

Acid - Base Titration Lab (80/1200) Name: _____

Objective: to determine Molarity of a $\text{NaOH}_{(\text{AQ})}$ by titrating with $\text{HCl}_{(\text{AQ})}$ of known Molarity

We will be working with 2 burets, which are glass tubes with valves at the bottom and mL markings to measure. **The acid always goes on the LEFT SIDE**, the base always goes on the RIGHT. We NEVER vary this.

We will use an indicator called phenolphthalein (say: FEEN-O-THAY-LEEN). The burets are difficult to read, you may want a clean piece of white paper to hold up behind the burets. Each team will titrate 4 times. Each person will do it twice while the other does the data collection. Then all math work is to be done alone. This isn't easy to do, although it looks easy. The math is easy. READ the whole procedure before you proceed with any activity.

PROCEDURE: The LEFT buret has the acid, which is _____ M HCl. Carefully drain out 1-2 mL to see how the valve works. Make it come out drop by drop SLOWLY. Make sure that there are no bubbles in the buret.

The RIGHT buret contains NaOH of unknown concentration. Drain about 1 mL of this solution as well. Record the initial (start) readings of both of the burets into the data table. Place a clean beaker under the acid buret as shown by the teacher. One partner is ready to begin the first titration while the other carries out the data collection job.

Put about 5.0 mL of acid into the flask. Go slowly. If you go over be sure to keep track of the EXACT amount to the 10th place in mL. Next, add 3 drops of the indicator phenolphthalein into the acid (not down the side, directly into the acid). Add about 20 mL deionized water. Swirl without spilling a drop.

Place beaker over a sheet of white paper under the right buret. NO SPLASHING OF BASE!!!. The buret must empty directly into the acid not down the side of the beaker. Add NaOH drop by drop with a constant swirling. Continue until a pink color remains.

*** If you over titrate (the pink color gets too deep in shade) you will have to go backwards by adding in some more acid. You will have to add this extra acid volume into your acid volume to do the titration math.

RECORD DATA on the next page. When you are done with each titration you may discard all solutions down the sink with plenty of water. Rinse well, no soap. Rinse beaker with deionized water. Tap water has a pH here of about 6.0
You will repeat this procedure 3 more times.

For each trial, use ABOUT 5.0 mL acid, but do not use the same acid volume twice.

DO NOT REFILL the burets during lab.

trial	initial reading ACID mL	final reading ACID mL	mL ACID USED	initial reading BASE mL	final reading BASE mL	mL BASE USED
Trial 1						
Trial 2						
Trial 3						
Trial 4						

1. Write the **BALANCED** chemical equation, with phases, for the reaction that you just did four times in a row.

2. What special type of reaction is this? _____

3. What are the OTHER 5 kinds of reactions that you already knew:

4. What is the Titration Formula you will use in questions 5, 6, 7 & 8? _____
SHOW ALL WORK ON ONE SHEET OF LOOSE LEAF PAPER...

