Chemistry
Molarity and Solution Stoichiometry

Name Key
Period ______ Date ____________

Show all work!!!

1. 12.2-grams of solid calcium chloride, $CaCl_2$, is dissolved in enough water to make 85.0 mL of solution.

(a) Calculate the molarity of the aqueous calcium chloride, $CaCl_2$ (aq).

$$\frac{12.2\,g}{} \cdot \frac{1\,mol}{110.98\,g} \cdot \frac{1}{0.085\,L} = 1.29\ M\ CaCl_2$$

(b) Calculate the molarity of the aqueous chloride ions, Cl^- (aq). [Hint: Write a balanced equation showing the dissociation of the $CaCl_2$ into separated ions]

$$CaCl_2 \rightarrow Ca^{2+} + 2Cl^- \qquad \frac{1.29\,M\,CaCl_2}{} \cdot \frac{2\,Cl^-}{1\,CaCl_2} = \boxed{2.58\,M\,Cl^-}$$

2. 25.0 mL of 0.20 M KCl solution is mixed with 15.0 mL of 0.30 M Na_2SO_4 solution.

(a) Calculate the ~~molarities~~ moles of the aqueous KCl (aq) and Na_2SO_4 (aq).

$$2KCl + Na_2SO_4 \rightarrow K_2SO_{4(aq)} + 2NaCl_{(aq)}$$

$$\frac{0.2\,mol\,KCl}{1\,L} \cdot \frac{0.025\,L}{} = \frac{0.005\,mol\,KCl}{0.040\,L} = 0.125\,M\,KCl$$

$$\frac{0.3\,mol\,Na_2SO_4}{1\,L} \cdot \frac{0.015\,L}{} = \frac{0.0045\,mol\,Na_2SO_4}{0.040\,L} = 0.1125\,M\,Na_2SO_4$$

(b) Calculate the molarity of the aqueous sodium ions, Na^+(aq).

$$1\,mol\,Na_2SO_4 : 2\,mol\,Na^+ \rightarrow 2 \cdot 0.1125\,M = \boxed{0.225\,M\,Na^+}$$

3. 15.0 mL of 0.50 M NaOH solution is mixed with 25.0 mL of 0.35 M NaCl solution. Calculate the molarity of the sodium ion, Na^+, in solution. [Hint: begin this problem by finding the moles of Na^+ ion in each of the original solutions]

$$NaOH + NaCl \rightarrow 2Na^+ + OH^- + Cl^-$$

$$\frac{0.5\,mol}{L} \cdot \frac{0.015\,L}{} = 0.0075\,mol\,NaOH$$

$$\frac{0.35\,mol}{L} \cdot \frac{0.025\,L}{} = 0.009\,mol\,NaCl$$

$$= 0.0165\,mol\,Na \rightarrow \frac{0.0165\,mol\,Na}{(0.015+0.025)} \boxed{= 0.4125\,M\,Na^+}$$

4. 30.0 mL of 1.0 M HCl is reacted with excess zinc metal.

$$Zn\ (s) + 2\ HCl\ (aq) \rightarrow H_2\ (g) + ZnCl_2\ (aq)$$

(a) Calculate the moles of HCl in the 30.0 mL of solution.

$$\frac{1\,mol}{L} \cdot \frac{0.03\,L}{} = \boxed{0.03\,mol\,HCl}$$

(b) Calculate the moles of hydrogen gas and zinc chloride produced in the reaction.

$$\frac{0.03\,mol\,HCl}{} \cdot \frac{1\,mol\,H_2}{2\,mol\,HCl} = \boxed{0.015\,mol\,H_2}$$

$$\frac{0.03\,mol\,HCl}{} \cdot \frac{1\,mol\,ZnCl_2}{2\,mol\,HCl} = \boxed{0.015\,mol\,ZnCl_2}$$

(c) How many liters of hydrogen gas does your answer in (a) represent if conditions are at STP?

$$\frac{0.015\,mol}{} \cdot \frac{22.4\,L}{1\,mol} = \boxed{0.336\,L}$$

(d) Calculate the molarity of the aqueous zinc chloride, $ZnCl_2$ (aq), produced.

$$\frac{0.015}{0.336} = \boxed{0.045\,M\,ZnCl_2}$$

5. A piece of copper wire is immersed in 100.0 mL of 0.100 M silver nitrate, $AgNO_3$. Answer the following questions if the copper wire is the excess reactant.

$$Cu\ (s) + 2\ AgNO_3\ (aq) \rightarrow 2\ Ag\ (s) + Cu(NO_3)_2\ (aq)$$

(a) Calculate the moles of $AgNO_3$ in the beaker before the copper is added.

$\frac{0.100\ mol}{L} \cdot 0.1\ L = \boxed{0.01\ mol\ AgNO_3}$

(b) Calculate the moles of silver and copper (II) nitrate produced in this reaction. [Hint: If the copper wire is assumed to be excess, then the $AgNO_3$ must be limiting!]

$0.01\ mol\ AgNO_3 \cdot \frac{2\ mol\ Ag}{2\ mol\ AgNO_3} = \boxed{0.01\ mol\ Ag}$

$0.01\ mol\ AgNO_3 \cdot \frac{1\ mol\ Cu(NO_3)_2}{2\ mol\ AgNO_3} = \boxed{0.005\ mol\ Cu(NO_3)_2}$

(c) Calculate the grams of silver produced.

$0.01\ mol\ Ag \cdot \frac{107.87\ g}{1\ mol} = \boxed{1.08\ g\ Ag}$

(d) Calculate the molarity of the copper (II) nitrate solution produced in this reaction.

$\frac{0.005\ mol\ Cu(NO_3)_2}{0.1\ L} = \boxed{0.05\ M\ Cu(NO_3)_2}$

6. 15.0 mL of 0.75 M $AgNO_3$ is added to a beaker containing 120.0 mL of 0.10 M KCl. Upon mixing the $AgNO_3$ and KCl undergo a double replacement reaction, precipitating silver chloride, AgCl (s), and producing aqueous potassium nitrate, KNO_3 (aq).

$$AgNO_3\ (aq) + KCl\ (aq) \rightarrow AgCl\ (s) + KNO_3\ (aq)$$

(a) Calculate the moles of $AgNO_3$ and KCl that were initially mixed together.

$\frac{0.75\ mol\ AgNO_3}{1\ L} \cdot 0.015\ L = 0.01125\ mol\ AgNO_3$

$\frac{0.1\ mol\ KCl}{1\ L} \cdot .120\ L = 0.012\ mol\ KCl$

(b) Determine the limiting reagent

$0.01125\ mol\ AgNO_3$ = limiting since it is less!

(c) Calculate the grams of AgCl that precipitated.

$0.01125\ mol\ AgCl \cdot \frac{143.32\ g\ AgCl}{1\ mol} = \boxed{1.61\ g\ AgCl}$