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Chemistry Lab

Experiment

Booklet

March 16th, 2019

State Tournament

University of Wisconsin - Stout

Instructions: This exam consists of an acid-base experiment worth 100 points, a physical properties experiment worth 100 points, and a multiple choice exam worth 100 points (300 points total). **Students may NOT write on the Experiment or Exam Booklet.** Students may **only mark on their answer sheets.**

Be strategic, figure out the way that you and your team can bank as many points as possible in the time given. Place the answers to the lab experiments and multiple choice exam on the provided answer sheets. Answers not placed on the answer sheet will not be scored.

Ties will be broken by first the quality, accuracy, and completeness of the **acid-base experimental data**, followed by the quality, accuracy, and completeness of the **physical properties experimental data**.

YOU WILL HAVE 30 MINUTES TO COMPLETE EACH EXPERIMENT

Half of the teams present will start with the acid-base experiment and half will start with the physical properties experiment. **After 30 minutes**, you will switch stations. You will need to perform the experiment and have your station completely cleaned up **and reset to their original positions** or a penalty of up to 10 % will be assessed against your score.

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Potentially Useful Information

1 mL = 1 cm^3

Acid	MW (g/mol)
formic acid	46
acetic acid	60
carbonic acid	62
propionic acid	74
butyric acid	88
valeric acid	102
malonic acid	104
fumaric acid	116
caproic acid	116
succinic acid	118
benzoic acid	122
itaconic acid	130
4-hydroxybenzoic acid	132
glutaric acid	132
malic acid	134
phenylacetic acid	136
salicylic acid	138
tartaric acid	150
terephthalic acid	166
phthalic acid	166
capric acid	172
ascorbic acid	176
undecylic acid	186
citric acid	192
pentadecanoic acid	242
palmitic acid	256
arachidic acid	313

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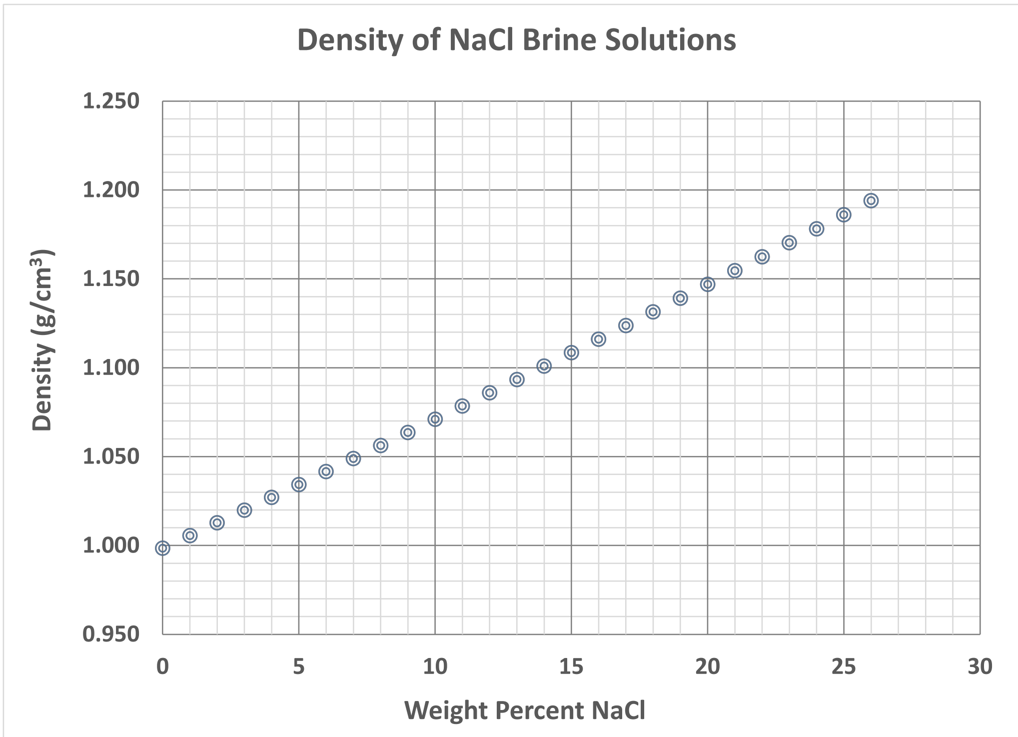
Potentially Useful Information

