Question 1 (8 Points)

On the rough work paper provided draw the Lewis Dot Structures for the following molecules. Classify each as **polar** or **nonpolar**?

a) NO_3^-: NONPOLAR

b) CO_2: NONPOLAR

c) CH_2Cl_2: POLAR

d) PF_2Cl_3: NONPOLAR

Question 2 (4 Points)

In our discussion on the **consequences of molecular polarity**, the data shown below was used to discuss:

Solubility of Some Common Substances

Compound	Solubility in H_2O g/100mL	
O_2	4.5×10^{-3}	18°C
N_2	2.0×10^{-3}	18°C
NH_3	89.5	0°C
CO_2	0.179	18°C
HCl	72.1	20°C

a) Membranes

b) Micelle action

c) Fabric softeners

d) Like dissolves like

e) Detergents

Question 3 (6 Points)

A molecule has **sp3d** hybridization with **3 lone pairs**.

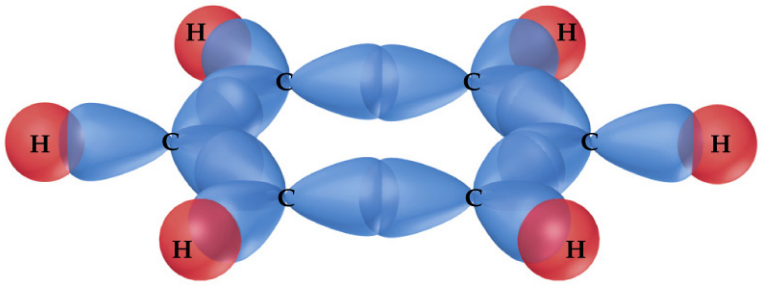
a) The **electron pair geometry** of this molecule is: TRIGONAL BIPYRAMID

b) The **molecular geometry** of this molecule is: LINEAR

c) Molecule will have an **approximate bond angle(s)** of: 180°

Question 4 (8 Points)

Depicted below is the **sigma** bonds **benzene (C_6H_6)**.



a) The **sigma** bond formed between **the carbon atoms** is best described as being between the overlap of two sp^2 hybrid orbitals.

b) The **sigma** bonds formed between the **hydrogen** and **carbon** is best described as being the overlap of an sp^2 hybrid orbital on each carbon with the 1s orbital on the hydrogen atoms.

c) If the **pi** bonds were to be depicted one would see 3 pi bond(s).

d) These **pi** bonds are formed by of overlap of the 2p **orbital** on each **carbon**.

Question 5 (6 Points)

Classify each of the compounds as **soluble** (**s**) or **not soluble** (**ns**):

Magnesium acetate: s Sodium phosphate: s Barium sulfide: s

Question 6 (4 Points)

Write a **balanced chemical equation** for the reaction that occurs when **aqueous solutions** of **barium iodide** and **iron(III) sulfate** are combined:

$3\ BaI_2(aq) + Fe_2(SO_4)_3(aq) = 3\ BaSO_4(s) + 2\ FeI_3(aq)$

Question 7 (4 Points)

Write a **net ionic equation** for the reaction that occurs when aqueous solutions of **potassium hydroxide** and **hydrosulfuric acid** (H_2S) are combined.

$H_2S(aq) + 2\ OH^- = S^{2-} + 2\ H_2O(l)$

Question 8 (4 Points)

Write a **net ionic equation** for the reaction that occurs when an aqueous solution of **nitric acid** is added to **solid barium sulfite**.

$BaSO_3(s) + 2\ H^+ = Ba^{2+} + SO_2(g) + H_2O(l)$

Question 9 (6 Points)

In the laboratory a student finds that it takes **23.8 Joules** to increase the temperature of **13.5 grams** of solid **platinum** from **22.6** to **36.6** degrees Celsius. Determine the **heat capacity** of the platinum the student measured?

For full credit you must show work.

$q = m \times C \times \Delta T$

$23.8 = 13.5 \times C \times (36.6 - 22.6)$

$23.8 = 13.5 \times C \times 14$

$C = \frac{23.8}{13.5 \times 14} = 0.126\ J/g.^\circ C$

0.126 $J/g^\circ C$

Question 10 (6 Points)

A chunk of **silver** weighing **19.7 grams** and originally at **97.48°C** is dropped into an insulated cup containing **76.6 grams of water** at **23.38°C**. Assuming that all of the heat is transferred to the water, calculate the **final temperature** of the water.

