**Rowan College at Burlington County**

**CHE 118**

**Lab Assignments and Supplemental Information Packet**

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**Laboratory Equipment List**

**Mt. Laurel campus, Science building, room 100**

**Student Drawer 1**

Beaker, 50 mL (1)

Beaker, 100 mL (1)

Beaker, 150 mL or 100 mL (3)

Beaker, 250 mL (3)

Beaker, 400 mL (1)

Beaker, 600 mL (1)

Erlenmeyer flask, 125 mL, (3)

Erlenmeyer flask, 250 mL, (3)

Funnel (1)

Graduated cylinder, 10 mL (1)

Graduated cylinder, 100 mL (1)

Spatula (1)

Stir rod (1)

Test tube holder (1)

Test tube rack (1)

Watch glass (1)

**Student Drawer 2**

Bunsen burner with hose (1)

Clay triangle (1)

Crucible tongs (1)

Ring Clamp (1)

Striker (1)

Wire screen (1)

**Student Drawer 3 (left drawer)**

Hot plate / stirrer

Timer

**Student Center Cabinet**

Burette stand with clamp

**Laboratory Equipment List**

**Pemberton campus, Parker building, room 144**

**Student Drawer 1**

Beaker, 50 mL (1)

Beaker, 100 mL (1)

Beaker, 150 mL (4)

Beaker, 250 mL (1)

Beaker, 400 mL (1)

Beaker, 600 mL (1)

Erlenmeyer flask, 125 mL, (3)

Erlenmeyer flask, 250 mL, (3)

Graduated cylinder, 10 mL (1)

Graduated cylinder, 100 mL (1)

**Student Drawer 2**

Clay triangle (1)

Bunsen burner with hose (1)

Striker (1)

Wire screen (1)

**Student Drawer 3**

Crucible tongs (1)

Eye dropper (1)

Funnel (1)

Spatula (1)

Stir rod (1)

Test tube holder (1)

Test tube rack (1)

Watch glass (1)

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab Partners: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CHE118 Rowan College at Burlington County**

**Week 1 Calibration Curve Report**

**Preparing a Calibration Curve and Determining the Concentration of an Unknown**

There are 4 standard solutions of a red dye. The concentrations are 0.010%(v/v), 0.020%(v/v), 0.030%(v/v), and 0.050%(v/v). Using DI water to zero the spectrophotometer, take an absorbance reading of each of the 4 standard solutions and the unknown solution. Make sure the spectrophotometer is set to the correct wavelength (λ = 560 nm). Fill in the table below.

|  |  |
| --- | --- |
| Concentration, %(v/v) | Absorbance |
| 0.010 |  |
| 0.020 |  |
| 0.030 |  |
| 0.050 |  |
| Unknown |  |

Use the data from this table to graph absorbance versus concentration on the graph provided. Use a ruler or other straight edge to draw the best, straight line through your points. A check list for constructing calibration curves is given on the next page. Please use this checklist for all of the experiments in CHE118 that involve a calibration curve.

Use your calibration curve to determine the concentration of the unknown. Show on the graph how the unknown’s concentration was determined (use a horizontal and a vertical line).

 Concentration of unknown = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Checklist for the construction of a calibration curve.**

1. Label each axis of the graph, include units. *(Absorbance does not use units.) Put absorbance on the y axis and concentration on the x axis.*

2. Determine the scale to use for each axis. *The y and x scales should be quick and easy to figure out by any person looking at the graph. Each square may be worth 0.5, 1, 2, or 5. It is not good practice to have 3 squares equal to 1 or 10, because then each square is worth 0.333 or 3.33 which is very confusing. The scales should allow the data points to be spread out across most of the graph, not squished in one corner.*

3. Plot each data point on the graph. *Each point is made with a concentration value and the corresponding absorbance reading. Use a darkened circle for each data point.*

4. Use a ruler to draw the best-fit, straight line through the data points. *Not all of the data points may be on the line, some data points may be above the line and some may be below the line. DO NOT connect the dots to produce a zigzag line. DO NOT draw the line “free hand”; use a ruler.*

5. Give the graph a title.

**Determining the concentration of an unknown in solution:**

1. Determine the absorbance reading of the unknown solution using the spectrophotometer.

2. Find the position of the unknown’s absorbance reading on the y axis of the calibration curve.

3. Use a ruler to draw a horizontal, straight line from the absorbance reading on the y axis to the calibration curve (the best-fit line).