NaCl wt%	Density (g/cm^3)
0	0.998
1	1.006
2	1.013
3	1.020
4	1.027
5	1.034
6	1.042
7	1.049
8	1.056
9	1.064
10	1.071
11	1.078
12	1.086
13	1.093
14	1.101
15	1.108
16	1.116
17	1.124
18	1.131
19	1.139
20	1.147
21	1.155
22	1.162
23	1.170
24	1.178
25	1.186
26	1.194



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ACID-BASE

EXPERIMENT 1: MOLECULAR WEIGHT BY TITRATION

Introduction

The purpose of this experiment is to determine the molecular weight of unknown organic acid samples by titration.

Discussion

Organic acids can be neutralized by a strong base such as sodium hydroxide. Organic acids are weak acids and typically produce pH values between 2 – 4 at moderate concentrations. After neutralization with sodium hydroxide at the equivilance point, the pH of the solution will rapidly rise to 10 or above with a very small amount of aditional base. As a result, an appropriate pH indicator may be used to determine the equivalance point where the number of moles of acid is equal to the number of moles of base.

Some organic acids have only one acid group per molecule and are called monoprotic acids since they can only donate one proton (H^+ ion) to an acid base reaction. On the other hand, some organic acids have two, three, or even more acid groups per molecule and are called diprotic acids, triprotic acids, etc.

If the mass of an unknown acid is known and if the number of acid groups per molecule is known, the molecular weight of the acid can be determined by titration with a strong base of known concentration.

Materials

50-mL burett and stand
100-mL graduated cyllinder
125-mL Erlenmeyer flask
150-mL beaker
400-mL beaker
Paper towels
Funnel
Indicator solution (phenolphthalein)
NaOH solution (~0.100 M)
Deionized water (at sink)
Analytical balance
Weigh paper
Unknown Acid samples A through E

Take careful notice of the layout of your station.

Points will be deducted (up to 10%) from your score if you do not clean and replace all of the items back to their original positions!

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Safety Precautions

Sodium hydroxide is a strong base and very caustic to the eyes and skin! Wear chemical splash goggles to perform this experiment. Immediately rinse off any base that gets on your skin with runnung water.

OPTIONAL: Gloves and a chemical-resistant apron or lab coat may be worn for this experient as well if desired.

Procedure

1. Obtain approximately **100 mL of sodium hydroxide solution** from the reagent area in your 150-mL beaker.
2. Record the exact molarity of the sodium hydroxide (labeled on the carbuoy) on your data sheet.
3. Place your 400-mL beaker under your burett (to catch any spill if you overflow the burett . . . it happens).
4. Place a funnel in the top of your burett.
5. Carefully fill your burett with approximately 50 mL of sodium hydroxide untill the meniscus is near the top but still within the graduated scale area.
6. Read the bottom of the meniscus and record your starting burett position on your data sheet.
7. Place a piece of weigh paper on the balance and press tare to zero the balance.
8. Wipe any spatulas used before and after use with a piece of paper towel or tissue paper.
9. Weigh out approximately **0.20 g of Unknown Acid** from the reagent area, record the exact value on your data sheet to at least 3 places past the decimal point.
10. Place unknown container back where it was and clean up any mess at the balance station.
11. Place the Unknown Acid sample into a 125-mL Erlenmeyer flask
12. Measure out **50 mL of deionized water** (from the grey plastic tap at the back sinks) and add to your Unknown Acid sample.
13. Swirl until all of the sample has disolved.
14. Place **5 drops of phenolphthalein indicator** solution into the Unknown Acid solution in the 125-mL Erlenmeyer flask.
15. **Titrate** the solution with sodium hydroxide from the burett. Gently swirl the flask by hand as you add titrant to mix the solution during addition. Titrate until the color of the solution is a persistent slightly pink color. The more pale the pink color, the more accurate the titration will be. Add the titrant very slowly as you suspect you are nearing the equivalence point, brief “flashes” of pink color indicate that the equivalence point is near. A dark pink color can indicate that you added too much base and have gone past the equivalence point and the run will likely need to be re-done.
16. When you are satisfied that you have achieved the endpoint, read the bottom of the meniscus and record the ending burett position on your data sheet.

