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Acid/Base Titration of an Eggshell

Introduction:

During the 1960's and 1970's the United States used a pesticide called DDT extensively. Unfortunately, the run-off from this pesticide entered our waterways and eventually into many of our wild birdlife. DDT affected the population by weakening the eggshells which would break before hatching. An example of this devastation was the American Bald Eagle whose population was as low as 400 mating pairs in the lower 48 states.

The pesticide has been banned in the United States and the Bald Eagle is no longer on the endangered species list. One method of monitoring the strength of the egg is by determining the percentage calcium carbonate in the eggshell. This can be accomplished through an acid/base titration method.

Materials:

1 150 mL beaker labeled **[EXCESS NaOH]**
1 150 mL beaker labeled **[DEIONIZED WATER]**
1 250 mL beaker labeled **[Titration #1]**
1 250 mL beaker labeled **[Titration #2]**
1 25 mL graduated cylinder labeled **[0.1 M HCl]**
1 buret
1 funnel
1 buret clamp
1 ring stand
1 plastic pipet labeled **[NaOH]**
1 plastic pipet labeled **[HCl]**
1 bottle 0.1 M HCl
1 bottle unknown molarity NaOH
Analytical balance

Procedure:
Titration #1-Determining the Molarity of the NaOH

1) Clean and label a 150 mL beaker (**EXCESS NaOH**). This beaker will be used when filling your buret and removing air bubbles.

2) Set up a buret using a clamp and ring stand as modeled by your teacher. Put a funnel in the top of the buret. Fill the buret with NaOH. Run out enough NaOH from the bottom of the buret to remove any air bubbles from the tip of the buret. Refill the buret with NaOH to the 0.00 mL mark and record this amount on your data table.
3) Using the graduated cylinder and the plastic pipet, measure exactly 25.0 mL HCl and pour it into a 250 mL beaker labeled **Titration #1**. Add approximately 50 mL deionized water and 2-3 drops of phenolthalein. Swirl to mix well.

4) Slowly add the NaOH into the beaker until a slight pink color remains throughout the beaker. Use the white paper under the beaker to accurately see the color. Do not add too much base! As you get closer to the endpoint (the color will take longer to disappear), you should be adding drop by drop. Record the amount of NaOH added. Determine the molarity of the NaOH using the equation below: and the date table:

$$M_1V_1 = M_2V_2$$

Reaction Equation : $HCl + NaOH \rightarrow H_2O + NaCl$

Titration #2-Determining the amount of Calcium Carbonate in the eggshell

5) Obtain an eggshell from your teacher. Grind it with the mortar and pestle into a very fine powder. Weight out 0.2 grams into a clean dry 250 mL beaker [Titration #2].

6) Add 50 mL of HCl and 2-3 drops phenolphthalein to the beaker. Stir this beaker for 5 minutes, taking turns within your group.

7) Refill the buret with NaOH. Record the initial volume in your data table. Titrate your eggshell mixture with the NaOH, following the procedure outlined in Step #4. Record your final volume and volume used in your data table.

8) Calculate the number of moles of HCl left in solution based on how many moles reacted with the NaOH in titration #2. Remember, the unknown in the equation this time is the volume of your HCl. Even though you started with 50 mL, some of it reacted with the $CaCO_3$ according to the equation below:

Reaction Equation : $2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$

For every two moles of HCl consumed in the reaction, you have one mole of $CaCO_3$ in the eggshell.

9) Determine the number of moles of Calcium Carbonate in the mixture. Convert that to grams using the molar mass of Calcium Carbonate. Determine the percentage of calcium carbonate in the eggshell. Show all work.

Titration #1

Molarity of HCl	.1
Volume of HCl	25mL
Initial volume of NaOH	0
Final volume of NaOH	9
Total volume of NaOH (final – initial)	9

Titration #2

Molarity of NaOH	0.28
Initial volume of NaOH	9
Final volume of NaOH	19
Total volume of NaOH (final – initial)	10
Volume of reacted HCl	
Moles of reacted HCl	0.0022
Moles of calcium carbonate	0.0011m
Grams of calcium carbonate	0.110099g
% calcium carbonate (grams $CaCO_3$/grams eggshell) x100	55.05

Conclusion:

1) What was the percentage of Calcium carbonate in the eggshell? Is this a safe amount? How could scientists use this method to test the eggshells of birds they think were exposed to DDT?
2) Describe any possible sources of error.
3) If you had time to do this experiment again, what would you do differently? How might your changes improve the goals of the experiment?

Conclusion:

1. 70% This is not a safe amount. They can use this method to see wether or not it was exposed.

2. · too much NaOH
   · not gotten all the membrane off the shell

3. measure more accurately. You would get a more accurate % of calcium carbonate