**Is Household Vinegar Really 5%?**

The quantity of acid in a sample of vinegar may be found by titrating the sample against a standard basic solution. Titration is the process of finding the exact volume of a solution that reacts according to a balanced chemical equation with a given volume of known concentration of a second solution. The endpoint occurs when stoichiometric quantities of the reagents have been mixed. The endpoint of a titration for reactions of acids and bases is usually indicated by a third reagent, the indicator, which has an abrupt and distinctive colour change at the hydrogen ion concentration which is present after neutralization has occurred.

A good indicator of choice is phenolphthalein. Phenolphthalein is colourless in acidic solutions and pink in basic solutions. Since it is much easier and distinctive to see a colour change from colourless to pink rather than from pink to colourless, the sodium hydroxide will be added to household vinegar which already contains the phenolphthalein. Most commercial preparations of vinegar have a mass percentage of between 4.0% and 5.5% acetic acid. By determining the volume of sodium hydroxide solution of known concentration necessary to neutralize a measured volume of vinegar, the concentration of the vinegar can then be calculated.

**Caution: Sodium Hydroxide is caustic and corrosive. Avoid contact and immediately rinse all spills with copious amounts of water.**

**Materials:**

-distilled water -polyethylene stir stick

-5 mL vinegar -5 ml 1.0M NaOH

-1% phenolphthalein indicator -24-well plate

-1mL microtip pipets (2) -electronic balance

**Procedure:**

1. Put goggles on now.
2. Label one pipet “NaOH” and fill. Label another pipet “vinegar” and fill.
3. Find the initial mass of each pipet (and its solution) and record.
4. Add 25 drops of vinegar to a well in your 24-well plate. Make sure all drops fall directly to the bottom of the well. Add 1 drop of phenolphthalein indicator to each well. Place the 24-well plate o white paper.
5. Stir the vinegar and phenolphthalein mixture with the polyethylene stir stick.
6. Add sodium hydroxide solution drop wise. Count the number of drops added until you observe a pink colour that remains for at least 30 seconds (this will make subsequent trials faster). Be sure to hold the pipet vertically while adding drops. Back titrate if you overshoot the endpoint.
7. Mass each pipet and solution and record.
8. Refill pipets and repeat until you get three to four consistent trials.
9. Clean all your equipment and wash any leftover acid or base down the sink.

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**Data:** (5 marks)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Trial | 1 | 2 | 3 | 4 |
| Mass NaOH sol’n before (g) |  |  |  |  |
| Mass NaOH sol’n after (g) |  |  |  |  |
| Mass NaOH sol’n used (g) |  |  |  |  |
|  |  |  |  |  |
| Mass vinegar before (g) |  |  |  |  |
| Mass vinegar after (g) |  |  |  |  |
| Mass vinegar used (g) |  |  |  |  |
|  |  |  |  |  |

**Analysis:**

1. Write the neutralization reaction. (1 mark)
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Assume a density of 1.0g/mL for each solution. Find the volume of NaOH solution used in litres.
4. Calculate the moles of NaOH reacted. (1 mark)
5. Calculate the moles of acetic acid it reacts with. (Hint: What is the mole ratio in the equation?)
6. Calculate the concentration of the acetic acid. (1 mark)

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1. Repeat for all trials. Calculate an average concentration of acetic acid. (1 mark)
2. Calculate the % acetic acid by mass. (2 marks)

**Questions:**

1. Is the density of the solutions actually 1.0 g/mL. Explain why (not). How could you measure the density? (2 marks)
2. If the [NaOH] used was actually 0.90 mol/L, would your calculation of [CH3COOH] be
3. Too high?
4. Too low?

Explain. (2 marks)

Score: \_\_\_\_\_\_\_\_/ 15

Hand in pages 2 and 3.