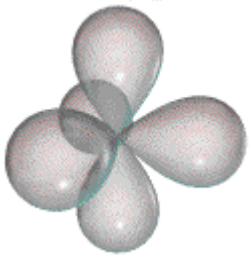
Question 1 (9 Points)

Classify each of the following molecules as polar or nonpolar?

1. SO_3 Nonpolar
2. NCl_3 Polar
3. I_3^- Nonpolar

Question 2 (10 Points)



There are 5 **hybrid orbitals** represented by the picture on the left. They are composed of* 1 (s) 3 (p) 1 (d) **atomic orbitals**, corresponding to sp^3d **hybridization**. They have the **electron pair geometry** Trigonal bipyramid with **bond angles** of 90°, 120° (180°).

* - Give the **number** of each of these orbitals that make the hybrid orbital depicted.

Question 3 (6 Points)

A molecule has sp^2 hybridization with **1 lone pair**:

a) The **electron pair geometry** of this molecule is Trigonal planar

b) The **geometry** of this molecule is Bent/angular (120°)

c) The **approximate bond angle** in the molecule 120°

Question 4 (4 Points)

The compound **chromium(III) nitrate** is a strong electrolyte. Write the reaction when chromium(III) nitrate is put into **water**:

$Cr(NO_3)_3(s) = Cr^{3+} + 3NO_3^-$

Question 5 (9 Points)

Give the **formula** for the **precipitate** that is formed when each of the following aqueous solutions are mixed. (If **no precipitate** is expected then write **no precipitate**)

1. **Iron(III) bromide** and **sodium sulfide** $Fe_2S_3(s)$
2. **Calcium chloride** and **ammonium iodide** No precipitate
3. **Lead (II) nitrate** and **potassium chloride** $PbCl_2(s)$

Question 6 (5 Points)

Write the **net ionic equation** for the reaction that takes places when aqueous solutions of **silver(I) nitrate** and **nickel(II) chloride** are combined.

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

$2Ag^+ + 2NO_3^- + Ni^{2+} + 2Cl^- = 2AgCl(s) + Ni^{2+} + 2NO_3^-$

$2Ag^+ + 2Cl^- = 2AgCl(s)$

$Ag^+ + Cl^- = AgCl(s)$

Question 7
5 Points

Write the **net ionic equation** for the reaction that takes places when aqueous solutions of **hydrofluoric acid (HF)** and **ammonia (NH_3)** are combined.

$HF(aq) + NH_3(aq) = NH_4F(aq)$

$HF(aq) + NH_3(aq) = NH_4^+ + F^-$

$HF(aq) + NH_3(aq)$ = $NH_4^+ + F^-$

Question 8
5 Points

Write the **net ionic equation** for the reaction that takes places when solid **calcium carbonate** is added to **perchloric acid**.

$CaCO_3(s) + 2\,HClO_4(aq) = Ca(ClO_4)_2(aq) + H_2O(l) + CO_2(g)$

$CaCO_3(s) + 2H^+ + 2ClO_4^- = Ca^{2+} + 2ClO_4^- + H_2O(l) + CO_2(g)$

$CaCO_3(s) + 2H^+$ = $Ca^{2+} + H_2O(l) + CO_2(g)$

Question 9
5 Points

In the laboratory a student finds that it takes **21.7 Joules** to increase the temperature of **11.7 grams** of liquid mercury from **22.3** to **36.8** degrees Celsius.
Determine the **specific heat** of mercury.
For full credit you must show work.

$\Delta T = 36.8 - 22.3 = 14.5\,^\circ C$

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

$21.7 = 11.7 \times C \times 14.5$

$C = \frac{21.7}{11.7 \times 14.5} = 0.128\ J/g.^\circ C$

0.128 J/g.$^\circ$C

Question 10
5 Points

A sample of solid gold is heated with an electrical coil. If **29.4 Joules** of energy are added to a **15.0 gram** sample and the final temperature is **38.7°C**, what is the **initial temperature** of the gold? Heat capacity of gold, **0.129 J/g.°C**

For full credit you must show work.

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

$29.4 = 15.0 \times 0.129 \times \Delta T$

$\Delta T = \frac{29.4}{15.0 \times 0.129}$

$\Delta T = 15.2°C$

$T_f - T_i = 15.2$

$38.7 - T_i = 15.2$

$-T_i = 15.2 - 38.7$

$-T_i = -23.5$

$T_i = 23.5°C$

23.5 °C

Question 11
5 Points

The following thermochemical equation is for the reaction of **hydrogen peroxide(l)** to form **water(l)** and **oxygen(g)**.

$2\ H_2O_2(l) = 2\ H_2O(l) + O_2(g) \quad \Delta H = -196\ kJ$

How many **grams** of **H_2O_2(l)** would have to react to produce **30.4 kJ** of energy?

For full credit you must show work.

