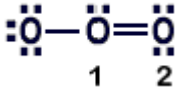
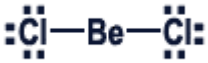
Question 1
14 Points

The following questions refer to the molecules whose Lewis Dot Structure are depicted below.

A	B	C	D
			

1. The **number** of molecules whose sigma bonding about the central atom is best described by **sp** hybridization? **1**
2. The **molecule(s)** whose bonding about the central atom is best described using **sp^2** hybrid orbitals? ***A, C***
3. The bonding about the central **I** atom in **B** is best described using what type of **hybridization?** **sp^3d**
4. The molecule with the **greatest** number of **pi bonds**? **C**
5. The molecule with the **greatest** number of **sigma bonds**? ***A***

The following questions refer to the O_3 (**Molecule *C***)

6. The lone pair on the central oxygen atom is best described as being in what **type** of **orbital?** **sp^2**
7. The ***O*=*O*** bond is best described: as a sigma bond formed from the overlap of a(n) **sp^2** on ***O*1** with a(n) **sp^2** on ***O*2**; and a pi bond formed by the overlap of a(n) **2p** orbital on ***O*1** with a(n) **2p** orbital on ***O*2**.

Question 2
10 Points

Complete the following chemical reactions: (Give the **formula** for the **products**)

A. Iron(III) perchlorate + sodium hydroxide = **$NaClO_4(aq) + Fe(OH)_3(s)$**
B. Hydrofluoric acid (HF) + potassium hydroxide = **$KF(aq) + H_2O(l)$**
C. Cobalt(II) carbonate + hydrochloric acid = **$CoCl_2(aq) + CO_2(g) + H_2O(l)$**

With respect to the above reactions, which one is:

1. An **acid base** reaction: **B**
2. A **gas forming** reaction: ***C***
3. A **precipitation** reaction: ***A***

Question 3
12 Points

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

   $Ca^{2+} + 2\ OH^- = Ca(OH)_2(s)$

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

   $OH^- + HCN(aq) = CN^- + H_2O(l)$

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

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

Question 4
8 Points

A sample of ethylene glycol with a mass of **74.0**g at **6**^{0}C is placed into a perfectly insulated container together with **93.0**g of glass at **76**^{0}C. Calculate the final temperature of the sample when thermal equilibrium is reached?

Heat capacities: Glass = **0.84** J/g^{0}C Ethylene glycol = **2.41** J/g^{0}C

$q_{eg} = 74 \times 2.41 \times (T_f - 6)$
$q_{eg} = 178.3 \times (T_f - 6)$
$\mathbf{q_{eg} = 178.3T_f - 1070}$

$q_{gl} = 93 \times 0.84 \times (T_f - 76)$
$q_{gl} = 78.1 \times (T_f - 76)$
$\mathbf{q_{gl} = 78.1T_f - 5937}$

$178.3T_f - 1070 + 78.1T_f - 5937 = 0$
$\mathbf{256.4T_f = 7007}$

$\mathbf{T_f = 27.3\ ^0C}$

Question 5
8 Points

21.19 g of **LiCl** are dissolved in **170.0**g of **water** in a calorimeter the following data was collected:

Initial Temperature:	**24.4^{0}C**	Final Temperature:	**42.5^{0}C**
Solution Heat Capacity:	**4.184 J/g^{0}C**	Calorimeter constant:	**63.9 J/^{0}C**

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

$q_{Sol} = 191.19 \times 4.184 \times 18.1$
$q_{Sol} = 14{,}479$ J

$q_{Cal} = 63.9 \times 18.1$
$q_{Cal} = 1{,}157$ J

$q_{Sol} + q_{Cal} = 15{,}636$ J

$q_{Rxn} + q_{Cal} + q_{Rxn} = 0$
$q_{Rxn} + = -(q_{Cal} + q_{Rxn})$

LiCl = 6.94 + 35.45 = 42.39 g/mol
21.19 g LiCl = 0.5 mol LiCl

$\Delta H_{Sol} = \mathbf{-31{,}272\ J/mol}$

Question 6
7 Points

How many grams of solid **barium hydroxide** are needed to exactly neutralize **12.1** mL of a **0.562 M nitric acid** solution? Assume that the volume remains constant.

