Chem 10113, Exam 2 Name: _____
(Please Print)
October 24, 2018

1. (10 points) **SHOW ALL WORK.** An average single-family household consumes about 2500 kWh (kilowatt hours) of electrical energy per month (mainly for air-conditioning). Suppose that this energy comes from a power plant that burns coal (i.e., carbon) containing 0.80 % sulfur by mass. Assume that all of the sulfur is converted to SO_2 which then reacts with O_2 and H_2O in the atmosphere to form H_2SO_4. Determine the mass of H_2SO_4 (in kg) that results from this monthly energy consumption. (***Note***: The molar mass of H_2SO_4 = 98.1. The standard heat of formation of $CO_{2(g)}$ = -394 kJ/mole. 1 kWh = 3600 kJ)

2. (9 points) Write a ***balanced chemical equation*** for the process that occurs when each of the following substances are mixed with water. If the substance is a weak electrolyte, indicate that by using the appropriate symbol(s) in your equation.
   (a) C_4H_4NH

   (b) BaO

   (c) HN_3

3. (4 points) List all *possible* quantum numbers for the *unpaired* electron of indium (In).
   l = _____ m_s = _____ m_l = _____ n = _____

4. (2 points) Write a specific, ***balanced chemical equation*** for which the $\Delta H°$ value is equal to the third ionization energy of calcium.

5. (3 points) Magnetic experiments show that atoms of molybdenum (Mo) have 6 unpaired electrons. Write the ***valence shell*** electron configuration of Mo that is consistent with this fact.

6. (8 points) **SHOW ALL WORK.** According to tabulated data in your textbook, the average energy required to break C-H and C-Cl bonds are listed as 414 kJ/mole for C-H and 339 kJ/mole for C-Cl. If a sample of dichloromethane, CH_2Cl_2, is exposed to UV light with a wavelength of 353 nm, determine which bond (C-H or C-Cl) will be broken. (***Note***: $h = 6.626 \times 10^{-34}$ J·sec)

7. (4 points) For each of the following pairs of atoms or ions, circle the one that has the ***smaller*** radius.

   Se vs Se^{2-} Cr^{2+} vs Cr^{3+} Rb^{+} vs Br^{-} Br vs Ar

8. In a calorimetry experiment based on the following reaction, 1.25 g of NH_4NO_3 (molar mass = 80.0) was mixed with enough water to make 25.0 mL of solution. Upon mixing, the temperature decreased from 25.8 °C to 21.9 °C.

$$NH_4NO_{3(s)} \longrightarrow NH_4^{+}(aq) + NO_3^{-}(aq)$$

   (a) (1 point) Before doing any calculations, indicate whether this reaction is endothermic or exothermic. (circle one.)

   (b) (7 points) **SHOW ALL WORK.** Using the above data, determine $\Delta H°$ (in kJ) for the reaction as written. (If necessary, use 1.00 g/mL as the density of the solution and 4.184 J/g·°C as the specific heat.)

9. (7 points) **SHOW ALL WORK.** You are asked to select a high precision valve that will be used to accurately deliver 1.00 L of uranium hexafluoride (UF_6) gas in 30.0 minutes. For safety and economic reasons, you decide to use nitrogen (N_2) to test the new valve before using it with UF_6. Determine the time required for this valve to deliver 1.00 L of N_2. (molar mass: $UF_6 = 352$)

10. (2 points) In aqueous solution, PH_3 reacts with perchlorate ion to produce $Cl^-_{(aq)}$ and phosphate ion. Write the chemical formula for the ***oxidizing agent*** in this process.

11. (4 points) Write the oxidation number of nitrogen in each of the following.

N_2O_4 _____ Mg_3N_2 _____ N_2 _____ NaN_3 _____

12. (8 points) **SHOW ALL WORK.** Given the following thermochemical equations, calculate the ***standard heat of formation*** ($\Delta H°_f$) of thiophene, $C_4H_4S_{(l)}$, in kJ/mole. Your solution method ***must include*** the appropriate chemical equation for the ***formation reaction*** of $C_4H_4S_{(l)}$.

$C_4H_4S_{(l)} + 6\ O_{2(g)} \longrightarrow 4\ CO_{2(g)} + 2\ H_2O_{(l)} + SO_{2(g)}$ $\Delta H° = -2{,}829$ kJ

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H° = -394$ kJ

$SO_{2(g)} \longrightarrow O_{2(g)} + S_{(s)}$ $\Delta H° = 297$ kJ

$H_2O_{(l)} \longrightarrow H_{2(g)} + 1/2\ O_{2(g)}$ $\Delta H° = 286$ kJ

13. (9 points) In the space below each of the following reactions, clearly write the ***balanced, net ionic equation***. Use subscripts [(s), (aq), (g), etc.] to indicate the phase of each compound or ion.

(a) $NH_4C_2H_3O_{2(aq)} + Ba(OH)_{2(aq)} \longrightarrow$

(b) $HCO_2H_{(aq)} + KOH_{(aq)} \longrightarrow$

(c) $Na_2CO_{3(aq)} + Fe_2(SO_4)_{3(aq)} \longrightarrow$

14. (4 points) Write the complete electron configuration for arsenic (As).

15. (4 points) Write the ***short-hand*** electron configuration for osmium (Os).

16. (4 points) Write the ***valence shell orbital diagram*** of the tungsten(III) ion (W^{3+}).

17. (10 points) **SHOW ALL WORK.** A "copper" penny is mainly zinc coated with a small amount of copper. In a simple lab experiment, a new penny weighing 2.500 g is treated with excess hydrochloric acid in which the zinc reacts as follows (Cu does not react).

$$Zn_{(s)} + 2\,HCl_{(aq)} \longrightarrow ZnCl_{2(aq)} + H_{2(g)}$$

The hydrogen gas was collected over water at 20.0 °C in a 1.15 L container and the total pressure was found to be 610.3 torr. Determine the mass percent of Zn in the penny.
(At 20 °C, the vapor pressure of water is 17.6 torr.)