H_2O_2: $2(1.01) + 2(16.00) = 34.02\ g \cdot mol^{-1}$

$$30.4\ kJ \left| \frac{2\ mol\ H_2O_2}{196\ kJ} \right| \frac{34.02\ g}{1\ mol} = 10.6\ g$$

10.6 g H_2O_2

Question 12
5 Points

0.927 grams of benzoic acid is burned completely in a bomb calorimeter. The bomb is surrounded by **1.000 kg** of water. The temperature increases from **25.12** to **29.36** degrees Celsius. If the **heat capacity** of the bomb is **1.60 kJ/°C**, calculate the **heat of combustion** of the benzoic acid **in kJ/gram**. The specific heat of water is **4.184 J/g°C**.

Circle the best answer!

- o 21.4 kJ/gram
- o 18.9 kJ/gram
- (o) -26.5 kJ/gram
- o -9.2 kJ/gram
- o -32.7 kJ/gram

Question 13 5 Points

Given the **standard enthalpy changes** for the following two reactions:

(1) $2\ Ni(s) + O_2(g) = 2\ NiO(s)$ ..... $\Delta H^\circ = -479.4$ kJ

(2) $Ni(s) + Cl_2(g) = NiCl_2(s)$ ..... $\Delta H^\circ = -305.3$ kJ

what is the **standard enthalpy change** for the reaction:

(3) $2\ NiCl_2(s) + O_2(g) = 2\ NiO(s) + 2\ Cl_2(g)$ ..... $\Delta H^\circ = ?$

For full credit you must show work.

(2) Rev, x2
(1) as is

$2\ NiCl_2(s) = 2\ Ni(s) + 2\ Cl_2(g)$ $\quad \Delta H^\circ = 610.6$

$2\ Ni(s) + O_2(g) = 2\ NiO(s)$ $\quad \Delta H^\circ = -479.4$

$2\ NiCl_2(s) + O_2(g) = 2\ NiO(s) + 2\ Cl_2(g)$ $\quad \Delta H^\circ = 131.2$

131.2 **kJ**

Question 14 5 Points

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

$4\ NO(g) + 6\ H_2O(g) = 4\ NH_3(g) + 5\ O_2(g)$

[ΔH^0_f: $NH_3(g)$, **-46** kJ/mol $NO(g)$, **90** kJ/mol $H_2O(g)$, **-242** kJ/mol]

For full credit you must show work.

$\Delta H^\circ_{RXN} = \sum \Delta H^\circ_f (Products) - \sum \Delta H^\circ_f (Reactants)$

$= 4\Delta H^\circ_f NH_3(g) + 5\Delta H^\circ_f O_2(g) - 4\Delta H^\circ_f NO(g) - 6\Delta H^\circ_f H_2O(g)$

$4(-46) + 5(0) - 4(90) - 6(-242) =$

908 **kJ**

Question 15 5 Points

In the laboratory you dilute **4.83** mL of a concentrated **6.00 M hydriodic acid** solution to a total volume of **50.0** mL. What is the concentration of the dilute solution?

For full credit you must show work.

$\#mol = 6.00(0.00483) = 2.90 \times 10^{-2}$ mol HI

$M = \frac{2.90 \times 10^{-2}\ mol\ HI}{0.050\ L} = 0.580$

0.580 **M**

Question 16
6 Points

For the following reaction, **6.64** grams of **nitrogen gas** are mixed with excess **oxygen gas**. The reaction yields **12.5** 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 include a balanced chemical equation.

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

$N_2: 2(14.01) = 28.02\ g \cdot mol^{-1}$

$6.64\,g \left| \frac{1\ mol}{28.02\,g} \right. = 0.237\ mol\ N_2(g)$

$0.237\ mol\ N_2 \left| \frac{2\ NO}{1\ N_2} \right. = 0.474\ mol\ NO(g)$

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

$0.474\ mol\ NO \left| \frac{30.01\,g}{1\ mol} \right. = 14.2\,g$

$\%\ Yield: \left(\frac{12.5\,g}{14.2\,g}\right)100 = 88\%$

88 %

Question 17
6 Points

For the following reaction, **3.69** grams of **chlorine gas** are mixed with **6.56x10^{-2}** moles of **sodium iodide**.

chlorine + sodium iodide = sodium chloride + iodine

What is the maximum amount of **iodine** that can be formed?

For full credit you must show work and include a balanced chemical equation.

$Cl_2 + 2\,NaI = 2\,NaCl + I_2$

3.69g 6.56×10^{-2} mol

Cl_2 : $2(35.45) = 70.90\ g\cdot mol^{-1}$

$$3.69\ g\ Cl_2 \left| \frac{1\ mol}{70.90\ g} \right. = 5.20\times10^{-2}\ mol\ Cl_2$$

$$5.20\times10^{-2}\ mol\ Cl_2 \left| \frac{1\ I_2}{1\ Cl_2} \right. = 5.20\times10^{-2}\ mol\ I_2$$

$$6.56\times10^{-2}\ mol\ NaI \left| \frac{1\ I_2}{2\ NaI} \right. = 3.28\times10^{-2}\ mol\ I_2\ *$$

NaI the Limiting Reagent

3.28×10^{-2} **mol of iodine**

Do Not Write Below This

Exam III Score