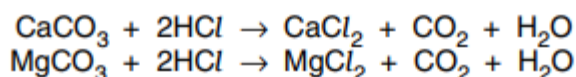


Stoichiometry

Past Year Topical Question

May/June 2003

- (c) Each tablet contains the same number of moles of CaCO_3 and MgCO_3 . One tablet reacted with excess hydrochloric acid to produce 0.24 dm^3 of carbon dioxide at r.t.p.



- (i) Calculate how many moles of CaCO_3 there are in one tablet.

number of moles CO_2 =

number of moles of CaCO_3 and MgCO_3 =

number of moles of CaCO_3 =

[3]

- (ii) Calculate the volume of hydrochloric acid, 1.0 mol/dm^3 , needed to react with one tablet.

number of moles of CaCO_3 and MgCO_3 in one tablet =
Use your answer to (c)(i).

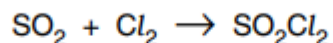
number of moles of HCl needed to react with one tablet =

volume of hydrochloric acid, 1.0 mol/dm^3 , needed to react with one tablet =

[2]

Oct/Nov 2003

(d) Sulphur dioxide reacts with chlorine in an addition reaction to form sulphuryl chloride.



8.0 g of sulphur dioxide was mixed with 14.2 g of chlorine. The mass of one mole of SO_2Cl_2 is 135 g.

Calculate the mass of sulphuryl chloride formed by this mixture.

Calculate the number of moles of SO_2 in the mixture =

Calculate the number of moles of Cl_2 in the mixture =

Which reagent was not in excess?

How many moles of SO_2Cl_2 were formed =

Calculate the mass of sulphuryl chloride formed = g [5]

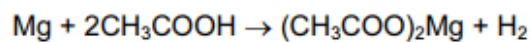
May/June 2004

7 Chemists use the concept of the mole to calculate the amounts of chemicals involved in a reaction.

(a) Define *mole*.

..... [1]

(b) 3.0 g of magnesium was added to 12.0 g of ethanoic acid.



The mass of one mole of Mg is 24 g.

The mass of one mole of CH₃COOH is 60 g.

(i) Which one, magnesium or ethanoic acid, is in excess? You must show your reasoning.

..... [3]

(ii) How many moles of hydrogen were formed?

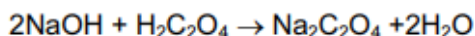
..... [1]



(iii) Calculate the volume of hydrogen formed, measured at r.t.p.

..... [2]

(c) In an experiment, 25.0 cm³ of aqueous sodium hydroxide, 0.4 mol/dm³, was neutralised by 20.0 cm³ of aqueous oxalic acid, H₂C₂O₄.



Calculate the concentration of the oxalic acid in mol/dm³.

(i) Calculate the number of moles of NaOH in 25.0 cm³ of 0.4 mol/dm³ solution.

..... [1]

(ii) Use your answer to (i) and the mole ratio in the equation to find out the number of moles of H₂C₂O₄ in 20 cm³ of solution.

..... [1]

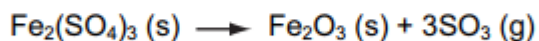
(iii) Calculate the concentration, mol/dm³, of the aqueous oxalic acid.

..... [2]

Oct/Nov 2004

- (c) Iron(III) sulphate decomposes when heated. Calculate the mass of iron(III) oxide formed and the volume of sulphur trioxide produced when 10.0 g of iron(III) sulphate was heated.

Mass of one mole of $\text{Fe}_2(\text{SO}_4)_3$ is 400 g.



Number of moles of $\text{Fe}_2(\text{SO}_4)_3 =$	
Number of moles of Fe_2O_3 formed =	
Mass of iron(III) oxide formed =	g
Number of moles of SO_3 produced =	
Volume of sulphur trioxide at r.t.p. =	dm^3

[5]

May/June 2005

- (d) Gypsum is hydrated calcium sulphate, $\text{CaSO}_4 \cdot x\text{H}_2\text{O}$. It contains 20.9% water by mass. Calculate x.

M_r : CaSO_4 , 136; H_2O , 18.

79.1 g of $\text{CaSO}_4 =$ moles

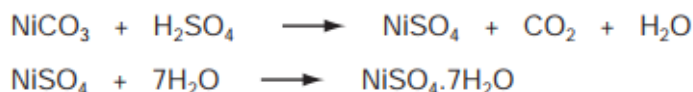
20.9 g of $\text{H}_2\text{O} =$ moles

x = [3]

Oct/Nov 2005

6 (a) The following method is used to make crystals of hydrated nickel sulphate.

An excess of nickel carbonate, 12.0 g, was added to 40 cm³ of sulphuric acid, 2.0 mol/dm³. The unreacted nickel carbonate was filtered off and the filtrate evaporated to obtain the crystals.



Mass of one mole of NiSO₄·7H₂O = 281 g

Mass of one mole of NiCO₃ = 119 g

(i) Calculate the mass of unreacted nickel carbonate.

