Chem 120 B Guidelines for

Reports

and

Notebook Pages

Guidelines for Writing Reports

1. The point assignments are approximate and your TA can change the point assignments after informing you.
2. If Data sheets or Spectra or Other Calculations are not included at the time of turning in the report, you will be assigned a zero grade for those items.
3. No late work will be accepted.
4. If your work is not legible, especially on the Data Sheets that you work on during lab, you will be docked off points.
5. Abstract, Introduction, Results and Discussion must be typed up. Times/Times New Roman/Helvetica/Geneva 12 points. Titles and Subtitles must be Bolded. Paragraphs must have a line spacing in between them. Lines must be spaced 1.5. Each point on the bulleted items of the Guidelines would usually require upto 3 sentences, usually not more than that.
6. Calculations may be handwritten, but must be on the Report in the space that you leave aside for calculations when initially typing it up, and must not on a separate sheet of paper.
7. Results MUST be Tabulated on Microsoft Word or inserted from Excel. All results must be tabulated and labeled.
8. All graphs must be drawn on Excel and inserted within the report after the results sections. The graphs will receive zero points if not labeled properly (X, Y axis and the units).

Notebook Pages

All work done during lab must be recorded on Notebook. In other words, you must have a running commentary of all the work that you do listed chronologically on your notebook. When you note down Physical Data such as weights, volumes, temperatures, color changes etc. they must be boxed, i.e. draw a box around the data and make sure you have the correct units.

When you turn in your reports, make sure you turn in the lab notebook page carbon copies stapled on the left hand side top corner. All pages must contain your name, date and expt. Title.

Grades for 120 B Labs.

Experiments	Prelab/quiz	Notebook Pages	Report Grade	Demeanor	Due Date
B4	3	2	32	2	
B1	3	2	30	2	
B2	3	2	30	2	
B3	3	2	30	2	
B6	3	2	30	2	
B7	3	2	32	2	
B5	3	2	30	2	
B8	3	2	30	2	
Total	24	16	244	16	Total= 300 pts*

*The final score will be adjusted to 200 points and will be worth 20% of your grade.

B4 Report Guideline /32 pts)

Abstract: (3 pts)

- This is a 5 sentence summary of the entire paper. This covers the objective of experiment, methods and instrumentation used, and the most important results obtained (order of components of the reaction, k_{fund}, E_a). The abstract is usually sent to a Publisher for acceptance of your article to a scientific journal. As such, it must not be verbose or have detailed explanations or experimental procedures. It is a summary of Why, How and What of the experiment. Why did you perform the Expt.? What was the purpose/goal or hypothesis you planned to prove; How was the experiment performed-brief description of methods used to obtain end goal; and What were the results (summary of Physical constants and trends that you established by performing the experiments)?

Introduction: (1 - 1 ½ pages) (4 points. Use the guidelines below and assume approximately 1 pt/item. Paragraph the topics by the bulleted items and see that you have a flow between the paragraphs. i.e. one leading to the other.

- Talk about MO and what are the properties that make it good for kinetic experiments, and what is the purpose of the tin and acid.
- Discuss beers law, and how it plays a role in this experiment.
- What are the possible factors that affect the rate of a reaction, how?
- List important equations and explain their importance (given during lab lecture)
- State the purpose of the experiment and/or your hypothesis at the end of the introduction.

Must cite either lab manual or textbook

Results: Attach all Data Sheets from labs. Make sure they are legible and signed by the instructor. Do not use words that are not precise such as 'quite hot' or 'pretty much the same' or 'totally off' etc. Mention exact temperatures, volumes, changes in color or emissions, and quantify all results for reprocibility. (7 pts for all graphs with proper labeling of axes and figures).

- 23-24 graphs total: the beers law graph, runs 1-7, and graphs for finding the orders of tin and acid
- All figures must be labeled correctly (proper units and proper axis labels). Each figure must have a description at the bottom of the figure (or the top of a table).
    - Example: Figure 1. The absorbance change of MO over time using a mix of [# MO], [# Tin], [# Acid]. When you refer to a figure in text write Fig. 1, no need to write out figure 1.
- Paragraph of the observations that were made during the experiment and other data that you consider important to note that is not described by your figures and tables.
- ***DO NOT INTERPRET DATA IN THE RESULTS SECTION.***

Also make a table like the one below

Table 1. description (4 points, Attach Data Sheet from lab)

Run #	$k_{exp\ (graph)}$	1/2 life average	k_{exp} (calc from 1/2 life)	[MO] M	[Tin] M	[Acid] M	$k_{fundamental}$
1	xxx	Xxx	xxx	xxx	xxx	xxx	xxx
2	xxx	Xxx	xxx	xxx	xxx	xxx	xxx
3	xxx	Xxx	xxx	xxx	xxx	xxx	xxx
4	xxx	Xxx	xxx	xxx	xxx	xxx	xxx
5	xxx	Xxx	xxx	xxx	xxx	xxx	xxx
6	xxx	xxx	xxx	xxx	xxx	xxx	xxx
						Avg $K_{fundamental}$	xxxx
						AD	xxxx
						%RAD	xxxx

- **CALCULATIONS** (4 points) are to be done in the results sections (show all work and equations- otherwise no points will be given)
  - Do **ONE** calculation each for Molarity (moles/liter) for **MO, tin, and acid**
  - Do the calculation for **Ea**
  - Show one calculation for **$k_{fundamental}$**
  - Show how you found AD and RAD for **$k_{fundamental}$**

Discussion/Conclusion (8 points, 1-3 points/item).

