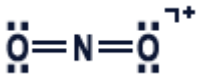
Chem 111 **Summer 2010** **Exam III** **Whelan**

Question 1
8 Points

A	B	C	D
			

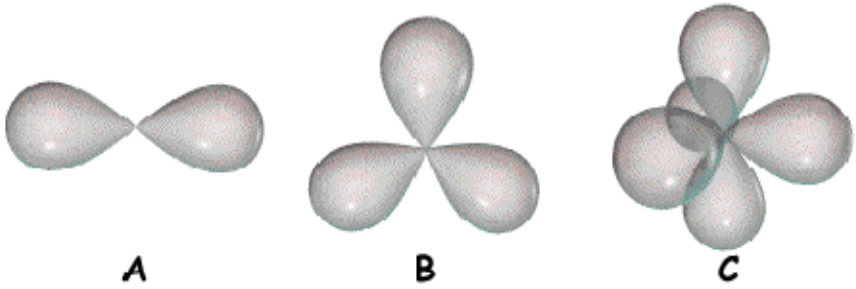
Classify the above molecules as either **polar** or **nonpolar**.

A. NONPOLAR C. POLAR

B. NONPOLAR D. NONPOLAR

Question 2
12 Points

For each **hybridization type**, choose a **picture** that corresponds to the correct orbital picture and specify the electron pair geometry. If **no picture** matches, enter **N**.



A B C

Hybridization	Picture	Electron Pair Geometry
sp	A	LINEAR
sp^3d	C	TRIGONAL BIPYRAMID
sp^2	B	TRIGONAL PLANAR

Question 3
6 Points

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

a) The **electron pair geometry** of this molecule is TETRAHEDRON

b) The **geometry** of this molecule is ANGULAR / BENT

c) The **approximate bond angle** in the molecule ~ 109°

Question 4
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 hydroxide** $Fe(OH)_3(s)$
2. **Calcium chloride** and **ammonium sulfide** $CaS(s)$
3. **Calcium hydroxide** and **hydrochloric acid** No precipitate

Question 5
6 Points

Write the **net ionic equation** for the reaction that takes places when aqueous solutions of **ammonium sulfide** and **chromium(III) iodide** are combined.

$3\,(NH_4)_2S(aq) + 2CrI_3(aq) = Cr_2S_3(s) + 6NH_4I(aq)$

$6\,NH_4^+ + 3S^{2-} + 2Cr^{3+} + 6I^- = Cr_2S_3(s) + 6\,NH_4^+ + 6I^-$

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

Question 6
6 Points

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

$HCN(aq) + LiOH(aq) = LiCN(aq) + H_2O(l)$

(Weak acid) (Strong base)

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

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

Question 7
6 Points

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

$CaCO_3(s) + 2\,HI(aq) = CaI_2(aq) + CO_2(g) + H_2O(l)$

(Strong acid)

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

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

1,810 J 723 g

Question 8
5 Points

After absorbing **1.81 kJ** of heat the temperature of **a 0.723 kg** block of copper is **40.6°C**. The specific heat of copper is **0.385 J/g.°C**. What was the **initial temperature** of the copper block?

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

$1810 = 723 \times 0.385 \times \Delta T$

$\Delta T = \frac{1810}{723 \times 0.385} = 6.5^\circ C$

$T_f - T_i = 6.5$

$40.6 - T_i = 6.5$

$-T_i = 6.5 - 40.6 = -34.1^\circ C$

34.1 °C

Question 9
7 Points

0.301 g of C (graphite) is burned in excess oxygen to give $CO_2(g)$

C(graphite) + O_2(g) = CO_2(g)

The temperature of the calorimeter, which contained **775g** of **water**, increases from **25.1**°C to **27.48**°C. What quantity of heat is evolved per mole of carbon?

[Heat capacity water = **4.184** J/g°C Heat capacity calorimeter = **893** J/°C]

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

$q_{H_2O} = 775 \times 4.184 \times 2.38 = 7717.4\ J$

$q_{cal} = 893 \times 2.38 = 2125.3\ J$

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

$q_{RXN} = -(q_{H_2O} + q_{cal})$

$= 9842.7\ J$

$0.301\ g\ C \left| \frac{1\ mol}{12.01\ g} \right. = 0.0251\ mol\ C$

$q_{RXN} = \frac{9842.7\ J}{0.0251\ mol} =$

392,139 J/mol

Question 10
4 Points

Given the standard enthalpy changes for the following two reactions:

1. **2 Hg(l) + O_2(g) = 2 HgO(s)** ΔH° = **-181.6** kJ
2. **Hg(l) + Cl_2(g) = $HgCl_2$(s)** ΔH° = **-224.3** kJ

what is the standard enthalpy change for the reaction:

2 $HgCl_2$(s) + O_2(g) = 2 HgO(s) + 2 Cl_2(g) ΔH° = ?

