

Sample Questions for Chem 002 Final FS13

1. MSDS (the rest listed on review):

- Proper attire –
- Acid Spill –
- Bunsen Burners –
- Phenolphthalein –

2. Heat of Neutralization:

A reaction of 100mL of 1.35M HCl and 100mL of 1.76M NaOH is monitored and the following temperatures were recorded: starting temperature = 24.6 °C; and final temperature = 38.8 °C. Calculate the ΔH of this reaction.

Given: C_p of solution (J/K) = 4.13 J/(g · K) * Volume of solution in mL (1 mL \approx 1 g for aqueous soln)

C_p of calorimeter (J/K) = 50

$Q = (-\text{total } C_p * \Delta T)$

$\Delta H = Q/n$

$\Delta T = T_f - T_i$

$n = \#$ of moles reacted

- Determine the change in temperature for the system.
- Determine the C_p of the solution (J/K).
- Determine the **total** C_p of the system.
- Determine the number of moles of the acid and the base. Which is the **limiting reagent**?
- Determine the **Heat Transfer, Q**, for the reaction.
- Determine the **change in enthalpy, ΔH** , for the reaction.

3. Heat of Fusion. An ice cube with mass 9.53 grams (presume $T_i = 0\text{ }^\circ\text{C}$) is placed in a calorimeter containing 111.24 grams of distilled water at a temperature of $23.2\text{ }^\circ\text{C}$. After equilibration, the final temperature was $15.8\text{ }^\circ\text{C}$.

Given: $\Delta H_{\text{total}} = \Delta H_{\text{ice}} + \Delta H_{\text{water}} + \Delta H_{\text{calorimeter}} + \Delta H_{\text{fus}} = 0$

$$\Delta H_{\text{water}} (\text{J}) = C_{p,\text{H}_2\text{O}} * (\text{mass}) * \Delta T$$

$$\Delta H_{\text{ice}} (\text{J}) = C_{p,\text{ice}} * (\text{mass}) * \Delta T$$

$$\Delta H_{\text{calorimeter}} (\text{J}) = C_{p,\text{Cal}} * \Delta T$$

$$C_{p,\text{H}_2\text{O}} = 4.18 \text{ J}/(\text{g}^\circ\text{C})$$

$$C_{p,\text{Cal}} = 50 \text{ J}/^\circ\text{C}$$

$$\Delta T = T_f - T_i$$

a. Determine the ΔH_{water} .

b. Determine the ΔH_{ice} . (*Hint for C_p – The ice has melted.*)

c. Determine the $\Delta H_{\text{calorimeter}}$.

d. Determine the ΔH_{fus} for **one gram** of ice.

(*Hint:* For a calorimeter (i.e., closed systems) $\Delta H_{\text{total}} = 0$)

4. General Thermochemistry Concepts – a-d.) Circle appropriate answer. e-h.) Define.

a. If heat transfers from the system (*solute*) to the surroundings (*solvent*), then ΔH is negative ($\Delta H < 0$), and the reaction is defined as (endothermic / exothermic) and the temperature of the solvent will go (up / down).

b. If heat transfers from the surroundings (*solvent*) to the system (*solute*), then ΔH is positive ($\Delta H > 0$), and the reaction is defined as (endothermic / exothermic) and the temperature of the solvent will go (up / down).

c. The heat of neutralization experiment was an (endothermic / exothermic) reaction .

d. The heat of fusion experiment was an (endothermic / exothermic) reaction.

e. This term means “the techniques that are used to measure enthalpy”:

f. This term means “the energy needed to raise the temperature of an object 1°C ”:

g. This term means “the energy needed to raise the temperature of one gram of a substance 1°C ”:

h. Heat capacity is an extrinsic property. Define intrinsic and extrinsic properties and give an example of each.

5. Radioactive Decay:

a. Safety precautions: Types of radiation (listed below) are stopped by what type of material?

