Chemistry 222 **Name______________________________________**
Spring 2020 **80 Points**
Exam 1: Chapters 1-5

Complete three (3) of problems 1-4 and three (3) of problems 5-8. CLEARLY mark the problems you do not want graded. Show your work to receive credit for problems requiring math. Report your answers with the appropriate number of significant figures and with the appropriate units.

Do <u>three</u> of problems 1-4. Clearly mark the problem you do not want graded. (10 pts each)

1. Choose ONE of the following pairs of terms and briefly (but clearly) compare and contrast the two concepts.
   a. TC vs. TD
   b. Systematic Error vs.Random Error

2. While preparing for this exam, one of your classmates asks you why a confidence interval is used to describe the "quality" of a result, as opposed to a standard deviation alone. Clearly explain why a confidence interval is used and what types of information we can infer from the confidence interval about the quality of a result.

3. In producing a calibration curve, raw data is typically subjected to a “linear least squares” analysis. Dissect the phrase “linear least squares” and describe qualitatively what is done in a linear least squares analysis. Why “linear”? “Least squares” of what? No calculations are necessary.

4. The sensitivity of an analytical method is often confused with the limit of detection, even though they are not the same. Explain the differences between the sensitivity and limit of detection.

Do <u>three</u> of #'s 5-8. Clearly mark the problem you do not want graded. (16 pts each)

5. In the EDTA experiment, we use a solution of zinc ion to standardize a solution of EDTA. The data below was obtained for such a titration. Based on this information, calculate the concentration of EDTA in moles per liter (with its associated uncertainty) in the solution. NOTE: EDTA and zinc react in a one to one stoichiometric ratio.

Concentration of zinc standard	0.01117 ± 0.00001 M
Volume of zinc solution used	20.00 ± 0.03 mL
Initial buret reading	1.46 ± 0.05 mL
Final buret reading	23.54 ± 0.05 mL

6. A 5.24 g sample of a solid containing Ni is dissolved in 20.0 mL water. A 5.00 mL aliquot of this solution is diluted to 100.0 mL and analyzed in the lab. The analyzed solution was determined to contain 6.16 ppm Ni.
   a. Determine the molar concentration (molarity) of Ni in the sample.

   b. Determine the weight percent (% w/w) of Ni in the sample.

7. You have run a series of titrations to determine the unknown concentration of KHP in a solid sample. The results of titrations indicate KHP concentrations of 35.69%, 30.03%, 35.55%, 36.07%, 35.98%. The "true" value for KHP in this sample is 36.29%. Evaluate the data and determine if your results differ from the true value at the 95% confidence level.

8. Nitrite (NO_2^-) was measured in rainwater and unchlorinated drinking water using U by an established spectrophotometric method. Based on the results below, does drinking water sample contain significantly more nitrite than rainwater sample (at the 95% confidence level)?

Replicate	**1**	**2**	**3**	**4**	**5**
Rainwater (ppb)	55.1	59.6	63.1	66.4	71.5
Drinking Water (ppb)	74.6	81.0	87.3	91.8	93.2

Note that the question was worded poorly. I intended for it to read: "Nitrite (NO_2^-) was measured in rainwater and unchlorinated drinking water using an established spectrophotometric method, measuring replicates of a single sample of each water type. Based on the results below, does drinking water sample contain significantly more nitrite than rainwater sample (at the 95% confidence level)?"

Possibly Useful Information

$m = \dfrac{m'\left(1-\dfrac{d_a}{d_w}\right)}{\left(1-\dfrac{d_a}{d}\right)}$	Density of air = 0.012 g/ml Density of balance weights = 8.0 g/ml
$\mu = \bar{x} \pm \dfrac{ts}{\sqrt{n}}$	$y = \dfrac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}$
$e_C = \sqrt{e_A^2 + e_B^2}$	$e_C = C\sqrt{\left(\dfrac{e_A}{A}\right)^2 + \left(\dfrac{e_B}{B}\right)^2}$
$t_{calculated} = \dfrac{\lvert\text{known value} - \bar{x}\rvert}{s}\sqrt{n}$	$s = \sqrt{\dfrac{\sum_i (x_i - \bar{x})^2}{n-1}}$
$t_{calculated} = \dfrac{\lvert\bar{x}_1 - \bar{x}_2\rvert}{s_{pooled}}\sqrt{\dfrac{n_1 n_2}{n_1 + n_2}}$	$s_{pooled} = \sqrt{\dfrac{s_1^2(n_1-1) + s_2^2(n_2-1)}{n_1 + n_2 - 2}}$
$t_{calculated} = \dfrac{\bar{d}}{s_d}\sqrt{n}$	$s_d = \sqrt{\dfrac{\sum_i (d_i - \bar{d})^2}{n-1}}$
$s_x = \dfrac{s_y}{\lvert m\rvert}\sqrt{\dfrac{1}{k} + \dfrac{1}{n} + \dfrac{(y-\bar{y})^2}{m^2 \sum (x_i - \bar{x})^2}}$	$s_y = \sqrt{\dfrac{\sum (d_i - \bar{d})^2}{n-2}} = \sqrt{\dfrac{\sum d_i^2}{n-2}}$
$s_m^2 = \dfrac{s_y^2 \times n}{D}$	$s_b^2 = \dfrac{s_y^2 \sum x_i^2}{D}$
$y_{LOD} = y_{blank} + 3s$	$F_{calculated} = \dfrac{(s_1)^2}{(s_2)^2}$
$Q_{calculated} = \dfrac{gap}{range}$	$G_{calculated} = \dfrac{\lvert\text{suspect value} - \bar{x}\rvert}{s}$

Values of Student's t

Degrees of Freedom	Confidence Level (%) 90	95	99.5	99.9
1	6.314	12.706	127.32	636.61
2	2.920	4.303	14.089	31.598
3	2.353	3.182	7.453	12.924
4	2.132	2.776	5.598	8.610
5	2.015	2.571	4.773	6.869
6	1.943	2.447	4.317	5.959
7	1.895	2.365	4.029	5.408
8	1.860	2.306	3.832	5.041
9	1.833	2.262	3.690	4.781
10	1.812	2.228	3.581	4.587
∞	1.645	1.960	2.807	3.291

Values of *Q* for rejection of data

# of Observations	Q (90% Confidence)
4	0.76
5	0.64
6	0.56

Grubbs Test for Outliers

# of Observations	$G_{critical}$ At 95% confidence
4	1.463
5	1.672
6	1.822

Critical Values of F at the 95% Confidence Level

Degrees of freedom for s_2	Degrees of freedom for s_1: 2	3	4	5	6	7	8	9	10
2	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4
3	9.55	9.28	9.12	9.01	8.94	8.89	8.84	8.81	8.79
4	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96
5	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74