total for Question 16 is 6 marks)

Mark scheme · C3F Quantitative Chemistry: Foundation Tier Practice

Question 1

- **B1** the average mass of an atom of an element compared with 1/12 of an atom of carbon-12, oe
- **Answer: Average mass of an atom of the element compared with 1/12 of carbon-12.**

Question 2

- **B1** Mr = 23 + 35.5 = 58.5 cao
- **Answer: 58.5**

Question 3

- **M1** substitutes numbers: Mr = (2 x 1) + 16
- **A1** Mr = 18 cao
- **Answer: 18**

Question 4

- **M1** substitutes into moles = mass / Mr: moles = 36 / 18
- **A1** 2.0 mol cao
- **Answer: 2.0 mol**

Question 5

- **M1** calculate moles of Mg: moles = 24 / 24 = 1
- **M1** use reaction ratio Mg : MgO = 1 : 1 so moles MgO = 1
- **A1** mass MgO = moles x Mr = 1 x (24 + 16) = 40 g cao
- **Answer: 40 g**

Question 6

- **B1** amount of solute (in moles) dissolved per unit volume of solution, usually mol per dm3, oe
- **B1** can be described as moles of solute per dm3 of solution, oe
- **Answer: Amount of solute (in moles) dissolved per unit volume of solution, mol per dm3.**

Question 7

- **M1** substitutes: concentration = 0.50 mol / 0.50 dm3
- **M1** calculate value 1.0
- **A1** 1.0 mol per dm3 cao
- **Answer: 1.0 mol per dm3**

Question 8

- **M1** convert volume: 250 cm3 = 0.250 dm3
- **M1** use moles = concentration x volume: moles = 0.20 x 0.250
- **A1** moles = 0.050 mol cao
- **Answer: 0.050 mol**

Question 9

- **M1** correct formulae and balancing: Zn + 2HCl -> ZnCl2 + H2 cao
- **A1** equation balanced with correct formulas cao
- **Answer: Zn + 2HCl -> ZnCl2 + H2**

Question 10

- **M1** substitutes: number = 0.25 x 6.0 x 10^{23}
- **A1** 1.5 x 10^{23} molecules cao
- **Answer: 1.5 x 10^{23} molecules**

Question 11

- **M1** use conservation of mass: mass CO2 = mass reactants = 2.0 + 5.5
- **A1** 7.5 g cao
- **Answer: 7.5 g**

Question 12

- **M1** use c1v1 = c2v2 or moles approach: moles initial = 1.0 x 0.040 = 0.040 mol
- **M1** new concentration = moles / volume = 0.040 / 0.200
- **A1** 0.20 mol per dm3 cao
- **Answer: 0.20 mol per dm3**

Question 13

- **M1** convert volume: 100 cm3 = 0.100 dm3 then moles = concentration x volume = 0.10 x 0.100
- **A1** 0.010 mol cao
- **Answer: 0.010 mol**

Question 14

- **M1** calculate Mr: Mr = 40 + 12 + (3 x 16)
- **M1** Mr = 100
- **M1** mass = moles x Mr = 2.5 x 100
- **A1** mass = 250 g cao
- **Answer: 250 g**

Question 15

- **M1** calculate mean: (23.4 + 23.6 + 23.2) / 3 = 70.2 / 3
- **M1** value = 23.4
- **A1** mean = 23.4 cm3 to 3 s.f. cao
- **Answer: 23.4 cm3**

Question 16

- **Level 3** (5-6): Detailed method with correct use of a burette and pipette, clear description of measurements and calculations, and two valid sources of error with appropriate ways to reduce them.
- **Level 2** (3-4): Method is mostly correct with some detail missing; includes at least one correct calculation and one source of error with a way to reduce it.
- **Level 1** (1-2): Only basic steps given or brief description of titration with limited or no evaluation of errors.
- **Indicative content:**
  - Use a pipette to transfer a measured volume (for example 25.0 cm3) of the HCl sample to a conical flask and add a few drops of an appropriate indicator such as methyl orange or phenolphthalein.
  - Fill a burette with the standard 0.10 mol per dm3 sodium carbonate solution and record the initial burette reading.
  - Titrate by adding the carbonate from the burette to the acid while swirling the flask until the indicator shows the end point; record the final burette reading and calculate the volume used (final - initial).
  - Repeat the titration at least three times and use concordant results to find a mean volume; use the mean to reduce random error.
  - Calculate moles of Na2CO3 added using moles = concentration x volume (convert cm3 to dm3), use the mole ratio between Na2CO3 and HCl to find moles of HCl, then calculate concentration of HCl from moles / volume of acid pipetted.
  - Sources of error: parallax reading error at the burette (reduce by reading at eye level and using consistent readings), overshooting the end point (reduce by adding indicator near the end and adding solution dropwise), impure standard or inaccurate pipette (reduce by using calibrated glassware and standard solution)