IG.C7 Moles, Formulae and Reacting Mass Calculations

Total Marks

EDEXCEL 4CH1 · Calculator allowed · about 50 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Calculate the relative formula mass, Mr, of calcium carbonate, $CaCO_3$, using relative atomic masses Ar: Ca = 40, C = 12, O = 16. Show your working.

(Total for Question 1 is 1 mark)

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2 A sample of magnesium oxide, MgO, has a mass of 40 g. Calculate the number of moles of MgO present. Use Ar: Mg = 24, O = 16 and show your working.

(Total for Question 2 is 2 marks)

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3 Determine the mass of 0.25 mol of sodium chloride, NaCl. Use Ar: Na = 23, Cl = 35.5 and show your working.

(Total for Question 3 is 2 marks)

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4 A compound contains 2.4 g of iron and 0.8 g of oxygen. Deduce the empirical formula of the compound. Use Ar: Fe = 56, O = 16 and show your working.

(Total for Question 4 is 3 marks)

5 Calculate the Mr of aluminium sulfate, Al2(SO4)3. Use Ar: Al = 27, S = 32, O = 16 and show your working.

(Total for Question 5 is 2 marks)

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6 Hydrogen gas reacts with nitrogen to form ammonia according to the balanced equation: N2 + 3 H2 -> 2 NH3. Calculate the mass of ammonia produced when 28 g of nitrogen reacts with excess hydrogen. Use Ar: N = 14, H = 1 and show your working.

(Total for Question 6 is 3 marks)

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7 A student has 5.00 g of ethanol, C2H5OH, and burns it completely. Calculate the number of moles of ethanol used. Use Ar: C = 12, H = 1, O = 16 and show your working.

(Total for Question 7 is 2 marks)

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8 Copper(II) oxide, CuO, reacts with hydrogen gas to produce copper and water: CuO + H2 -> Cu + H2O. If 7.95 g of CuO are reduced and hydrogen is in excess, calculate the mass of copper produced. Use Ar: Cu = 63.5, O = 16 and show your working.

(Total for Question 8 is 3 marks)

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9 A compound is analysed and found to contain 60.0% magnesium and 40.0% oxygen by mass. Determine the empirical formula of the compound. Use Ar: Mg = 24, O = 16 and show your working.

(Total for Question 9 is 2 marks)

10 Calculate the mass of calcium sulfide, CaS, that would be formed when 5.00 g of calcium reacts with excess sulfur according to the equation Ca + S -> CaS. Use Ar: Ca = 40, S = 32 and show your working.

(Total for Question 10 is 2 marks)

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11 10.0 g of aluminium react with 5.00 g of oxygen according to the balanced equation: 4 Al + 3 O2 -> 2 Al2O3. Determine the mass of aluminium oxide, Al2O3, that can be produced. Use Ar: Al = 27, O = 16 and show your working. Indicate which reactant is limiting.

(Total for Question 11 is 4 marks)

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12 A 100.0 g sample of hydrated copper(II) sulfate contains 25.0 g of water and 75.0 g of anhydrous CuSO4. Determine the formula of the hydrate, CuSO4.xH2O. Use Ar: Cu = 63.5, S = 32, O = 16 and show your working.

(Total for Question 12 is 3 marks)

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13 Calculate the relative formula mass, Mr, of potassium dichromate, K2Cr2O7, using Ar: K = 39, Cr = 52, O = 16. Then calculate the number of moles present in a 10.0 g sample. Show your working.

(Total for Question 13 is 3 marks)

Mark scheme · IG.C7 Moles, Formulae and Reacting Mass Calculations

Question 1

- **M1** adds Ar values correctly: 40 + 12 + (3 x 16)
- **A1** Mr = 100 cao
- **Answer: Mr(CaCO3) = 100**

Question 2

- **M1** calculates Mr(MgO) = 24 + 16 = 40
- **A1** moles = mass / Mr = 40 / 40 = 1.0 mol cao
- **Answer: 1.0 mol**

Question 3

- **M1** calculates Mr(NaCl) = 23 + 35.5 = 58.5
- **A1** mass = moles x Mr = 0.25 x 58.5 = 14.625 g, cao (allow 14.6 g)
- **Answer: 14.6 g (to 3 s.f.) or 14.625 g**