4. At the point where this horizontal line intersects the calibration curve, draw a straight line vertically down to the x axis.

5. Read the concentration from the x axis where the vertical line intersects the x axis. This is the concentration of unknown in the solution.

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**CHE118 Rowan College at Burlington County**

**Week 3 Experiment 29 (CHE118 Packet)**

**Rates of Chemical Reactions; The Iodination of Acetone**

On the basis of experiments that you have performed, you may have noticed that not all chemical reactions take place at the same speed. Some reactions proceed much more rapidly than others. The rate at which a chemical reaction occurs depends on several factors:

 The nature of the reactants

 The concentration of the reactants

 The temperature at which the reaction takes place

 The presence of any catalysts

 How each of these factors affects the rate of reaction can be explained as follows:

 The nature of the reactants should be obvious. We know that an active substance, such as sodium, reacts much more readily than a less active substance, such as gold.

 Since a reaction takes place by contact of particles (ions or molecules), if the concentration of particles is higher, there will be more chance for contact and the reaction will be more likely to proceed.

 If the temperature is higher, the particles have more kinetic energy. They move around faster, have more contact, and are more likely to have the energy to react with another particle.

 A catalyst can affect a reaction in various ways. One of these ways is thought to be by bringing the particles into contact in the proper position to promote their reacting, thus making the reaction proceed more readily.

**Order of Reaction**

 First we must look at what is precisely meant by the term *rate of reaction.* Consider a typical reaction

 aA + bB 🡪 cC + dD

The rate of this reaction is measured either by observing the rate of disappearance of one of the reactants, A or B, or by observing the appearance of one of the products, C or D. We use whichever one of these is convenient because of the appearance or disappearance of a color or some other measurable property. The rate of reaction could then be expressed mathematically as follows:

 Rate of reaction = (-1) (1/a) (Δ[A]/Δt)

 Rate of reaction = (1/c) (Δ[C]/Δt)

Where a and c are the coefficients in the balanced chemical equation. The rate of disappearance of reactant A is Δ[A]/Δt and the rate of appearance of product C is Δ[C]/Δt.

 In general the rate of reaction will depend on the concentration of reactants. The rate of our typical reaction may be expressed in the format of a rate law equation:

 Rate = k[A]x[B]y

Where [A] and [B] are the molar concentrations of reactants A and B, x and y are the powers to which these concentrations must be raised to describe the rate, and k is the *rate constant.* One goal of chemical kinetics is to determine the values for these exponents, x and y. This is known as ‘determining the rate law equation’. For instance, if we found that x = 2 and y = 1 for our reaction then we can express the reaction rate as

 Rate = k[A]2[B]

We can see by this that if the concentration of B in our reaction were doubled, the rate would double. If the concentration of A were doubled, the rate would change by a factor of four. In this case the reaction is said to be second order in A and first order in B. The overall order of the reaction is the sum of the exponents. Thus, this is a third order reaction.

In this experiment you will study the kinetics of the reaction between iodine and acetone in an acid solution:



+ 2 H+

H+  +

 For this reaction you will determine the order of the reaction with respect to acetone, H+ (as HCl), and iodine, and find a value for the rate constant, k. The time for each trial will be determined by the time needed for the limiting reactant, iodine, to be used up. Iodine has color, so you can easily follow changes in iodine concentration visually; yellow to colorless for this experiment. The rate law equation [reaction rate = k(A)m(H+)n(I2)p ] will be determined. The average reaction rate can be calculated with the data for the consumption of iodine, [ reaction rate = (-1) (Δ[I2]) / (Δt) ]. This will be needed to determine the value of k.

**Purpose**

 The purpose of this reaction is to determine the rate law equation: the orders for the reactants and the rate constant for the reaction between iodine and acetone.

