Chapter 13

Answers to Questions

1.

Strategy	Relationship
Mass Na_2SO_4 → mol Na_2SO_4	1 mol ≡ 142.1 g
Mol/vol → conc	c = n/V

$$\text{Mol } Na_2SO_4 = 40.0 \text{ g } Na_2SO_4 \times \left(\frac{1 \text{ mol}}{142.1 \text{ g}}\right) = 0.281 \text{ mol } Na_2SO_4$$

$$\text{Concentration} = \frac{0.281 \text{ mol}}{0.5000 \text{ L}} = 0.562 \text{ mol} \cdot \text{L}^{-1}$$

2.

Strategy	Relationship
Mass $Fe(NO_3)_3$ → mol $Fe(NO_3)_3$	1 mol ≡ 241.8 g
Mol/vol → conc	c = n/V

$$\text{Mol } Fe(NO_3)_3 = 0.850 \text{ g } Fe(NO_3)_3 \times \left(\frac{1 \text{ mol}}{241.8 \text{ g}}\right) = 3.52 \times 10^{-3} \text{ mol } Fe(NO_3)_3$$

$$\text{Concentration} = \frac{3.52 \times 10^{-3} \text{ mol}}{2.50 \times 10^{-2} \text{ L}} = 0.141 \text{ mol} \cdot \text{L}^{-1}$$

3.

Strategy	Relationship
Vol/conc → mol	n = c × V
Mol $MgCl_2$ → mass $MgCl_2$	1 mol ≡ 95.2 g

$$\text{Mol} = 1.50 \text{ mol} \cdot \text{L}^{-1} \times 0.125 \text{ L} = 0.188 \text{ mol}$$

$$\text{Mass } MgCl_2 = 0.188 \text{ mol } MgCl_2 \times \left(\frac{95.2 \text{ g}}{1 \text{ mol}}\right) = 17.9 \text{ g } MgCl_2$$

4.

Strategy	Relationship
Vol/conc → mol	$n = c \times V$
Mol $Cu(NO_3)_2$ → mass $Cu(NO_3)_2$	1 mol ≡ 187.5 g

$$\text{Mol} = 2.25\ \text{mol} \cdot \text{L}^{-1} \times 0.125\ \text{L} = 0.281\ \text{mol}$$

$$\text{Mass } Cu(NO_3)_2 = 0.281\ \text{mol } Cu(NO_3)_2 \times \left(\frac{187.5\ \text{g}}{1\ \text{mol}}\right) = 52.7\ \text{g } Cu(NO_3)_2$$

5.

Strategy	Relationship
Mass $AlCl_3$ → mol $AlCl_3$	1 mol ≡ 133.5 g
Mol $AlCl_3$ → mol Cl^-	1 mol $AlCl_3$ ≡ 3 mol Cl^-
Mol/vol → conc	c = n/V

$$\text{Mol } AlCl_3 = 5.64\ \text{g } AlCl_3 \times \left(\frac{1\ \text{mol}}{133.5\ \text{g}}\right) = 4.22 \times 10^{-2}\ \text{mol } AlCl_3$$

$$\text{Mol } Cl^- = 4.22 \times 10^{-2}\ \text{mol } AlCl_3 \times \left(\frac{3\ \text{mol } Cl^-}{1\ \text{mol } AlCl_3}\right) = 0.127\ \text{mol } Cl^-$$

$$\text{Concentration} = \frac{0.127\ \text{mol}}{2.00\ \text{L}} = 6.34 \times 10^{-2}\ \text{mol} \cdot \text{L}^{-1}$$

6.

