

Chem 10113, Exam 2

October 24, 2018

Name: _____

(Please Print)

- (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 $\text{H}_2\text{SO}_4 = 98.1$. The standard heat of formation of $\text{CO}_2(\text{g}) = -394 \text{ kJ/mole}$. $1 \text{ kWh} = 3600 \text{ kJ}$)

- (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.
 - $\text{C}_4\text{H}_4\text{NH}$

 - BaO

 - HN_3

- (4 points) List all *possible* quantum numbers for the *unpaired* electron of indium (In).
 $l = \underline{\hspace{2cm}}$ $m_s = \underline{\hspace{2cm}}$ $m_l = \underline{\hspace{2cm}}$ $n = \underline{\hspace{2cm}}$

- (2 points) Write a specific, **balanced chemical equation** for which the ΔH° value is equal to the third ionization energy of calcium.

- (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:* $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{sec}$)

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.



- (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 ΔH° (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.)

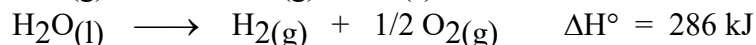
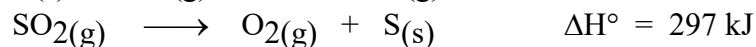
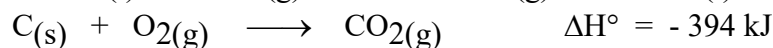
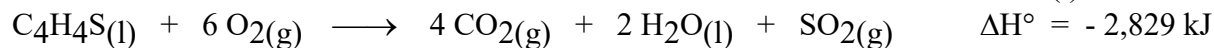
9. (7 points) **SHOW ALL WORK.** You are asked to select a high precision valve that will be used to accurately deliver 1.00 L of uranium hexafluoride (UF₆) gas in 30.0 minutes. For safety and economic reasons, you decide to use nitrogen (N₂) to test the new valve before using it with UF₆. Determine the time required for this valve to deliver 1.00 L of N₂. (molar mass: UF₆ = 352)

10. (2 points) In aqueous solution, PH₃ reacts with perchlorate ion to produce Cl⁻(aq) and phosphate ion. Write the chemical formula for the *oxidizing agent* in this process.

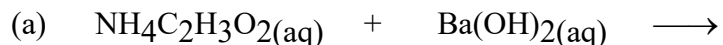
11. (4 points) Write the oxidation number of nitrogen in each of the following.



12. (8 points) **SHOW ALL WORK.** Given the following thermochemical equations, calculate the *standard heat of formation* (ΔH°_f) of thiophene, C₄H₄S(l), in kJ/mole. Your solution method *must include* the appropriate chemical equation for the *formation reaction* of C₄H₄S(l).



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.

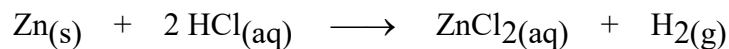


14. (4 points) Write the complete electron configuration for arsenic (As).

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).



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.)