**Equipment/Materials**:

 4.0 M acetone solution 125 mL Erlenmeyer flasks

 1.0 M HCl solution 10 mL graduated cylinders

 0.0050 M iodine solution watch or other timing device

 100 mL beakers watch glass covers for beakers

**Procedure**:

# Fill clean, dry 100 mL beakers with 4.0 M acetone, 0.0050 M iodine, and 1.0 M HCl solutions. Keep the first two beakers covered, as the concentrations may change with evaporation. For the first trial, measure out 10.0 mL of acetone solution, 10.0 mL of 1.0 M HCl, and 20.0 mL of distilled water. Use graduated cylinders for measuring volumes. These should be added to a 125 mL Erlenmeyer flask. Use another graduated cylinder to measure 10.0 mL of the iodine solution.

1. Noting the time on a clock or timer, to the nearest second, pour the iodine solution into the flask and gently swirl to mix the contents. **Constantly swirl** the contents while holding the flask over a white sheet of paper, note the time when the last trace of color disappears. Repeat. The times should agree within a few seconds.
2. For trial 2, double the volume of HCl and use only 10.0 ml of water to keep the total volume the same at 50.0 ml. Perform this reaction twice, timing the disappearance of color as before.
3. For trial 3, double the volume of acetone (20.0ml) and use 10.0 ml each of HCl, iodine and water. Perform this reaction twice.
4. For the fourth trial, double the volume of the iodine solution, keeping the volumes of acetone, HCl and water at 10.0 ml. Once again perform this reaction twice.
5. Finally, combine volumes of acetone, HCl, iodine, and water so that the total volume equals 50.0 mL. Repeat. One suggestion would be to use 20.0 ml of acetone and HCl, and eliminate the water.

This is trial 5; perform this reaction twice.

Name :\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lab Partners: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The Iodination of Acetone

**Data and Calculations:**

# Table 1: Reaction Rate Data

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Trial | VolumeAcetone(mL) | VolumeHCl(mL) | VolumeIodine(mL) | VolumeH2O(mL) | Time1st Run(s) | Time2nd Run(s) | AverageTime(s) |
| 1 | 10.0 | 10.0 | 10.0 | 20.0 |  |  |  |
| 2 | 10.0 | 20.0 | 10.0 | 10.0 |  |  |  |
| 3 |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |

# Table 2: Determination of Orders Rate = k[acetone]m[H+]p [I2]n

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Trial | [acetone] | [H+] | [I2] | Rxn Rate = (-1)(1/1)(Δ [I2]) / Δtave | Ratio of Rxn Rates |
| 1 |  |  |  |  | (leave this blank) |
| 2 |  |  |  |  | Trial 2/ Trial 1= |
| 3 |  |  |  |  | Trial 3/Trial 1= |
| 4 |  |  |  |  | Trial 4/Trial 1= |
| 5 |  |  |  |  | (leave this blank) |

Calculate the order of Acetone, “m” (show calculations)

Calculate the order of Hydrogen Ion, “p” (show calculations)

Calculate the order of Iodine, “n” (show calculations)

The Rate Law equation format is: Reaction Rate = k[acetone]m[H+]p [I2]n

The Rate Law equation for this reaction is: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Determination of the Rate Constant k (show calculations)

Trial 1

Trial 2

Trial 3

Trial 4

Average Value for k \_\_\_\_\_\_\_\_\_\_ *(show units)*

(show calculations)

# Prediction of Reaction Rate

Use the data from Trial 5 to compare the experimental reaction rate (in Table 2) and the calculated reaction rate.

Rate = k[acetone]m[H+]p [I2]n (use the exponents you determined)

Trial 5 Concentrations:

[acetone] = \_\_\_\_\_\_\_\_\_\_ [H+] = \_\_\_\_\_\_\_\_\_\_ [I2] = \_\_\_\_\_\_\_\_\_\_

k(average) = \_\_\_\_\_\_\_\_\_\_*(calculated at the bottom of the previous page)*

Calculated Reaction Rate *(use trial 5 data for calculations and the rate law equation you determined)*

Calculated Reaction Rate = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(show calculations)

Experimental Rate for trial 5 (*from Table 2*) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Comment on how well the calculated and experimental rates compare:

**Questions:**

1. Why is the concentration of iodine so much lower than the other reactants?

2. How are time and rate related? How are 1/time and rate related?

*(answer proportional or inversely proportional for each question)*

1. What does it mean when someone says a reaction is “first order”?

4. In a reaction, A + B → C, it is found that the reaction is first order in terms of A and first order in terms of B.

What happens to the rate if the concentration of A is doubled and the concentration of B is kept the same?

