Activity 3F: Water of crystallisation

Ans p. 14

1. A 2.07 g sample of hydrated sodium carbonate is heated strongly to determine the water of crystallisation. The final mass of the anhydrous salt is 0.77 g.

a. Calculate the moles of sodium carbonate left after the water has been driven off.
$M(Na_2CO_3) = 106.0$ g mol^{-1}

b. Calculate the moles of water lost and hence the formula of the hydrated salt.

2. Calcium chloride is often used as a drying agent, since it can absorb water from the atmosphere to become hydrated (i.e. forms $CaCl_2 \cdot xH_2O$).

5.00 g of anhydrous calcium chloride was used as a drying agent until it could absorb no more water. The hydrated crystals had a mass of 9.86 g. Calculate the formula of the hydrated salt. $M(CaCl_2) = 111.1$ g mol^{-1}, $M(H_2O) = 18.0$ g mol^{-1}

3. To find the formula of the hydrated salt $Na_2S_2O_3 \cdot xH_2O$, the following data were collected:

- mass of crucible and lid 20.26 g
- mass of crucible, lid and hydrated salt 25.58 g
- mass after heating to constant mass 23.66 g

Calculate the formula of the hydrated salt.

$M(Na_2S_2O_3) = 158$ g mol^{-1}, $M(H_2O) = 18.0$ g mol^{-1}

ESA PUBLICATIONS ISBN 978-0-947504-92-2

Activity 3F: Water of crystalisation (page 13)

1. a. $m(Na_2CO_3) = 0.77\ g$ $\quad n(Na_2CO_3) = \dfrac{0.77\ g}{106\ g\ mol^{-1}} = 0.00726\ mol$

b. $m(H_2O) = 2.07\ g - 0.77\ g = 1.30\ g$

$$n(H_2O) = \frac{1.30\ g}{18.0\ g\ mol^{-1}} = 0.0722\ mol$$

$$n(Na_2CO_3) : n(H_2O) = 0.00726 : 0.0722$$
$$= 1 : 10$$

Formula $Na_2CO_3 \cdot 10H_2O$

2. $m(CaCl_2) = 5.00\ g$ $\quad n(CaCl_2) = \dfrac{5.00\ g}{111.1\ g\ mol^{-1}} = 0.0450\ mol$

$m(H_2O) = 9.86\ g - 5.00\ g = 4.86\ g$

$$n(H_2O) = \frac{4.86\ g}{18.0\ g\ mol^{-1}} = 0.270\ mol$$

$$n(CaCl_2) : n(H_2O) = 0.0450 : 0.270$$
$$= 1 : 6$$

Formula $CaCl_2 \cdot 6H_2O$

3. $m(Na_2S_2O_3) = 23.66\ g - 20.26\ g = 3.40\ g$

$$n(Na_2S_2O_3) = \frac{3.40\ g}{158\ g\ mol^{-1}} = 0.0215\ mol$$

$m(H_2O) = 25.58 - 23.66\ g = 1.92\ g$

$$n(H_2O) = \frac{1.92\ g}{18.0\ g\ mol^{-1}} = 0.107\ mol$$

$n(Na_2S_2O_3) : n(H_2O) = 0.0215 : 0.107 = 1 : 4.98$

Formula $Na_2S_2O_3 \cdot 5H_2O$

ESA PUBLICATIONS *ISBN 978-0-947504-92-2*