1. Discuss; what is the wavelength max and why do you choose this wavelength. What is the order of MO, tin, and acid? How did you determine this order of the reaction, explain. What does the order of MO tell us about the rate of decomposition of this compound? How closely does the estimated Kexp compare to the Kexp from the graph? What is the activation energy (Ea), was the Ea value calculated reasonable? What is the $k_{fundamental,}$ was the $k_{fundamental}$ calculated reasonable? Were the results what you expected?
2. Discuss possible errors- Why didn't you get a linear plot when you expected a linear plot, why may your wavelength obtained using beers law not the same as the rest of the class, and although none of you go the correct order for the ln(kexp) vs ln (tin or acid) just report the data that you got and explain why it was not what you expected (for both tin and acid). What may be possible reasons you got the wrong order for tin and acid.
3. Discuss the hypothesis- correct or not, and why
4. Possible changes to experiment to make it more precise- what would you have done differently in this experiment if you had more time to improve your results?

Conclusion: Summary of the most important points of the discussion. (~ 5 sentences) (2 pts)

Reference: ACS format (-1 if missing).

12 point font, times roman, 1 inch margins all around, double spaced (can print 2-sided to save paper).

B1 Report Guidelines (30 points)

Abstract:v: (3 points)

1.) 1 sentence= big picture statement, what was the purpose of this lab
2.) Methods- briefly touch on the methods and instruments we used for characterization of aspirin and SA (2-3 sentences)
3.) Recap the results obtained (% yield, positive characterization test results, etc . . . .)

Introduction: (5 pts. 1 pt/item below)

1.) Background
    a. Write about synthesis and its usefulness in science
    b. What type of purification methods were used, how do they work
    c. Write about how the starting materials and the products for synthesis, what fundamental properties were useful for characterization
    d. Input the equations that helped in the analysis of the data, what is it used for?
2.) Purpose and/or Hypothesis

Results: (3 pts for completed data sheet, 2 pts for table, 3 pts for ir spectra and 3 pts for interpretation)

1.) Staple data sheet to report (in the results section- NOT the last page)
2.) Make a table for your % yield and characterization results for salicylic acid and aspirin.
3.) For your IR spectrum staple into results section as well, please write out by hand the properly label (Figure 1. 1 sentence description) Indicate on the IR spectrum the important peaks that show that what you have is really Aspirin or SA (at least 2 peaks).

4.) In a paragraph discuss important observations made during the lab, and literature values/visual cues that are already known (must cite reference= try not to use the internet use chemistry desk reference from lab).

CALCULATIONS (3 pts for showing all work)

- Theoretical yield for SA and aspirin
- % yield for SA and Aspirin

Discussion & Conclusion: (7 pts. 1-2 points/item below).

1.) % yield of SA and Aspirin, why did you get a high or low yield. Explain with details about error in accuracy of the experiment and use literature data and physical observations you made to back up your claims.
2.) Discuss the characterization results for Aspirin and SA. Were they what you expected, why or why not? What do you think contributed to results that you were not expecting?
3.) Talk about the IR graph in words and how you know what your compound is by this ENTIRE spectrum (hint: fingerprint region)
4.) How would you change this experiment, what would you have done differently?
5.) Talk about your hypothesis, correct or not?
6.) Conclusion: 3-4 sentences summarizing your discussion.

B2 Report Guideline/30 pts

Abstract: (3 pts)

- Purpose
- Recap of important methods and instruments used
- Recap of the Results (ex. [NaOH], [HCl], RAD)

Introduction (5 pts. 1 pt/bullet item).

- Background- What is acid/ base standardization?
- What is the usefulness of KHP as a standardizing agent?
- What are pH indicators, and how are they useful?
- What are the equations used in this experiment and what will each equation tell you?
- Hypothesis/Purpose of experiment

Results and Calculations (5 pts data sheet, 3 pts titration curve, 3 pts Observation)

- Staple Data Sheet to Report (make sure it's neat)
- Draw a titration curve and label all its parts (plus reaction occurring (starting material→ products (example HAc + NaOH → Ac^- + H_2O), moles of the reactants and products at the starting point, and equivalence point, label the x and y axis with proper labels and draw the curve in the correct direction)
- Paragraph of observations made during the experiment, degree of color change, etc . . . .

Calculations (4 pts)

- AD of Buret Calibration
- RAD of Buret Calibration
- [NaOH] concentration
- AD of [NaOH]
- RAD of [NaOH]
- [HCl] concentration
- AD of [HCl]
- RAD of [HCl]

Discussion/Conclusion: (7 pts. 1-2 pts/item).