5. Calculate the Molarity of the base in trial 1? _____

6. Calculate the Molarity of the base in trial 2? _____

7. Calculate the Molarity of the base in trial 3? _____

8. Calculate the Molarity of the base in trial 4? _____

9. What is the AVERAGE Molarity of the base in all four trials? _____

~~~~ The actual Molarity of the NaOH is: \_\_\_\_\_ (get from teacher)

10. My % Error for Molarity was: \_\_\_\_\_ (compare average to actual)

11. A truck carrying 22,500 L of 6.83 M HCl which is used as a masonry and brick cleaner crashed and dumped its contents in your town. As the fire chief you are called to deal with this disaster. How many moles of HCl will you have to neutralize?
12. If you have unlimited  $\text{KOH}_{(\text{AQ})}$  as a neutralizing agent that is 4.00 M, how much will you need to completely neutralize this acid spill?
14. Write a balanced chemical reaction with phases for this problem.
15. It's a bad week for the fire department in your town and you get a call at 3:30 am just two days later! A trucker with not enough sleep decided to nap on Route 17 West while driving his rig filled with  $2.51 \times 10^3$  L of 5.50 M  $\text{Ca}(\text{OH})_{2(\text{AQ})}$ . It's hanging and looks like it will spill over at any moment. After a quick thought that this truck should have crashed into the first one, you get up and call your fire department together. How much of your 2.95 M HCl neutralizing agent do you tell the team to bring to the scene of the accident to completely neutralize this base? This is a special case of a single acid ion combining to a double base ion. ASK HOW TO ADJUST this math before you calculate incorrectly.
16. Write a balanced chemical reaction with phases for this problem.

### A Special Note

Many of you might realize that phenolphthalein is an acid base indicator that changes from colorless to pink at a pH of 8.2 (not really very neutral at all!). You might even wonder about this.

We are using very small volumes of acid and base. A single drop of the base into the acid is ENOUGH to change the pH from acidic to alkaline (vocabulary).

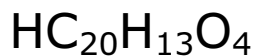
The difference between neutral and pH of 8.2 is very small, so small as to be almost immeasurable in this lab because of the small volumes we are using, and since the pH of the acid and base is relatively high since both dissociate so well.

We can use this indicator even though when we see the pink color, we have actually overshoot the neutral by a little bit.

Furthermore, although the acid base strengths are made as accurately as I can make them, they are NOT perfect. There are many potential errors here, but this is high school chem lab, not a heart medicine making company. We'll be good people no matter what.

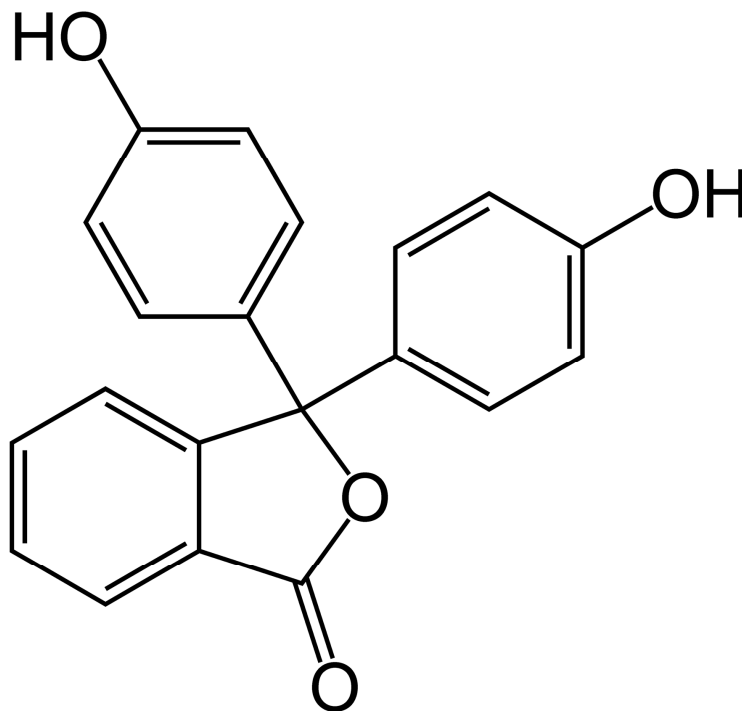
Phenolphthalein  
Is an organic molecule.

This diagram shows the  
chemical formula,



The diagram shows the molecule  
in a structural way.

During organic chemistry, starting  
in a few days, you'll learn most of  
the diagramming at right, and not  
be afraid of it at all. Really, the  
symbols are easy, the chem can  
be pretty dense, but everyone of  
you will be able to look at any  
diagram like this one and  
"understand" what all those lines  
mean, as well as the letters, and  
the "not letters".



Stay with me!

Phenolphthalein is a polar molecule, it dissolves into water. It is also a weak acid, meaning that some of the molecules will dissociate into  $\text{H}^{+1}$  and  $\text{C}_{20}\text{H}_{13}\text{O}_4^{-1}$  anions. Since the molecule is clear in color while the anion is pink, the acids and bases we add will shift the dynamic equilibrium of the indicator, making it change colors!

| This lab report | requires                                                                                                                                                                                                                                                                                                                                                                                | points      |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Page 1          | cover page with formal Title, a fun title and/or drawing (optional)<br>PLUS a 1 sentence introduction                                                                                                                                                                                                                                                                                   | 1 + 1 = 2   |
| Page 2          | Data table                                                                                                                                                                                                                                                                                                                                                                              | 4           |
| Page 3          | questions 1 through 16                                                                                                                                                                                                                                                                                                                                                                  | 1 each = 15 |
| Page 4          | Conclusion: include Arrhenius acid + base theory, acid base neutralization reactions, how $\text{NH}_3$ can be a base (the alternate theory), how acid base indicators work (by LeChatelier's Principle), and how to manage with acids and bases with different numbers of ions in the titration math problems (use sulfuric acid combining to aluminum hydroxide base in your example) | 4           |
| due by: _____   |                                                                                                                                                                                                                                                                                                                                                                                         | 25          |