Solutions

Each answer shows the steps, then the **result**.

2.1

- moles $CaCO_3 = 10/100 = 0.10$; ratio 1:1
- 0.10 mol CO_2; $m = 0.10 \times 44 = 4.4$ g

2.2

- $V = 0.50 \times 24.0 = 12\ \mathrm{dm^3}$

2.3

- $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$, so the volume ratio is $1:5$; $50 \times 5 = 250\ \mathrm{cm^3}$

2.4

- Percentage yield compares the product actually obtained with the theoretical maximum, so it measures how well the reaction ran; atom economy compares the mass of the desired product with the total mass of all products, and is fixed by the equation itself

2.5

- N_2: $\dfrac{0.40}{1} = 0.40$; H_2: $\dfrac{0.90}{3} = 0.30$; the smaller value is hydrogen, so hydrogen is limiting

3.1 B

- Ratio $CH_4 : CO_2$ is 1:1, so 24 $\mathrm{cm^3}$ of CO_2

3.2 A

- $0.30/2 = 0.15$ for H_2 vs $0.20/1 = 0.20$ for O_2; H_2 gives the smaller value, so hydrogen is limiting

3.3

(a)

- $n = 0.100 \times 0.0200 = 2.00 \times 10^{-3}$ mol

(b)

- ratio H_2SO_4 : NaOH is 1:2, so moles $H_2SO_4 = 1.00 \times 10^{-3}$; $c = n/V = 1.00 \times 10^{-3}/0.0250 = 0.0400\ \mathrm{mol\ dm^{-3}}$

3.4

- $\dfrac{8.0}{12.8} \times 100 = 62.5\%$

3.5

(a)

- $n(N_2) = \dfrac{2800}{28.0} = 100$ mol; $n(H_2) = \dfrac{750}{2.0} = 375$ mol

(b)

- N_2: $\dfrac{100}{1} = 100$; H_2: $\dfrac{375}{3} = 125$; nitrogen gives the smaller value, so nitrogen is limiting

(c)

- Ratio $N_2 : NH_3 = 1 : 2$, so $n(NH_3) = 200$ mol; $M_r(NH_3) = 17.0$; $m = 200 \times 17.0 = 3400$ g $= 3.40$ kg

(d)

- $\dfrac{1.02}{3.40} \times 100 = 30.0\%$

(e)

- Ammonia is the only product, so the atom economy is 100%; every atom of both reactants ends up in the desired product, which is characteristic of an addition or combination reaction

(f)

- Hydrogen used $= 3 \times 100 = 300$ mol, so $375 - 300 = 75$ mol remains; $V = 75 \times 24.0 = 1800$ dm^3