QUANTITATIVE EQ BOOKLET 1

ANSWERS

EMPIRICAL FORMULA

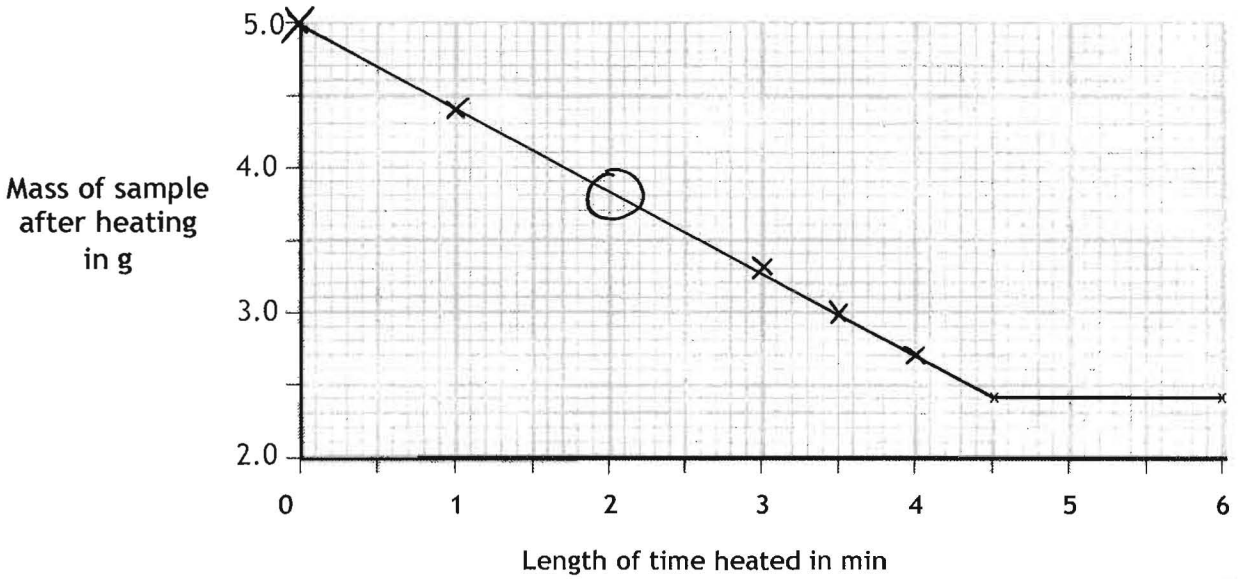
1. Lansfordite is the common name for a form of hydrated magnesium carbonate, $MgCO_3.xH_2O$. Its formula shows that lansfordite contains water of crystallisation. When a sample of lansfordite is heated gently, the water of crystallisation is given off and eventually anhydrous magnesium carbonate is left.

A teacher gave 5.0 g samples of powdered lansfordite to some students and told each student to heat the sample, then to let it cool and reweigh it.

The students heated the samples for different times. The teacher recorded their results in a table.

Length of time heated in min	0.0	1.0	3.0	3.5	4.0	5.0	6.0
Mass of sample after heating in g	5.0	4.4	3.3	3.0	2.7	2.4	2.4

(a) Plot a graph of these results on the grid. The last two results have been plotted for you.
Draw a straight line of best fit through the points you have plotted.



(3)

(b) Use your graph to predict the mass of a sample after heating for 2.0 minutes.

(1)

Ans. in range 3·8 – 3·9 g

(c) Suggest why the masses of the samples after heating for 4.5 minutes and after heating for 6.0 minutes were the same.

(1)

all water lost / same amount of water lost.

(d) The teacher told one of the students that the amount of hydrated salt in a sample of lansfordite was 0.030 mol, and that the amount of water lost on heating was 0.15 mol.

Calculate the value of x in the formula $MgCO_3.xH_2O$

Ratio $MgCO_3$: H_2O (1)

$0.03 : 0.15$

$\Rightarrow \frac{0.03}{0.03} : \frac{0.15}{0.03}$ $\therefore x = 5$

$\Rightarrow 1 : 5$

(e) When anhydrous magnesium carbonate is heated strongly it decomposes. The equation for the reaction is:

0.03 mole ? vol

$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$

Calculate the volume, in dm^3, of carbon dioxide formed when 0.030 mol of anhydrous magnesium carbonate is completely decomposed.

(You may assume that the molar volume of a gas is 24 dm^3)

(2)

Ratio $MgCO_3$: CO_2

$\Rightarrow 1 : 1$

$\therefore 0.03 : 0.03$

- Volume $= n \times 24 \Rightarrow 0.03 \times 24$
- $= 0.72\ (dm^3)$

Total 8 marks

TOTAL MARKS

(2) Analysis of another rock showed that it contained an oxide of tin in which 3.57 g of tin was combined with 0.96 g of oxygen.

(i) Calculate the empirical formula of the tin oxide present in the rock.
(Relative atomic masses: O = 16, Sn = 119)

Elements	Sn	O
Masses	3.57 g	0.96 g
(1) Moles	$\frac{3.57}{119}$	$\frac{0.96}{16}$
	$\Rightarrow 0.03$	0.06
(1)	$\Rightarrow 1$	$= 2$

(1) $\therefore SnO_2$ (3)

(3) Ammonium sulphate is used to supply plants with increased levels of nitrogen. Calculate the relative formula mass of ammonium sulphate, $(NH_4)_2SO_4$, and hence the percentage by mass of nitrogen (N) in this compound.
(Relative atomic masses: H = 1.0; N = 14; O = 16; S = 32)

$(NH_4)_2SO_4 = 2(N) + 8(H) + S + 4(O)$

$= 2(14) + 8(1) + 32 + 4(16)$

(1) $= 28 + 8 + 32 + 64 = 132$

(1) $\%\ N = \frac{28}{132} \times 100$

(1) $= 21.2\%$ (3)

(4) When chlorine reacts with concentrated sodium hydroxide solution, a compound is formed that contains 21.6% by mass of sodium and 33.3% by mass of chlorine. The rest is oxygen. Calculate the empirical formula of this compound.

(4)

- $\%\ O = 100 - 21.6 - 33.3 = 45.1\%$

Elements	Na	Cl	O
Mass	21.6 g	33.3 g	45.1 g
• Moles	$\frac{21.6}{23} = 0.939$	$\frac{33.3}{35.5} = 0.938$	$\frac{45.1}{16} = 2.82$
Ratio	$\frac{0.939}{0.938}$	$\frac{0.938}{0.938}$	$\frac{2.82}{0.938}$
•	$\Rightarrow 1$	$\Rightarrow 1$	$\Rightarrow 3$

• $\therefore NaClO_3$

..... tonnes [3]