Key for Sample Questions for Chem 1319 Final WS16

1. MSDS (the rest listed on review):

a. Proper attire – goggles, closed toe shoes, long pants or skirt or lab apron

b. Acid Spill – neutralize with sodium bicarbonate

c. Bunsen Burners – do not light if flammable reactants or products (e.g., H_2 gas) are present

d. Phenolphthalein – has a laxative effect when ingested

e. Fire Safety – On fire? - Stop! Drop! & Roll!

2. Studies of Light - Atomic Spectra Portion: 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.

$$C = \lambda\upsilon$$

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
$n_2 = 3$ & $n_1 = 1$	2.92×10^{15}	1.02×10^{-7} m = 102 nm	Ultraviolet so Lyman
$n_2 = 2$ & $n_1 = 1$	2.47×10^{15}	1.21×10^{-7} m = 121 nm	Ultraviolet so Lyman
$n_2 = 5$ & $n_1 = 2$	6.91×10^{15}	4.34×10^{-7} m = 434 nm	Visible so Balmer
$n_2 = 4$ & $n_1 = 2$	6.19×10^{15}	4.84×10^{-7} m = 484 nm	Visible so Balmer
$n_2 = 3$ & $n_1 = 2$	4.57×10^{15}	6.56×10^{-7} m = 656 nm	Visible so Balmer

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

The lines are created when the electrons make transitions from one level to another. Since Hydrogen has only one electron and since there are only so many allowable transitions, then the Hydrogen spectrum has the fewest lines.

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

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3. Studies of Light – Colorimetry Portion: The student was using a **blue dye standard solution (5.05 ppm)** and diluted it. The student used 3 drops of dye and added 5 drops of distilled water to it.

a. Using $C_1V_1 = C_2V_2$, what is the approximate concentration in ppm for the unknown?

C_1 = original volume of dye & C_2 = total volume

5.05ppm (3 drops) = C_2 (8 drops)

1.89(375) ppm = C_2

b. Using the equation, A=abc determine the concentration of an unknown solution when %T = 61.1. (b = 1.00) **in order to answer this an a value = slope of line would be needed, e.g. a=186.27**

This equation will also be given: A = log (100 / %T) A= log (100 / 61.1) = 0.214

Then using the equation generated for the trendline for the graph on the right: y = 186.27x where y = Absorbance and x = concentration (M), then:

x = y / 186.27 = 0.214 / 186.27 = 0.228 / 186.27 = 0.00115 M

4. Radioactive Decay:

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

alpha – paper or hand

beta – aluminum (goes through paper, hand)

gamma – lead (goes through paper, hand, aluminum)

neutron – concrete (goes through paper, hand, aluminum, lead)

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

(alpha = $^{4}_{2}He$ / beta) $$^{222}_{86}Rn \rightarrow {}^{218}_{84}Po + {}^{4}_{2}He$$

(alpha / beta = $^{0}_{-1}e$) $$^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + {}^{0}_{-1}e + \textit{anti-}\upsilon$$

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

$A = A_o e^{-kt}$ **$\ln A = -kt + \ln A_o$** **$\ln 2 = 0.693$** **$t_{½} = \ln 2 / k$** **$y = mx + b$** **$m = (y_2 - y_1) / (x_2 - x_1)$**

and the data:

x **Time, minutes**	**Counts/Min**	y **ln (Counts/Min)**
0		
2	14472	9.58
3	14328	9.57
4	14248	9.56
5	14095	9.55
6	13920	9.54
10	13359	9.50

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

   $k = -m$ $m = (y_2 - y_1) / (x_2 - x_1) = (9.58 - 9.50) / (2 - 10)$ min $= -0.01$

   $k = 0.01 \text{ min}^{-1}$

2. Determine the initial activity, A_o.

   $y = mx + b$ $\ln A = -kt + \ln Ao$

   $9.50 = -(0.01)(10) + \ln Ao$

   $9.50 = -0.10 + \ln Ao$

   $9.60 = \ln Ao$ $Ao = e^{\ln Ao} = e^{9.60} = 14764$ counts/min

3. Determine the half-life.

   $t_{1/2} = \ln 2 / k = 0.693 / 0.01 \text{ min}^{-1} = 69.3$ min

5. 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.