- Buret calibration= talk about AD and RAD, what do these numbers tell us about precision of you instrument, can your concentrations be trusted?
- NaOH standardization, [NaOH] M (restate), and talk about how your result (based on AD and RAD) can or cannot be trusted. Can you use this as a standard for the next acid standardization, also use observations to discuss possible sources for error.
- HCl standardization, [HCl] M (restate), and talk about how your result (based on AD and RAD) can or cannot be trusted. Can you use this as a standard for standardization, also use observations to discuss possible sources for error.
- Discuss what you would do if time permitted to ensure that your standardization could be trusted in order to use these solutions for other experiments.
- Conclusion- summary of discussion and comments about your hypothesis

B3 Lab Report Guidelines /30 pts

Abstract: (3 pts)

1.) 1 sentence= big picture statement, what was the purpose of this lab
2.) Methods- briefly touch on the methods used to measure heat capacity of calorimeter, and how to measure the ΔT of the 3 acids (2-3 sentences)
3.) Recap the results obtained all ΔH(molar) values obtained.

Introduction: (5 pts. 1 pt/item below)

1.) Background
    a. What is the usefulness of a calorimeter in chemistry
    b. Write out important equations used and explain each component
    c. How are ΔH and K related using Gibbs free energy relationship
    d. Draw out the scheme for Δ Hw, Δ Ha, ΔHb and explain how we can experimentally find these values.
2.) Hypothesis

Results: (5 pts for Data Sheet. 4 pts for explaining Calculations and 2 pts Observations)

1.) Staple data sheet given in class.
2.) Calculations:
    a. Reference data sheet. Explain Calculations.
3.) Paragraph of observations while performing the experiment. Talk about any instances where you ran into trouble with issues such as standardization of base, calibration runs (> or < 1.0-1.2).

Discussion & Conclusion: (9 pts. 2-3 pts/item)

In the context of the Discussion remember to hit these key points

1. Talk about why we are doing the experiment we are doing. Why do you need to measure enthalpy of the acids in the presence of a base? Why can't you just directly measure ΔHw, ΔHa and ΔHb experimentally?
2. Talk about the precision of all measurements taken, comment on part B and C in relation to the reliability of your ΔHw, ΔHa and ΔHb calculated. Can precision of your measurements affect the reliability of your ΔHw, ΔHa and ΔHb values. Use observations and RAD to back up your claims.
3. Discuss the ΔH of reaction for all 3 acids. Were they what you expected? Was the reaction endothermic or exothermic.
4. The ΔHa was positive for one acid and negative for the other acid, why do you think this is. Investigate and make your case for what you think. Which reaction requires energy to proceed forward and which reaction does not require as much energy to be pushed forward.

Conclusion- summary of discussion and talk about your hypothesis. (2 pts)

B6 Report Guidelines /32 pts

Abstract: (3 pts)

1.) 1 sentence= big picture statement, what was the purpose of this lab
2.) Methods- briefly touch on the test we used for characterization (2-3 sentences)
3.) Recap the results obtained (% difference between theoretical and experimental neutralization capacity, pka of the known salt, pka and molar mass of SA and Aspirin.

Introduction: (4 pts)

Background

a. Talk about the usefulness of a pH meter used in this experiment, what was the purpose of tracking the pH of the known salt, SA, and aspirin?
b. Also talk about indicators again and how they are used to detect end points (how is an indicator a better source for finding the pka of a solution than using a pH meter?)
c. Write out all of the important equations used in this experiment and explain what they are used for
d. Explain why we had to perform a back titration for the neutralization of the antacid tablet.
e. Explain how you can find the pka of your salt, SA, and Aspirin through this experiment.

2.) Hypothesis

Results: (4 pts for completed date sheet, 6 pts figures and labels, 2 pts Observations, 4 pts Calculations)

1.) Staple data sheet to Results Section
2.) Figure 1, pH vs. volume graph for known salt. Below each graph you should have a calculation for how decided which indicator to use (show raw data in a table below the figure)
3.) Figure 2, pH vs. volume graph for known SA. Below each graph you should have a calculation for how decided which indicator to use (show raw data in a table below the figure)
4.) Figure 3, pH vs. volume graph for known Aspirin. Below each graph you should have a calculation for how decided which indicator to use (show raw data in a table below the figure)
5.) Figure 4 Show one example drawn out on one figure (1,2 or 3) of how you found pKa of the salt/ or Aspirin/ or SA (circle the raw data that corresponds to your answer).
6.) Paragraph about observations made during the experiment.
7.) Calculations
    a. Experimental determination of neutralization capacity of antacid tablet
    b. Theoretical determination of neutralization of antacid tablet
    c. Calculation question found in the lab manual
    d. % error of theoretical vs. experimental
    e. One example of how you found V_{stoich} (pH meter)
    f. Show one example of how you found the MW of SA OR Aspirin

Discussion & Conclusion: (7 pts. 1-2 pts/item)

1.) Compare your pKa of the salt, SA, and Aspirin with known literature values (cite the reference you used to find this info). Address reasons for why you were off in your values, use observations to back up your claims, and address % error calculated.
2.) Talk about your % Error for the theoretical vs experimental results for neutralizing acid with your antacid. Why do you think there was a difference between these 2 values? Also discuss the back titration, was it necessary? If it was why was it necessary?
3.) Compare the MW you calculated and the known MW of SA and Asprin, explain the error, what was a contributing factor to loss of accuracy of your result?
4.) Talk about your hypothesis, correct or not?

