Part I. – *Circle your answers*

1. You are holding two identical balloons of equal volume. One balloon is filled with H_2 gas and the other is filled with Ne gas. Which of the following best represents the ratio (H_2:Ne) of <u>total masses</u> of the gases in the balloons?

   A) 1:1
   B) 1:20
   C) 1:10
   D) 2:1
   E) 1:2

2. Which of the following is true for a chemical reaction carried out at constant volume?

   A) The pressure must stay constant.
   B) The amount of work must always be a positive value.
   C) The total number of molecules is constant.
   D) The heat flow is equal to the change in enthalpy.
   E) The heat flow is equal to the change in internal energy.

3. What is the ratio of cations to anions in a 2.0 M solution of ammonium phosphate?

   A) 1:1
   B) 2:1
   C) 3:2
   D) 3:1
   E) 1:3

4. What volume of 10.0 M H_2SO_4 is required to prepare 4.0 L of 0.50 M H_2SO_4?

   A) 0.20 L
   B) 0.40 L
   C) 0.50 L
   D) 1.0 L
   E) 4.0 L

5. If the $\Delta H°$ for the reaction, $2\ Mg_{(s)} + 2\ Cl_{2\,(g)} \rightarrow 2\ MgCl_{2\,(s)}$, is -1283.6 kJ, what is the standard enthalpy of formation of magnesium chloride?

   A) 0 kJ/mol
   B) -320.9 kJ/mol
   C) -641.8 kJ/mol
   D) 1283.6 kJ/mol
   E) -1283.6 kJ/mol

6. Which of the following pairs of compounds include a *weak acid* and an *insoluble ionic compound*?

   A) HF, $Ca_3(PO_4)_2$
   B) HCl, $Ca_3(PO_4)_2$
   C) CH_3COOH, K_2CO_3
   D) HNO_3, FeS
   E) CH_3COOH, $(NH_4)_2CO_3$

7. In which of the following species is nitrogen in its +1 oxidation state?

   I. NO^{-1} II. N_2 III. NCl_3

   A) I only
   B) II only
   C) III only
   D) I and III
   E) Neither I, II, nor III.

Part II. SHOW ALL WORK!

8. You measured 0.2573 g of $KMnO_4$ salt and diluted it to 450.0 mL in a volumetric flask with water. What is the molarity of your $KMnO_4$ solution?

9. A mixture of two gases in a 3:1 molar ratio are placed in an 0.500 L container and the total pressure is measured to be 2.40 atm. The container volume is then increased to 2.00 L. What is the partial pressure of the gas present in the largest quantity?

10. Balance the following oxidation-reduction reaction that takes place in an acidic solution:

$$Zn + NO_3^{-1} \rightarrow Zn^{+2} + NH_4^{+1}$$

11. Write a *total ionic equation* for the neutralization of phosphoric acid by calcium hydroxide.

12. In a coffee-cup calorimeter, 0.6076 g of $Mg_{(s)}$ are oxidized in excess acid at an initial temperature of 23.20 °C. Upon completion of the reaction, the temperature of the calorimeter increases to 27.36 °C. The (experimentally determined) heat capacity of the calorimeter is 2775 J/°C. *Note: assume an isolated system as you answer the following.*

a) Write a balanced chemical equation for the oxidation of 1 mol of magnesium metal in excess acid to yield $Mg^{2+}_{(aq)}$ and $H_{2\ (g)}$.

b) Using the calorimetry data, calculate the molar enthalpy of reaction for the oxidation of $Mg_{(s)}$ (the same reaction that you determined in part (a)).

13. Dichlorodimethylsilane ($(CH_3)_2SiCl_2$) is made by the reaction below (which, industrially, is carried out at high temperature and in the presence of a catalyst).

$$Si_{(s)} + 2\ CH_3Cl_{(g)} \rightarrow (CH_3)_2SiCl_{2\ (g)} \qquad \text{(this equation is balanced)}$$

A 16.5 L flask is filled with gaseous CH_3Cl to a pressure of 885 mmHg at 175 ^{o}C. You place 0.200 mole of solid silicon in the flask and initiate the reaction. What is the *total* pressure in the flask (also at 175 ^{o}C) upon completion of the reaction?

Equations and Constants

$q = C\Delta T = mc\Delta T$

$\Delta E_{universe} = 0 \quad \Delta E_{system} = -\Delta E_{surroundings} \quad \Delta E_{system} + \Delta E_{surroundings} = 0$

$q_{system} = -q_{surroundings} \quad q_{rxn} = -q_{cal}$

$E_k = \frac{1}{2} mv^2 \quad E_P = mgh \quad E_P = V \text{ (voltage)} = \kappa \frac{Q_1 Q_2}{d} \quad (\kappa = 8.99 \times 10^9 \text{ J m C}^2)$

$w = F\ d = F\ \Delta x \qquad w = -P\Delta V \qquad P = \frac{F}{A}$

$\Delta H = \Delta E + P\Delta V = q_P \qquad q_V = \Delta E$

$\Delta H_{rxn}^\circ = \sum n\ \Delta H_f^\circ(\text{products}) - \sum m\ \Delta H_f^\circ(\text{reactants})$

$\Delta H_{rxn} = \sum n\ \Delta H_f(\text{products}) - \sum m\ \Delta H_f(\text{reactants})$

$R = 0.08206\ \text{L·atm·mol}^{-1}\text{·K}^{-1} = 8.314\ \text{J·mol}^{-1}\text{·K}^{-1} = 62.36\ \text{L·torr·mol}^{-1}\text{·K}^{-1}$

1.00 atm = 760 mm Hg = 101.325 kPa = 1.01325 bar