Question 1 (6 Points)

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

a) NO^+: Polar

b) XeF_4: Nonpolar

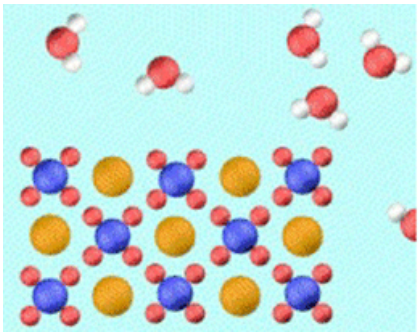
c) CH_2Cl_2: Polar

Question 2 (3 Points)

The hypothetical molecule PY_3Z_2 has the general classification AX_5E_0 and is found to be **non polar**. Based on this information what can you infer as to the **relative size** of **Y** when compared to **Z**?

Y is larger than Z

Question 3 (3 Points)



In our discussion on the **consequences of molecular polarity**. The depiction on the left was used to discuss:

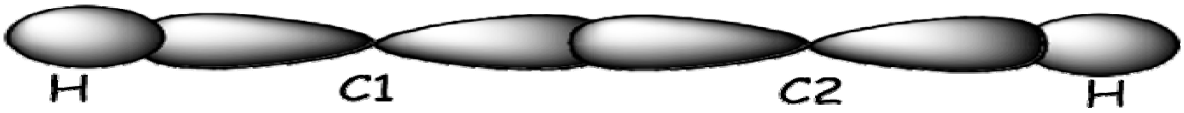
- o Detergents
- (o) Water dissolving $KMnO_4$
- o Fabric softeners
- o Chelating therapy

Question 4 (4 Points)

The **hybridization** used to describe the bonding about the central atom in **NOBr** is sp^2, which makes the **approximate bond angles** in this molecule 120° degrees.

Question 5 (6 Points)

Depicted below is the **sigma** bonds **HCCH**.



a) The **sigma** bond formed between **C1** and **C2** is best described as being between the overlap of two sp hybrid orbitals.

b) The **sigma** bonds formed between the **hydrogen** and **carbon** is best described as being the overlap of an sp 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 2 pi bond(s).

Question 6 (3 Points)

The bonding in a molecule is best described using **sp3d hybridization**. The **electron pair geometry** of this molecule is: TRIGONAL BIPYRAMID

Question 7 (3 Points)

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

Zinc sulfate: S Calcium carbonate: NS Silver(I) acetate: S

Question 8 (3 Points)

Write a **balanced chemical equation** for the reaction that occurs when **aqueous solutions** of **silver(I) nitrate** and **nickel(II) chloride** are combined:

$2AgNO_3(aq) + NiCl_2(aq) = Ni(NO_3)_2(aq) + 2AgCl(s)$

Question 9 (3 Points)

Write the **net ionic equation** for the reaction that takes place when aqueous solutions of **ammonium sulfide** and **chromium(III) chloride** are mixed.

$2Cr^{3+} + 3S^{2-} = Cr_2S_3(s)$

Question 10 (3 Points)

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

$H^+ + OH^- = H_2O(l)$

Question 11 (3 Points)

Write a **net ionic equation** for the reaction that occurs when a **hydrochloric acid (aq)** and **chromium(II) sulfide (s)** are combined.

$CrS(s) + 2H^+ = Cr^{2+} + H_2S(g)$

Question 12 (8 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°C Ag = 0.237 J/g°C

For full credit you must show work.