Conclusion: 3-4 sentences summarizing your discussion. Concusion regarding the graphs , back titration methods and comparison of methods. (2 pts)

B5 Lab Report Guidelines/30

Abstract: (3 pts)

1.) 1 sentence= big picture statement, what was the purpose of this lab
2.) Methods- briefly touch on tests to find each type (I, II, and III) and how they work.
3.) Recap the results obtained what are your unknown cations

Introduction: (4 pts)

1.) Background
    a. Describe in detail the 3 types of cations-how are they tested, why they form precipitate or do not (solubility rules).
    b. Describe each test performed and what was expected for each test, list important physical or chemical changes which are seen to verify which cation is present in solution.
    c. Describe how knowing what cations are present in a solution may be important for environmental chemistry (be creative).
2.) Hypothesis

Results: (5-6 pts/unknown) Approx. 18 pts

1. Staple Data sheet *note= all the points for the results will come from here, make sure you properly format the flow chart.

Discussion & Conclusion: (narrative minimum 1 page→ give me your thought process) (5 pts)

In the context of the Discussion remember to hit these key points

1. You are allowed to ask upto 2 questions for which the responses must be either yes or no, or how many. What were the two questions that you asked, and what were the responses.
2. Talk about your difficulties with this experiment, I know not all of your test came out correctly talk about what may have happened to not give you the correct result (hint= multiple cations in the mix, possible contamination, etc . . .).
3. Talk about methods you used to determine your cations outside of the instructions given to you in the lab notebook, even if you did not need to do this during the experiment. Be creative, what type of other tests could you do to verify your cations?

Conclusion- How did you arrive at the identity of your unknowns?

B7 Lab Report Guideline (30 pts)

Abstract: (3 pts)

1.) 1 sentence= big picture statement, what was the purpose of this lab
2.) Methods- briefly touch on the methods used to make buffer solutions (2-3 sentences)
3.) Recap the results obtained [HA] and [A] calculated for part A and part B and a statement about your conclusions for part C

Introduction: (5 pts)

1.) Background
    a. What is the ENTIRE definition of a buffer
    b. What is the usefulness of a buffer in science or in our bodies
    c. Describe the 4 methods for making a buffer solution
    d. Draw by hand a titration curve for a diprotic acid H_2CO_3 labeling the buffering ranges, the pka's and the stoichiometric points and what major species are present at the starting points, midpoints, the stoichiometric points.
    e. What is the importance of having 'significant' amounts of HA and A- in a buffer solution
    f. Equation used- Henderson hasselbach- what is the importance of this equation to describe buffers- (ex, ratio of HA vs A-; pka values, etc. . .)
    g. Draw the reaction equilibrium scheme for the buffer solutions for acetic acid (part A) and the carbonic acid (part B)
2.) Purpose/Hypothesis

Results: (5 pts Data for completed data sheets, 2 pts Observations, 5 pts Calculations)

1.) Figure 1, Data sheet with part A (make sure to write a figure description- one to two full sentences)
2.) Figure 2, make a table just like the green data sheet given (just like part d from Part A) and fill in the table with the results you got for Part B and for part C
3.) Observations: Trends and physical changes in properties, colors etc.
4.) Calculations
    a. Attach B7 calculations sheet (make sure it is neat and readable= pencil is ok to use here). ALL QUESTIONS MUST BE ANSWERED IN FULL

Discussion & Conclusion:v(8 pts)

In the context of the Discussion remember to hit these key points

1. What method was the best method for making a 0.100M buffer solution (@ a specific pH), and why? Back this up with evidence and observations from your results section.
2. Why is it important to have 'approximately' equal moles of HA and A- in a buffer solution (use evidence from part A and part B results to explain why)?
3. Explain how you made your buffer in part B, explain which method you used and why. What were the advantages that the exercise in part A gave you to make a buffer without any instructions for part B.
4. What were the species HA and A- present in Part B, why can you say this (describe with your known knowledge of pka's of carbonic acid the Henderson Hasselbach equations for buffer solutions, etc . . .)
5. Describe the reasons why the 0.020 M $NaHCO_3^-$ from part C is not a buffer solution; use evidence from the results to substantiate this claim.
6. Why does blowing into the 0.02M $NaHCO_3^-$ solution cause the pH of the solution to change (what kind of change)?
7. Why does blowing more into the 0.02M $NaHCO_3^-$ after the pH has changed one unit not decrease the pH anymore after its decreased 1 pH? Use your observations and knowledge of buffers to explain
8. Explain how this experiment can be improved.

Conclusion- (2 pts) Summary of discussion and give me reasons for why your experiment was successful/ or not and use results to back up your concluding claims.

