Chemistry 14CL
Amino Acid Analysis Experiment

Post-lab Report Guidelines
The post-lab report must be written inside your lab notebook (except graphs)

This is a Group report (i.e. turn in ONE report per group)

Before attempting to work on this group report, please take a moment and read the following items carefully.

Definitions of Group Report and/or Group Experiment

(1) All members in the group MUST contribute equally when working on the experiment as well as writing the post-lab report

(2) Each group member must prepare ahead of time when writing the reports. This means review materials from lectures or from your Chemistry textbook or from on-line resources on certain topics that are relevant to the concepts when writing the reports.

Contribution to the group work is meaningless if a group member does not understand the concepts behind the experiment.

(3) It is the responsibility of the group members to plan ahead on when they should get together to work on the report. In other words, maintain good communication between group members.

(4) It is the responsibility of each group member to honestly describe the work that they did during the experiment and in writing the report. *No one should take advantage of the other group member. Report to the course instructor or your TA if you feel that other group members are taking advantage of your work.*

(5) Each member in the group MUST understand the concepts behind the ENTIRE experiment regardless of which portions of the report or experiment a person is responsible for. This is especially important for the exams.

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<u>Refer to the lab schedule for the due date of this report</u>

Post-lab Report Guidelines

(I) Write down the unknown serial number

(II) Write down the names of the all the group members and their responsibilities in writing the post-lab report and during the experiment.

(III) Abstract - goal(s) of the experiment plus a summary of your experimental results.

(IV) Graphs (Use EXCEL or any other spreadsheet software for this part of the report)

(You may need to review how to plot the various types of titration graphs from you old 14BL post-lab reports for experiment #3 as well as the EXCEL workshop handouts from 14BL)

<u>Read the section "Graphs and Calculations" on page 97 of the lab manual.</u>

Total Number of Graphs for the Amino Acid Experiment:
(i) Expanded derivative graph for EACH TRIAL of NaOH/amino acid titration
(ii) Expanded titration graph for EACH TRIAL of NaOH/amino acid titration
(iii) ONE FULL titration graph for the determination of pK_a's (see page 93). Pick the best trial for the HCl/amino acid titration and the best trial for the NaOH/amino acid titration and combine them to ONE full titration graph. *Make sure that you <u>normalized the HCl volume</u> before plotting the full titration graph. Refer to the lecture guide for the meaning of normalization and how to calculate the normalized HCl volumes.*

When plotting the titration graphs, please keep in mind the followings.

- Correct scales and full use of graph paper
- Gridlines for proper readings of the scales
- Axes (labeled with units)
- Appropriate titles

IMPORTANT: For the expanded graphs for NaOH/amino acid, you should print out **<u>EACH equivalence point</u>** <u>region on a</u> **<u>SEPARATE piece of paper for each trial</u>**. This is especially important for the expanded derivative graphs. *You will run into problem when locating the equivalence point volumes if you combine both equivalence point regions on the same piece of paper.* For any expanded titration graphs, you should plot no more than +/- 2.00mL around the equivalence point region.

Make sure that the **minor gridlines** have a scaling of about 0.05mL for **ALL** the expanded titration and first derivative graphs.

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(V) Data & Data Analysis (SHOW ALL YOUR WORK)

Print out ALL the titration data from EXCEL and attach them to your post-lab report. <u>The print out of the data should include all the titration data that you collected in the lab not simply the ones that you used in plotting the titration graphs.</u>

Calculate the following quantities. Show ALL your work. <u>Read the section "Graphs and Calculations" on page 97 of the lab manual.</u>

- Concentration of primary standard (i.e. the TRIS solution)
- Average Concentration of HCl
- Average Concentration of NaOH
- Average Concentration of unknown amino acid
- Determine the values of pK_{a1} and pK_{a2} for the amino acid

For any calculations listed above, make sure that you use the CALIBRATED pipet volume for the calculations.

(Make sure you use the average concentration calculated for TRIS, HCl, and NaOH when calculating the unknown amino acid concentration)

(VI) Error Analysis (Review concepts on error propagation from 14BL before you start working on the error analysis for this post-lab).

