2.6 Quantitative Chemistry: Test Pack

AQA 8462 · Calculator allowed · about 45 minutes

Total Marks

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 Masses are often conserved in chemical reactions. A student reacts 3.0 g of carbon with 8.0 g of oxygen to make carbon dioxide. Calculate the mass of carbon dioxide formed.

(Total for Question 2 is 2 marks)

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

(Total for Question 3 is 1 mark)

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4 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 4 is 2 marks)

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5 Dilution: A teacher has 1.0 mol per dm3 hydrochloric acid solution. She dilutes 40 cm^3 of this solution to a total volume of 200 cm^3. Calculate the new concentration in mol per dm3.

(Total for Question 5 is 3 marks)

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6 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 6 is 3 marks)

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7 Concentration and units.

(a) Which unit is used to measure the concentration of a solution? **(1)**

- ☐ A) g
- ☐ B) mol
- ☐ C) mol/dm3
- ☐ D) dm3/mol

(b) A conical flask contains 500 cm^3 of solution. State this volume in dm3. **(1)**

(Total for Question 7 is 2 marks)

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8 Zinc reacts with dilute sulfuric acid: $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$. A student reacts 6.5 g of zinc (Ar = 65) with 100 cm^3 of 1.20 mol/dm3 sulfuric acid. (Mr of $ZnSO_4$ = 161; molar gas volume at RTP = 24 dm3/mol)

(a) Show that zinc is the limiting reactant. **(3)**

(b) Calculate the maximum mass of zinc sulfate, $ZnSO_4$, that could be produced. **(2)**

(c) Calculate the volume of hydrogen gas produced at RTP. **(2)**

(Total for Question 8 is 7 marks)

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9 Ammonium nitrate, NH_4NO_3, is used as a fertiliser. Calculate the percentage by mass of nitrogen in ammonium nitrate. (Ar: N = 14, H = 1, O = 16)

(Total for Question 9 is 3 marks)

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10 State the law of conservation of mass, and explain why the measured mass of a reaction mixture appears to decrease when a metal carbonate is heated in an open test tube.

(Total for Question 10 is 2 marks)

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11 Explain, giving two reasons, why the actual yield of a reaction carried out in a school laboratory is often less than the theoretical yield calculated from the balanced equation.

(Total for Question 11 is 2 marks)

12 Explain why a chemical process with a high atom economy is generally considered more sustainable than a process with a low atom economy, even if both processes have the same percentage yield.

(Total for Question 12 is 2 marks)

13 A compound contains only carbon, hydrogen and oxygen. A sample of the compound with mass 4.60 g is found by analysis to contain 2.40 g of carbon, 0.60 g of hydrogen and 1.60 g of oxygen. Relative atomic masses: C = 12, H = 1, O = 16.

Calculate the empirical formula of the compound. Show your working clearly.

(Total for Question 13 is 3 marks)

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Mark scheme · 2.6 Quantitative Chemistry: Test Pack

Question 1

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

Answer: Average mass of an atom of the element compared with 1/12 of carbon-12.

Question 2

use conservation of mass: mass CO_2 = mass reactants = 3.0 + 8.0 **M1**

11.0 g cao **A1**

Answer: 11.0 g

Question 3

Mr = 23 + 35.5 = 58.5 cao **B1**

Answer: 58.5

Question 4

correct formulae and balancing: Zn + 2HCl -> $ZnCl_2$ + H_2 cao **M1**

equation balanced with correct formulas cao **A1**

Answer: Zn + 2HCl -> $ZnCl_2$ + H_2

Question 5

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 **M1**

0.20 mol per dm3 cao **A1**

Answer: 0.20 mol per dm3

Question 6

substitutes: concentration = 0.50 mol / 0.50 dm3 **M1**

calculate value 1.0 **M1**

1.0 mol per dm3 cao **A1**

Answer: 1.0 mol per dm3

Question 7

(a) C **B1**

(a) Answer: C

(b) 0.5 dm3 (cao) **B1**

(b) Answer: 0.5 dm3

Question 8

(a) moles Zn = 6.5/65 = 0.1 mol **M1**

(a) moles H_2SO_4 = 0.100 x 1.20 = 0.12 mol **M1**

(a) cso: 1:1 ratio means only 0.1 mol H_2SO_4 is needed to react with all the zinc, but 0.12 mol is available (excess acid), so zinc is the limiting reactant **A1**

(a) Answer: Zinc is the limiting reactant.

(b) uses limiting reactant (Zn) with 1:1 ratio, so moles $ZnSO_4$ = 0.1 mol (ft from a) **M1**

(b) 16.1 g (cao, ft) **A1**

(b) Answer: 16.1 g

(c) 1:1 ratio Zn:H_2, so moles H_2 = 0.1 mol; volume = moles x 24 (ft from a) **M1**

(c) 2.4 dm3 (cao, ft) **A1**

(c) Answer: 2.4 dm3

Question 9

Mr of NH_4NO_3 = 14 + (4 x 1) + 14 + (3 x 16) = 80 shown **M1**

total mass of N in formula = 14 + 14 = 28 shown **M1**

35% (cao) **A1**

Answer: 35%

Question 10

no atoms are gained or lost in a chemical reaction, so the total mass of reactants equals the total mass of products, oe **B1**

the mass appears to decrease because a gas (carbon dioxide) is produced and escapes into the atmosphere, so it is not included in the measured mass, oe **B1**

Answer: Mass is conserved because no atoms are gained or lost. The apparent decrease happens because carbon dioxide gas escapes and is not weighed.

Question 11

some product may be lost during the practical steps (e.g. filtering, transferring between containers, or product left behind on apparatus), oe **B1**

the reaction may not go to completion, or there may be unwanted side/reverse reactions producing other products, so not all reactant is converted to the desired product, oe **B1**

Answer: Some product is lost during transfer/filtration steps, and the reaction may not go to completion or may form unwanted side products, so less product than the theoretical maximum is obtained.

Question 12

a high atom economy means most of the mass of the reactants ends up as the useful (desired) product, with little mass wasted as by-products, oe **B1**

a low atom economy means a large proportion of reactant mass becomes waste by-products, which uses up raw materials unnecessarily and often has to be disposed of, costing money and causing environmental impact, oe **B1**

Answer: High atom economy means less reactant mass is wasted as by-products, so raw materials are used more efficiently and there is less waste to dispose of, making the process cheaper and better for the environment.

Question 13

calculates moles of each element: C = 2.40/12 = 0.20, H = 0.60/1 = 0.60, O = 1.60/16 = 0.10 **M1**

divides each by the smallest value (0.10): C = 2, H = 6, O = 1 **M1**

empirical formula C_2H_6O cao **A1**

Answer: C_2H_6O

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