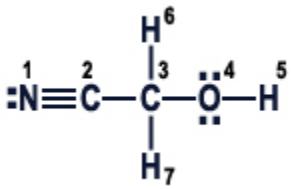
Question 1
10 Points

1. The atoms that form a sigma bond by the overlap of an **sp** and an **sp** hybrid orbitals?

   1 and 2



2. The bonding between **N1** and **C2** is best described as:

   a) A triple bond — **c) 2 pi bonds and 1 sigma bond**

   b) A double bond and a sigma bond — d) 3 pi bond

   e) 2 sigma bonds and a pi bond — f) covalent bonding

3. The bonding between **H6** and **C3** is best described as being the overlap of the **sp^3** orbital on **C3** with the **1s** orbital on **H6**

Question 2
12 Points

Classify each of the following salts as being either soluble (S) or non-soluble (NS) in water?

a) Silver(I) hydroxide **NS** — b) Na_2SO_4 **S**

c) Ammonium sulfide **S** — d) $FeCO_3$ **NS**

Question 3
8 Points

Indicate whether a precipitate is expected when each of the following pairs of aqueous solutions are mixed. If a precipitate forms, give the formula for the precipitate.

1. $Pb(NO_3)_2$ and KCl — **Y** or N — **$PbCl_2(s)$**
2. Iron(II) nitrate and sodium carbonate — **Y** or N — **$FeCO_3(s)$**
3. $CuCl_2$ and NH_4SO_4 — Y or **N**

Question 4
6 Points

In the laboratory you dilute **2.50** mL of a concentrated **3.00** M **nitric acid** solution to a total volume of **150** mL. What is the concentration of the dilute solution ?

$$3.00M \times 0.0025L = 7.5\times10^{-3} \text{ mol } HNO_3$$

$$\frac{7.5\times10^{-3} \text{ mol}}{0.150L} = \mathbf{5.0\times10^{-2}\ M}$$

Question 5
12 Points

1. Consider the reaction when aqueous solutions of **calcium nitrate** and **potassium sulfate** are combined. The net ionic equation for this reaction is:

   $Ca^{2+} + SO_4^{2-} = CaSO_4(s)$

2. Write a net ionic equation for the reaction that occurs when aqueous solutions of **sodium hydroxide** and **nitrous acid** (HNO_2) are combined.

   $OH^- + HNO_2(aq) = NO_2^- + H_2O(l)$

3. Write a net ionic equation for the reaction that occurs when aqueous solutions of **ammonium carbonate** and **hydrobromic acid** are combined.

   $CO_3^{2-} + 2H^+ = CO_2(g) + H_2O(l)$

Question 6
8 Points

A sample of ethylene glycol with a mass of 57.0g at 8^0C is placed into a perfectly insulated container together with 79.0g of glass at 34^0C. Calculate the final temperature of the sample when thermal equilibrium is reached?
Heat capacities: Glass = 0.84 J/g°C Ethylene glycol = 2.14 J/g^{0}C

$$q_{glycol} = 57.0 \times 2.14 \times (T_f - 8)$$
$$q_{glycol} = 121.98T_f - 975.84$$

$$q_{glass} = 79.0 \times 0.84 \times (T_f - 34)$$
$$q_{glass} = 66.36T_f - 2256.24$$

$$q_{glycol} + q_{glass} = 0$$
$$121.98T_f - 975.84 + 66.36T_f - 2256.24 = 0$$
$$188.34T_f = 3232.08$$
$$\mathbf{T_f = 17.16^0C}$$

Question 7
8 Points

Given the following thermodynamic data:

$\Delta H^0_f N_2O_5(s) = 11.0$ kJ/mol $\Delta H^0_f H_2O(l) = -285.8$ kJ/mol
$\Delta H^0_f H_2O(g) = -241.8$ kJ/mol $\Delta H^0_f HNO_3(aq) = -207.4$ kJ/mol

