Name ____ CHM 1045
Fall 2015
October 21

EXAMINATION TWO

I _______ II _______ III _______ IV _______ V _______ VI _______ Total __________

This exam consists of several questions. Rough point values are given. The total will be scaled to 100 points after the exams are marked. For questions with multiple parts, you do not necessarily need the answer to part A in order to work part B, etc. Please glance over the entire exam, and then attempt the questions in the order of your choice. For calculations, draw a box around your final answer given to the correct number of significant figures, and ***be sure to include the correct units. You must show your work to receive any credit for a calculated answer.*** Additional information is provided in a separate information packet, and there should be ample space on the packet for scratch work. Good luck!

I. (2 points) Circle the time above your recitation instructor's name corresponding to the section you attend.

5:00 pm	6:00 pm	7:00 pm	5:00 pm	6:00 pm	7:00 pm	5:00 pm	6:00 pm	7:00 pm
Karin Vallega, 214 HTL			Felipe Andrade, 219 HTL			Lenzi Williams, 520 HTL		

II. (21 points) Write balanced molecular equations (ME) and net ionic equations (NIE) for the following reactions. *Be sure to include the correct states in your final equations and charges for ions in the NIE.*

A. $CuCl_2(aq) + Pb(s) \rightarrow$

ME:

NIE:

B. $KF(aq) + HI(aq) \rightarrow$

ME:

NIE:

C. $K_2SO_4(aq) + CaCl_2(aq) \rightarrow$

ME:

NIE:

III. (16 points) We never got a chance to consider the "deflategate" controversy using the ideal gas law, so I thought we might do it here.

Tom Brady and the New England Patriots were accused of deflating footballs used in their AFC championship game against the Indianapolis Colts on January 18, 2015. The NFL requires footballs to be inflated to a pressure between 12.5 and 13.5 "psi." During halftime it was discovered that some of the footballs used by the Patriots were 2 psi below the minimum allowed pressure. Patriots supporters claimed that the drop in pressure was due to the difference in temperature between the locker room and the playing field.

A. Let's assume that the footballs were filled to 12.5 psi before game and checked with a pressure gauge. That's "gauge pressure" (psi-g) – the actual pressure (sometimes called "absolute" pressure) inside the ball would be 27.2 psi.

What's the difference between gauge pressure and absolute pressure? In other words, explain why the numbers are different.

B. According to reports, the temperature in the locker room before the game was 74°F (23°C) and the temperature on the field at halftime was 48°F (9°C). Assuming a pressure of 27.2 psi at 23°C, what would the pressure be after the temperature dropped to 9°C?

What is another assumption you make in the above calculation?

C. Would a temperature drop from 23°C to 9°C account for the footballs being 2 psi below the minimum allowed pressure?

Explain your reasoning.

IV. (28 points) We carried out the thermite reaction way back in Chapter 3 and used that reaction to talk about limiting reagents and percent yield. Since then, it showed up in a recitation exercise and a homework problem. It's a pretty impressive reaction. A large part of the driving force in the thermite reaction is based on the stability of aluminum oxide, as reflected in ΔH° of the following reaction.

$$2Al(s) + {}^{3}/_{2}O_2(g) \rightarrow Al_2O_3(s) \qquad \Delta H° = -1669.8 \text{ kJ/mol}$$

If 34 g of aluminum reacts with oxygen to form $Al_2O_3(s)$, how much heat is released assuming the reaction goes to completion?

Researchers at Purdue University have exploited this reactivity to develop a novel type of rocket fuel consisting of aluminum nanoparticles dispersed in $H_2O(s)$. They nicknamed this propellant "ALICE" (get it? Al-ice) and noted that in addition to being environmentally friendly, ALICE could be produced on any extraterrestrial body that contains water. The recent discovery of water on Mars could draw new attention to this intriguing fuel. (*International Journal of Aerospace Engineering*, **2012**)

One can speculate that the reaction that causes ALICE to act as a propellant is

$$2Al(s) + 3H_2O(s) \rightarrow Al_2O_3(s) + 3H_2(g)$$

where the hydrogen gas is subsequently burned.

A. Given the molar enthalpies for the following reactions

$$2Al(s) + {}^{3}/_{2}O_2(g) \rightarrow Al_2O_3(s) \qquad \Delta H° = -1669.8 \text{ kJ/mol}$$
$$H_2(g) + {}^{1}/_{2}O_2(g) \rightarrow H_2O(l) \qquad \Delta H° = -285.8 \text{ kJ/mol}$$
$$H_2O(s) \rightarrow H_2O(l) \qquad \Delta H° = 6.01 \text{ kJ/mol}$$

determine ΔH° for the ALICE reaction

$$2Al(s) + 3H_2O(s) \rightarrow Al_2O_3(s) + 3H_2(g)$$

Is the ΔH° you calculated consistent with Al-ice serving as a fuel? ________________

Give two reasons to support your answer.

B. Consider again the following reactions from Part A:

1. $2Al(s) + {}^{3}/_{2}O_2(g) \rightarrow Al_2O_3(s)$ $\qquad \Delta H° = -1669.8$ kJ/mol
2. $H_2(g) + {}^{1}/_{2}O_2(g) \rightarrow H_2O(l)$ $\qquad \Delta H° = -285.8$ kJ/mol
3. $H_2O(s) \rightarrow H_2O(l)$ $\qquad \Delta H° = 6.01$ kJ/mol

For which, if any, reactions does ΔH° correspond to a molar enthalpy of formation?

C. Write the oxidation numbers in the spaces provided.

___ ___ ___ ___ ___ ___

$$2Al(s) + 3H_2O(s) \rightarrow Al_2O_3(s) + 3H_2(g)$$

V. (24 points) We looked at the decomposition of hydrogen peroxide in class. The reaction is slow, but if you add a catalyst, it proceeds rather quickly.

$$2H_2O_2(aq) \longrightarrow 2H_2O(\ell) + O_2(g)$$

A. If a catalyst is added to 143 mL of 0.818 *M* $H_2O_2(aq)$, how many moles of $O_2(g)$ are produced, assuming the reaction goes to completion?

B. The oxygen gas from the above procedure was collected and dried to remove water vapor. The volume of $O_2(g)$ was 765 mL at 26.1°C and 755 mmHg. Determine the amount (moles) of O_2 gas collected.

C. What was the percent yield for the reaction?

D. Why was it necessary to remove the water vapor?

IV. (3 points) Looks like we might finally be getting some fall weather, with cooler and less humid days.

Which is heavier, humid air or dry air?

Briefly explain your reasoning.