SHOW YOUR WORK. NO WORK, NO CREDIT

1. (10 pts) A 0.10 M NaHCO₃ solution has a pH around 9. If 0.05 mole of solid BaCl₂ is added to 1 L of this solution, will the pH increase, decrease or stay the same? Assume the volume does not change when the solid is added.

2. (10 pts) Tears have a slightly acidic pH. One particular eyewash solution contains 0.050 M boric acid (H₃BO₃) to approximate the pH of tears and reduce sting when used. Assuming the other ingredients in the eyewash are neutral, write the charge balance and borate mass balance equations for this solution.

3. (10 pts) The absorbance of a saturated solution of Tl₂CrO₄ at 370 nm in a 1.000 cm cell is 0.2997. The molar absorptivity of chromate at 370 nm is 4.79 x 10³ M⁻¹cm⁻¹ and thallium (I) does not absorb at 370 nm. Assuming the acid-base character of the thallium (I) and the chromate can be ignored, what is the Ksp of Tl₂CrO₄?

4. (10 pts) 1.3540 g of a stainless steel sample is dissolved in aqua regia (HCl + HNO₃) and then the iron is precipitated as iron(III) oxide. The precipitate, after heating to constant weight, weighed 0.7058 g. What is the percent of iron in the stainless steel?

When you are finished with this portion of the exam:

- sign the honesty pledge or see the instructor
- attach this page to your answer sheets & turn them in
- pick up the take home exam

On my honor, I pledge that I have upheld the Honor Code, and that the work I have done on this assignment has been honest, and that the work of others in this class has, to the best of my knowledge, been honest as well.

Signed ____________________________

If you feel you can’t sign this, contact the instructor (e-mail or in person)
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The problems are stated as you might encounter them in the "real world." That means that all the steps needed to arrive at the final answer may not be explicitly stated. Consider all the pertinent aspects of statistical analysis for each problem.

- Work on your own, not in groups. Use any books, notes, calculators, and/or computers. You may consult with the instructor for clarification, hints or help in using the computers, but I may not answer all your questions.
- Show your work in a logical sequence so I can follow it. Write down enough steps so I can see what you did and locate where you may have made errors.
- WORK ON ONE SIDE OF PAGE ONLY
- NAME OR INITIALS ON EACH PAGE.
- INCLUDE LABELS AND PROPER NUMBER OF SIG FIGS
- UP TO 75% OF THE CREDIT GIVEN FOR CORRECT SET UP, INCLUDING LABELS AND SIG FIGS.
- You don’t have to use a computer for these problems, but if you do:
  - Turn in a hard copy of the file and make sure you show the formulas as you entered them (document your formulas) so I can follow your calculations.
  - Also email the spreadsheet file(s) - include Ex1 and your initials in the spreadsheet file name.

1. Six samples of an unknown monoprotic acid were titrated with standard sodium hydroxide to determine the molecular weight of the acid. The six runs yielded molecular weight values of 69.60, 69.54, 69.63, 69.21, 69.50, and 69.65 g/mole.
   a. (10 pts) What is the absolute 90% confidence interval for the average molecular weight of the acid?
   b. (5 pts) A solution of this acid contains 3.9280 ± 0.0002 g/L where the 0.0002 g/L is the standard deviation for the concentration. What is the molarity of the solution and its absolute standard deviation?

2. The Sampling Constant for a mineral supplement formulation is 10.0 g. This supplement is packaged as 500 mg tablets.
   a. (5 pts) What percent relative standard deviation is expected for a sample size of 2 tablets?
   b. (10 pts) How many samples of two tablets each must be analyzed to give a 50% confidence interval that is equal to one third of the %RSD found in a)?

3. (10 pts) A cattle feed company makes several formulations of a fortified feed. There are several formulations, so rather than mix the feed and then make pellets, this company mixes feed pellets with the specified level of additive pellets. To allow analysis using automatic counters, the feed pellets are brown, the additive pellets are dyed red, and all the pellets are the same size.