(1.12 mmole / ml HCl) x (35.0 ml HCl) = 39.2 mmole HCl

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

(1.48 mmole / ml NaOH) x (21.8 ml NaOH) = 32.3 mmole NaOH

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

Excess HCl = mmole HCl – mmole NaOH = 39.2 -32.3 = 6.9 mmole HCl

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

$CaCO_3 + 2\ HCl \rightarrow CaCl_2 + H_2CO_3 \rightarrow CaCl_2 + H_2O + CO_2$

$Al(OH)_3 + 3\ HCl \rightarrow AlCl_3 + 3\ H_2O$

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

300 mg $CaCO_3$ x (1 mmole / 100 mg $CaCO_3$) = 3.00 mmole $CaCO_3$

100 mg $Al(OH)_3$ x (1 mmole / 78 mg $Al(OH)_3$) = 1.30 mmole $Al(OH)_3$

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*.)

3.00 mmole $CaCO_3$ x (2 mmole HCl / 1 mmole $CaCO_3$) = 6.00 mmole HCl

1.30 mmole $Al(OH)_3$ x (3 mmole HCl / 1 mmole $Al(OH)_3$) = 3.90 mmole HCl

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

6.00 + 3.90 mmole HCl = 9.9 mmole HCl

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?

$$\%Error = \frac{Theoretical - Observed}{Theoretical} \times 100 = \frac{9.9-6.9}{9.9} \times 100 = 30.3\%$$

Actual is 6.9 mmole < Theoretical 9.9 mmole

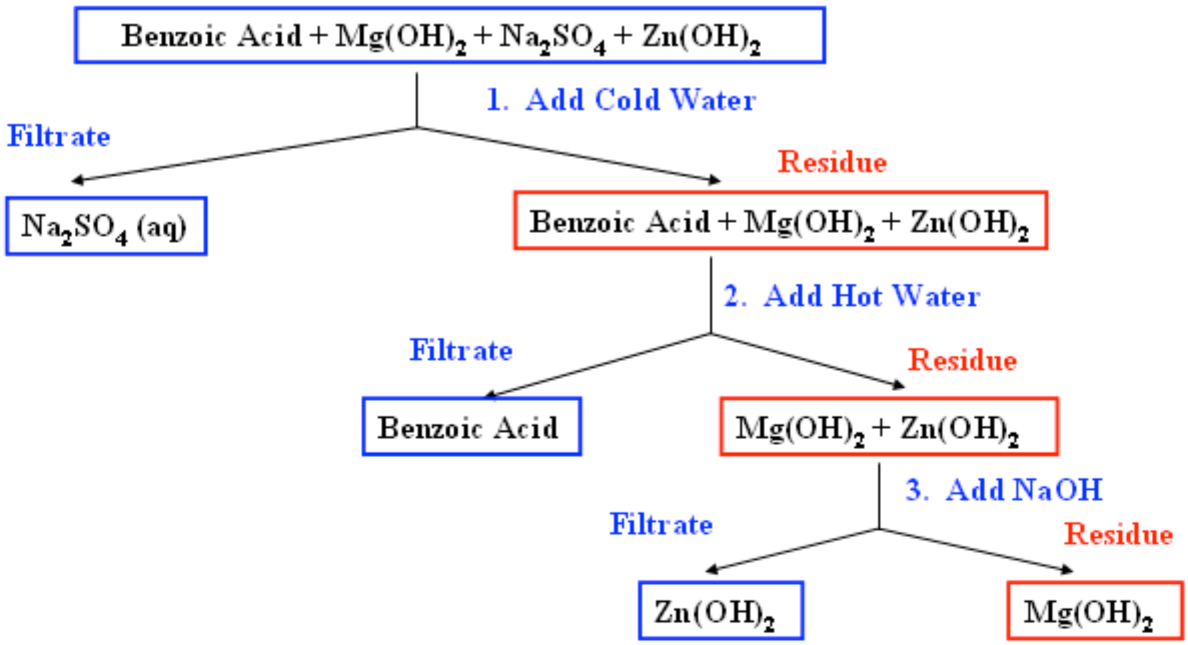
Possible Reasons:

Student may not have performed the titration accurately.
Manufacturer may not have quality control standards that ensure the amount of ingredients.
Binders and other additives may have interfered with the effectiveness of the antacids.
Transfer Errors – some of the antacid may have been spilled when it was being added to the erlenmeyer flask.