What happens to the reaction rate if the concentration of B is doubled and the concentration of A is kept the same?

What happens to the reaction rate if both the concentration of A and B are doubled at the same time?

5. Name at least two places in the experimental procedure where errors could occur. For each of these, specify what the error would be and describe how it would affect the calculations for the experiment.

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**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab Partners: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CHE118 Rowan College at Burlington County**

**Week 6 Titration Introduction Experiment**

This experiment introduces the usefulness of a titration and how a titration is done. A titration is a wet chemical technique performed to determine information about an unknown substance. The determination of the molarity of an acid solution is a very common type of titration, and that is the type of titration for this experiment. A solution of sodium hydroxide with a known concentration is used to determine the concentration of a hydrochloric acid solution.

When mixed together, the sodium hydroxide and hydrochloric acid undergo an acid base neutralization reaction. The clear and colorless solution of sodium hydroxide reacts with the clear and colorless solution of hydrochloric acid to produce a clear and colorless solution containing the products of the reaction. The titration is stopped when the moles of OH1- added is equal to the moles of H1+ in the titration flask; this is the equivalence point. In order to “see” the equivalence point, an indicator is used to produce an observable color change in the hydroxide and acid mixture; this is the end point. The end point should occur at the equivalence point.

The selection of the indicator is critical to the success of the titration. The indicators used in this experiment will produce a color change because of the change in pH of the solution in the flask. The color change is the end point, and the end point must occur at the equivalence point for an accurate experimental result. Phenolphthalein is a good indicator to use for a strong acid strong base titration (Part 1). The pH of the solution at the equivalence point is very close to the pH that causes the initial color change from colorless to very faint pink. Two other indicators will be used in Part 2 of the experiment to demonstrate the problem with using the wrong indicator for a titration.

Chemicals and Equipment

0.10 M NaOH solution

Approximately 0.1 M HCl solution

Phenolphthalein Indicator solution (dropper bottles)

Methyl Red Indicator solution (dropper bottles)

Bromthymol Blue Indicator solution (dropper bottles)

One 50 mL buret

One buret stand with clamp

One Erlenmeyer flask, 125 mL size

One 10 mL pipet and pipetter

One narrow stem funnel

Two small beakers, 100 mL

Recommended YouTube Titration Video

<https://www.youtube.com/watch?v=9DkB82xLvNE>

Part 1 Procedure:

Do one trial at a time, from start to finish. After the trial is complete, dispose of the titration solution in the appropriate waste container. Fill out Table 1 as you do each trial of the experiment.

1. Obtain the buret stand, buret clamp, and buret. Assemble as shown by the instructor.

2. Turn the stopcock to the open position, and rinse the buret with approximately 10 ml of DI water. Let the rinse water drain into a large waste beaker. Repeat this rinsing step two more times.

3. Rinse the buret with approximately 5 mL of 0.10 M sodium hydroxide solution. Let the rinse drain into the waste beaker. Repeat this rinse step two more times.

4. Fill the buret with the 0.10 M sodium hydroxide solution; open the stopcock to drain out some of the sodium hydroxide solution so the top of the solution is within the calibration marks and the air bubble in the buret tip is removed. Have the waste beaker under the buret tip while this is done.

5. Record the volume of the sodium hydroxide solution in the buret; this is the initial volume of sodium hydroxide solution. Remember to use two digits after the decimal point when you record a buret volume.

6. Pipet 10.0 mL of the hydrochloric acid solution into the Erlenmeyer flask.

7. Add three drops of phenolphthalein solution and 10 mL of deionized water to the hydrochloric acid solution in the Erlenmeyer flask. Swirl to mix well. The acidic solution should be colorless.