$$2\ HNO_3(aq) + Ba(OH)_2 = Ba(NO_3)_2(aq) + 2\ H_2O(l)$$

$$0.562\ mol/L \times 0.0121\ L = 6.80\times10^{-3}\ mol\ HNO_3$$

$$\frac{6.80\times10^{-3}\ mol\ HNO_3 \mid 1\ Ba(OH)_2}{2\ HNO_3} = 3.40\times10^{-3}\ mol\ Ba(OH)_2$$

$$\frac{3.40\times10^{-3}\ mol\ Ba(OH)_2 \mid 171.35\ g}{1\ mol} = \mathbf{0.583\ g\ Ba(OH)_2}$$

Question 7
12 Points

For the following reaction, **4.34** grams of **benzene (C_6H_6)** are allowed to react with **5.6** grams of **oxygen gas**.

Benzene (C_6H_6) (l) + oxygen (g) = carbon monoxide (g) + water (g)

1. What is the maximum amount **in moles** of **carbon monoxide** that can be formed?

$$2\ C_6H_6 + 9\ O_2 = 12\ CO + 6\ H_2O$$

$$\frac{4.34g\ C_6H_6 \mid 1\ mol}{78.12\ g} = 0.0556\ mol\ C_6H_6$$

$$\frac{0.0556\ mol\ C_6H_6 \mid 12\ Co}{2\ C_6H_6} = 0.333\ mol\ CO$$

$$\frac{5.6\ g\ O_2 \mid 1\ mol}{32\ g} = \mathbf{0.175\ mol\ O_2}$$

$$\frac{0.175\ mol\ O_2 \mid 12\ CO}{9\ O_2} = 0.233\ mol\ CO$$

2. What is the **FORMULA** for the limiting reagent? O_2

3. What amount **in grams** of the excess reagent remains after the reaction is complete? Grams

$$\frac{0.175\ mol\ O_2 \mid 2\ C_6H_6}{9\ O_2} = 0.0389\ mol\ C_6H_6$$

$$0.0556 - 0.0389 = 0.0167\ mol\ C_6H_6$$

$$\frac{0.0167\ mol\ C_6H_6 \mid 78.12\ g}{1\ mol} = \mathbf{1.30\ g}$$

Question 8
7 Points

For the following reaction, **5.61** grams of sulfur are mixed with excess carbon monoxide. The reaction yields **3.16** grams of **carbon**. What is the percent yield?

sulfur (s) + carbon monoxide (g) = sulfur dioxide (g) + carbon (s)

$S + 2\ CO = SO_2 + 2\ C$

$$\frac{5.61\ g\ S \mid 1\ mol}{32.07\ g} = 0.175\ mol\ S$$

$$\frac{0.175\ mol\ S \mid 2\ C}{1\ S} = 0.350\ mol\ C$$

$$\frac{0.350\ mol\ C \mid 12.01\ g}{1\ mol} = 4.20\ g\ C$$

75.2%

Question 9
6 Points

After a **533** g block of **copper** absorbs **1,700** J of heat it reaches a temperature of **44.6** ^0C . If the heat capacity of copper is **0.385** $J/g.^0C$, what was the initial temperature of the piece of copper?

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

$1{,}700 = 533 \times 0.386 \times DT$

$\Delta T = 8.2\ ^0C$

$T_i = 44.6 - 8.2 =$ **36.4**

Question 10
8 Points

Given the following thermodynamic data:

$\Delta H^0_f MnO_2(s) = -504.0$ kJ/mol $\Delta H^0_f Al_2O_3(s) = -1675.7$ kJ/mol

What quantity of heat is absorbed or evolved upon the production of **25.49g** of Al_2O_3:

4 Al(s) + 3 MnO_2(s) = 3 Mn(s) + 2 Al_2O_3(s)

$\Delta H^0_{Rxn} = 2\ \Delta H^0_f Al_2O_3(s) - 3\ \Delta H^0_f MnO_2(s)$

$\Delta H^0_{Rxn} = 2(-1675.7) - 3(-504.0) = -1839.4$ kJ

919.7 kJ per mol Al_2O_3

$$\frac{27\ g \mid 1\ mol}{101.96\ g} = 0.25$$

230 kJ heat released

Question 11
4 Points

The Ideal Gas equation, **PV = nRT**, breaks down at **high pressures** and **low temperatures**. Why is this?

Under these conditions the actual volume occupied by the gas molecule and the intermolecular forces can no longer be ignored.

Do Not Write Below This Line

Exam III Score	