LAB-Honors [30 pts]
Titration of Vinegar & Acid Rain

Name _____
Lab Partner(s) _____
Period _____ ***Date*** _____

Overview:

Part A: You will make 100 mL of an NaOH solution by dissolving some NaOH pellets into water.

Part B: You will standardize the NaOH solution by titrating it with a solid acid, potassium hydrogen phthalate. Thus, you will now be able to determine the molarity of the NaOH solution.

Part C: You will use the standardized NaOH solution to titrate 10.0 mL of household vinegar. Thus, you will be able to determine the molarity of household vinegar.

Procedure Part A: **Making NaOH solution**

1) Mass out 3.0 g -3.5 g of NaOH solid. Mass of NaOH (s) = _____
2) Put the NaOH pellets into a 100 mL volumetric flask. Fill the flask ~½ - ¾ full with distilled water. Stopper and shake until all has dissolved. Then, add water to the 100 mL mark.
3) **[1 pt]** Make a quick calculation to determine the approximate molarity of your NaOH solution. Show calculation here. *(This calculation is not very exact because NaOH pellets soak up water easily.)* **** This calc will only give an approximate NaOH molarity value. You will do the titration to get a precise value.*

Procedure Part B: Standardizing the NaOH solution (Determining the exact molarity of the NaOH)

K H-phthalate (s) + **NaOH (aq)** ⟶ **K H phthalate (aq)** + **H_2O (l)** (1:1 mole ratio)
potassium hydrogen phthalate *Molarity??*

1) Mass out approximately 0.45 g (record exact mass to 0.001 g) of potassium hydrogen phthalate (KHP), a solid acid. Put the KHP solid into clean 125 mL Erlenmeyer flask. A**dd 3 drops of phenolphthalein indicator.** Add some distilled water --just enough to cover solid. (Solution should be clear.)
2) Pour **some your NaOH** solution into a clean 100 ml beaker.
3) Fill the buret all the way up *(actually a little above the 0.0 mL mark)*. Then carefully drain a little NaOH until you get it set at exactly the 0.0 mL mark. *(This gets the air bubbles out of the **tip of the buret**.)*
4) Record the initial volume reading of the NaOH in the buret. *(It should be at 0.0 mL for the first trial.)*
5) Start adding NaOH into the flask containing the KHP solid. *(You should see a flash of pink --if not-- add INDICATOR!!)* You can add about 1 mL at a time at the start. Swirl the flask after every addition until the pink color disappears. Use shorter length squirts when the pink color persists longer. Try to get it so that one quick squirt suddenly causes the color to PERMANENTLY (at least 30 sec) stay pink. *At first the solid may not be dissolved-- don't worry-- it should all dissolve after adding some base.*
6) Note final volume reading of NaOH in buret when the solution in the flask has a permanent pink color.
7) Do **one** more trial, starting with a fresh sample of the potassium hydrogen phthalate in your rinsed out flask. Add new indicator too. HOWEVER, you do not need to refill buret with more NaOH.
8) You MUST do a third trial if your values for the volume of NaOH are not within 0.4 mL of each other.

	Mass of K H-phthalate (g)	Initial Vol reading in buret (mL)	Final Volume reading in buret (mL)	Volume of NaOH added (mL)
Trial #1		**0.0 mL**		
Trial #2				
Trial #3 (if needed)				

Closest two trials:

Trial # : **[2 pts] Watch sig figs.**

a) moles of KHP (MM = 204.23 g/mole)

b) moles of NaOH reacted =

c) Molarity of NaOH (aq)

Trial # :

a) moles of KHP

b) moles of NaOH reacted =

c) Molarity of NaOH (aq)

Procedure Part C: **Titration of Vinegar** $CH_3COOH\ (aq) + NaOH\ (aq) \longrightarrow NaCH_3COO\ (aq) + H_2O$
acetic acid

1) Get about 30 mL of vinegar and put it into a 50 mL Erlenmeyer flask *(so you can distinguish it from the NaOH)*
2) Obtain a 10-mL volumetric pipet and a pump. Use the pipet and pump to put exactly 10.0 mL of vinegar into a clean 125 ml flask. **Add 2-3 drops of phenolphthalein** indicator to the flask. (Should be clear)
3) Fill your buret back up to the top with more NaOH. Get air bubbles out of the tip. Set to 0.0 mL
4) Record the initial volume reading of the NaOH in the buret. (Read/record to 0.1 mL.)
5) Start adding NaOH to the flask. Again, you may begin by adding about 1 mL at a time. Swirl the flask after every squirt until the pink color disappears. Use shorter length squirts when the pink color persists longer.
6) Note final volume reading of NaOH in buret when the solution in the flask has a permanent pink color.
7) Rinse out your flask and do at least one more trial, starting with a fresh sample of vinegar. Add new indicator too. HOWEVER, you do not need to refill buret with more NaOH *(only refill a little, if you know you will need more than what is already in the buret.)* Final NaOH volume from trial 1 will be initial volume for trial 2.
8) You MUST do a third trial if your values for the volume of NaOH are not within 0.4 mL of each other.
9) If your values look good, call me over to check. Once okayed, drain any leftover NaOH solution into a beaker and pour it into a large bottle labeled **"? M NaOH**". Return any unused vinegar. Rinse out the buret, flasks and beakers with deionized water and put them away. Put the buret back into the box with the valve left open to dry.

