Problem 1 (20 Points)
Given the following chemical equilibrium:

$$Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^+_{(aq)} + CrO_4^{2-}{}_{(aq)} \quad K_{sp}=1.2x10^{-12}$$

(a) What would the concentration (moles/liter) of silver ion (Ag^+) be at equilibrium if an excess of $Ag_2CrO_{4(s)}$ (i.e., not all of it dissolves) is added to 100.00 mL of pure water?
(b) What would the solubility be if the same 100.00 mL of water solution also had added to it 2.5000 grams of K_2CrO_4 (mw= 194.188 g/mole) which is completely soluble in the 100.00 ml of water? (You may use appropriate mathematical approximations, but make sure to show that the approximation is valid)

(a) _____ moles/liter

(b) _____ moles/liter

Problem 2 (20 Points)
Diprotic oxalic acid [**H**OOCCOO**H**] has a $K_{a1}=5.60 \times 10^{-2}$ and a $K_{a2}=5.42 \times 10^{-5}$.

(a) Write the base association chemical reactions for the conjugate base forms of oxalic acid in water.

(b) Determine the K_{b1} and K_{b2} base association equilibrium constants for the reactions written in part (a) of this problem?

$K_{b1}=$ _____ $K_{b2}=$ _____

Problem 3 (10 Points)

Determine the numerical value for the following calculation and express the answer with the correct number of significant figures and rounding. Also, determine the **absolute** uncertainty in the calculation, given the **absolute** errors provided.

$$\frac{[(227.45 \pm 0.51) - (103.27 \pm 0.12)]}{[(23.20 \pm 0.09) - (14.75 \pm 0.09) + (2.02 \pm 0.05)]}$$

Answer = _____ ± _____

Problem 4 (10 Points)

The concentration of Hg^{2+} in a particular waste water sample is known to be 57.5 parts per billion (ppb). A new analysis method is employed to analyze this sample five different times and the following data is obtained.

Analysis number	$[Hg^{2+}]$
1	32.5 ppb
2	32.1 ppb
3	32.2 ppb
4	32.6 ppb
5	32.7 ppb

Which of the following best describes the results from this new analysis method? (**circle** the correct answer)

(a) accurate and precise (b) accurate but not precise (c) precise but not accurate (d) neither precise nor accurate

Problem 5 (10 Points)
A solution is prepared by completely dissolving 1.3207 grams of copper (II) chloride ($CuCl_2$ MW = 134.45 g/mole) in H_2O and diluting to a total volume of 100.00 mL. Express the concentration of $CuCl_2$ in this solution as (a) percent composition (wt./wt.) and (b) molarity. The density of this solution is 1.06 g/mL.

(a) _____ wt. % (b) _____ M

Problem 6 (10 Points)
Identify the following chemical species as one of the following: strong acid, strong base, weak acid, weak base. **Circle** the correct answer.

(a) Ammonium ion (NH^{4+}) is a:
(i) strong acid (ii) strong base (iii) weak acid (iv) weak base

(b) Hydroxide ion (OH^-) is a:
(i) strong acid (ii) strong base (iii) weak acid (iv) weak base

(c) Perchloric acid ($HClO_4$) is a:
(i) strong acid (ii) strong base (iii) weak acid (iv) weak base

(d) Acetate ion (CH_3COO^-) is a:
(i) strong acid (ii) strong base (iii) weak acid (iv) weak base

(e) tetrabutylammonium hydroxide $(CH_3CH_2CH_2CH_2)_4N^+OH^-$ is a:
(i) strong acid (ii) strong base (iii) weak acid (iv) weak base

Problem 7 (10 Points)

Six separate samples of Logan city water were collected and the concentration of F^- (Fluoride ion) was measured in each sample. The average concentration of F^- in these six samples was found to be 174.0 parts per billion (ppb) with a standard deviation of 6.1 ppb. Using the attached tables, determine the 95% and 99% confidence intervals for the Fluoride ion concentration in ppb.

95% confidence interval _____ 99% confidence interval _____

Problem 8 (10 Points)

You have a photographic solution containing silver in the form of Ag^+ that you wish to recover the silver as $Ag_2C_2O_4$ (silver oxalate). You know that the solubility product (K_{sp}) of $Ag_2C_2O_4$ is 3.5×10^{-11}. If the Ag^+ concentration in your solution is 0.25 M, what concentration of oxalate ($C_2O_4^{2-}$) would be needed in the solution to precipitate 99.99% of the Ag^+?

$[C_2O_4^{2-}]$= _____ moles/liter