6. Ternary Mixture: A mixture is known to contain the four compounds in the table.

A.) Draw a flow chart to show the steps that you would use to separate the following compounds.

	Cold water	Hot water	3M HCl	3M NaOH
benzoic acid	no	yes	no	yes
$Mg(OH)_2$	no	no	yes	no
Na_2SO_4	yes	yes	yes	yes
$Zn(OH)_2$	no	no	yes	yes



B.) The initial mass was 5.025g. The resulting masses were benzoic acid = 1.760g, $Mg(OH)_2$ = 0.754g, Na_2SO_4 =1.005g, and $Zn(OH)_2$ 1.256g. Calculate the percent recovery of each component and the total percent recovery.

% benzoic acid = (1.760g / 5.025 g) x 100 = **35%**

Note: Be sure to always divide by initial mass.

% $Mg(OH)_2$ = (0.754g / 5.025 g) x 100 = **15%**

% Na_2SO_4 = (1.005g / 5.025 g) x 100 = **20%**

% $Zn(OH)_2$ = (1.256g / 5.025 g) x 100 = **25%**

Total % Recovery = (4.775 g / 5.025 g) x 100 = **95%**

% Error = [(100-95) / 100] x 100 = **5%**

7. Millikan Drop:

a. For the following data, reorder it by descending masses, then take the mass difference (*1st value minus 2nd value, 2nd value minus 3rd value, etc.*)

Number	Mass (g)	Masses in Descending Order	Mass Differences	Divided Answer
1	19.624	42.080	xxx	
2	30.852	37.268	42.080-37.268 = 4.8.12	3
3	14.812	30.852	37.268-30.852 = 6.416	4
4	42.080	27.644	30.852-27.644 = 3.208	2
5	18.020	19.624	27.644-19.624 = 8.020	5
6	27.644	18.020	19.624-18.020 = 1.604	1
7	37.268	14.812	18.020-14.812 = 3.208	2

b. Determine the mass value of a single "electron."

Divide each of the mass differences by the smallest mass difference
Since all of the values are whole number multiples of 1.604,
then "electron" mass = 1.604g

8. Statistics:

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

x_{bar} = (2.10 + 3.20 + 3.50 + 4.90 + 4.30 + 2.90) / 6

= 20.9 / 6

= 3.48

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

%Error = [(3.500 – 3.483) / 3.500] x 100

= 0.4857%

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

The standard deviation estimate because we have a data set of less than 30.

Also note: The standard deviation estimate value is greater than the true standard deviation. This is because if the data collection continues beyond 30 and a standard deviation was then calculated, we want our true standard deviation to fall in the range of the estimate.

9. 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 ^{o}C to K in the gas laws problem.

10. Scientific Notation & Significant Figures:

a. Choose problems from sets 1 & 2 and work them.
b. Review problems similar to those on the midterm exams.

_____ 24. What is the **numerical value** of 5.000 x 10^2 ?
a. 0.05 b. 0.05000 **c. 500.0** d. 500

_____ 25. How many **significant figures** are there in the number 0.0**30170** ?
a. 4 **b. 5** c. 6 d. 7

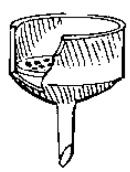
_____ 26. Which of the following numbers has **3 significant figures**?
a. 0.0290 b. 0.4160 c. 508.0 d. 29.10

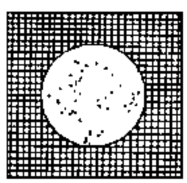
_____ 27. Using the **correct number of significant figures**, what is the answer to 1453.2-6.58 g?
a. 1450 g b. 1447 g **c. 1446.6 g** d. 1446.62 g

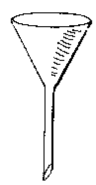
_____ 28. Using the **correct number of significant figures**, what is the answer when 6.5 is multiplied by 0.0341?
a. 0.222 b. 0.2217 c. 0.2 **d. 0.22**

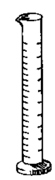
_____ 29. Find the **number of moles** in 50.00g of carbon dioxide, CO_2.
a. 6.840 x 10^{23} b. 44.01 **c. 1.136** d. 0.8802

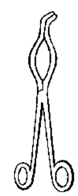
11. Glassware and equipment: Identify the equipment below.