Determine the enthalpy change associated with the following reaction:

$$N_2O_5(s) + H_2O(l) = 2\ HNO_3(aq)$$

$$\Delta H^\circ_{rxn} = 2\Delta H^0_f HNO_3(aq) - \Delta H^0_f N_2O_5(s) + \Delta H^0_f H_2O(l)$$
$$\Delta H^\circ_{rxn} = 2(-207.4) - [11.0 - 285.8]$$
$$\mathbf{\Delta H^\circ_{rxn} = -140 kJ/mol}$$

Question 8
8 Points

14.0g of LiF are dissolved in 155.0g of water in a calorimeter the following data was collected:

Initial Temperature: 41.1^0C
Final Temperature: 58.5^0C

Heat capacity of the solution = 4.184 J/g^0C Calorimeter constant = 63.9 $J/^0C$

What is the heat of solution for this compound in J/mol?

$$\frac{14.0g\ LiF \mid 1\ mol\ LiF}{\mid 25.94g\ LiF} = 0.540mol\ LiF$$

$$q_{water} = 169.0 \times 4.184 \times 17.4 = 12.3\times10^3 J$$
$$q_{calorimeter} = 63.9 \times 17.4 = 1.11\times10^3\ J$$

$$q_{rxn} = q_{water} + q_{calorimeter} = 13.4\times10^3\ J\ (per\ 0.540mol\ LiF)$$

$$\mathbf{q_{rxn} = 24.8\times10^3\ J/mol}$$

Question 9
8 Points

Increasing the temperature of a sample of gas in a contained causes the pressure to increase. What two factors contribute to this increase in pressure?

1. **Number of collisions with the walls of the container increases.**
2. **Force (momentum) of the collisions increases.**

Question 10
8 Points

How many grams of solid **potassium hydroxide** are needed to exactly neutralize **28.2** mL of a **1.18** M **hydrochloric acid** solution ? Assume that the volume remains constant.

$$KOH(aq) + HCl(aq) = KCl(aq) + H_2O(l)$$

$$1.18 \times 0.0282 = 3.33\times10^{-2}\ mol\ HCl$$

$$\frac{3.33\times10^{-2}\ mol\ HCl \mid 1\ KOH}{\mid 1\ HCl} = 3.33\times10^{-2}\ mol\ KOH$$

$$\frac{3.33\times10^{-2}\ mol\ KOH \mid 56.11g\ KOH}{\mid 1\ mol\ KOH} = \mathbf{1.87g\ KOH}$$

Question 11
12 Points

For the following reaction, **63.6** grams of **KOH** are allowed to react with **34.4** grams of **H_3PO_4**.

$$3KOH\ (aq) + H_3PO_4\ (aq) = K_3PO_4\ (aq) + 3H_2O\ (l)$$

1. What is the maximum amount (in moles) of **potassium phosphate** that can be formed?
2. What is the **FORMULA** for the limiting reagent?
3. What amount (in moles) of the excess reagent remains after the reaction is complete?

$$\frac{63.6g\ KOH}{}\ \left|\ \frac{1\ mol\ KOH}{56.11g\ KOH}\right. = 1.13\ mol\ KOH$$

$$\frac{1.13\ mol\ KOH}{}\ \left|\ \frac{1\ K_3PO_4}{3\ KOH}\right. = \mathbf{3.78x10^{-1}\ mol\ K_3PO_4}$$

$$\frac{34.4g\ H_3PO_4}{}\ \left|\ \frac{1\ mol\ H_3PO_4}{98.0g\ H_3PO_4}\right. = 3.51x10^{-1}\ mol\ H_3PO_4$$

$$\frac{3.51x10^{-1}\ mol\ H_3PO_4}{}\ \left|\ \frac{1\ K_3PO_4}{1\ H_3PO_4}\right. = \mathbf{3.51x10^{-1}\ mol\ K_3PO_4}$$

$$\frac{3.51x10^{-1}\ mol\ H_3PO_4}{}\ \left|\ \frac{3\ KOH}{1\ H_3PO_4}\right. = 1.05\ mol\ KOH$$

1.13 – 1.05 = 0.08 mol KOH

Ans: **1.** **$3.51x10^{-1}$mol** **2.** **H_3PO_4** **3.** **0.08 mol**