Worksheet for Experiment B4 (Mod 1-27-10)			Name:			Section:	
Chem 120 B			Partner's name:				
							Rm temp:
Run	**1**	**2**	**3**	**4**	**5**	**6**	**6 (repeat)**
mL of MO solution to be used							
mL Sn/HCl Soln	3.0	4.0	6.0	6.0	6.0	6.0	6.0
mL HCl	5.0	4.0	2.0	6.0	4.0	2.0	2.0
mL NaCl	4.0	4.0	4.0	0.0	2.0	4.0	4.0
TOTAL VOLUME in rxnMIXTURE!!							
Conc **MO** in rxn MIXTURE, **mg/L**							
ConC **MO**, **M (molarity)**							
Conc **Sn^{2+}** in rxn MIXTURE, **M**							
Conc **H^+** in rxn MIXTURE, **M**							
x, order for MO (why?)	Reason:						
Half life (sec) est. from graphs/tables							
k exptl (from slope), s^{-1}							
y, (unrounded) for Sn^{2+} from plot							
z, (unrounded) for H^+ from plot							
k (fundamental, from each run)							
Average k (**excluding** run 7),							
% RAD (rel ave dev)							
Temps of run 6 (repeat) and 7							
Ea, kJ							
Note: Which runs are "duplicates"? How will you use this in your analysis of data?							

Name_____ 120B Section _____ INSTRUCTOR NAME_____

Data and results sheet for Expt B1 (USE CORRECT NUMBER OF SIGNIFICANT FIGURES!)

A: Synthesis of Salicylic Acid

Amt of oil of wintergreen OW:	_____g	= >	_____mol
Molar mass used:			
Theoretical yield of Salicylic Acid, SA	_____g	<=	_____mol
Molar mass used:			
Mass, mol of your crystallized SA	_____g	= >	_____mol
Per cent yield of recrystallized SA (based on original moles of OW)	_____ %		
Melting point(range) of SA		_____	
Expected melting point of SA		_____	
Literature source (details):			

B: Synthesis of Aspirin

Amt of oil of SA used :	_____g	= >	_____mol
Molar mass used:			
Theoretical yield of Aspirin, ASA	_____g	<=	_____mol
Molar mass used:			
Mass, mol CRUDE ASA	_____g	= >	_____mol
Per cent yield of CRUDE ASA (based on original moles of SA)	_____ %		

Mass, mol RECRYSTALLIZED ASA	_____g	= >	_____mol
Per cent yield of RECRYSTALLIZED ASA (based on original moles of SA)	_____ %		
Melting point(range) of ASA		_____	
Expected melting point of ASA		_____	
Literature source (details):			

Experiment B2 Data Sheet

Part A: Calculations

1.) Useful equations M1V1 = moles 1 ------for dilutions. Then we have moles 1=moles 2 ---- = moles 2 = M2V2, because (moles/L→ M1)*(L→ V1)=moles 1=moles 2=(moles/L→ M2)*(L→V2)

HCL (stock 12.1M)→ want final [] M to be 0.1 M in 500 mL, what volume of HCl do you need to measure of the stock solution to dilute to 0.1M in a 500 mL solution?

2.) NaOH (stock 50% by mass→ 50g NaOH/100g solution), density(ρ)=1.53 g/mL. What is the molarity of the diluted solution of NaOH if you dilute 3 mL of stock solution of NaOH to a final volume of 500 mL?

3.) KHP=potassium acid phthalate (MM=204.23 g/mol). Find the mass needed of KHP that will require 20 mL of base (calculated from question #2) to neutralize (reach the stoichiometric point)?

Calibration of Buret

	Trial 1	Trial 2	Trial 3
Intial Volume (mL)			
Final Volume (mL)			
Volume Delivered of the DI water (mL)			
Average volume delivered (mL) (20 drops)			
Average deviation (AD) of volume delivered of DI water (mL) (20 drops)			
Relative average deviation (RAD) of volume delivered of DI water (mL) (20 drops)			
Average of 1 drop (ml)			

Standardization of Base (NaOH)

	Trial 1	Trial 2	Trial 3
Mass of KHP (g)			
Intial Volume (mL)			
Final Volume (mL)			
Total volume Delivered (mL)			
Calculated Concentration of Base (M)			
Average Concentration of Base (M)			
Average deviation (AD)			
Relative average deviation (RAD)			

Standardization of Acid

	Trial 1	Trial 2	Trial 3
Intial Volume (mL)			
Final Volume (mL0			
Total volume Delivered (mL)			
Calculated Concentration of Acid (M)			
Average Concentration of Acid (M)			
Average deviation (AD)			
Relative average deviation (RAD)			

B3 Data/ Calculation Sheet

Day 1

Part A: Preparing 1.1 M Acid solutions

Acid Name	Amount used (g or ml)