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17. Calculate the volume of sodium hydroxide solution added (final –initial) and record on your data sheet.
18. Calculate the number of moles of base added based on the concentration and volume added and record on your answer sheet (***be careful about mL to L conversions!)***
19. Calculate the number of moles of acid neutralized and record on your answer sheet (be careful about monoprotic, diprotic, and triprotic acids!).
20. Using the number of moles of acid neutralized, the stated number of acid groups per molecule (listed for each unknown), and the mass of acid added to the flask, calculate the molecular weight of the unknown acid and record on your data sheet.
21. Using the reference material on page 2 of this experiment booklet, determine a likely identity of your unknown acid and record on your data sheet.
22. Dump your pink neutralised acid solution down the sink drain.
23. Rinse your 125-mL Erlenmeyer flask three times with deionized water and gently shake dry (the flask does not need to be completely dry, a little bit of pure water remaining in the flask does not impace the titration).
24. Remember to top-off the burett with aditional sodium hydroxide solution before each titration.
25. **REPEAT** this procedure for each unknown and record all answers on your data sheet.

Disposal

- *After each neutralization, all solutions produced in this experiment are non-toxic and may be disposed of down the sink drain.*
- *Drain any residual titrant from your burett into your 400-mL beaker and rinse down the sink drain.*
- ***DO NOT RINSE BURETT WITH WATER OR REMOVE IT FROM THE BURETT STAND! RESIDUAL TITRANT DROPLETS DO NOT NEED TO BE REMOVED FROM THE BURETT!***
- ***Thoroughly rinse all beakers and graduated cylinders, shake dry, and return ALL ITEMS to their original places at your station.***

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PHYSICAL PROPERTIES

EXPERIMENT 2: DENSITY DETERMINATION OF LIQUIDS

Introduction

The purpose of this experiment is to determine the density of unknown NaCl brine solutions using a pycnometer.

Discussion

For this experiment, we will be using a 10 mL volumetric flask as a pycnometer. If an accurate mass and volume of a sample are measured, the density of the sample can be easily calculated. The accuracy of mass determinations is highly dependent on the equipment used. For this experiment, electronic balances that report values to 3 places (or more) past the decimal point should be used. This type of balance has a small cabinet enclosure with sliding doors to prevent air currents in the room from affecting the accuracy of the mass measurements. Volumetric glassware is accurate to 4 significant figures. For example, the 10 mL volumetric flask that we will be using in this experiment will measure out 10.00 mL of liquid if properly used. To use a volumetric flask as a pycnometer, the liquid of unknown density is added until the bottom of the meniscus is ***exactly*** at the ground line on the neck of the flask. Since we will also be weighing the flask, all liquid droplets that may be clinging to the inside wall of the flask above the line MUST be wiped away. Additionally, any liquid in the stopper area or on the outside of the flask MUST be COMPLETELY wiped away. Only mass that has been added up to the line of the flask should be weighed.

Since the same volumetric flask will be used repeatedly in this experiment, the flask should be carefully emptied and dried inside before each determination. The thin neck of the volumetric flask makes this task somewhat difficult to accomplish. However, by twisting a piect of tissue paper (Kem-wipe lint free "delicate task wipers") into a thin string and pushing onto the flask, you should be able to twist the paper inside to absorb nearly all of the remining solution before each determination.