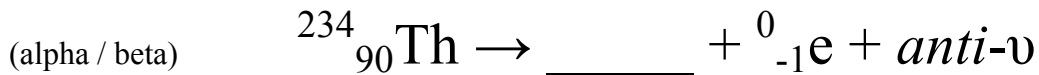
alpha –

beta –

gamma –

neutron –

b. Determine if alpha or beta, then balance the following radioactive decay equations:



c. Determine the specific decay constant, initial activity and half-life of a radioactive isotope. Given the equations:

$$A = A_0 e^{-kt} \quad \ln A = -kt + \ln A_0 \quad \ln 2 = 0.693 \quad t_{1/2} = \ln 2 / k \quad y = mx + b \quad m = (y_2 - y_1) / (x_2 - x_1)$$

and the data:

Time, minutes	Counts/Min	ln (Counts/Min)
0		
2	14472	
3	14328	
4	14248	
5	14095	
6	13920	
10	13359	

1. Determine the specific decay constant, k , for this radioactive decay.

2. Determine the initial activity, A_0 .

3. Determine the half-life.

6. Antacids: You are given 1.12 M HCl and 1.48 M NaOH. The antacid you use contains 300 mg of CaCO_3 and 100 mg of Al(OH)_3 . If the antacid dissolved in 35.0 ml of HCl and was then back titrated with 21.8 ml of NaOH, find the following:

- a. The original number **mmoles of HCl** used to dissolve the antacid and neutralize the base.

- b. The number of **mmoles of NaOH** used to back titrate the acid.

- c. The number of **mmoles of acid** used to neutralize only the antacid (a.k.a. the excess HCl).

- d. Write the **balanced equations** for the neutralization of the antacid (Both CaCO_3 and Al(OH)_3).

- e. Using the **number of mg in the tablet**, calculate the mmoles of each component (Both CaCO_3 and Al(OH)_3).

- f. Based on the **mmoles of each component**, calculate the theoretical number of mmoles of HCl that should have been needed to neutralize the antacid. (*Hint: Use the mole ratios.*)

- g. What was the **total number of theoretical mmoles of HCl** that should have been neutralized?

- h. Calculate the **percent error** in order to compare the theoretical (g.) to the actual (c.). What are possible reasons this discrepancy could have occurred?

7. Spectrophotometry: Using a Spectrophotometer (Spec 20), a student recorded below the Percent Transmittance data for the following solutions:

**Red Dye Standard (6.30 ppm)
Blue Dye Standard (5.05 ppm)
Purple Unknown**

	400 nm	450 nm	500 nm	550 nm	600 nm	650 nm
Red Std	63.5	48.5	23.5	38.6	78.3	98.5
Blue Std	80.5	99.0	82.5	56.5	8.5	72.4
Purple Unk	79.3	72.5	35.5	85.8	45.5	65.3

a. Calculate the Absorbance for each of the %T listed above .

	400 nm	450 nm	500 nm	550 nm	600 nm	650 nm
Red Std						
Blue Std						
Purple Unk						

b. Determine the following from the data calculated in Part 1 (2 pts):

Red Dye Max. Absorbance = _____ at _____ nm (λ Max)

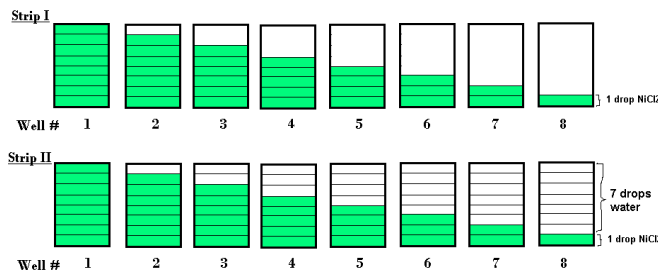
Blue Dye Max. Absorbance = _____ at _____ nm (λ Max)

c. Calculate the Absorbance Ratio of the Unknown/Standard at (λ Max).

d. Calculate the Dye Concentration in the Unknown. (*Standard Concentrations given above.*)

	Abs of Unknown (at λ Max)	Abs of Standard (at λ Max)	Abs Ratio Unk/Std (at λ Max)	Dye Conc. in Unknown
Red in Purple				
Blue in Purple				

8. Colorimetry: Using the well strips below, the student put the following number of drops in the wells. In strips I& II, 1-8 drops of **blue dye standard solution (5.05 ppm)** were added as shown in the diagram. In strip II, additional drops of water were added in order to have the same total volume of 8 drops for each well.