8. Place the Erlenmeyer flask under the tip of the buret, as shown in the titration video.

9. Perform the titration by opening the stopcock to allow the sodium hydroxide solution to go into the Erlenmeyer flask and react with the hydrochloric acid solution; swirl the flask while this is being done. There should be some pink color at the point where the sodium hydroxide enters the acid solution. When this pink color starts to be present for a longer period of time, slow down the rate at which the sodium hydroxide is added. Remember to swirl. When the pink color lingers for a longer period of time, add the sodium hydroxide dropwise; first fast drops and then slow drops. When the very faint pink color does not disappear, stop the titration. The color should exist in the solution for at least one minute; do not titrate during this minute.

10. Record the final volume of sodium hydroxide in the buret. Use two digits after the decimal point for the volume.

11. This first titration was the practice trial. Repeat the experiment three more times to obtain data for trials one, two, and three. The buret does not need to be rinsed in between trials. Add more sodium hydroxide solution to the buret when there is not enough solution in the buret for the next trial. Always make sure there is enough solution in the buret before you start a trial.

Molarity of the NaOH solution: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Volume of HCl solution pipeted into flask for each trial: \_\_\_\_\_\_\_\_\_\_\_\_

**Table 1 Titration Data for All Trials Part 1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Practice Trial | Trial 1 | Trial 2 | Trial 3 |
| Final NaOH volume reading |  |  |  |  |
| Initial NaOH volume reading |  |  |  |  |
| Volume of NaOH used |  |  |  |  |

\*\*Do not use the practice trial data for calculations.

**Table 2 Titration Calculations Part 1**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Trial 1 | Trial 2 | Trial 3 |
| Moles of NaOH used |  |  |  |
| Moles of HCl in the Erlenmeyer flask |  |  |  |
| Molarity of the original HCl solution |  |  |  |

Average Molarity of HCl : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Write the acid base neutralization reaction below:

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Show calculations for each trial below:

**Trial 1:**

moles NaOH used:

moles of HCl in flask:

Molarity of HCl:

**Trial 2:**

moles NaOH used:

moles of HCl in flask:

Molarity of HCl:

**Trial 3:**

moles NaOH used:

moles of HCl in flask:

Molarity of HCl:

**Average Molarity of HCl:**

(Show the calculation.)

Part 2 Procedure:

1. Perform an additional titration as in Part 1, except use 3 drops of methyl red indicator instead of the phenolphthalein indicator. Record your data in Table 3.

2. Perform an additional titration as in Part 1, except use 3 drops of bromthymol blue indicator instead of the phenolphthalein indicator. Record your data in Table 3.

**Table 3 Titration Data for Different Indicators, Part 2**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Phenolphthalein indicator (already done; use trial 3 from Table 1) | Methyl Red indicator | Bromthymol Blue indicator |
| Final NaOH volume reading |  |  |  |
| Initial NaOH volume reading |  |  |  |
| Volume of NaOH used |  |  |  |

**Table 4 Titration Calculations for Different Indicators, Part 2**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Phenolphthalein(trial 3 in Table 1) | Methyl Red | Bromthymol Blue |
| Moles of NaOH used |  |  |  |
| Moles of HCl in the Erlenmeyer flask |  |  |  |
| Molarity of the original HCl solution |  |  |  |

Show calculations for the methyl red indicator and bromthymol blue indicator trials on the following page.

**Methyl Red Indicator:**

moles NaOH used:

moles of HCl in flask:

Molarity of HCl:

**Bromthymol Blue Indicator:**

moles NaOH used:

moles of HCl in flask:

Molarity of HCl:

**Do the three indicators give the same experimental result? \_\_\_\_\_\_\_\_\_\_\_\_\_**

**Did the methyl red indicator change color too soon or too late? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Did the bromthymol blue indicator change color too soon or too late? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Questions**

1. Write the definitions for the end point and the equivalence point for a titration.

End point:

Equivalence point:

Use the following description to answer questions 2 – 4; **show all calculations:**

A titration is done using 1.0 M NaOH in the buret and 15.0 mL of 1.4 M HCl in the Erlenmeyer flask.