Part B: Calibration Procedure

Trial #	T_h	T_c	T_f	Ratio (T_f-T_c/T_h-T_f)
1				
2				

NOTIFY INSTRUCTOR IF RATIO IS NOT BETWEEN 1.0 AND 1.2

Part C: Volume Delivery Check

Trial #	Weight of 250-ml beaker (g)	Weight of 250-ml beaker + 100 ml water (g)	Weight of 100 ml water (g)	Calculated Volume of water delivered (ml)
1				

Titrate Stockroom 1.0 M solution to determine its exact molarity with your standard acid (B2)

Initial buret Reading (ml)	Final buret reading (ml)	Total Volume delivered (ml)	Concentration of NaOH (M)

NOTIFY INSTRUCTOR IF [NaOH] > 1.1 M

Day 2

Part B: Calibration Procedure

Trial #	T_h	T_c	T_f	Ratio (T_f-T_c/T_h-T_f)
1				
2				

NOTIFY INSTRUCTOR IF RATIO IS NOT BETWEEN 1.0 AND 1.2

Part C: Volume Delivery Check

Trial #	Weight of 250-ml beaker (g)	Weight of 250-ml beaker + 100 ml water (g)	Weight of 100 ml water (g)	Calculated Volume of water delivered (ml)
1				
2				

Part D: Acid-Base Runs

Concentration of _____: M

Trial #	T_b	T_a	T_{end}	$\Delta T = T_{end}-((T_a+T_b)/2)$
1				
2				

Part B: Calibration Procedure

Trial #	T_h	T_c	T_f	Ratio (T_f-T_c/T_h-T_f)
1				
2				

Part C: Volume Delivery Check

Trial #	Weight of 250-ml beaker (g)	Weight of 250-ml beaker + 100 ml water (g)	Weight of 100 ml water (g)	Calculated Volume of water delivered (ml)
1				
2				

Part D: Acid-Base Runs

Concentration of _____: M

Trial #	T_b	T_a	T_{end}	$\Delta T = T_{end}-((T_a+T_b)/2)$
1				
2				

Day 3

Part B: Calibration Procedure

Trial #	T_h	T_c	T_f	Ratio (T_f-T_c/T_h-T_f)
1				
2				

NOTIFY INSTRUCTOR IF RATIO IS NOT BETWEEN 1.0 AND 1.2

Part C: Volume Delivery Check

Trial #	Weight of 250-ml beaker (g)	Weight of 250-ml beaker + 100 ml water (g)	Weight of 100 ml water (g)	Calculated Volume of water delivered (ml)
1				
2				

Part D: Acid-Base Runs

Concentration of _____: M

Trial #	T_b	T_a	T_{end}	$\Delta T = T_{end}-((T_a+T_b)/2)$
1				
2				

Calculations:

m average (g)	V average (ml)	(Calibration Ratio average)-1	Cp, soln	Cp, cal	Cp system

Precision Error

	AD	RAD
V average		
m		
Ratio-1		

Show AD/RAD calculation work below for m

Acid analyzed	Average Δ T	Δ H1 (dissociation of HCl)	Δ H2 (dissociation of the other acid)
HCl			

Hess's Law (page 64)

Using Hess's Law and literature values fill in the table below.

Acid	Δ Hw	Δ Ha	Δ Hb	pka

Below show your work using Hess's Law to find delta Hw, Ha, and Hb for ***HCl, CH_3COOH, and HSO_4^-.***

Titration Practice Worksheet

1.) If it takes 54 mL of 0.1 M NaOH to neutralize 125 mL of an HCl solution, what is the concentration of HCl?

2.) If it takes 25 mL of 0.05 M HCl to neutralize 345 mL of NaOH solution, what is the concentration of the NaOH solution?

3.) If it takes 50 mL of 0.5 M KOH solution to ***completely*** neutralize 125 mL of sulfuric acid (H_2SO_4), what is the concentration of the sulfuric acid solution?

4.) Can I titrate a solution of unknown concentration with another solution of unknown concentration and still get a meaningful answer? Explain your answer in a few sentences.

5.) Explain the difference between an endpoint and equivalence point in a titration.

6.) What is the pH of the equivalence point of the titration of a strong acid and strong base, explain.

7.) **To obtain the data needed to plot a titration curve for the titration of a strong acid with a strong base, a chemist used 25.00 mL of 0.1000 M HCl. The molarity of the base was also 0.1000 M, and this solution was added in small portions to the acid. Calculate the pH of the resulting solution after each of the following quantities of base had been added to the original solution (you must take into account the change in volume). Graph the result.**

(a) 0 mL **(d) 24.99 mL** **(g) 25.10 mL**
(b) 10.00 mL **(e) 25.00 mL** **(h) 26.00 mL**
(c) 24.90 mL **(f) 25.01 mL** **(i) 50.00 mL**

8.) Consider the titration of 50.0 mL of 2.0 M HNO_3 with 1.0 M KOH. At each step of the titration...

a) write a reaction to show the initial reaction upon mixing

b) construct an ICE table to represent the reaction (Should you use concentration or moles?)

c) determine the major species present *after* the reaction is complete

d) calculate the pH of the solution after the addition of 0.0 mL, 25.0 mL, 50.0 mL, 90.0 mL, 100.0 mL, 110.0 mL and 150.0 mL of 1.0 M KOH. Graph the result.

