Mark schemes compress a calculation to "C1 A1". These are written the way you should write them: convert to moles first, use the BALANCED equation for the ratio, then convert back – and show every step, because the method marks survive an arithmetic slip. 官方答案只写 *C1 A1;* 这里完整写出*:* 先换算摩尔、按配平方程取比例、再换算回去。

Moles and masses

Calculate the mass of magnesium oxide formed when 4.8 g of magnesium burns completely in oxygen. (A_r: Mg = 24, O = 16) [4]

The equation is $2Mg + O_2 \rightarrow 2MgO$. Moles of Mg $= \frac{4.8}{24} = 0.20$ mol. From the equation the ratio Mg : MgO is 2 : 2, so moles of MgO = 0.20 mol. $M_r(MgO) = 24 + 16 = 40$, so mass $= 0.20 \times 40 = 8.0$ g.

Convert to moles FIRST. Working with masses in the ratio gives 4.8 g and is the standard error.

The ratio comes from the balanced equation, not from the formula. Writing the equation is itself a mark.

25.0 cm^3 of 0.100 mol/dm^3 sodium hydroxide is neutralised by 20.0 cm^3 of hydrochloric acid. Calculate the concentration of the acid. [4]

Moles of NaOH $= c \times \frac{V}{1000} = 0.100 \times \frac{25.0}{1000} = 2.50 \times 10^{-3}$ mol. The equation $NaOH + HCl \rightarrow NaCl + H_2O$ gives a 1 : 1 ratio, so moles of HCl $= 2.50 \times 10^{-3}$ mol. Concentration $= \frac{n}{V} = \frac{2.50 \times 10^{-3}}{20.0/1000} = 0.125$ mol/dm^3.

Divide the volume in cm^3 by 1000 to get dm^3. Forgetting this is worth two marks and gives an answer out by a factor of 1000.

State the 1 : 1 ratio explicitly – in a titration question it is a mark, even though it looks obvious.

A sample of copper(II) sulfate crystals, $CuSO_4 \cdot 5H_2O$, has mass 5.00 g. Calculate the mass of water it contains. (M_r: $CuSO_4 = 160$, $H_2O = 18$) [3]

M_r of the hydrated salt $= 160 + (5 \times 18) = 160 + 90 = 250$. The fraction that is water $= \frac{90}{250} = 0.36$. Mass of water $= 0.36 \times 5.00 = 1.8$ g.

Multiply the water's M_r by 5 BEFORE adding – using 18 alone gives 178 and everything after is wrong.

The fraction method avoids a second mole calculation and is less error-prone under time pressure.

Yield, gases and electrolysis

In a reaction the theoretical yield of product is 12.0 g but only 9.0 g is obtained. Calculate the percentage yield, and give one reason it is less than 100%. [3]

Percentage yield $= \frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{9.0}{12.0} \times 100 = 75\%$. It is less than 100% because some product is lost during transfer and filtration.

Actual over theoretical, not the reverse – an answer above 100% always signals this error.

'The reaction did not finish' is also accepted, but 'human error' is not; name a specific loss.

Calculate the volume of carbon dioxide, at room temperature and pressure, produced when 10.0 g of calcium carbonate decomposes completely. (Molar gas volume = 24 dm^3/mol; $M_r(\mathbf{CaCO_3}) = 100$) [4]

$CaCO_3 \rightarrow CaO + CO_2$. Moles of $CaCO_3 = \dfrac{10.0}{100} = 0.100$ mol. The ratio is $1:1$, so moles of $CO_2 = 0.100$ mol. Volume $= 0.100 \times 24 = 2.4$ dm^3.

The molar gas volume is given on the paper; using 22.4 (the value at STP) instead is a common substitution error.

Give the unit as dm^3 – an answer in cm^3 needs multiplying by 1000 and must say so.

During the electrolysis of molten lead(II) bromide, write the equation for the reaction at each electrode. [4]

At the cathode (negative), lead ions gain electrons: $Pb^{2+} + 2e^- \rightarrow Pb$. At the anode (positive), bromide ions lose electrons: $2Br^- \rightarrow Br_2 + 2e^-$.

Cathode is reduction (gain of electrons), anode is oxidation. Reversing them loses both marks.

Balance the charges as well as the atoms – the electrons must make each side's total charge equal.