2. How many moles of HCl are in the flask before the titration is started?

3. How many moles of HCl are left in the flask after a total of 4.0 mL of the 1.0 M NaOH solution were added to the flask?

4. How many moles of HCl are left in the flask after a total of 12.0 mL of the 1.0 M NaOH solution were added to the flask?

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**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab Partners: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CHE118 Rowan College at Burlington County**

**Week 9 Experiment 24 (first part) pH Range of Solutions**

Observe the three vials of each of the three different solutions already prepared. Note the type of indicator used in each vial. Use the color of each solution and Figure 24.1 in your lab manual to determine the pH range in each vial. Use the three vials to determine the narrowest pH range possible for each solution. Explain your results in the space beneath the table.

Table 1: Observations

|  |  |  |  |
| --- | --- | --- | --- |
| **Vial (indicator and color)** | **Solution 1** | **Solution 2** | **Solution 3** |
| Vial A indicator used |  |  |  |
| Vial A color |  |  |  |
| pH range in vial A |  |  |  |
| Vial B indicator used |  |  |  |
| Vial B color |  |  |  |
| pH range in vial B |  |  |  |
| Vial C indicator used |  |  |  |
| Vial C color |  |  |  |
| pH range in vial C |  |  |  |

Table 2: Final Results

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Solution 1** | **Solution 2** | **Solution 3** |
| **pH Range** |  |  |  |

**Explain your results here:**

Solution 1:

Solution 2:

Solution 3:

**(Equation problems are on the next page.)**

Complete the following hydrolysis equations and write the Ka or Kb expression for each.

(There are no numerical calculations for this part.)

CH3COOH(aq) + H2O(l) \_\_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_\_

Ka =

HF(aq) + H2O(l) \_\_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_\_

Ka =

NH3(aq) + H2O(l) \_\_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_\_

Kb =

F1-(aq) + H2O(l) \_\_\_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_\_\_\_

Kb =

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CHE118 Rowan College at Burlington County**

**Week 9 Assignment: Rewriting a page in a scientific notebook**

Below is someone’s poorly written entry in a scientific notebook. Please rewrite the information on a sheet of paper, to simulate a correctly written page in a scientific notebook. The general rules for writing in a scientific notebook should be followed, and the data and calculations organized well enough for a reader to follow what was done.

Please refer to experiment 1, part E, in the lab manual (page 10 and page 14). The student’s notebook entry was done when the student was performing this experiment. Refer to this experiment when you write the notebook entry the correct way. Please follow these guidelines when writing your scientific notebook page:

1. Explain what is going on with the experiment (write a purpose statement in your notebook entry).

2. List the chemical(s), glassware, and lab equipment used for part E of experiment 1.

3. Organize and rewrite the data, make table(s) for the data (see page 14).

4. Finish the calculations, include units, and use correct significant figures.

**General Rules for Using a Scientific Notebook:**

1. Use a pen for all entries (no pencil); erasing is not permitted.
2. Use correct units and significant figures. Show all calculations.
3. White-out, scribbles, and ink blotches to cover mistakes are not allowed.
4. Doodling is not allowed, but diagrams are good.
5. Errors are crossed-out with a single line through them, the correct entry is written near the cross-out, initial the change.
6. Pages cannot be removed from the notebook (the notebook should be bound, not spiral)
7. Pages should be numbered, consecutively, in the upper right corner. Do not tear pages out. Do not leave blank pages.
8. Sign and date the bottom of each page.



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**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab Partners: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CHE118 Rowan College at Burlington County**

**Week 11 Experiment 17, Electrochemical Cells and Thermodynamics**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Shorthand Cell designation** | **Tempertature (°C)** | **Ecell (measured)****(use voltmeter)** | **ΔG (calculated)** | **Keq (calculated)** |
|  |  |  |  |  |

**Show calculations for ΔG and Keq :**

Based on your numerical value for Ecell (measured), is the reaction spontaneous or nonspontaneous? (explain your answer) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Based on your numerical value for ΔG (calculated), is the reaction spontaneous or nonspontaneous? (explain your answer) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Based on your numerical value for Keq (calculated), are the reactants or products favored? (explain your answer) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Based on your observation in lab (no numbers), is the reaction spontaneous or nonspontaneous? (explain your answer) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Half-Cell equations:**