2. (-2) $2\ HgCl_2(s) = 2\ Hg(l) + 2\ Cl_2(g)$ $\Delta H^\circ = 448.6$

1. $2\ Hg(l) + O_2(g) = 2\ HgO(s)$ $\Delta H^\circ = -181.6$

$2\ HgCl_2(s) + O_2(g) = 2\ HgO(s) + 2\ Cl_2(g)$ $\Delta H^\circ = 267\ kJ$

267 kJ

Question 11
4 Points

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

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

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

$$\Delta H^\circ = \Sigma \Delta H_f^\circ(\text{Products}) - \Sigma \Delta H_f^\circ(\text{Reactants})$$
$$= 4\Delta H_f^\circ NO(g) + 6\Delta H_f^\circ H_2O(g) - 4\Delta H_f^\circ NH_3(g) - 5\Delta H_f^\circ O_2(g)$$
$$= 4(90) + 6(-242) - 4(-46) - 5(0)$$
$$= -908\ kJ/mol$$

-908 **kJ/mol**

Question 12
8 Points

a) A 1.13 mol sample of **He** gas is confined in a **27.3** liter container at **21.5**°C.

If **1.13** mol of O_2 is **substituted** for the **1.13** mol of **He**, holding the volume and temperature constant, the average **kinetic energy** will

- ❍ Decrease
- ❍ Increase
- ❍ not enough information given
- ◉ remain the same

b) A **1.36** mol sample of O_2 gas is confined in a **32.9** liter container at **21.5**°C.

If the amount of gas is **decreased** to **0.680** mol, holding the volume and temperature constant, the **pressure** will

- ◉ Decrease
- ❍ Increase
- ❍ not enough information given
- ❍ remain the same

c) A **0.708** mol sample of CO_2 gas is confined in a **17.4** liter container at **26.8**°C.

If the volume of the gas sample is **decreased** to **8.71** L holding the temperature constant, the number of **molecule-wall collisions per unit area per unit time** will

- ❍ Decrease
- ◉ Increase
- ❍ not enough information given
- ❍ remain the same

d) A **0.708** mol sample of CO_2 gas is confined in a **17.4 liter** container at **26.8**°C.

If the **temperature** of the gas sample is **decreased** to **8.00**°C, holding the volume constant, the **pressure will decrease because**:

- ❍ The gas molecules are moving slower.
- ❍ The average kinetic energy of the molecules has decreased.
- ❍ The number of collision per unit time decreases
- ◉ All of the above.

Question 13
5 Points

In the laboratory you dilute **4.91** mL of a concentrated **6.02** M **nitric acid** solution to a total volume of **155** mL. What is the concentration of the dilute solution ?

$$\#\ mol\ HNO_3 = 6.02 \times 0.00491 = 2.96 \times 10^{-2}\ mol\ HNO_3$$

$$M = \frac{\#\ mol}{V(L)} = \frac{2.96 \times 10^{-2}}{0.155} = 0.191\ M$$

0.191 **M**

Question 14
7 Points

For the following reaction, **4.89** grams of **sodium** are mixed with **0.308** moles of **water**.

sodium (s) + water (l) = sodium hydroxide (aq) + hydrogen (g)

What is the **maximum amount** (in grams) of **hydrogen gas** that can be produced?

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

$$2\ Na(s) + 2\ H_2O(l) = 2\ NaOH(aq) + H_2(g)$$

$$4.89\ g\ Na \left| \frac{1\ mol}{22.99\ g} \right. = 0.213\ mol\ Na$$

$$0.213\ mol\ Na \left| \frac{1\ H_2}{2\ Na} \right. = 0.106\ mol\ H_2$$

LIMITING REAGENT

$$0.308\ mol\ H_2O \left| \frac{1\ H_2}{2\ H_2O} \right. = 0.154\ mol\ H_2$$

$$0.106\ mol\ H_2 \left| \frac{2.02\ g}{1\ mol} \right. = 0.215\ g$$

0.215 **grams of hydrogen gas**

Question 15
7 Points

How many **grams** of **solid barium hydroxide** are needed to exactly **neutralize 25.8 mL** of a **0.701 M perchloric acid** solution? Assume that the volume remains constant.

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

$2\,HClO_4(aq) + Ba(OH)_2 = Ba(ClO_4)_2(aq) + 2\,H_2O$

25.8 mL
0.701 M

$0.701(0.0258) = 1.81\times10^{-2}\ mol\ HClO_4$

$1.81\times10^{-2}\ mol\ HClO_4 \left| \frac{1\ Ba(OH)_2}{2\ HClO_4} \right.$

$= 9.04\times10^{-3}\ mol\ Ba(OH)_2$

$Ba(OH)_2 = 137.33 + 2(16) + 2(1.01)$
$= 171.35\ g\cdot mol^{-1}$

$9.04\times10^{-3}\ mol\ Ba(OH)_2 \left| \frac{171.35\ g}{1\ mol} \right.$

$= 1.55\ g$

1.55 **grams**

Do Not Write Below This

Exam III Score