Given: The student found that the unknown solution of blue dye matched well #7 on Strip II.

- What is changing in the first well strip – concentration or pathlength?
- What is changing in the second well strip – concentration or pathlength?
- Looking from the top how does the intensity compare for Strip 1 to Strip 2?
more intense – the same – less intense
- Using $C_1V_1 = C_2V_2$, what is the approximate concentration in ppm for the unknown?

9. Atomic Spectra: Using the Rydberg equation (where $R = 3.29 \times 10^{15}$ Hz) and the speed of light ($C = 2.998 \times 10^8$ m/s):

a. Calculate the expected frequencies in Hertz (s^{-1}) of the radiation emitted by a hydrogen atom for the following electronic transitions.

$$\nu = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

b. Calculate the expected wavelengths in nanometers (nm) of the radiation emitted by a hydrogen atom for the same electronic transitions.

$$C = \lambda\nu$$

c. Label which wavelengths correspond to the Balmer series and which wavelengths correspond to the Lyman series.

Transitions	Frequency (s^{-1})	Wavelength (nm)	Balmer / Lyman
$n_2 = 3$ & $n_1 = 1$			
$n_2 = 2$ & $n_1 = 1$			
$n_2 = 5$ & $n_1 = 2$			
$n_2 = 4$ & $n_1 = 2$			
$n_2 = 3$ & $n_1 = 2$			

d. Why did the Hydrogen spectrum have the fewest lines?

e. For the Hydrogen spectra, why was the red line more intense (brighter) than the other lines?

10. Flame Tests – What color flame is produced by each of the following elements?

- copper –
- iron –
- lithium –
- potassium –
- magnesium –
- sodium –

11. Periodic Properties – What are the periodic trends of the following elements?

- Magnesium – Aluminum – Silicon
 - with water
 - with acid
 - with base
- Magnesium – Calcium
 - with water
 - with acid
 - with base

12. Equilibrium Constant & Beer's Law:

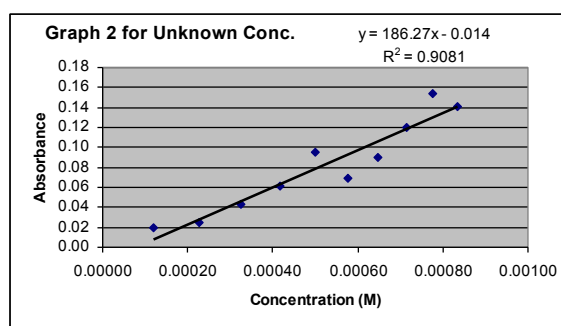
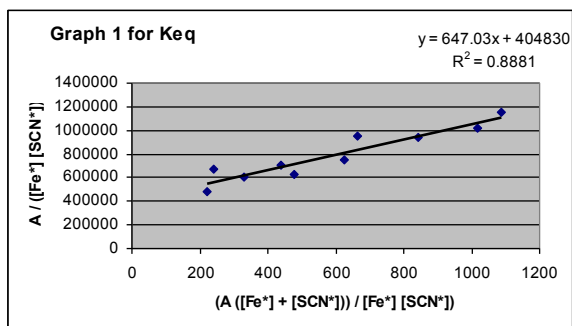
1. Why is it important that you avoid any loss of solutions when transferring and measuring solutions in an equilibrium experiment similar to the one done in class?

2. According to the Beer's Law equation, $A = abc$. Why is it you did not need to know the value for the molar absorptivity constant or the pathlength for the calculations you did in this experiment?

3. While doing the Beer's Law experiment, Bob and his lab partner used ~5ml of solution for each determination of the %T. Their classmate Suzy and her lab partner used ~10ml of solution for each determination. Explain briefly what differences if any would result from doubling the amount of solution.

4. While doing a Beer's Law experiment, Frank thought that he would run out of solution. Rather than go get more from the hood. He diluted his original solution to half its original concentration. How would this effect his absorbance readings compared to a student who had used the solution with the original concentration?

