Chem 121 **Name** _____
Final exam **October 26, 2005**

1. (18) Consider a reaction between 0.51 g sample of magnesium metal and 95.0 mL of 0.250 M hydrochloric acid.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

(a) How many moles of magnesium are present?

(b) How many moles of hydrochloric acid are present?

(c) Which is the limiting reagent?

(d) How many liters of hydrogen gas, measured at 22°C and 747 torr, will be produced when the reaction occurs?

2. (10) (a) Circle the acid in the following acid/base reaction.

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

(b) Write the net ionic equation for the following precipitation reaction.

$$Pb(NO_3)_2(aq) + Na_2CO_3(aq) \rightarrow PbCO_3(s) + 2NaNO_3(aq)$$

(c) In the following redox reaction, assign oxidation numbers to all atoms in all molecules and ions, and circle the reducing agent.

$$6I^-(aq) + 2MnO_4^-(aq) + 4H_2O(l) \rightarrow 8OH^-(aq) + 2MnO_2(s) + 3I_2(s)$$

3. (8) Forty miles above the earth's surface, the temperature is 250 K and the pressure is only 0.20 torr.

(a) If a balloon containing 1.00 mol of H_2 is held at these conditions, what will its volume be?

(b) What is the density of H_2 under these conditions?

4. (9) Consider zirconium.

(a) How many electrons, protons, and neutrons are there in the ^{91}Zr atom?

(b) Write the electron configuration for zirconium. (The noble gas abbreviation is fine.)

(c) Cross out the sets of quantum numbers (n, l, m_l, m_s) that would not be possible for an electron in a ground-state zirconium atom.

(3, 1, 0, +1/2)	(2, -1, 0, +1/2)
(3, 1, 1, +1/2)	(4, 2, 0, +1/2)
(2, 2, 0, +1/2)	(4, 1, 0, +1/2)

5. (8) Enthalpy changes for the following reactions can be determined experimentally.

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H^o = -91.8$ kJ

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$ $\Delta H^o = -906.2$ kJ

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\Delta H^o = -483.6$ kJ

Use these values to determine the enthalpy change for the formation of NO(g) from the elements (an enthalpy change that cannot be measured directly):

$N_2(g) + O_2(g) \rightarrow 2NO(g)$ $\Delta H^o = ?$

6. (17) Consider the combustion of acetylene:

$$2C_2H_2(g) + 5O_2(g) \text{ ---> } 4CO_2(g) + 2H_2O(g)$$

(a) Use the bond enthalpy values provided to calculate the enthalpy change for the reaction. (C_2H_2 contains a carbon-carbon double bond.)

(b) If 0.260 g of C_2H_2 are burned, how much heat will be released?

(c) If all of the heat released in (b) is absorbed by 525 g of water, originally at 25^{o}C, what will be the final temperature of the water?

7. (6) Write a chemical equation (reactants ---> products) for which the enthalpy change is equal to:

(a) the enthalpy of formation of $N_2O_4(g)$

(b) the ionization energy of Na

(c) the lattice enthalpy of NaCl

8. (20) (a) Draw Lewis structures for the following molecules and ions. Include more than one resonance structure, if appropriate. Show non-zero formal charges. Give the shape of each molecule or ion, and the approximate bond angles. State the hybridization on each central atom.

$TeCl_2$ CO_3^{2-} ClF_3

(b) For each neutral molecule, state whether the molecule will be polar or non-polar.

9. (12) Describe the bonding in N_2H_2 (HNNH). Begin by drawing a Lewis structure for the molecule. What is the hybridization of each nitrogen atom? How many sigma and pi bonds does the molecule contain? State which orbitals are used in forming each bond.

10. (8) Both Fe and $FeCl_2$ have high melting points, but the bonds holding these two substances together are quite different.

(a) Describe the bonding within a sample of Fe.

(b) Describe the bonding in a sample of $FeCl_2$.

11. (10) Choose the appropriate member of each pair. No explanations are required.

(a) More acidic oxide: Ca or P

(b) Shorter bond: C-O or C-N

(c) Stronger bond: KCl or CaS

(d) More polar bond: S-Cl or S-Br

(e) Larger radius: K^+ or Cl^-

12. (4) Name (or give the symbol for) this element: It has a high electron affinity. The element just before it in the periodic table has a lower ionization energy and a lower electron affinity. The element just after it in the periodic table has a higher ionization energy and basically no electron affinity. Within its group (column), it has the second highest ionization energy. What is it?

13. (4) Name (or give the symbol for) this element: It is a metal. Its atomic radius is smaller than the atomic radius of the element just before it in the periodic table. Its +1 ionic radius is larger than the element just before it would be if it formed a +1 ion. It has the greatest electron affinity of any element in its group (column). What is it?