2.9 Moles, Molar Mass and Empirical Formula Calculations: 30-minute Pack

EDEXCEL 4CH1 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Use a calculator where allowed. Suggested time 30 minutes.

1 State the equation that links amount in moles, mass in grams and relative formula mass, and give its units as required in a calculation.

(Total for Question 1 is 1 mark)

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2 A sample contains 0.250 mol of sodium chloride, NaCl. Calculate the mass in grams of this sample. Use Ar: Na = 23.0, Cl = 35.5. Quote the equation, substitute and give the final answer with units.

(Total for Question 2 is 4 marks)

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3 Calculate the number of moles in 24 g of carbon dioxide, CO_2. Use Ar: C = 12, O = 16 and show the equation, substitution and final evaluation with units.

(Total for Question 3 is 3 marks)

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4 A 10.0 g sample of magnesium oxide was analysed and found to contain 6.12 g of magnesium and 3.88 g of oxygen. Determine the empirical formula of this magnesium oxide. Show the steps: convert masses to moles, find simplest whole number ratio and give the formula.

(Total for Question 4 is 3 marks)

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5 An organic compound is analysed and found to contain 40.0% carbon, 6.71% hydrogen and 53.29% oxygen by mass. Determine the empirical formula of the compound. Show working: assume 100 g sample, convert to moles, find simplest whole number ratio and give empirical formula.

(Total for Question 5 is 4 marks)

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6 A student combusts 0.500 g of an unknown metal and obtains 0.644 g of the metal oxide product. The mass of oxygen combined is therefore 0.144 g. Using Ar: O = 16.0, and a metal Ar of 27.0, determine the empirical formula of the oxide. Show all steps converting masses to moles and finding simplest ratio.

(Total for Question 6 is 6 marks)

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7 A molecule has empirical formula CH and a relative molecular mass, Mr, of 78. Calculate the molecular formula. Show the empirical Mr calculation, division step and final molecular formula.

(Total for Question 7 is 5 marks)

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Mark scheme · 2.9 Moles, Molar Mass and Empirical Formula Calculations: 30-minute Pack

Question 1

moles = mass / Mr with mass in g, Mr unitless and moles in mol	**B1**

Answer: moles = mass / Mr ; mass in g, Mr unitless, moles in mol

Question 2

writes Mr NaCl = 23.0 + 35.5 = 58.5 and equation mass = moles x Mr or moles = mass / Mr rearranged to mass = moles x Mr	**M1**
substitutes: mass = 0.250 x 58.5	**M1**
evaluates mass = 14.625 g	**A1**
gives final answer with correct units, mass = 14.6 g (to 3 s.f.) cao	**A1**

Answer: Mr NaCl = 58.5; mass = 0.250 x 58.5 = 14.6 g

Question 3

writes equation Mr CO_2 = 12 + (2 x 16) = 44 and moles = mass / Mr	**M1**
substitutes: moles = 24 / 44	**M1**
gives moles = 0.545 mol cao (to 3 s.f.)	**A1**

Answer: Mr CO_2 = 12 + 2(16) = 44; moles = 24 / 44 = 0.545 mol

Question 4

converts masses to moles: moles Mg = 6.12 / 24.3 and moles O = 3.88 / 16	**M1**
divides by smallest to get ratio and simplifies to whole numbers	**M1**
gives empirical formula MgO cao	**A1**

Answer: Moles Mg = 6.12 / 24.3 = 0.252 mol; moles O = 3.88 / 16 = 0.243 mol; ratio approx 0.252:0.243 -> 1.04:1 -> empirical formula MgO

Question 5

assumes 100 g: masses C 40.0 g, H 6.71 g, O 53.29 g and converts to moles using Ar 12.0, 1.01, 16.0	**M1**
calculates moles: C = 40.0/12.0, H = 6.71/1.01, O = 53.29/16.0	**M1**
divides by smallest mole value and finds simplest whole number ratio	**M1**
gives empirical formula CH_2O cao	**A1**

Answer: Moles: C = 40.0/12.0 = 3.333; H = 6.71/1.01 = 6.644; O = 53.29/16.0 = 3.330. Ratio C:H:O = 3.333:6.644:3.330 -> divide by 3.330 -> 1.001:1.996:1 -> approx 1:2:1 so empirical formula CH_2O

Question 6

finds mass of metal and oxygen combined into moles: moles metal = 0.500 / 27.0, moles O = 0.144 / 16.0	**M1**
calculates numerical mole values correctly	**M1**
divides both mole values by the smallest to get simplest ratio	**M1**
adjusts ratio to whole numbers if necessary and states the simplest whole number ratio	**M1**
gives empirical formula M2O, consistent with the calculated 2:1 metal to oxygen ratio, cao	**A1**
final empirical formula stated correctly with correct subscripts	**A1**

Answer: Moles metal = 0.500 / 27.0 = 0.01852 mol; moles O = 0.144 / 16.0 = 0.00900 mol; ratio metal:O = 0.01852:0.00900 = 2.058:1 -> approx 2:1 so empirical formula M2O

Question 7

calculates Mr(empirical) = 12.0 + 1.01 = 13.01	**M1**
divides 78 by 13.01 to find n	**M1**
finds integer n = 6 (or 5.993 awrt) and states this	**M1**
constructs molecular formula by multiplying empirical subscripts by n	**A1**
gives final molecular formula C_6H_6 cao	**A1**

Answer: Mr(empirical) = 13.01; n = 78 / 13.01 = 6.00; molecular formula = C_6H_6

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