Exercise 1

Calculate the molarity of a solution prepared by dissolving 11.5 g of solid NaOH in enough water to make 1.50 L of solution.

$$11.5\ g\ NaOH \left| \frac{1\ mol\ NaOH}{40\ g\ NaOH} \right. = 0.288\ mol\ NaOH$$

$$[NaOH] = \frac{mol\ NaOH}{L\ soln} = \frac{0.288\ mol}{1.50\ L} = 0.192\ M\ NaOH$$

0.192 *M* NaOH

Exercise 2

Calculate the molarity of a solution prepared by dissolving 1.56 g of gaseous HC1 in enough water to make 26.8 mL of solution.

$$1.56\ g\ HCl \left| \frac{1\ mol\ HCl}{36.46\ g\ HCl} \right. = 0.0428\ mol\ HCl$$

$$[HCl] = \frac{mol\ HCl}{L\ soln} = \frac{0.0428\ mol}{0.0268\ L} = 1.60\ M\ HCl$$

1.60 *M* HC1

Exercise 3

Give the concentration of each type of ion in the following solutions

a. 0.50 *M* $Co(NO_3)_2$ $[Co^{2+}] = 1 \times 0.50\,M = 0.50\,M\ Co^{2+}$ $[NO_3^-] = 2 \times 0.50\,M = 1.0\,M\ NO_3^-$

b. 1 *M* $Fe(ClO_4)_3$

$[Fe^{3+}] = 1 \times 1\,M = 1\,M\ Fe^{3+}$ $[ClO_4^-] = 3 \times 1\,M = 3\,M\ ClO_4^-$

a. 0.50 *M* Co^{2+} and (2 × 0.50) *M* NO_3^- or 1.0 *M* NO_3^-
b. 1 *M* Fe^{3+} ions and 3 *M* ClO_4^- ions

Exercise 4

Calculate the number of moles of Cl^- ions in 1.75 L of 1.0×10^{-3} *M* $ZnCl_2$.

$M = \frac{mol}{L}$ $[Cl^-] = 2\,(1.0 \times 10^{-3}) = 2.0 \times 10^{-3}\,M\ Cl^-$

$mol = M \times L$

$mols\ Cl^- = (2.0 \times 10^{-3}\,M)(1.75\,L) = 3.5 \times 10^{-3}\ mol\ Cl^-$

3.5×10^{-3} mol Cl^-

Exercise 5

Typical blood serum is about 0.14 *M* NaC1. What volume of blood contains 1.0 mg NaC1?

$$1.0\ \text{mg NaCl} = 1.0 \times 10^{-3}\ \text{g NaCl} \left| \frac{1\ \text{mol NaCl}}{58.44\ \text{g NaCl}} \right. = 1.7 \times 10^{-5}\ \text{mol NaCl}$$

$$0.14\ \text{M NaCl} = \frac{1.7 \times 10^{-5}\ \text{mol NaCl}}{\text{L blood}}$$

$$= \boxed{1.2 \times 10^{-4}\ \text{L blood}}$$

0.12 mL of blood contains 1.7×10^{-5} mol NaC1 or 1.0 mg NaC1

Exercise 6

To analyze the alcohol content of a certain wine, a chemist needs 1.00 L of an aqueous 0.200 *M* $K_2Cr_2O_7$ (potassium dichromate) solution. How much solid $K_2Cr_2O_7$ must be weighed out to make this solution? [FYI – this was initially the "stuff" used for breathalyzers!]

$$\text{mols } K_2Cr_2O_7 = (0.200\ \text{M } K_2Cr_2O_7)(1.00\ \text{L}) = 0.200\ \text{mol } K_2Cr_2O_7$$

$$0.200\ \text{mol } K_2Cr_2O_7 \left| \frac{294.2\ \text{g } K_2Cr_2O_7}{1\ \text{mol } K_2Cr_2O_7} \right. = \boxed{58.8\ \text{g } K_2Cr_2O_7}$$

58.8 g $K_2Cr_2O_7$

Exercise 7 V_1 M_1 V_2 M_2

What volume of 16 *M* sulfuric acid must be used to prepare 1.5 L of a 0.10 *M* H_2SO_4 solution?

$M_1V_1 = M_2V_2$

$(16\ M)V_1 = (0.10\ M)(1.5\ L)$

$V_1 = 9.4 \times 10^{-3}\ L$

9.4 mL of acid

Exercise 10

Calculate the mass of solid NaC1 that must be added to 1.50 L of a 0.100 *M* $AgNO_3$ solution to precipitate all the Ag^+ ions in the form of AgC1.

$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

? g 1.50 L 0.100 M

$\text{mols } AgNO_3 = (0.100\ M)(1.50\ L) = 0.150 \text{ mols } AgNO_3$

$$0.150 \text{ mols } AgNO_3 \left| \frac{1 \text{ mol NaCl}}{1 \text{ mol } AgNO_3} \right| \frac{58.44 \text{ g NaCl}}{1 \text{ mol NaCl}} = 8.77 \text{ g NaCl}$$

8.77 g NaC1

Exercise 11

When aqueous solutions of Na_2SO_4 and $Pb(NO_3)_2$ are mixed, $PbSO_4$ precipitates. Calculate the mass of $PbSO_4$ formed when 1.25 L of 0.0500 *M* $Pb(NO_3)_2$ and 2.00 L of 0.0250 *M* Na_2SO_4 are mixed.

$Na_2SO_4 + Pb(NO_3)_2 \longrightarrow PbSO_4 + 2NaNO_3$

2.00 L, 0.0250 M — 1.25 L, 0.0500 M — ? g

$(0.0250\ M\ Na_2SO_4)(2.00\ L) = 0.0500\ mol\ Na_2SO_4 \left|\frac{1\ mol\ PbSO_4}{1\ mol\ Na_2SO_4}\right|\frac{303.26\ g\ PbSO_4}{1\ mol\ PbSO_4} = 15.2\ g\ PbSO_4$

$(0.0500\ M\ Pb(NO_3)_2)(1.25\ L) = 0.0625\ mol\ Pb(NO_3)_2 \left|\frac{1\ mol\ PbSO_4}{1\ mol\ Pb(NO_3)_2}\right|\frac{303.26\ g\ PbSO_4}{1\ mol\ PbSO_4} = 19.0\ g\ PbSO_4$

15.2 g $PbSO_4$

Exercise 12

What volume of a 0.100 *M* HC1 solution is needed to neutralize 25.0 mL of 0.350 *M* NaOH ?

$HCl + NaOH \longrightarrow NaCl + H_2O$

0.100 M, ? mL — 0.350 M, 25.0 mL

$mols\ NaOH = (0.350\ M\ NaOH)(0.025\ L) = 8.75 \times 10^{-3}\ mol\ NaOH$

$8.75 \times 10^{-3}\ mol\ NaOH \left|\frac{1\ mol\ HCl}{1\ mol\ NaOH}\right. = 8.75 \times 10^{-3}\ mol\ HCl$

$0.100\ M\ HCl = \frac{8.75 \times 10^{-3}\ mol}{L} \Rightarrow 8.75 \times 10^{-2}\ L \text{ or } 87.5\ mL\ HCl$

8.75×10^{-2} L (87.5 mL)