$q_{Ag} = 19.7(0.237)\Delta T$
$= 4.669(T_f - 97.48)$
$= 4.669T_f - 455.12$

$q_{H_2O} = 76.6(4.184)\Delta T$
$= 320.49(T_f - 23.38)$
$= 320.49T_f - 7493.16$

$\Sigma q_{rs} = 0$
$4.669T_f - 455.12 + 320.49T_f - 7493.16 = 0$
$325.16T_f - 7948.28 = 0$
$325.16T_f = 7948.28$

$T_f = \frac{7948.28}{325.16} = 24.44°C$

24.44 °C

Question 13
4 Points

The reaction of iron(III) oxide(s) with hydrogen(g) to form iron(s) and water(g) proceeds as follows:

$$Fe_2O_3(s) + 3H_2(g) = 2Fe(s) + 3H_2O(g)$$

When **56.5 grams** of **Fe_2O_3(s)** react with sufficient H_2(g), **35.0 kJ** of energy are **absorbed**. What is the value of **ΔH** for the reaction **per mole of Fe_2O_3**?

For full credit you must show work.

Fe_2O_3: $2(55.86) + 3(16.00) = 159.72\ g.mol^{-1}$

$$56.5\ g\ Fe_2O_3 \left| \frac{1\ mol}{159.72\ g} \right. = 0.354\ mol\ Fe_2O_3$$

$$\Delta H_{RXN} = \frac{35.0\ kJ}{0.354\ mol} = 98.9\ kJ.mol^{-1}$$

98.9 kJ

Question 14
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.

$q_{H_2O} = 600(4.184)1.8$
$= 4518.72\ J$

$q_{Cal} = 420(1.8)$
$= 756\ J$

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

$$0.32\ g\ N_2H_4 \left| \frac{1\ mol}{32.06\ g} \right. = 0.01\ mol\ N_2H_4$$

$$q_{RXN} = \frac{-5274.72}{0.01} = -5.3 \times 10^5\ J.mol^{-1}$$

$\Sigma q's = 0$

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

$q_{RXN} + 4518.72 + 756 = 0$

$q_{RXN} = -5274.72\ J$

-5.3×10^5 J/mol

Question 15
4 Points

Given the standard enthalpy changes for the following two reactions:

(1) $2\ C(s) + 2\ H_2(g) = C_2H_4(g)$ ..... $\Delta H^\circ = 52.3$ kJ

(2) $2\ C(s) + 3\ H_2(g) = C_2H_6(g)$ .....$\Delta H^\circ = -84.7$ kJ

what is the standard enthalpy change for the reaction:

(3) $C_2H_4(g) + H_2(g) = C_2H_6(g)$ .....$\Delta H^\circ = ?$

For full credit you must show work.

$-(1)$ $C_2H_4(g) = 2C(s) + 2H_2(g)$ $\quad \Delta H^\circ = -52.3$

(2) $2C(s) + 3H_2(g) = C_2H_6(g)$ $\quad \Delta H^\circ = -84.7$

$C_2H_4(g) + H_2(g) = C_2H_6(g)$ $\quad \Delta H^\circ = -137.0$

-137.0 kJ

Question 16
4 Points

Using **standard heats of formation given** below, calculate the **standard enthalpy** change for the following reaction.

$$2NO(g) + 2H_2(g) = N_2(g) + 2H_2O(l)$$

ΔH°_f: $NO(g) = 90.3$ kJ.mol^{-1} $\quad H_2O(l) = -285.8$ kJ.mol^{-1}

$$\Delta H^\circ_{RXN} = \Sigma \Delta H^\circ_f(\text{Products}) - \Sigma \Delta H^\circ_f(\text{Reactants})$$
$$= \Delta H^\circ_f N_2(g) + 2\Delta H^\circ_f H_2O(l) - 2\Delta H^\circ_f NO(g) - 2\Delta H^\circ_f H_2(g)$$
$$= 0 + 2(-285.8) - 2(90.3) - 2(0)$$
$$= -752.2\ kJ$$

-752.2 kJ

Question 17
4 Points

A **0.884 mol** sample of **O_2 gas** is confined in a **21.0 liter container** at **16.2°C**. If the **temperature** of the gas sample is **decreased** to **-1.10°C**, holding the **volume constant**, the **pressure will decrease** because:

Choose all that apply

- o With higher average speeds, the molecules hit the walls of the container more often.
- (o) At lower temperatures molecules have lower average speeds.
- o As the average speed increases, the number of molecule-wall collisions decreases.
- (o) With lower average speeds, on average the molecules hit the walls of the container with less force.

