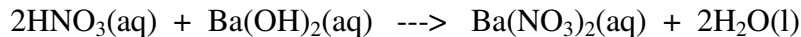
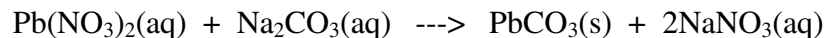




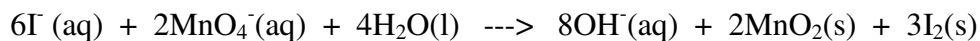
2. (10) (a) Circle the acid in the following acid/base reaction.



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



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



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  $\text{H}_2$  is held at these conditions, what will its volume be?

(b) What is the density of  $\text{H}_2$  under these conditions?

4. (9) Consider zirconium.

(a) How many electrons, protons, and neutrons are there in the  $^{91}\text{Zr}$  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)

(3, 1, 1, +1/2)

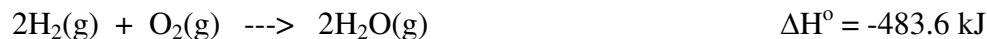
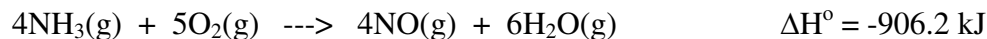
(2, 2, 0, +1/2)

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

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

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

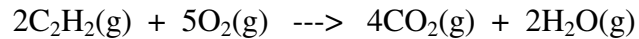
5. (8) Enthalpy changes for the following reactions can be determined experimentally.



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



6. (17) Consider the combustion of acetylene:



(a) Use the bond enthalpy values provided to calculate the enthalpy change for the reaction. ( $\text{C}_2\text{H}_2$  contains a carbon-carbon double bond.)

(b) If 0.260 g of  $\text{C}_2\text{H}_2$  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  $25^\circ\text{C}$ , what will be the final temperature of the water?

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

(a) the enthalpy of formation of  $\text{N}_2\text{O}_4(\text{g})$

(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.



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

9. (12) Describe the bonding in  $\text{N}_2\text{H}_2$  (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  $\text{FeCl}_2$  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  $\text{FeCl}_2$ .

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?