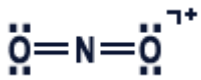
Chem 111 **Summer 2015** **Exam III** **Whelan**

Question 1
8 Points

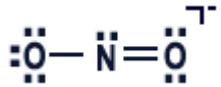
Classify each of the following molecules as **polar** or **nonpolar**?



Non polar

Polar

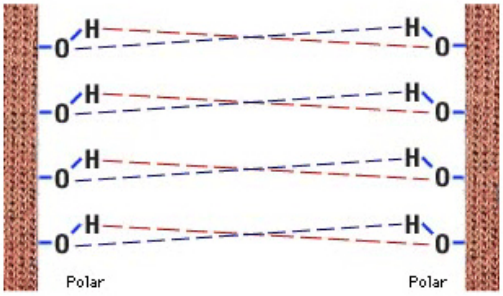
Non polar



Polar

Question 2
4 Points

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



a) Membranes
b) Micelle action
c) Fabric softeners
d) Like dissolves like
e) Detergents

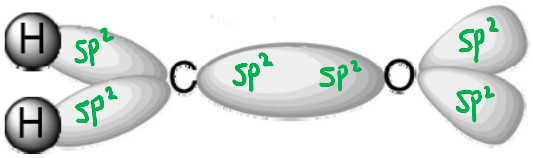
Question 3
9 Points

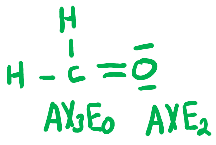
A molecule has **sp^3d^2 hybridization** with **2 lone pairs**.

a) The **electron pair geometry** of this molecule is: Octahedron
b) The **molecular geometry** of this molecule is: SQUARE PLANAR
c) Molecule will have an **approximate bond angle(s)** of: 90° (180°)

Question 4
8 Points

Depicted below are the sigma bonds in **formaldehyde (H_2CO)**.





a) The **sigma** bond formed between **the carbon and oxygen atoms** is best described as being between the overlap of a(n) sp^2 hybrid orbital on *C* with a(n) sp^2 hybrid orbital on *O*.

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) The **pi** bond formed between carbon and oxygen is the result of the overlap by of a 2p **orbital** on **carbon** and **oxygen**.

d) The **lone pairs** on the **oxygen atom** are found on sp^2 **hybrid orbitals**

Question 5 (6 Points)

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

a) Calcium iodide: S

b) Magnesium hydroxide: NS

c) Barium fluoride: NS

Question 6 (4 Points)

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

$3\,PbI_2(aq) + 2\,FeBr_3(aq) = 3\,PbBr_2(s) + 2\,FeI_3(aq)$

Question 7 (4 Points)

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

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

Question 8 (4 Points)

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

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

Question 9 (7 Points)

A **41.2g** sample of **copper** at **99.8°C** is dropped into a beaker containing **153g** of **water** at **18.5°C**. What is the **final temperature** when thermal equilibrium is reached?
Assume the beaker neither absorbs nor loses heat.

Heat Capacities : H_2O = **4.184 J/g°C** Cu = **0.385 J/g°C**

For full credit you must show work.

$q_{H_2O} = 153(4.184)\Delta T$
$= 640.152(T_f - T_i)$
$= 640.152(T_f - 18.5)$
$= 640.152\,T_f - 11{,}842.8$

$q_{Cu} = 41.2(0.385)\Delta T$
$= 15.862(T_f - T_i)$
$= 15.862(T_f - 99.8)$
$= 15.862\,T_f - 1583.0$

$\Sigma q's = 0$
$640.152\,T_f - 11{,}842.8 + 15.862\,T_f - 1583.0 = 0$
$656.014\,T_f = 13{,}425.8$

$T_f = \frac{13{,}425.8}{656.014} = 20.5°C$

20.5 °C

Question 10
8 Points

In an experiment, a **1.452g** sample of **L-ascorbic acid** ($C_6H_8O_6$) is burned completely in a bomb calorimeter. The calorimeter is surrounded by **1319g** of water. During the combustion the temperature **increases** from **24.21** to **27.15** °C.

Assuming that no energy is lost to the surroundings, **calculate the molar heat** of combustion of L-ascorbic acid based on these data.

Heat Capacities: H_2O = **4.184 J/g°C** Calorimeter = **784.2 J/°C**
Molar Mass: $C_6H_8O_6$ = **176.13 g.mol^{-1}**

For full credit you must show work.

$q_{H_2O} = 1319(4.184)(27.15-24.21)$
$= 16,224.97$ J

$q_{cal} = 784.2(27.15-24.21)$
$= 2,305.55$ J

$\Sigma q's = 0$

$q_{RXN} + q_{H_2O} + q_{cal} = 0$

$q_{RXN} + 16,244.97 + 2,305.55 = 0$

$q_{RXN} = -18,530.5$ J

$1.452\text{g} \left| \frac{1\text{ mol}}{176.13\text{g}} \right. = 8.244 \times 10^{-3}$ mol

$q_{RXN} = \frac{-18,530.5\text{ J}}{8.244 \times 10^{-3}\text{ mol}}$

$= -2247695$ J.mol^{-1}

$= -2.248 \times 10^6$ J.mol^{-1}

$\boxed{-2.248 \times 10^6}$ J.mol^{-1}

Question 11
6 Points

Given the standard enthalpy changes for the following two reactions:

(1) $N_2(g) + 2\ O_2(g) \longrightarrow 2\ NO_2(g)$ ..... $\Delta H° = 66.4$ kJ

(2) $2\ N_2O(g) \longrightarrow 2\ N_2(g) + O_2(g)$ ..... $\Delta H° = -164.2$ kJ

what is the standard enthalpy change for the reaction:

(3) $2N_2O(g) + 3\ O_2(g) \longrightarrow 4\ NO_2(g)$ ..... $\Delta H° = ?$

For full credit you must show work.