Question 4

- **M1** converts masses to moles: n(Fe) = 2.4 / 56 = 0.04286; n(O) = 0.8 / 16 = 0.05
- **M1** divides by smallest mole: Fe ratio = 0.04286/0.04286 = 1; O ratio = 0.05/0.04286 = 1.1667 (or 7/6)
- **A1** scales to whole numbers: multiply ratios by 6 to get Fe6O7, empirical formula = Fe6O7 cao
- **Answer: Empirical formula Fe6O7**

Question 5

- **M1** calculates contribution: 2 x 27 for Al = 54; 3 x (32 + 4 x 16) for (SO4)3 = 3 x (32 + 64) = 3 x 96 = 288
- **A1** Mr = 54 + 288 = 342 cao
- **Answer: Mr(Al2(SO4)3) = 342**

Question 6

- **M1** calculates moles of N2: Mr(N2) = 28 so moles = 28 / 28 = 1.0 mol
- **M1** uses mole ratio: 1 mol N2 produces 2 mol NH3, so moles NH3 = 2 x 1.0 = 2.0 mol
- **A1** mass NH3 = moles x Mr(NH3) = 2.0 x (14 + 3 x 1) = 2.0 x 17 = 34 g cao
- **Answer: 34 g NH3**

Question 7

- **M1** calculates Mr(C2H5OH) = 2x12 + 6x1 + 16 = 24 + 6 + 16 = 46
- **A1** moles = 5.00 / 46 = 0.1087 mol, cao (allow 0.109 mol)
- **Answer: 0.109 mol (to 3 s.f.)**

Question 8

- **M1** calculates Mr(CuO) = 63.5 + 16 = 79.5 and moles CuO = 7.95 / 79.5
- **M1** uses mole ratio 1:1 so moles Cu = moles CuO = 7.95 / 79.5 = 0.1000 mol ecf
- **A1** mass Cu = moles x Ar(Cu) = 0.1000 x 63.5 = 6.35 g cao
- **Answer: 6.35 g Cu**

Question 9

- **M1** converts percentages to moles using a convenient 100 g sample: n(Mg) = 60.0 / 24 = 2.5; n(O) = 40.0 / 16 = 2.5
- **A1** ratio Mg:O = 2.5:2.5 = 1:1 so empirical formula = MgO cao
- **Answer: Empirical formula MgO**

Question 10

- **M1** calculates moles Ca = 5.00 / 40 = 0.125 mol and uses 1:1 mole ratio so moles CaS = 0.125
- **A1** mass CaS = moles x Mr = 0.125 x (40 + 32) = 0.125 x 72 = 9.00 g cao
- **Answer: 9.00 g CaS**

Question 11

- **M1** calculates moles Al = 10.0 / 27 = 0.37037 mol and moles O2 = 5.00 / 32 = 0.15625 mol
- **M1** uses stoichiometry to find limiting reactant: for 0.37037 mol Al requires 0.37037 x (3/4) = 0.27778 mol O2 but only 0.15625 mol O2 is available, so O2 is limiting
- **M1** finds moles Al2O3 from limiting O2: 3 mol O2 -> 2 mol Al2O3 so moles Al2O3 = 0.15625 x (2/3) = 0.104167 mol
- **A1** mass Al2O3 = moles x Mr = 0.104167 x (2x27 + 3x16) = 0.104167 x 102 = 10.625 g, cao (allow 10.6 g)
- **Answer: 10.6 g Al2O3 (to 3 s.f.), oxygen is limiting**

Question 12

- **M1** calculates moles H2O = 25.0 / 18 = 1.3889 and Mr CuSO4 = 63.5 + 32 + 4x16 = 159.5 then moles CuSO4 = 75.0 / 159.5 = 0.47022
- **M1** calculates ratio H2O : CuSO4 = 1.3889 : 0.47022 = 2.955 and recognises this is about 3 : 1
- **A1** gives formula CuSO4.3H2O cao
- **Answer: CuSO4.3H2O**

Question 13

- **M1** calculates Mr = 2x39 + 2x52 + 7x16 = 78 + 104 + 112 = 294
- **M1** sets up moles = mass / Mr = 10.0 / 294
- **A1** gives moles = 0.0340 mol cao
- **Answer: Mr = 294; moles = 10.0 / 294 = 0.0340 mol**