Strategy	Relationship
Mass K_2CO_3 → mol K_2CO_3	1 mol ≡ 138.2 g
Mol K_2CO_3 → mol K^+	1 mol K_2CO_3 ≡ 2 mol K^+
Mol/vol → conc	c = n/V

$$\text{Mol } K_2CO_3 = 12.4\ \text{g } K_2CO_3 \times \left(\frac{1\ \text{mol}}{138.2\ \text{g}}\right) = 8.97 \times 10^{-2}\ \text{mol } K_2CO_3$$

$$\text{Mol } K^+ = 8.97 \times 10^{-2} \text{ mol } K_2CO_3 \times \left(\frac{2 \text{ mol } K^+}{1 \text{ mol } K_2CO_3}\right) = 0.179 \text{ mol } K^+$$

$$\text{Concentration} = \frac{0.179 \text{ mol}}{1.25 \text{ L}} = 0.144 \text{ mol} \cdot \text{L}^{-1}$$

7.

Strategy	Relationship
Vol/conc → mol	$n = c \times V$
Mol $AgNO_3$ → mass $AgNO_3$	1 mol ≡ 169.9 g

$$\text{Mol} = 0.1000 \text{ mol} \cdot \text{L}^{-1} \times 0.2500 \text{ L} = 2.500 \times 10^{-2} \text{ mol}$$

$$\text{Mass } AgNO_3 = 2.500 \times 10^{-2} \text{ mol } AgNO_3 \times \left(\frac{169.9 \text{ g}}{1 \text{ mol}}\right) = 4.248 \text{ g } AgNO_3$$

8.

Strategy	Relationship
Vol/conc → mol	$n = c \times V$
Mol $KMnO_4$ → mass $KMnO_4$	1 mol ≡ 158.0 g

$$\text{Mol} = 0.2000 \text{ mol} \cdot \text{L}^{-1} \times 0.1000 \text{ L} = 2.000 \times 10^{-2} \text{ mol}$$

$$\text{Mass } KMnO_4 = 2.000 \times 10^{-2} \text{ mol } KMnO_4 \times \left(\frac{158.0 \text{ g}}{1 \text{ mol}}\right) = 3.160 \text{ g } KMnO_4$$

9. Only for dilution problems, the following short-cut formula can be used:

$$c_{conc} \times v_{conc} = c_{dil} \times v_{dil}$$

$$c_{dil} = \frac{c_{conc} \times v_{conc}}{v_{dil}} = \frac{(16.0 \text{ mol} \cdot \text{L}^{-1}) \times (2.50 \times 10^{-2} \text{ L})}{1.00 \text{ L}} = 0.400 \text{ mol} \cdot \text{L}^{-1}$$

10. Only for dilution problems, the following short-cut formula can be used:

$$c_{conc} \times v_{conc} = c_{dil} \times v_{dil}$$

$$c_{dil} = \frac{c_{conc} \times v_{conc}}{v_{dil}} = \frac{(5.00\ \text{mol} \cdot \text{L}^{-1}) \times (5.00 \times 10^{-2}\ \text{L})}{0.2500\ \text{L}} = 1.00\ \text{mol} \cdot \text{L}^{-1}$$

11. Only for dilution problems, the following short-cut formula can be used:

$$c_{conc} \times v_{conc} = c_{dil} \times v_{dil}$$

$$v_{conc} = \frac{c_{dil} \times v_{dil}}{c_{conc}} = \frac{(1.00\ \text{mol} \cdot \text{L}^{-1}) \times (0.2500\ \text{L})}{6.00\ \text{mol} \cdot \text{L}^{-1}} = 4.17 \times 10^{-2}\ \text{L} = 41.7\ \text{mL}$$

12. Only for dilution problems, the following short-cut formula can be used:

$$c_{conc} \times v_{conc} = c_{dil} \times v_{dil}$$

$$v_{dil} = \frac{c_{conc} \times v_{conc}}{c_{dil}} = \frac{(5.00\ \text{mol} \cdot \text{L}^{-1}) \times (5.00 \times 10^{-2}\ \text{L})}{1.00\ \text{mol} \cdot \text{L}^{-1}} = 0.250\ \text{L} = 250.\ \text{mL}$$