B6 Data Sheet

	Salt-	SA	Asprin
Mass of Salt (g) (pH meter experiment)			
Mass of Salt (g) (indicator experiment)			
Initial Volume (ml) (indicator experiment)			
Final Volume (ml) (indicator experiment)			
Total Volume used (ml)			
Calculated Vstoich (pH titration experiment)			
Volume to reach midpoint of pH titration experiment			
pH @ stoichiometric point			
pKa estimated			
pka (literature value)			
% Error			
MW calculated			
MW (literature value)			
% Error			

Chemistry 120B		Fall 10	**NAME:**		**PARTNER:**
Buffer Experiment Calculation Summary Chart					
Desired pH: 4.950	a	b	c		d
					(titration)
	mL needed	mL needed	mL needed		mL needed
Reagent:					
1.00 M HAc (Acetic Acid)					
1.00 M NaAc (Sodium acetate)					
1.00 M NaOH (Sodium Hydroxide)					mL **used**, not calculated:
1.00 M HCl (Hydrochloric Acid)					
Volume of DI to be added:					
Total volume:					
INSTRUCTOR INITIALS:					
Resulting pH:					
Which reagent should be used to adjust pH? Volume of (reagent) needed to adjust pH to 4.950; 1 drop =.050 mL					
NEW Volume					
NEW Concentration of buffer					
Instructor Initials:					

Chemistry 120B Rev 10-8-10
Laboratory Procedure: B7 Buffers

Read the INTRODUCTION in the laboratory manual, pp. 119-121 to anticipate the basic relationships between a weak acid and its conjugate base (or a base and its conjugate acid). Do not follow the remaining procedures in the lab manual. Complete the worksheet provided here.

You will begin by making buffers containing acetic acid (HA) and its conjugate base (A^-) of specified composition ("formal concentration") and pH = 4.950 by different methods and you will compare the theoretical calculations done to prepare the buffer of a desired pH with the actual pH's of the buffers. You will discuss with the instructor the differences observed and strategies for "correcting" the solution composition to get the desired pH (or concentration), before you make the adjustments.

Equations:

The K_a of acetic acid is $1.75X10^{-5}$, or a pK_a of 4.757. Remember the basic K equation,

$$K = [H^+][A^-]/[HA] \qquad \text{(Equation 1a)}$$

or the log-version, the buffer equation,

$$pH = pK_a + \log([A^-]/[HA]) \qquad \text{(Equation 1b)}$$

and that "0.100 M acetate buffer" means that

$$[HA] + [A^-] = 0.100\ M. \qquad \text{(Equation 2)}$$

Thus by knowing the desired pH (or $[H^+]$), it will be possible to calculate (1) first the RATIO of concentrations of conjugate base to weak acid from Eq. 1a or 1b, and then (2) the individual concentrations of species in the final mixture, using Eq. 2. Starting with the 1.00 M reagents, it will then be possible to calculate the volume (mL) of each reagent required to get the desired final concentrations.

A. **Preparation of 100. mL of 0.100 M acetate buffers, pH 4.950** (or at a pH specified by your instructor) with a NEW partner. Set up the LabPro and calibrate the electrode.

(a) You will make the first buffer (column (a) of the worksheet) by mixing volumes of 1.00 M Acetic Acid and 1.00 M Sodium Acetate, diluting to 100.0 mL, followed by measurement of the resulting solution pH, and then, if necessary, adjustment to the correct value. Carry out these calculations and **show them to your lab instructor** for "sign off" at the appropriate place. The adjustment of the pH after you make it using the "theoretical" amounts is necessary since you may discover that after you have prepared 100 mL of the final solution, the pH is NOT what you wanted. Decide which

reagent should be used to make "minor" adjustments of the pH in order to get the desired pH – and **check with your instructor**! You may use the dropper for this adjustment, counting drops and estimating volumes (1 drop = 0.05 mL, approximately). Note that this will result in some "dilution" of your buffer, so calculate the new concentration of the buffer. Have the instructor "sign off" after you calculate the new concentration of the buffer.

(b) Then make the "same" resulting buffer by mixing volumes of 1.00 M Acetic Acid and 1.00 M Sodium Hydroxide, diluting to 100.0 mL, followed by measurement of the resulting solution pH, and adjustment to the correct value (as above). Get "sign offs" as indicated.

(c) Then make the "same" resulting buffer by mixing volumes of 1.00 M Sodium Acetate and 1.00 M Hydrochloric Acid, diluting to 100.0 mL, followed by measurement of the resulting solution pH, and adjustment to the correct value, and get "sign offs."

After successfully completing (a)-(c):

(d) Prepare the "same" resulting buffer by titrating a specified volume of 1.00 M Acetic Acid with 1.00 M Sodium Hydroxide FROM A BURET while monitoring the reaction with a pH meter, followed by dilution to 100.0 mL. You will only need to fill your buret to about the "30 mL" mark (not all the way to "0 mL") to conserve reagents. (NOTE: Since the total volume must be 100 mL, after you add the required volume of Acetic Acid, add a "substantial" amount (check with instructor on how much you would like to add) of DI water so that when you adjust the pH and make the final dilution, you will only be adding a small amount of DI water to make the total volume 100 mL. Hint: what is the MAXIMUM amount of NaOH you could possibly add? How much DI water would then be needed to make 100 mL?)