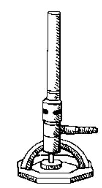

Buchner Funnel

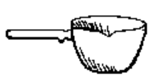

Wire Gauze


Short stemmed funnel


Graduated Cylinder

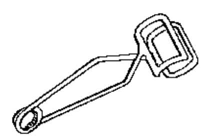

Crucible tongs


Bunsen Burner

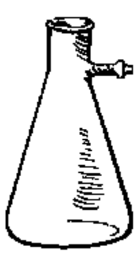

Casserole


Evaporating dish

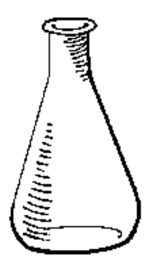

Watchglass

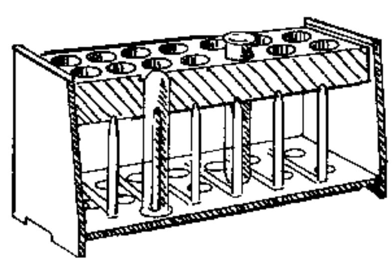

Test tube Clamp


Test tube brush


Vacuum flask


Beaker


Erlenmeyer flask


Test tube in test tube rack

12. Nomenclature: List the chemical names for the chemicals below.

a. HCl – hydrochloric acid

b. NaOH – sodium hydroxide

c. $Al(OH)_3$ – aluminum hydroxide

d. $MgCO_3$ – magnesium carbonate

e. $CaCO_3$ – calcium carbonate

f. $NaHCO_3$ – sodium bicarbonate (baking soda)

g. NaCl – sodium chloride

h. SiO_2 - silicon dioxide

i. K_2CO_3 – potassium carbonate

13. People – How did these people contribute to the experiments we did in Chem 1319?
(*All powerpoints are available at* http://web.mst.edu/~tbone)

a. Henri Becquerel (Nuclear) while studying fluorescence determined that some glowing rocks actually have particles coming off of them – the advent of radioactivity.

b. Svante Arrhenius (Antacid) defined an acid as a substance that, when dissolved in water, increases the amount of hydronium ion over that present in pure water.

c. Johannes Nicolaus Brønsted and Thomas Martin Lowry (Antacid) defines an acid as a substance that can donate a hydrogen ion.

d. Gilbert N. Lewis (Antacid) defines an acid as any species that accepts electrons through coordination to its lone pairs.

e. Joseph von Fraunhofer (Atomic Spectra) studied the solar spectrum to try and improve glass lenses and discovered black lines in the solar spectrum.

f. Bunsen & Kirchhoff (Atomic Spectra) figured out that the emission spectrum of elements matched the black solar lines seen by Fraunhofer.

g. Johann Balmer (Atomic Spectra) mathematically described the series of lines in the spectrum for hydrogen.

h. Max Planck (Atomic Spectra) quantized energy and described it mathematically with $E = nh\upsilon$.

i. Albert Einstein (Nuclear) was famous for his theories of relativity and $E=mc^2$; but he also envisioned particles of light as photons.

j. Neils Bohr (Atomic Spectra) developed the "planetary" model of the atom where electrons had fixed orbits.

Extra People from Millikan Drop Activity:

a. Thomas Alva Edison – invented the incandescent light bulb by creating an electric circuit
b. Johnstone Stoney – proposed an "atom of electricity" or electron
c. J.J. Thomson – discovered electrons &determined their average mass
d. Robert Millikan – determined the mass of an individual electron

k. My TA's name is…

C1 – Umanga De Silva
B1, F1 – Peng Geng
B2 – Hasan Golpour
A2, E2 – Ke Li
C2 – Prashanth Sandineni
A1, E1 – Sharen Wang
D1, ~~F1~~ F2 – Brad Welch

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

Extra Info

Oxidation / Reduction – This was postponed from the midterm until the final exam.

a. Define oxidation and reduction.

Oxidation – ***the loss of electrons*****. Reduction –** ***the gain of electrons***

b Which metal is in the **lowest oxidation state (i.e., has the lowest oxidation number)**?

A. $CrCl_3$ (+3 -1)   B. Cu (0)   C. $FeCO_3$ (+2 +4 -2)   D. MnO_2 (+4 -2)

c. In which species does sulfur leave the **same oxidation number** as the chlorine in $\mathbf{ClO_2^-}$? (+3 -2)

A. H_2S (+1 -2)

B. S_8 (0)

C. SO_3^{2-} (+4 -2)

D. none of the above