5. Trina's lab partner generated the following graphs for her and told her to finish the lab on her own.



Looking at the graphs,

a.) Determine the Keq for this reaction.

b.) Determine the concentration of an unknown solution when %T = 61.1.
(Assume the pathlength was 1.00cm.)

13. Gas Laws: Using the ideal gas law, calculate the volume of the system.

Given: pressure = 738 mmHg, mass = 0.725 grams, $MW_{\text{butane}} = 58.000 \text{ g/mole}$, $T = 20^\circ\text{C}$, $R = 0.08206 \text{ Latm/molK}$

a. What is the number of moles of butane?

b. What is the pressure in atm?

c. What is the temperature in K?

d. What is the volume of the system?

e. What would the volume be at STP?

14. Statistics:

a. For the following data set (2.10, 3.20, 3.50, 4.90, 4.30, 2.90) find the mean (average).

b. For the average of the data set above, calculate the % Error if the expected answer was 3.500.

b. For this data set would you calculate the standard deviation or the standard deviation estimate? Explain why.

15. Dimensional Analysis:

a. Choose problems from sets 1, 2, 4 or 5 and work them.

b. Dimensional analysis problems are generally incorporated within the other problems.

For example:

1. Converting from mg to mmole in the antacid problem.
2. Converting from mmHg to torr or atm in the gas laws problem.
3. Converting from $^\circ\text{C}$ to K in the gas laws problem.

16. Scientific Notation & Significant Figures:

- a. Choose problems from sets 1 & 2 and work them.
 b. Review problems similar to those on the midterm exam. (*Monday exam questions shown below.*)

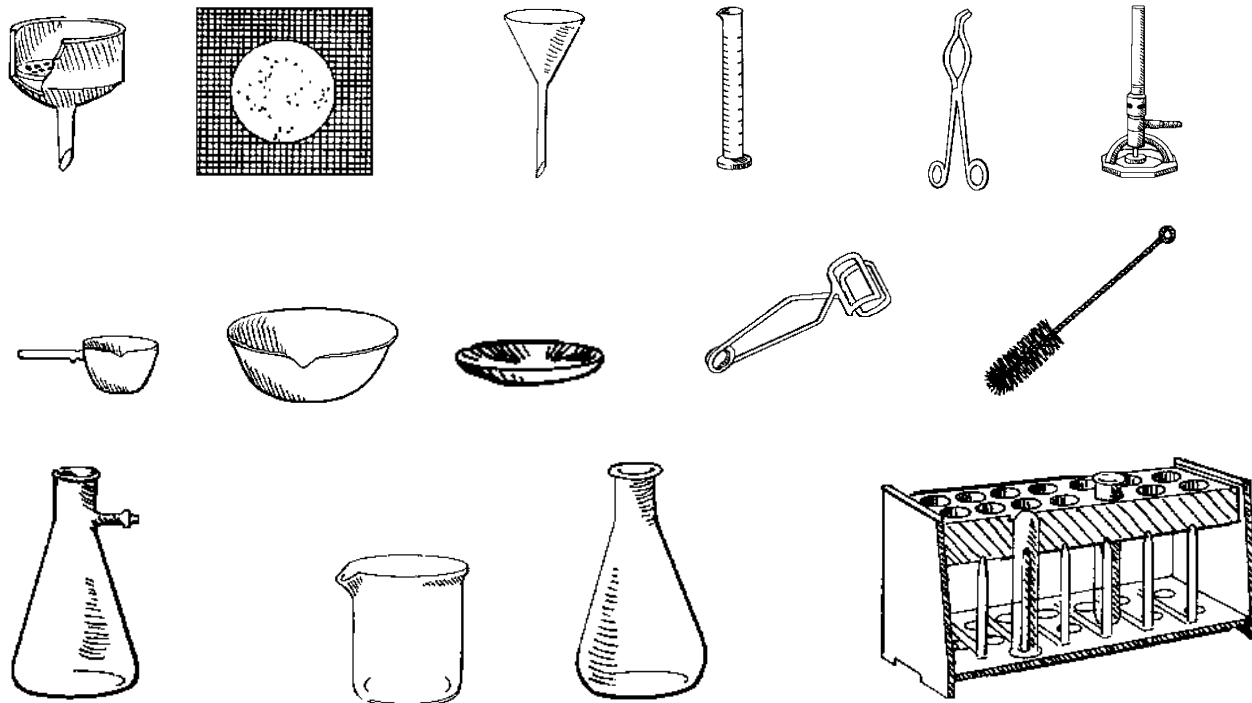
- ____ 22. How many **significant figures** are there in the number 0.010520 ?
 a. 3 b. 5 c. 6 d. 7
- ____ 23. What is the **numerical value** of 3.000×10^1 ?
 a. 30.00 b. 30 c. 0.3000 d. 3
- ____ 24. Which of the following numbers has **3 significant figures**?
 a. 0.2160 b. 0.0390 c. 405.0 d. 58.10
- ____ 25. Using the **correct number of significant figures**, what is the answer to $5729.8 \text{ g} + 2.29 \text{ g}$?
 a. 5730 g b. 5732 g c. 5732.1 g d. 5732.09 g
- ____ 26. Using the **correct number of significant figures**, what is the answer when 6.5 is divided by 0.341 ?
 a. 19.062 b. 19.06 c. 19.1 d. 19
- ____ 27. Find the **number of moles** in 50.0g of carbon dioxide, CO_2 .
 a. 0.8802 b. 1.136 c. 44.01 d. 6.840×10^{23}