   One formulation calls for 7% additive. If the analysis is required to have a 10% relative standard deviation, what is the sample size (total number of pellets) required for the analysis?

4. The following calibration data were collected in a polarographic determination of lead in a ground water sample.
(In polarography current is a linear function of the concentration.)

a. (5 pts) Plot the calibration curve.

b. (5 pts) 5 runs were made on the same unknown sample. Using linear regression, calculate the absolute 95% confidence interval for the lead concentration (mM) in the sample.

c. (5 pts) Convert the lead concentration and absolute 95% CI of the unknown sample to units of parts per million.

d. (5 pts) What is the relative 95% confidence interval for the unknown sample?

### Calibration Curve Data

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<th>Unknown run #</th>
<th>Current µA</th>
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</table>

Chemistry 242  
April 6, 2009  
Exam 2  
Name ________________

SHOW YOUR WORK. NO WORK, NO CREDIT

1. (10 pts) Why are activity coefficients not used in a charge balance equation?

2. (15 pts) Acetonitrile (CH₃CN) is an aprotic, polar solvent (no acid/base character). The Ksp of Fe₂(SO₄)₃ in acetonitrile is 3.85 x 10⁻³⁵. What is the pFe in an acetonitrile solution saturated with Fe₂(SO₄)₃?

3. (20 pts) You need a pH 5.50 buffer with an ionic strength around 0.25 M. What acid/base pair would you choose to make that buffer? What would be the composition (concentrations of each) in the final buffer?

4. 50.00 mL of 0.04000 M phthalic acid (H₂A) titrated with 0.2000 M NaOH.
   a. (15 pts) What is the pH at the second equivalence point?
   b. (5 pts) Which indicator would work best for detecting the second equivalence point? Explain your reasoning.
   c. (15 pts) What is the pH of this titration after 25 mL of NaOH have been added?

5. (20 pts) Set up this problem without making assumptions; DO NOT SOLVE. Use symbols like Ksp, Ka₁, etc. in the equations, you do not need the numerical values. What is the pH of a saturated aqueous solution of magnesium hydroxide?

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Signed __________________________________________________________________________

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1. (20 pts) Balance the following reaction which takes place in basic solution:

\[
\text{S}_2\text{O}_8^{2-} + \text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{SO}_4^{2-} + \text{CH}_3\text{COO}^-
\]

2. (15 pts) A bumper plating facility uses a dichromate \((\text{Cr}_2\text{O}_7^{2-})\) plating bath. To meet quota the plant needs to plate chromium at the rate of 25 kg/hr. What is the plating current required to achieve this deposition rate?

3. (20 pts) What voltage will the following cell produce?

\[
\text{C}||76.00 \text{ torr Cl}_2||1.00 \times 10^{-3} \text{ M Cl}^-||\text{sat’d KCl}||\text{AgCl}||\text{Ag}
\]

4. A 0.1000 M \(\text{Cr}^{3+}\) solution is used to titrate 10.00 mL of a solution containing 0.1000 M \(\text{I}_3^-\) and 0.4000 M \(\text{I}^-\). The titration is followed potentiometrically using the following cell:

\[
\text{Pt}||1.000 \text{ atm H}_2||1.000 \text{ M H}^+||\text{titration solution}||\text{Pt}
\]

The balanced titration reaction is:

\[
2 \text{ Cr}^{2+} + \text{ I}_3^- \rightarrow 2 \text{ Cr}^{3+} + 3 \text{ I}^-
\]

a. (15 pts) What is \(E_{\text{cell}}\) at the equivalence point?

b. (15 pts) What is the \(K_{\text{eq}}\) for the titration reaction?

5. (15 pts) You need to measure the pH of a soln that also contains a high concentration of \(\text{NaCl}\). You have a pH meter with a standard glass pH electrode calibrated with standard pH 7 and 4 buffers. Will the measured pH of your solution be higher than, lower than, or equal to the actual pH (within the tolerance of the instrument)? Explain your reasoning and the source of any error(s) you expect.

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