Data:

	Initial volume reading of NaOH (mL)	Final Volume reading of NaOH (mL)	Volume of NaOH added (mL
Trial #1	0.0 mL		
Trial #2			
Trial #3 (if necessary)			

Calculations part C: Keep correct sig figs. UNITS!! **Do rest of lab on separate sheet.**

1) **[4 pts**] Follow these steps to find the **molarity of acetic acid** (in the vinegar)
   a) What was the molarity of your NaOH solution? *(Average the two values determined on front page.)*
   b) What was the average volume of NaOH added to the vinegar?*(average the values of the best two trials)*
   c) Calculate the moles of NaOH added to the vinegar *(Remember: You know the Molarity of NaOH)*
   d) How many moles of acetic acid must be in the vinegar? *Briefly explain reasoning or show simple calc.*
   e) Calculate the **molarity** of acetic acid in vinegar. *(HINT: You used a 10.0 mL sample of vinegar)*

2) **[3 pts]** Follow these steps to determine the **percent by mass of acetic acid in vinegar.**
   a) Find **mass of acetic acid** in your vinegar sample. *(moles of acetic acid was calculated above)*
   b) Find the **mass of your total vinegar** sample. *Hint: You used 10.0 mL of vinegar. Since vinegar is mostly water, we can assume that the density of vinegar is very close to that of pure water (1 g/mL)*
   c) Calculate the **percent** by mass of acetic acid in vinegar. (mass of acetic acid/ mass of vinegar) × 100
   d) The % acetic acid reported on vinegar bottle is 5%. Was your value relatively close? Explain.

Post Lab Questions:

3) **[3 pts]** A bottle of H_2SO_4 is found in a lab cabinet, but the bottle is not labeled with any molarity. Thus, you decide to do a titration with a standardized solution of NaOH. It is found that it takes 45.8 mL of the 2.65 M NaOH solution to titrate 30.0 mL of the H_2SO_4 solution to its equivalence point.

$$\underset{\textbf{30.0 mL of ?? M}}{\mathbf{H_2SO_4\ (aq)}} + \underset{\textbf{\textit{45.8 mL of 2.65 M}}}{\mathbf{2\ NaOH\ (aq)}} \longrightarrow \mathbf{Na_2SO_4\ (aq)} + \mathbf{2\ HOH\ (l)}$$

   a) How many moles of NaOH were added to neutralize the H_2SO_4?
   b) How many moles of H_2SO_4 must have been in the sample? (Be careful — it's not a 1:1 mole ratio.)
   c) What is the molarity of the H_2SO_4 solution?

4) **[2 pts]** In each titration, you kept adding NaOH to your acid until the phenolphthalein turned from colorless to pink with the addition of one drop of NaOH. Why was this the correct time to stop the titration? *(You must include and define the term **equivalence point** in your answer.)*

Read the attached article on Acid Rain

I. Air pollutants which cause acid rain:

1) [1 pt] What gas in the air makes rain **naturally** slightly acidic? _____ Write the equation below:

2) [3 pts] What three gases released into the air cause "acid rain?" _____ Write the 3 equations:

II. Harmful effects of Acid Rain

3) [1 pt] Why does acid rain disintegrate buildings and statues made of limestone, marble and concrete? Write equation and explain.

4) [1 pt] Why is it harmful when acid rain falls on lakes?

5) [1 pt] What can be done to help an overly acidic lake?

III. Why SO_2 (g) and SO_3 (g) are released into the air

6) [2 pts] What is the major cause of SO_2 (g) and SO_3 (g) pollution? _____ Write the chemical equations.

7) [1 pt] What can be done to reduce the amount of SO_2 (g) released into the air?

IV. Why NO_2 (g) is released into the air.

8) [1 pt] What is the major source of NO_2 (g) pollution? _____

9) [2 pt] Write equations that show its formation.

10) [2 pt] What part of your car significantly reduces the amount of NO_2 (g) released into the air? _____ _____ Write equations involved. What catalysts are most commonly used? _____