COMPARE the four different methods and evaluate which is "best" and "easiest" – or does it make any difference?

B. Preparation of 100 mL of a "0.100 M bicarbonate buffer, pH 7.00

Using your understanding of the "best" method for buffer preparation gained above to make a "bicarbonate" buffer of pH = 7.00, starting with the 1.00 M $NaHCO_3$ solution.

Note that carbonic acid, H_2CO_3, has two pK_a values: 6.352 and 10.322. Determine which conjugate acid/base species will be present in significant amounts for a solution with a pH of **7.00** and check with your instructor. HINT: To help you decide, sketch a titration curve for "pure" carbonic acid H_2CO_3 with OH^- (or CO_3^{2-} with HCl) and then use this to help you decide which reagent (NaOH or HCl) will be required to produce the desired pH starting with 1.00M $NaHCO_3$. Check with your instructor to be sure you understand which species will be present at pH 7.00 (or at the pH specified by your instructor).

Set up and calibrate your pH electrode using the LabPro software. Prepare **100 mL of the desired "0.100 M bicarbonate" buffer of pH 7.00** using 1.00 M Sodium Bicarbonate and the appropriate reagent (see previous paragraph) and "partial dilution" using the "titration method" from the previous lab period. Measure the initial pH of the bicarbonate solution before titration and record it in the space below and in your

notebook. Add the required reagent dropwise from the buret (read volumes from buret – don't "count" the drops!) until the pH reaches the desired value ± 0.03 pH units. Record the volume of reagent added and the final pH after dilution to the required 100. mL. If you accidentally "overshoot" the desired pH, what could you do to "readjust" the pH?

Initial pH of the "bicarbonate" solution: _____

Volume(s) of reagent (specify) added to get pH 7.00 _____

Final (adjusted) pH of solution after dilution to 100. mL (should be 7:00±0.03) : _____

C. Preparation of 100.0 mL of a 0.020 M $NaHCO_3$ and the impact of CO_2 from your breath.

Working **individually**, prepare 100.0 mL of 0.020 M HCO_3^- solution (THIS IS **NOT** A BUFFER!!!! Why?) from 1.00 M $NaHCO_3$ by appropriate dilution with DI water using a 250 mL Erlenmeyer flask for storage. (How many mL of 1.00 M $NaHCO_3$ will be needed? How much DI water must be added?). Measure and record the initial pH of the solution (remember, this is **NOT** a buffer solution!).

With a soda straw, bubble air from your mouth and lungs into the solution **slowly** while monitoring the pH. Blow steadily and slowly to maximize the amount of CO_2 from your breath that gets into the solution, and count the breaths needed to change the pH by 1.00 pH units (**lower**). DON'T INHALE THE SOLUTION INTO YOUR MOUTH, although it is not dangerous. Record the number of breaths required.

What is the chemical reaction that is taking place when you blow your breath into the bicarbonate solution?

Then, continue breathing into the flask for a few more minutes. Can you get the pH to change ANOTHER 1.00 units lower? Why does the pH not change much after the initial decrease? Explain your success or lack of success.

Summarize your results and turn in the blue/yellow pages.

REPORT FOR Experiment B7
Abstract – summarize clearly your experiment and the key results
Introduction – Include descriptions of buffers, the chemical reactions being studied, and the algebraic approach used to solve the problem.
Experimental – summarize the preparations that you carried out.
Results – summarize your buffer preparations and the bicarbonate/CO_2 experiments. **Include a photocopy of the table (completed) and calculations of each part.**
Discussion – Evaluate the key results from your experiments, including the advantages and disadvantages of the various methods of preparing buffers. Include comments about the general properties of buffers as you have observed them.

Guidelines for Writing Reports

1. The point assignments are approximate and your TA can change the point assignments after informing you.
2. If Data sheets or Spectra or Other Calculations are not included at the time of turning in the report, you will be assigned a zero grade for those items.
3. No late work will be accepted.
4. If your work is not legible, especially on the Data Sheets that you work on during lab, you will be docked off points.
5. Abstract, Introduction, Results and Discussion must be typed up. Times/Times New Roman/Helvetica/Geneva 12 points. Titles and Subtitles must be Bolded. Paragraphs must have a line spacing in between them. Lines must be spaced 1.5. Each point on the bulleted items of the Guidelines would usually require upto 3 sentences, usually not more than that.
6. Calculations may be handwritten, but must be on the Report in the space that you leave aside for calculations when initially typing it up, and must not on a separate sheet of paper.
7. Results MUST be Tabulated on Microsoft Word or inserted from Excel. All results must be tabulated and labeled.
8. All graphs must be drawn on Excel and inserted within the report after the results sections. The graphs will receive zero points if not labeled properly (X, Y axis and the units).