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Materials

Electronic balance (at least 3 place past decimal)
10-mL volumetric flask
Plastic pipette
Kem-wipe lint free "delicate task wipers"
Paper towels
600-mL beaker
Unknown Brine samples A through E

Take careful notice of the layout of your station.

Points will be deducted (up to 10 %) from your score if you do not clean and replace all of the items back to their original positions!

Safety Precautions

There are no particular chemical hazards associated with this experiment. Liquids used in this experiment are generally non-toxic, but should not be ingested or gotten into the eyes. Glassware could potentially be inadvertently broken resulting in a broken glass or splash hazard. Wear chemical splash goggles to perform this experiment.

OPTIONAL: Gloves and a chemical-resistant apron or lab coat will be required for Experiment 2 and of course can be worn for this experient as well if desired.

Procedure

Empty weight

1. Inspect your 10-mL volumetric flask and glass stopper to ensure that they are clean and dry. If the flask is wet inside, twist strips of Kem-wipe lint free "delicate task wipers" to insert into the flask to dry out the inside.
2. Place the plastic stopper on the flask.
3. Weigh the 10-mL volumetric flask **empty** using an analytical electronic balance and record the value on your data sheet to an accuracy of at least 3 places past the decimal point. This only needs to be done once since the empty mass wont change if you use the same flask (**NOTICE:** the stopper should **ALWAYS** be on the flask for every subsequent measurement and therefore included in the empty weight.)

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Density Determination

4. Select one of the Unknown Brine samples.
   (Unknown brine samples are available near each experiment station, if you run out of a sample, let a lab assistant know so it can be refilled.)
5. Inspect your 10-mL volumetric flask and glass stopper to ensure that they are clean and dry. If the flask is wet inside, twist strips of Kem-wipe lint free "delicate task wipers" to insert into the flask to dry out the inside.
6. Using your plastic pipette, **fill the 10-mL volumetric flask with the Unknown Brine solution** until the bottom of the meniscus is exactly at the ground glass line on the neck of the flask. (HINT: by placing the tip of the pipette past the ground glass line and carefully removing without touching the wall of the container, you can prevent getting droplets of liquid stuck to the wall above the line.
7. Wipe any remaining liquid from the inside wall of the flask without disturbing the liquid below the ground glass line.
8. Place the plastic stopper on the flask.
9. The flask contains 10.00 mL of liquid (assuming you have carefully followed the instructions).
10. Weigh the **filled** 10-mL volumetric flask using an analytical electronic balance and record the filled value on your data sheet to an accuracy of at least 3 places past the decimal point.
11. Determine the **mass** of the 10-mL of liquid (filled weight – empty weight) and record the liquid mass value on your data sheet (follow significant-figure rules).
12. Use the mass you just determined and the volume to calculate the **density** for the unknown brine sample.
13. Use the reference table and plot on page 3 of this booklet to approximate the **brine concentration** of the sample **to the nearest whole number weight percent** for NaCl brine and report the value on your data sheet.
14. After you are finished with the sample, pour your unknown brine solution into your 600-mL beaker for later disposal down the drain. (DO NOT POUR YOUR UNKNOWN BACK INTO THE ORIGINAL BOTTLE!)
15. Carefully dry the inside of the flask using twisted tissue paper.
16. Shake any and squeeze any reamining brine solution from your pipette into your 600-mL beaker. Continue shaking and aspirating until no significant amount reamins in the pipette.
17. **REPEAT** this "**Density Determination"** procedure for each unknown and record all answers on your data sheet.

Disposal

- *All of the unknown liquids can be safely poured down the drain when you are finished with the experiment.*
- *Dump your 600-mL beaker of used brine solutions down the sink drain.*
- ***Thoroughly rinse all flasks, beakers, pipettes, and graduated cyllinders, shake dry, and return ALL ITEMS to their original places at your station.***