Molarity Review

1. Calculate the molarity of the following solutions.
   a) 1.00 L of a solution contains 0.260 mol of hydrochloric acid.

$C = \frac{n}{V} = \frac{0.260\ mol}{1.00\ L} = \boxed{0.260\ mol/L}$

   b) 250.0 mL of a solution contains 25.0 g of sodium chloride. $NaCl$

$mol = \frac{25.0\ g}{58.44377\ g/mol} = 0.428\ mol \qquad \frac{0.428\ mol}{0.2500\ L} = \boxed{1.71\ mol/L}$

   c) 600.0 mL of a solution contains 1.50 g of calcium carbonate. $CaCO_3$

$\frac{1.50\ g}{100.0872\ g/mol} = 0.0150\ mol \qquad \frac{0.0150\ mol}{0.6000\ L} = \boxed{0.0250\ mol/L}$

   d) 325 mL of a solution contains 10.0 g of chromium(III) nitrate nonahydrate. $Cr(NO_3)_3 \cdot 9H_2O$

$\frac{10.0\ g}{400.14822\ g/mol} = 0.0250\ mol \qquad \frac{0.0250\ mol}{0.325\ L} = \boxed{0.0769\ mol/L}$

   e) 50.0 mL of a solution contains 15.6 g of ammonium sulfate. $(NH_4)_2SO_4$

$\frac{15.6\ g}{132.14052\ g/mol} = 0.118\ mol \qquad \frac{0.118\ mol}{0.0500\ L} = \boxed{2.36\ mol/L}$

2. How would you prepare the following solutions?
   a) 1.00 L of 3.00 M ammonium chloride. NH_4Cl

$mol = C \cdot V = (3.00\ mol/L)(1.00\ L) = 3.00\ mol$

$(3.00\ mol)(53.49146\ g/mol) = 160.\ g$

dissolve 160. g in 1.00 L of sol'n

   b) 500.0 mL of 0.250 mol/L mercury(II) nitrate. $Hg(NO_3)_2$

$(0.5000\ L)(0.250\ mol/L) = 0.125\ mol$

$(0.125\ mol)(324.5998\ g/mol) = 40.6\ g$

dissolve 40.6 g $Hg(NO_3)_2$ in 500.0 mL of sol'n

c) 125.0 mL of 0.500 kmol/m^3 barium nitrate. $Ba(NO_3)_2$

$(0.1250\ L)(0.500\ mol/L) = 0.0625\ mol$

$(0.0625\ mol)(261.3398\ g/mol) = 16.3\ g$

16.3 g of $Ba(NO_3)_2$ in 125.0 mL sol'n

d) 250.0 cm^3 of 0.100 mol/dm^3 antimony(III) chloride. $SbCl_3$

$(0.2500\ dm^3)(0.100\ mol/dm^3) = 0.0250\ mol$

$(0.0250\ mol)(228.109\ g/mol) = 5.70\ g$

5.70 g $SbCl_3$ in 250.0 cm^3 sol'n

3. What volume of 2.40 kmol/m^3 aluminum chloride can be made from 100.0 g of aluminum chloride? $AlCl_3$

$\frac{100.0\ g}{133.34054\ g/mol} = 0.750\ mol$

$C = \frac{n}{V}$ $\quad V = \frac{n}{C} = \frac{0.750\ mol}{2.40\ mol/L}$

$= \boxed{0.312\ L}$

4. What volume of 2.80×10^{-2} M sodium fluoride contains 0.150 g of sodium fluoride? NaF

$\frac{0.150\ g}{41.988173\ g/mol} = 0.00357\ mol$ $\quad V = \frac{0.00357\ mol}{2.80 \times 10^{-2}\ mol/L} = \boxed{0.128\ L}$

5. If 20.0 mL of 0.750 mol/dm^3 hydrobromic acid is diluted to a final volume of 90.0 mL, what is the molar concentration of the hydrobromic acid in the resulting solution?

$C_1V_1 = C_2V_2$ $\quad C_2 = \frac{(0.750\ mol/L)(0.0200\ L)}{(0.0900\ L)}$

$= \boxed{0.167\ mol/L}$

6. What is the molar concentration of the potassium hydroxide solution resulting from the mixture of 50.0 mL of 0.150 M potassium hydroxide and 75.0 mL of 0.250 M potassium hydroxide?

