

9 Calculations from chemical equations

Answers to end-of-chapter questions

Pages 163–164 Questions

1. molar mass of $\text{Fe}_2(\text{SO}_4)_3 = [2 \times 55.8] + 3 \times [32.1 + (4 \times 16.0)] = 399.9 \text{ g mol}^{-1}$
molar mass of $\text{Fe}(\text{OH})_3 = 55.8 + (3 \times 17.0) = 106.8 \text{ g mol}^{-1}$
amount of $\text{Fe}_2(\text{SO}_4)_3$ (in moles) = mass/molar mass = $12.7 \text{ g}/399.9 \text{ g mol}^{-1} = 0.03176 \text{ mol}$
moles $\text{Fe}(\text{OH})_3$ = moles $\text{Fe}_2(\text{SO}_4)_3 \times$ number of $\text{Fe}(\text{OH})_3$ in equation/number of $\text{Fe}_2(\text{SO}_4)_3$ in equation
= $0.03176 \text{ mol} \times 2 = 0.06352 \text{ mol}$
mass of $\text{Fe}(\text{OH})_3$ = moles $\times$ molar mass = $0.06352 \text{ mol} \times 106.8 \text{ g mol}^{-1} = 6.78 \text{ g}$

[e] It is a good idea to work out the molar masses of the two substances involved before starting the rest of the calculation.

2. molar mass of $\text{AgNO}_3 = 107.9 + 14.0 + (3 \times 16.0) = 169.9 \text{ g mol}^{-1}$
amount (in moles) of AgNO_3 = mass/molar mass = $12.6 \text{ g}/169.9 \text{ g mol}^{-1} = 0.07416 \text{ mol}$
ratio of $\text{Cu}:\text{AgNO}_3 = 1:2$
so, amount of copper = $\frac{1}{2} \times 0.07416 = 0.03708 \text{ mol}$
mass of copper needed = moles $\times$ molar mass
= $0.03708 \text{ mol} \times 63.5 \text{ g mol}^{-1} = 2.35 \text{ g}$

[e] The answer 2.35 g was obtained keeping all the numbers on the calculator during the calculation. If the rounded up value of 0.0371 mol is used, the answer 2.36 g is obtained. Either would score full marks.

A common error is to calculate the molar mass of AgNO_3 as $2 \times 170 \text{ g mol}^{-1}$ because there are 2 moles of it in the equation. This is wrong. The number of moles of a substance depends only on its mass and not on the reaction. The stoichiometry comes into play when moles of one substance are converted to moles of another substance. This type of calculation can be done either by mass ratio or by converting to moles, then using the reaction stoichiometry and finally converting back to mass. The second method fits all types of calculation, so is the better one to use.

3. molar mass of $\text{NaNO}_3 = 23.0 + 14.0 + (3 \times 16.0) = 85.0 \text{ g mol}^{-1}$
amount of NaNO_3 = mass/molar mass = $33.3 \text{ g}/85.0 \text{ g mol}^{-1} = 0.392 \text{ mol}$
ratio of $\text{O}_2:\text{NaNO}_3 = 1:2$
so, amount of oxygen = $\frac{1}{2} \times 0.392 = 0.196 \text{ mol}$
volume of oxygen = moles $\times$ molar volume
= $0.196 \text{ mol} \times 25.0 \text{ dm}^3 \text{ mol}^{-1}$
= 4.90 dm^3
4. ratio of $\text{NH}_3:\text{H}_2 = 2:3$

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