Number of moles of H₂SO₄ in 40 cm³ of 2.0 mol/dm³ acid = 0.08

Number of moles of NiCO₃ reacted =

Mass of nickel carbonate reacted = g

Mass of unreacted nickel carbonate = g [3]

(ii) The experiment produced 10.4 g of hydrated nickel sulphate. Calculate the percentage yield.

The maximum number of moles of NiSO₄·7H₂O that could be formed =

.....

The maximum mass of NiSO₄·7H₂O that could be formed = g

The percentage yield = % [3]



May/June 2006

(d) Propene reacts with hydrogen iodide to form 2-iodopropane.



1.4 g of propene produced 4.0 g of 2-iodopropane.

Calculate the percentage yield.

moles of $\text{CH}_3\text{-CH=CH}_2$ reacted =

maximum moles of $\text{CH}_3\text{-CHI-CH}_3$ that could be formed =

mass of one mole of $\text{CH}_3\text{-CHI-CH}_3 = 170\text{ g}$

maximum mass of 2-iodopropane that could be formed =

percentage yield% [4]

Oct/Nov 2006

6 An ore of copper is the mineral, chalcopyrite. This is a mixed sulphide of iron and copper.

(a) Analysis of a sample of this ore shows that 13.80 g of the ore contained 4.80 g of copper, 4.20 g of iron and the rest sulphur.

Complete the table and calculate the empirical formula of chalcopyrite.

	copper	iron	sulphur
composition by mass/g	4.80	4.20	
number of moles of atoms			
simplest mole ratio of atoms			

The empirical formula is

[3]

.....

[1]



May/June 2007

- (d) A better way of measuring the degree of unsaturation is to find the iodine number of the unsaturated compound. This is the mass of iodine that reacts with all the double bonds in 100 g of the fat.

Use the following information to calculate the number of double bonds in one molecule of the fat.

Mass of one mole of the fat is 884 g.

One mole of I_2 reacts with one mole $\begin{array}{c} \diagup \\ \text{C}=\text{C} \\ \diagdown \end{array}$

The iodine number of the fat is 86.2 g.

Complete the following calculation.

100 g of fat reacts with 86.2 g of iodine.

884 g of fat reacts with g of iodine.

One mole of fat reacts with moles of iodine molecules.

Number of double bonds in one molecule of fat is [3]

Oct/Nov 2007

- (ii) One piece of marble, 0.3 g, was added to 5 cm³ of hydrochloric acid, concentration 1.00 mol/dm³. Which reagent is in excess? Give a reason for your choice.

mass of one mole of CaCO₃ = 100 g

number of moles of CaCO₃ =

number of moles of HCl =

reagent in excess is

reason [4]

- (iii) Use your answer to (ii) to calculate the maximum volume of carbon dioxide produced measured at r.t.p.

..... [1]



May/June 2008

- (b) Using 25.0 cm³ of aqueous sodium hydroxide, 2.24 mol / dm³, 3.86 g of crystals were obtained. Calculate the percentage yield.



Number of moles of NaOH used =

Maximum number of moles of Na₂SO₄·10H₂O that could be formed =

Mass of one mole of Na₂SO₄·10H₂O = 322 g

Maximum yield of sodium sulphate-10-water = g

Percentage yield = % [4]

Oct/Nov 2008

- (b) Benzene contains 92.3% of carbon and its relative molecular mass is 78.

(i) What is the percentage of hydrogen in benzene?

..... [1]

(ii) Calculate the ratio of moles of C atoms: moles of H atoms in benzene.

.....
..... [2]

(iii) Calculate its empirical formula and **then** its molecular formula.

The empirical formula of benzene is

The molecular formula of benzene is [2]



May/June 2009

9 Quantities of chemicals, expressed in moles, can be used to find the formula of a compound, to establish an equation and to determine reacting masses.

(a) A compound contains 72% magnesium and 28% nitrogen. What is its empirical formula?

.....
.....
.....
..... [2]

(b) A compound contains only aluminium and carbon. 0.03 moles of this compound reacted with excess water to form 0.12 moles of $\text{Al}(\text{OH})_3$ and 0.09 moles of CH_4 .

Write a balanced equation for this reaction.

.....
.....
.....
..... [2]

(c) 0.07 moles of silicon reacts with 25 g of bromine.



(i) Which one is the limiting reagent? Explain your choice.

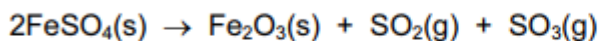
.....
.....
.....
..... [3]

(ii) How many moles of SiBr_4 are formed?

..... [1]

Oct/Nov 2009

- (c) 9.12 g of anhydrous iron(II) sulfate was heated. Calculate the mass of iron(III) oxide formed and the volume of sulfur trioxide, at r.t.p., formed.



mass of one mole of $\text{FeSO}_4 = 152 \text{ g}$

number of moles of FeSO_4 used =

number of moles of Fe_2O_3 formed =

mass of one mole of $\text{Fe}_2\text{O}_3 = \dots\dots\dots \text{ g}$

mass of iron(III) oxide formed =

number of moles of SO_3 formed =

volume of sulfur trioxide formed =

[6]