$C_{mixture} = \frac{n_{total}}{V_{total}} = \frac{C_aV_a + C_bV_b}{V_a + V_b} = \frac{(0.150\ M)(50.0\ mL) + (0.250\ M)(75.0\ mL)}{(50.0\ mL + 75.0\ mL)}$

$= \frac{7.5\ mmol + 18.75\ mmol}{125\ mL}$

$= 0.210\ \frac{mmol}{mL} = \boxed{0.210\ \frac{mol}{L}}$

7. If one drop (0.0500 mL) of 0.200 kmol/m^3 sodium bromide is added to 100.0 mL of water, what is [NaBr] in the resulting solution. 0.0000500 L

$C_1V_1 = C_2V_2$ $\quad C_2 = \dfrac{(0.200\ \text{mmol/mL})(0.0500\ \text{mL})}{100.05\ \text{mL}} = 9.995 \times 10^{-5}$

$0.10005\ \text{L}$ $\quad = \boxed{1.00 \times 10^{-4}\ \text{mol/L}}$

8. The density of pure water at 4°C is 1.00 kg/L. What is the molar concentration of water in pure water?

$\dfrac{1000\ \text{g}}{18.01528\ \text{g/mol}} = 55.5\ \text{mol}$ $\quad C = \dfrac{55.5\ \text{mol}}{1.00\ \text{L}} = \boxed{55.5\ \text{mol/L}}$

9. Concentrated nitric acid is 15.4 kmol/m^3. How would you prepare 2.50 L of 0.375 kmol/m^3 nitric acid?

$C_1V_1 = C_2V_2$ $\quad V_1 = \dfrac{C_2V_2}{C_1} = \dfrac{(0.375\ \text{M})(2.50\ \text{L})}{15.4\ \text{M}} = 0.0609\ \text{L}$

Dilute 60.9 mL of 15.4 M HNO_3 to a final volume of 2.50 L

10. If 300.0 mL of solution A contains 25.0 g of potassium chloride and 250.0 mL of solution B contains 60.0 g of potassium chloride, what is the molar concentration of the potassium chloride solution resulting from the mixture of solutions A and B? KCl

$C_{mix} = \dfrac{\text{total mol}}{\text{total vol}} = \dfrac{1.14\ \text{mol}}{0.5500\ \text{L}} = \boxed{2.07\ \text{mol/L}}$

$\text{mol} = \dfrac{85.0\ \text{g}}{74.5513\ \text{g/mol}} = 1.14\ \text{mol}$

*11. Solution A is 0.475 M sodium hydroxide. Solution B also contains sodium hydroxide. When 250.0 mL of solution A is mixed with 400.0 mL of solution B, the resulting solution is 0.325 M sodium hydroxide. What is the molar concentration of solution B?

$C_{total} = \frac{n_{total}}{V_{total}}$

$C_{AB} = \frac{C_A V_A + C_B V_B}{V_A + V_B}$

$0.325\ M = \frac{(0.475\ M)(0.2500\ L) + C_B(0.4000\ L)}{0.2500\ L + 0.4000\ L}$

$0.325\ M = \frac{0.11875\ mol + (.4\ L)(C_B)}{0.6500\ L}$

$0.21125\ mol = 0.11875\ mol + (0.4\ L)C_B$

$0.0925\ mol = (0.4000\ L)C_B$

$C_B = \boxed{0.231\ mol/L}$

*12. Solution X is 0.135 M sodium chloride. Solution Y also contains sodium chloride. When 55.0 mL of solution X is mixed with 125 mL of solution Y, the resulting solution is 0.165 M sodium chloride. How many grams of sodium chloride are contained in 300.0 mL of solution Y?

$0.165\ M = \frac{(0.135\ M)(0.0550\ L) + C_Y(0.125\ L)}{0.125 + 0.055}$

$0.165 M = \frac{0.007425\ mol + (0.125\ L)(C_Y)}{0.180\ L}$

$0.0297\ mol = 0.007425\ mol + 0.125\ L \cdot C_Y$

$0.022275\ mol = 0.125\ L \cdot C_Y$

$C_Y = 0.1782\ mol/L$

Y mol $= (0.1782\ M)(0.300\ L)$
$= 0.05346\ mol$

$0.05346\ mol \cdot 58.44277\ g/mol$
$= \boxed{3.12\ g}$

*13. Solution X is 0.125 M barium nitrate and solution Y is 1.50 M barium nitrate. What volume of solution Y must be added to 250.0 mL of solution X in order to produce a 0.500 M barium nitrate solution.

$0.500\ M = \frac{(0.125\ M)(0.2500\ L) + (1.50\ M)(V_Y)}{0.2500 + V_Y}$

$0.125\ mol + 1.5\ M\ V_Y = 0.03125\ mol + 1.5\ V_Y$

$0.09375\ mol = 1.00\ mol/L \cdot V_Y$

$V_Y = 0.09375\ L$

$\therefore \boxed{93.8\ mL\ of\ sol'n\ Y}$