Oxidation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Standard reduction potential at 25°C (appendix H): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reduction: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Standard reduction potential at 25°C (appendix H): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Overall Redox reaction: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Calculated E°cell using standard reduction potentials (show calculation): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Effect of Temperature on Cell Potential**

|  |  |  |  |
| --- | --- | --- | --- |
| **Ecell (measured)** | **Temperature (°C)** | **Temperature (K)** | **ΔG (calculated)** |
|  |  |  |  |
|  |  |  |  |

**ΔS determined from slope of ΔG vs. Temp (Kelvin) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

(show slope calculations)

**ΔH (calculated) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

(show calculations)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab Partners: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CHE118 Rowan College at Burlington County**

**Week 12 Voltaic Cell Project Prelab Assignment (Database Search)**

YouTube video (Voltaic Cell): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Please indicate in Table 1 what will be used for each component of the voltaic cell that will be built in lab.

**Apparatus available:**

Voltmeter, alligator clips, wires

Beakers, graduated cylinders

Porous cup

Electrodes (Al, Cu, Fe, Ni, Pb, Zn and graphite)

Aluminum foil

Thermometer

Hotplate

**Chemicals available:**

Sodium chloride, saturated solution

1 M Acetic Acid solution, (CH3COOH)

1 M Phosphoric Acid solution

1 M Citric Acid solution

Table 1: Voltaic Cell Components

|  |  |  |
| --- | --- | --- |
| **Voltaic Cell Components** | **Component items in YouTube video** | **Component items in lab class** |
| cathode |  |  |
| anode |  |  |
| salt bridge/porous barrier |  |  |
| electrolyte solution in cathode compartment |  |  |
| electrolyte solution in anode compartment |  |  |

**Continued on next page.**

Oxidation Reduction Reaction (indicate (s), (l), (g), or (aq)):

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Element oxidized: \_\_\_\_\_\_\_\_\_\_\_\_\_\_, Element reduced: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Calculated E°cell: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Show calculation for E°cell

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab Partners: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CHE118 Rowan College at Burlington County**

**Week 12 Voltaic Cell / Scientific Method Assignment 1**

The steps to the Scientific Method are listed below. Describe the parts of your laboratory adaptation of the YouTube video battery that corresponds to each step of the Scientific Method.

Question asked:

Background work

(YouTube video assigned)

Hypothesis (rewrite the ‘question asked’ as a statement):

Test hypothesis with experiment (briefly describe your lab work):

Analyze results (organize and write results):

Conclusion (was the hypothesis achieved, did it work or not?):

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**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab Partners: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CHE118 Rowan College at Burlington County**

**Week 12 Voltaic Cell / Scientific Method Assignment 2**

The steps to the Scientific Method are listed below. For one of your voltaic cell variations, describe the parts of your voltaic cell that correspond to each step of the Scientific Method.

Variation from original cell:

Question asked:

Background work

(YouTube video assigned)

Hypothesis (rewrite the ‘question asked’ as a statement):

Test hypothesis with experiment (briefly describe your lab work):

Analyze results (organize and write results):

Conclusion (was the hypothesis achieved, did it work or not?):

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**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab Partners: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CHE118 Rowan College at Burlington County**

**Week 12 Voltaic Cell / Scientific Method Assignment 3**

The steps to the Scientific Method are listed below. For one of your voltaic cell variations, describe the parts of your voltaic cell that correspond to each step of the Scientific Method.

Variation from original cell:

Question asked:

Background work

(YouTube video assigned)

Hypothesis (rewrite the ‘question asked’ as a statement):

Test hypothesis with experiment (briefly describe your lab work):

Analyze results (organize and write results):

Conclusion (was the hypothesis achieved, did it work or not?):

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**CHE118 Rowan College at Burlington County**

**Week 12 Voltaic Cell Project Guidelines**

1) Build the voltaic cell that is shown in your YouTube video. Do not use any produce, pennies, quarters, or burned pencils. Use the electrodes, equipment, and solutions supplied in lab.