Heat Capacity : H_2O = 4.184 $J/g^\circ C$ Ag = 0.237 $J/g^\circ C$

For full credit you must show work.

$q_{Ag} = 19.7 \times 0.237 \times \Delta T$

$= 4.669\ (T_f - 97.48)$

$= 4.669\ T_f - 455.1$

$q_{H_2O} = 76.6 \times 4.184 \times \Delta T$

$= 320.5\ (T_f - 23.38)$

$= 320.5\ T_f - 7493.2$

$\Sigma q's = 0$

$4.669\ T_f - 455.1 + 320.5\ T_f - 7493.2 = 0$

$352.2\ T_f = 7948.3$

$T_f = \frac{7948.3}{325.2} = 24.4^\circ C$

24.4 °C

Question 11
4 Points

The reaction of carbon monoxide(g) with water(l) to form carbon dioxide(g) and hydrogen(g) proceeds as follows:

$$CO(g) + H_2O(l) \longrightarrow CO_2(g) + H_2(g)$$

When **8.57 grams** of **CO(g)** react with sufficient $H_2O(l)$, **0.857 kJ of energy** are **absorbed**.. What is the value of **ΔH** for the reaction **per mole of CO(g)**?

For full credit you must show work.

CO: 12.01 + 16.00
= 28.01 g.mol^{-1}

$$8.57\text{g CO} \left| \frac{1\text{ mol}}{28.01\text{g}} \right. = 0.306\text{ mol CO}$$

$$\Delta H = \frac{0.857\text{ kJ}}{0.306\text{ mol}} = 2.80\text{ kJ.mol}^{-1}$$

2.80 kJ.mol^{-1}

Question 12
8 Points

When **0.32g** of **hydrazine** (N_2H_4) is burned in a bomb calorimeter containing **600g** of **water** the temperature of the water **increases** by **1.8°C**. Calculate the heat of combustion of hydrazine in J.mol^{-1}

Heat Capacities: H_2O = 4.184 J/g°C Calorimeter = 420 J/°C

For full credit you must show work.

$q_{H_2O} = 600 \times 4.184 \times 1.8$
$= 4518\text{ J}$

$q_{cal} = 420 \times 1.8$
$= 756\text{ J}$

$q_{RXN} + q_{H_2O} + q_{cal} = 0$
$q_{RXN} + 4518 + 756 = 0$
$q_{RX} = -5274\text{ J}$

N_2H_4: 2(14.01) + 4(1.01) = 32.06 g.mol^{-1}

$$0.32\text{g } N_2H_4 \left| \frac{1\text{ mol}}{32.06\text{g}} \right. = 9.98 \times 10^{-3}\text{ mol}$$

$$q = \frac{-5274\text{ J}}{9.98 \times 10^{-3}\text{ mol}} = -5.28 \times 10^5\text{ J.mol}^{-1}$$

-5.28×10^5 J.mol^{-1}

Question 13
4 Points

Given the standard enthalpy changes for the following two reactions:

(1) $Hg(l) + Cl_2(g) \longrightarrow HgCl_2(s)$ ..... $\Delta H^\circ = -224.3$ kJ

(2) $Fe(s) + Cl_2(g) \longrightarrow FeCl_2(s)$ ..... $\Delta H^\circ = -341.8$ kJ

what is the standard enthalpy change for the reaction:

(3) $Hg(l) + FeCl_2(s) \longrightarrow HgCl_2(s) + Fe(s)$ ..... $\Delta H^\circ = ?$

For full credit you must show work.

$$\begin{array}{lll} (1) & Hg(l) + Cl_2(g) = HgCl_2(s) & \Delta H^\circ = -224.3 \\ -(2) & FeCl_2(s) = Fe(s) + Cl_2(g) & \Delta H^\circ = 341.8 \\ \hline & Hg(l) + FeCl_2(s) = HgCl_2(s) + Fe(s) & \Delta H^\circ = 117.5 \end{array}$$

117.5 kJ

Question 14
4 Points

The **standard enthalpy change** for the following reaction is **496 kJ** at 298 K.

$$K_2O_2(s) \longrightarrow 2\,K(s) + O_2(g)$$

What is the **standard heat of formation** of $K_2O_2(s)$?