Refer to next page of this guideline for information on error analysis for this experiment.

SHOW ALL YOUR WORK

- %Inherent error in concentration of HCl solution determined from propagation of errors for **ONE** of your HCl/TRIS titration trials.
- %Inherent error in concentration of NaOH solution determined from propagation of errors for **ONE** of your HCl/NaOH titration trials.
- %Inherent error in unknown amino acid concentration determined from propagation of errors for **ONE** of your amino acid/NaOH trials.
- %RAD of unknown amino acid concentrations

(VII) Conclusion

- Summarize results
- Comment on the precision of unknown amino acid concentration.
- Compare %RAD with % inherent error for the amino acid. What can you conclude?

Error Analysis for the Amino Acid Titration Experiment

Refer to the page 23-27 for the derivations of the fundamental equations use in the following error analysis. The topic of error analysis was discussed extensively in 14BL. *Once you understand the derivations based on the concepts from 14BL, you should then be able to derive the following expressions on your own. This is especially important for the exam.*

(I) Error in the normality of HCl (M_a)

To calculate the concentration of HCl, we use the following equation,

$$M_a = \frac{M_{TRIS} V_{TRIS}}{V_a}$$

where *a* stands for HCl

Therefore, the inherent error in Ma is

$$\frac{\Delta M_a}{M_a} = \frac{\Delta M_{tris}}{M_{tris}} + \frac{\Delta V_{tris}}{V_{tris}} + \frac{\Delta V_a}{V_a}$$

$$= \frac{\Delta Wt_{tris}}{Wt_{tris}} + \frac{\Delta Vol.flk}{Vol.flk} + \frac{\Delta V_{tris}}{V_{tris}} + \frac{\Delta V_a}{V_a}$$

ΔWt_{tris} = Absolute error in balance
$\Delta_{Vol.\ flk}$ = Absolute error in 100ml volumetric flask
ΔV_{tris} = Absolute error in pipet
ΔV_a = Absolute error in buret reading

(II) To find the concentration of NaOH we used the formula

$$M_b = \frac{M_a V_a}{V_b}$$

where *a* stands for HCl and *b* stands for NaOH, Therefore, the inherent error in M_b is

$$\frac{\Delta M_b}{M_b} = \frac{\Delta M_a}{M_a} + \frac{\Delta V_a}{V_a} + \frac{\Delta V_b}{V_b}$$

ΔV_a = Absolute error in pipet reading (DO NOT MULTIPLY THIS VALUE BY 2) (Think about why!)
ΔV_b = Absolute error in buret reading (there is no graphing error since students are **NOT** required to plot the titration graphs for the NaOH/HCl trials).
ΔM_a / M_a = expression derived in (I)

(III) The concentration of the unknown amino acid can be calculated as follow.

$M_{unk} = [M_b*(V_{b2} - V_{b1})] / V_{unk}$

where V_{b2} and V_{b1} are the two equivalence points for the NaOH/unknown titration

The inherent error for the unknown amino acid is slightly different from (I) and (II) due to the subtraction term of the two volumes.

$$\frac{\Delta M_{unk}}{M_{unk}} = \frac{\Delta M_b}{M_b} + \frac{\Delta V_{unk}}{V_{unk}} + \frac{\Delta V_{b2}}{(V_{b2} - V_{b1})} + \frac{\Delta V_{b1}}{(V_{b2} - V_{b1})}$$

$\Delta M_b / M_b$ = expression derived in (II)

ΔV_{b1} = Absolute error in buret reading only . **NO NEED TO ESTIMATE THE ERROR IN GRAPH SINCE THE FIRST EQUIVALENCE POINT OCCURS TOO FAST ON THE TITRATION GRAPH.**

ΔV_{b2} = ($\Delta V/2$ + absolute error in buret reading) where $\Delta V/2$ is the absolute error in the equivalence point.

ΔV= difference in two data point volumes (i.e. the 2 data points closest to the equivalence point) surrounding the equivalence point.

Values for uncertainties in the equipment used can be found on page 27 of the lab manual.