Chapter 1: Moles and equations

Homework marking scheme

In these questions the main formulae used are $n = \frac{V}{24000}$ for gases and $n = \frac{m}{A_r}$ for solids.

1 **a** **i** $n(H_2) = \frac{300}{24000} = 1.25 \times 10^{-2}$ mol [1]

ii $n(Ca) = n(H_2) = 1.25 \times 10^{-2}$ mol [1]

iii 1 mark for formula $A_r = \frac{m}{n}$ [1]

The second mark is for using the values and calculating the A_r;

$A_r = \frac{0.52}{1.25 \times 10^{-2}} = 41.6$ [1]

b **i** $n(HCl) = 25.8 \times 10^{-3} \times 1$ (using $n = c \times V$) [1]

ii From equation, $n(Ca(OH)_2) = n(Ca) = ½\, n(HCl) = 1.29 \times 10^{-2}$

1 mark for the relationship and 1 mark for the calculation [2]

iii 1 mark is for $A_r = \frac{m}{n}$

The second mark is for using the values and calculating the A_r;

$A_r = \frac{0.52}{1.29 \times 10^{-2}} = 40.3$ [2]

c $A_r = \frac{(40 \times 96.97) + (42 \times 0.64) + (43 \times 0.15) + (44 \times 2.06) + (46 \times 0.003) + (48 \times 0.19)}{100}$

$= 40.12$

1 mark for formula, 1 mark for 40.1 and 1 mark for the second decimal place [3]

d **i** The titration is more accurate because it gave a result closer to the actual. [1]

ii Impurities on the sample of the calcium metal, such as calcium oxide. [1]

2 **a** The relative atomic mass is the weighted average mass of the (naturally occurring) atoms of an element [1]

compared with 1/12th [1]

the mass of an atom of carbon-12 [1]

b The isotope with a relative isotopic mass of 7 [1]

because the relative atomic mass is nearer 7 than 6

and it is the **weighted** average that is used [1]

c **i** $2Li(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2(g)$

1 mark for the correct symbols and formulae, 1 mark for the balancing [2]

ii $n(H_2) = \frac{V_{gas}}{24000} = \frac{245}{24000} = 1.02 \times 10^{-2}$ mol [1]

$n(Li) = 2 \times n(H_2) = 2 \times 1.02 \times 10^{-2} = 2.04 \times 10^{-2}$ mol [1]

$A_r = \frac{m}{n} = \frac{0.15}{2.04 \times 10^{-2}}$ [1]

$= 7.35$ (g mol^{-1}) [1]

d **i** Readings are 22.00; 21.55; 22.80; 21.55, use 21.55 cm^3
1 mark for all correct and 1 mark for giving all to 2 decimal places [2]

ii $n(\text{Li}) = n(\text{LiOH}) = n(\text{HCl})$ [1]
$n(\text{Li}) = 21.55 \times 10^{-3} \times 0.100 = 2.16 \times 10^{-3}$ mol [1]
This is one-tenth of the total amount of lithium hydroxide and therefore lithium (25 cm^3 out of total of 250 cm^3) [1]
Therefore, total amount of lithium = 2.16×10^{-2} mol [1]
$A_r(\text{Li}) = \frac{m}{n} = \frac{0.15}{2.16 \times 10^{-2}} = 6.94$ (g mol^{-1}) [1]

iii volumetric flask [1]
pipette [1]

3 **a** $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(l)$ [1]

b **i** $n(NaHCO_3) = \frac{m}{M_r} = \frac{0.42}{84}$ [1]
$= 5 \times 10^{-3}$ mol [1]

ii $n(CO_2) = \frac{48}{24000} = 2 \times 10^{-3}$ mol [1]

iii The actual number of moles of sodium hydrogencarbonate can be found from the equation:
$n(NaHCO_3) = 2 \times n(CO_2) = 4 \times 10^{-3}$ mol
1 mark for using the equation and 1 mark for the calculation [2]

iv Percentage purity = actual number of moles of $NaHCO_3$/number of moles weighed out
$= \frac{0.004}{0.005} \times 100\% = 80\%$
1 mark for the relationship and 1 mark for the calculation [2]

c $n(Na_2CO_3) = ½ \times n(NaHCO_3)$ [1]
$= ½ \times 4 \times 10^{-3} = 2 \times 10^{-3}$ mol [1]

d $n(HCl) = 2 \times n(Na_2CO_3) = 4 \times 10^{-3}$ mol [1]
$V(HCl)_l = \frac{n}{C} = \frac{4 \times 10^{-3}}{0.2} = 20 \times 10^{-3}$ dm^3 (= 20 cm^3) [1]