$$\Delta H^\circ_{RXN} = \Sigma \Delta H^\circ_f \text{ Products} - \Sigma \Delta H^\circ_f \text{ Reactants}$$

$$496 = 2\Delta H^\circ_f K(s) + \Delta H^\circ_f O_2(g) - \Delta H^\circ_f K_2O_2(s)$$

$$496 = 2(0) + 0 - \Delta H^\circ_f K_2O_2(s)$$

$$\Delta H^\circ_f K_2O_2(s) = -496 \text{ kJ}$$

-496 $kJ.mol^{-1}$

Question 15
4 Points

You need to make an aqueous solution of **0.127 M barium hydroxide** for an experiment in lab, using a **125 mL volumetric flask**. How much **solid barium hydroxide** should you add ?

For full credit you must show work.

$Ba(OH)_2$: $137.33 + 2(16.00 + 1.01)$

$= 171.35\ g.mol^{-1}$

mol $Ba(OH)_2 = 0.127 \times 0.125$

$= 0.0159$ mol $Ba(OH)_2$

$$0.0159 \text{ mol } Ba(OH)_2 \left| \frac{171.35 g}{1 \text{ mol}} \right. = 2.72 g$$

2.72 g

Question 16
6 Points

For the following reaction, **9.68 grams** of **iron** are mixed with **0.102 moles** of **oxygen gas**.

iron (s) + oxygen (g) = iron(II) oxide (s)

What is the **maximum amount** of **iron(II) oxide** (in moles) that can be formed?

For full credit you must show work and give balanced chemical equation(s).

$$2\,Fe(s) + O_2(g) = 2\,FeO(s)$$

$$9.68\,g\,Fe \left| \frac{1\,mol}{55.85\,g} \right. = 0.173\,mol\,Fe$$

$$0.173\,mol\,Fe \left| \frac{2\,FeO}{2\,Fe} \right. = 0.173\,mol\,FeO \quad *$$

$$0.102\,mol\,O_2 \left| \frac{2\,FeO}{1\,O_2} \right. = 0.204\,mol\,FeO$$

0.173 mol

Question 17
6 Points

For the following reaction, **3.43 grams** of **zinc(II) oxide** are mixed with **excess water**. The reaction yields **3.24 grams** of **zinc(II) hydroxide**.

zinc(II) oxide (s) + water (l) = zinc hydroxide (aq)

What is the **percent yield** for this reaction?

For full credit you must show work and give balanced chemical equation(s).

$$ZnO(s) + H_2O(l) = Zn(OH)_2$$

ZnO: $65.39 + 16.00 = 81.39\,g.mol^{-1}$

$$3.43\,g\,ZnO \left| \frac{1\,mol}{81.39\,g} \right. = 0.0421\,mol\,ZnO$$

$$0.0421\,mol\,ZnO \left| \frac{1\,Zn(OH)_2}{1\,ZnO} \right. = 0.0421\,mol\,Zn(OH)_2$$

$Zn(OH)_2$: $65.39 + 2(16.00 + 1.01) = 99.41\,g.mol^{-1}$

$$0.0421\,mol\,Zn(OH)_2 \left| \frac{99.41\,g}{1\,mol} \right. = 4.19\,g$$

$$\left(\frac{3.24\,g}{4.19\,g} \right) 100 = 77.3\%$$

77.3 %

Question 18
8 Points

If **15.0 mL** of a **0.105 M barium hydroxide** solution is required to neutralize **21.8 mL** of **hydroiodic acid**, what is the **molarity** of the **hydroiodic acid** solution?

For full credit you must show work and give balanced chemical equation(s).

$Ba(OH)_2 + 2HI = BaI_2 + 2H_2O$

0.105

15.0mL 21.8mL

$\#\ mol\ Ba(OH)_2 = 0.105 \times 0.015 = 1.575 \times 10^{-3}\ mol\ Ba(OH)_2$

$$1.575 \times 10^{-3}\ mol\ Ba(OH)_2 \left| \frac{2\ HI}{1\ Ba(OH)_2} \right. = 3.15 \times 10^{-3}\ mol\ HI$$

$$\frac{3.15 \times 10^{-3}\ mol}{0.0218\ L} = 0.144$$

0.144 M

Do Not Write Below This

Exam III Score