2) Try different physical or chemical parameters for your voltaic cell, using only the material supplied in lab. Make two variations; temperature changes do not count as a variation. (Do not put more than two voltaic cells together in series; do not put any voltaic cells together in parallel.)

**Suggestions for variations:**

1) Try changing one of the electrodes in the cell, compared to what was used previously.

2) Try changing the concentrations of one of the electrolyte solutions used previously.

3) Try changing the type(s) of electrolyte solution(s), compared to what was used previously.

4) Try letting the voltaic cell run for 10 to 15 minutes; measure the mass of the cathode or anode before and after the run period to determine if the mass of reduced material or oxidized material can be determined. Calculate the number of moles of substance reduced or moles of substance oxidized. *(Ask your lab instructor to turn on the drying oven.)*

Record all of your work, in detail, in your scientific notebook. The original voltaic cell, and each of the two variations, should be described (identify components, write redox equations for each cell, calculate the expected voltages). Follow the guidelines for writing a scientific notebook that were included in the scientific notebook rewriting assignment (page 27 of this packet). DO NOT recopy your scientific notebook; only original work should be in the notebook, as if it was a first draft.

**The URLs for the three YouTube videos are:**

Lemon Battery: <http://www.youtube.com/watch?v=ecYc85Qz710>

Coin Battery: <http://www.youtube.com/watch?v=a4n1HIsfjZM>

Al Air Battery: <http://www.youtube.com/watch?v=ITzAZFYFo_0>

**Report for Voltaic Cell Project\*\***

Prepare a typed report for the work done during the Voltaic Cell project. The report should consist of:

1. **Your name and the course** (CHE118)
2. **Name of your partner**
3. **Purpose** of the experiment for the original voltaic cell and each variation (mention which YouTube video you worked with)
4. **Experimental procedure**; details of work done, materials used (chemicals with molarities, volumes, glassware, setup) Pictures of the setup are nice, but not required
5. **Data tables**; organize data obtained from the experiment
6. **Oxidation reduction equation**; for the original redox cell and the two variations
7. **Calculate expected voltages**; for the original redox cell and the two variations (show calculations)
8. **Conclusions**, report final results and explain what the data/results mean

**\*\*Identical lab reports and/or scientific notebooks (wording, layout, and mistakes) among lab students will be given a grade of zero.**

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab Partners: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**CHE118 Rowan College at Burlington County**

**Week 13 Experiment 40, Molecular Geometry: Experience with Models**

**Please build a model (instructor’s initials needed) and write the condensed and expanded structural formulas for the molecules in questions 1 – 5:**

**1. Methane, CH4**

Model built, instructor’s initials: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Condensed structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Expanded structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

H-C-H bond angle: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2. Ethyne, C2H2**

Model built, instructor’s initials: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Condensed structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Expanded structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

H-C-C bond angle: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. Propene, C3H6**

Model built, instructor’s initials: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Condensed structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Expanded structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Is there rotation around the double bond?\_\_\_\_\_\_\_\_\_\_\_

**4. Cyclobutane, C4H8**

Model built, instructor’s initials: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Condensed structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Expanded structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Is this molecule planar (flat)? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**5. 2-pentene, C5H10**

Model built, instructor’s initials: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Condensed structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Expanded structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Is this molecule planar (flat)? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**6. Write the structural formulas and IUPAC name for each of the isomers of C4H8 . Expanded or condensed structural formulas can be used.**

**(Hint: ?-butene, ?-butene, ?-?thylpropene, cyclo??ane, ??ylcyclo??ane):**

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**7. Write the structural formulas and IUPAC name for three isomers of C7H16 . Condensed or expanded structural formulas can be used.**

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**8. Write the structural formulas (condensed or expanded) for each of the following molecules identified by their IUPAC name:**

IUPAC name: 1,3-diethylcyclohexane

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: 2-methyl-3-octene

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: 3-ethyl-5-methylheptane

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: 1-ethyl-3-propylcyclopentane

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IUPAC name: 1,2-dipropylcyclopropane

Structural formula: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_