Chem1A, General Chemistry I

1.) Solid magnesium will react with hydrochloric acid to produce hydrogen gas and magnesium chloride. A 0.315 g sample of a mixture containing magnesium and other unreactive materials is dissolved completely in excess hydrochloric acid. The resulting hydrogen gas was collected in a 202 mL container *over water* at 23°C. The total pressure inside the container was measured to be 752 torr. At this temperature, the vapor pressure of water is 21.07 mmHg.

a.) Write the **balanced** chemical equation for this reaction, *including* phases.

b.) What element is being **reduced**? _____

c.) What element is being **oxidized**? _____

d.) Assuming the percent yield of the reaction was 100%, calculate the mass percent of magnesium in the original sample.

2.) A tennis ball weighs 56.7 g. Calculate the de Broglie wavelength in m for a ball traveling at 125 mph. (1 mi. = 1.61 km)

3.) Nicotine is the addictive component of tobacco. An aqueous solution is made by dissolving 1.921 g nicotine into 48.92 g of water, changing the freezing point by -0.450°C. (K_f = 1.86 °C/m)

a.) Calculate the molar mass of nicotine.

b.) Nicotine contains only carbon, hydrogen, and nitrogen. Elemental analysis revealed a composition of 74.03% C, 8.70% H, and the rest N by mass. What is the molecular formula of nicotine?

4.) From a 0.871 M solution of barium nitrate, 267 mL are taken and mixed with 402 mL from a 0.487 M solution of ammonium sulfate. A double displacement reaction is observed.

a.) Write the **balanced molecular** equation for this reaction.

b.) Write the **total/complete ionic** equation for this reaction.

c.) Write the **net ionic** equation for this reaction.

d.) Calculate the **theoretical yield of solid precipitate**, in mols.

5.) Consider the following equation:

$$3\ C(\text{graphite}) + 4\ H_2(g) \rightarrow C_3H_8\ (g) \qquad \Delta H_{rxn} = ?$$

Use Hess's Law to determine ΔH_{rxn} from the following data:

$$C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(l) \qquad \Delta H_{rxn} = -2219.9\ kJ/mol$$
$$C(\text{graphite}) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H_{rxn} = -393.5\ kJ/mol$$
$$H_2(g) + \tfrac{1}{2}\ O_2(g) \rightarrow H_2O(l) \qquad \Delta H_{rxn} = -285.8\ kJ/mol$$

6.) When potassium iodide (KI, 166.00 g/mol) is added to water, the formation of the solution is an endothermic process with an enthalpy change of 20.3 kJ/mol KI dissolved. At 23.5°C, enough KI is dissolved in water to make 150.0 mL of a 2.50 M KI solution. Calculate the final temperature of the water, in °C, given the heat capacity of liquid water is 4.184 J/(g °C) and the density of the solution is 1.72 g/mL.

7.) Benzene (C_6H_6) is an aromatic organic hydrocarbon.

a.) **Balance** the following equation.

__2__ $C_6H_6(l)$ + _____ $O_2(g) \rightarrow$ _____ $CO_2(g)$ + _____ $H_2O(l)$

b.) The enthalpy change associated with the above reaction of 2 mols of C_6H_6 is -6535 kJ/mol. Given the following information, calculate the standard enthalpy of formation for 1 mol of $C_6H_6(l)$, in kJ/mol.

Compound	$CO_2(g)$	$H_2O(l)$
$\Delta H_f°$ (kJ/mol)	-393.5	-285.8

8.) Draw the molecular orbital diagram for N_2^{+2}, ignoring core electrons. Calculate the bond order and determine whether the molecule is paramagnetic or diamagnetic.

9.) Draw the most plausible Lewis structures for the following molecules, including all **resonance structures** and **formal charges**. Indicate the **electronic** and **molecular** geometry expected. Determine the **polarity** of the molecule, give the **hybridization** around each central atom and determine the **number of σ and π bonds** in the structure. (8 pts)

Element	**N**	**S**	**F**	**I**	**Cl**
eN	3.0	2.5	4.0	2.5	3.0

a.) NSF

b.) ICl_3

10.) One mole of photons contains 1799 kJ of energy.

a.) Calculate the energy per one photon, in J.

b.) Calculate the frequency of one photon, in Hz.

c.) Calculate the wavelength of one photon, in nm.

11.) A gaseous hydrocarbon weighs 0.231 g and occupies a volume of 102 mL at 23.0°C at 749 mmHg. Calculate the molar mass of the unknown, in g/mol.

12.) A "coffee-cup" calorimeter contains 100.0 mL of 0.300 M HCl at 20.3°C. When 1.82 g Zn(s) is added, a single displacement reaction is observed and the temperature rises to 30.5°C. Calculate the heat of reaction per mol Zn, in kJ/mol, assuming that the specific heat capacity of the solution is 4.184 J/(g °C), the density of the resulting solutiond is 1.18 g/mL (the Zn(s) and products add no volume), and no heat is lost.