17. Oxidation / Reduction: Choose problems similar to those on the handout and work them.

- ____ 1. Which metal is in the **lowest oxidation state (i.e., has the lowest oxidation number)**?
 a. CrCl_3 b. Cu c. FeCO_3 d. MnO_2
- ____ 2. In which species does sulfur leave the **same oxidation number** as the chlorine in ClO_2^- ?
 a. H_2S b. S_8 c. SO_3^{2-} d. none of the above
- ____ 3. The oxidation number of sulfur in SO_3^{2-} is the **same as the oxidation number** of carbon in?
 a. CO b. $\text{K}_2\text{C}_2\text{O}_4$ c. $\text{C}_2\text{H}_3\text{O}_2^-$ d. CO_2
- ____ 4. The **oxidation state of iodine** in the equation below changes from ____ to ____.

$$2 \text{IO}_3^- (\text{aq}) + 5 \text{HSO}_3^- (\text{aq}) \rightarrow \text{I}_2 (\text{s}) + 5 \text{SO}_4^{2-} (\text{aq}) + \text{H}_2\text{O} (\text{l}) + \text{H}^+ (\text{aq})$$
 a. +7 to -1 b. +5 to +1 c. +5 to 0 d. +3 to 0

18. Glassware and equipment: Identify the equipment below.



19. People – How did these people contribute to the experiments we did in Chem 2?

(All powerpoints are available at <http://web.mst.edu/~tbone>)

- a. Henri Becquerel (Nuclear)
- b. Pierre and Marie Curie (Nuclear)
- c. Ernst Rutherford (Nuclear)
- d. Albert Einstein (Nuclear)
- e. Svante Arrhenius (Antacid)
- f. Johannes Nicolaus Brønsted and Thomas Martin Lowry (Antacid)
- g. Gilbert N. Lewis (Antacid)
- h. August Beer & Johann Heinrich Lambert (Equilibrium)
- i. Henry Louis Le Chatelier (Equilibrium)
- j. Ibn Alhazen (Atomic Spectra)
- k. Galileo Galilei (Atomic Spectra)
- l. Sir Isaac Newton (Atomic Spectra)
- m. Joseph von Fraunhofer (Atomic Spectra)
- n. Bunsen & Kirchhoff (Atomic Spectra)
- o. Johann Balmer (Atomic Spectra)
- p. Max Planck (Atomic Spectra)
- q. Neils Bohr (Atomic Spectra)
- r. Robert Boyle (Gas Laws)
- s. Jacques-Alexandre Charles (Gas Laws)
- t. Amedeo Avogadro (Gas Laws)
- u. Joseph-Louis Gay-Lussac (Gas Laws)
- v. John Dalton (Gas Laws)
- w. Johannes Diderik van der Waals (Gas Laws)
- x. My TA's name is...

****Note:** Most of the questions on the final will be similar to those on review and/or on quizzes.