Question 18
5 Points

You need to make an aqueous solution of **0.142M calcium nitrate** for an experiment in lab, using a **250mL** volumetric flask. How much **solid calcium nitrate** should you add?

For full credit you must show work.

$\#\ mol\ Ca(NO_3)_2 = 0.142(0.250) = 3.55 \times 10^{-2}\ mol$

$Ca(NO_3)_2 : 40.08 + 2(14.01 + 48.00) = 164.1\ g.mol^{-1}$

$$3.55 \times 10^{-2}\ mol\ Ca(NO_3)_2 \left| \frac{164.1\ g}{1\ mol} \right. = 5.8\ g$$

5.8 g

Question 19
5 Points

For the following reaction, **0.355 moles of carbon disulfide** are mixed with **0.579 moles of chlorine gas**.

carbon disulfide (s) + chlorine (g) = carbon tetrachloride (l) + sulfur dichloride (s)

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

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

$$CS_2(s) + 4\,Cl_2(g) = CCl_4(l) + 2\,SCl_2(s)$$

$$0.355\ mol\ CS_2 \left| \frac{1\ CCl_4}{1\ CS_2} \right. = 0.355\ mol\ CCl_4$$

$$0.579\ mol\ Cl_2 \left| \frac{1\ CCl_4}{4\ Cl_2} \right. = 0.145\ mol\ CCl_4\ *$$

0.145 mol

Question 20
8 Points

For the following reaction, **3.86 grams of oxygen gas** are mixed with **excess nitrogen gas**. The reaction yields **5.81 grams of nitrogen monoxide**.

nitrogen (g) + oxygen (g) = nitrogen monoxide (g)

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

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

$N_2(g) + O_2(g) = 2NO(g)$

$3.86\,g\ O_2 \left| \frac{1\ mol}{32.0\,g} \right. = 0.121\ mol\ O_2$

$O_2: 2(16.00) = 32.0\,g.mol^{-1}$

$0.121\ mol\ O_2 \left| \frac{2\ NO}{1\ O_2} \right. = 0.241\ mol\ NO$

$0.241\ mol\ NO \left| \frac{30.01\,g}{1\ mol} \right. = 7.24\,g$

$NO: 14.01 + 16.00 = 30.01\,g.mol^{-1}$

$\left(\frac{5.81}{7.24}\right)100 = 80.02\%$

80.02 %

Question 21
10 Points

47.2mL of 0.113M hydrobromic acid is added to **21.4mL of calcium hydroxide**, and the **resulting solution is found to be acidic**.

29.8mL of 0.0862M sodium hydroxide is required to reach neutrality.

What is the **molarity** of the **original calcium hydroxide** solution?

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

Added HBr

$0.113(0.0472) = 5.33\times10^{-3}\ mol$

$HBr + NaOH = NaBr + H_2O$

$\#mol\ NaOH = 0.0862(0.0298)$

$= 2.57\times10^{-3}\ mol\ NaOH$

$2.57\times10^{-3}\ mol\ NaOH \left| \frac{1\ HBr}{1\ NaOH} \right. = 2.57\times10^{-3}\ mol\ HBr$

HBr that neutralized the $Ca(OH)_2$

$5.33\times10^{-3} - 2.57\times10^{-3} = 2.76\times10^{-3}\ mol$

$Ca(OH)_2 + 2HBr = CaBr_2 + 2H_2O$

$2.76\times10^{-3}\ mol\ HBr \left| \frac{1\ Ca(OH)_2}{2\ HBr} \right. = 1.38\times10^{-3}\ mol\ Ca(OH)_2$

$M = \frac{1.38\times10^{-3}}{0.0214} = 0.0645$

0.0645 M

Do Not Write Below This

Exam III Score	