(2) $2\ N_2O(g) \rightarrow 2\ N_2(g) + O_2(g)$ $\quad \Delta H = -164.2$ kJ

(1)x2 $2\ N_2(g) + 4\ O_2(g) \rightarrow 4\ NO_2(g)$ $\quad \Delta H = 132.8$ kJ

$2\ N_2O(g) + 3\ O_2(g) \rightarrow 4\ NO_2(g)$ $\quad -31.4$ kJ

$\boxed{-31.4}$ kJ

Question 12
6 Points

Using **standard heats of formation**, ***given on the first page of this exam***, calculate the **standard enthalpy change** for the following reaction.

$$H_2CO(g) + O_2(g) \longrightarrow CO_2(g) + H_2O(l)$$

$$\Delta H^\circ_{RXN} = \Sigma \Delta H^\circ_f(\text{Products}) - \Delta H^\circ_f(\text{Reactants})$$
$$= \Delta H^\circ_f\, CO_2(g) + \Delta H^\circ_f\, H_2O(l) - \Delta H^\circ_f\, H_2CO(g) - \Delta H^\circ_f O_2(g)$$
$$= -393.5 - 285.8 + 116.0 - 0$$

-563.3 kJ

Question 13
6 Points

How many **milliliters** of an aqueous solution of **0.204M magnesium iodide** is needed to obtain **13.7 grams** of the salt?

For full credit you must show work.

MgI_2

$24.31 + 2(126.90) = 278.11\ g.mol^{-1}$

$$13.7\ g\ MgI_2 \left| \frac{1\ mol}{278.11\ g} \right. = 0.0493\ mol$$

$$\#mol = M \times V(L)$$
$$0.0493 = 0.204 \times V(L)$$
$$V(L) = \frac{0.0493}{0.204} = 0.241\ L$$

241 mL

Question 14
6 Points

For the following reaction, **0.126 moles** of **propane** (C_3H_8) are mixed with **0.222 moles** of oxygen gas.

$$\text{propane}(g)\ (C_3H_8) + \text{oxygen}(g) \longrightarrow \text{carbon dioxide}(g) + \text{water}(g)$$

What is the **maximum amount** of **carbon dioxide** that can be produced?

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

$$C_3H_8(g) + 5O_2(g) = 3\,CO_2(g) + 4\,H_2O(g)$$

$$0.126\ mol\ C_3H_8 \left| \frac{3\ CO_2}{1\ C_3H_8} \right. = 0.378\ mol\ CO_2$$

$$0.222\ mol\ O_2 \left| \frac{3\ CO_2}{5\ O_2} \right. = 0.133\ mol\ CO_2$$

0.133 mol

Question 15
7 Points

For the following reaction, **3.43 grams** of **oxygen gas** are mixed with **excess butane** (C_4H_{10}). The reaction yields **1.97 grams** of **carbon dioxide**.

butane(g) (C_4H_{10}) + oxygen(g) ⟶ carbon dioxide(g) + water(g)

What is the **percent yield** of **carbon dioxide** ?

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

$2\ C_4H_{10}(g) + 13\ O_2(g) = 8\ CO_2(g) + 10\ H_2O(g)$

$3.42\text{g } O_2 \left| \frac{1\text{ mol}}{32.00\text{g}} \right. = 0.107\text{ mol } O_2$

$0.107\text{ mol } O_2 \left| \frac{8\ CO_2}{13\ O_2} \right. = 0.0658\text{ mol } CO_2$

CO_2: $12.01 + 2(16.00) = 44.01\text{ g.mol}^{-1}$

$0.0658\text{ mol } CO_2 \left| \frac{44.01\text{g}}{1\text{ mol}} \right. = 2.89\text{g}$

$$\% = \left(\frac{1.97}{2.89}\right)100$$

68.2 %

Question 16
7 Points

What **volume** in **mL** of a **0.178M hydrochloric acid** solution is required to neutralize **24.7 mL** of a **0.158M calcium hydroxide** solution?

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

$Ca(OH)_2 + 2\ HCl = CaCl_2 + 2\ H_2O$

$\#\text{mol } Ca(OH)_2 = 0.158 \times 0.0247 = 3.90 \times 10^{-3}\text{ mol } Ca(OH)_2$

$3.90\text{ mol } Ca(OH)_2 \left| \frac{2\ HCl}{1\ Ca(OH)_2} \right. = 7.81 \times 10^{-3}\text{ mol } HCl$

$\#\text{mol } HCl = M \times V(L)$

$7.81 \times 10^{-3} = 0.178 \times V(L)$

$V(L) = \frac{7.81 \times 10^{-3}}{0.178} = 0.0439\text{L}$

43.9 mL

Do Not Write Below This

Exam III Score	