Acid – Base Neutralization Reactions

Why?

What foods leave you with an upset stomach? Many times upset stomachs result from acidic foods. In this activity you will explore what is meant by the terms acidic and basic solutions.

Success Criteria

- Ability to correctly identify solutions as acidic, basic, or neutral.
- Ability to model a neutralization reaction.

Prerequisites:

- Ion concentration
- Acid / Base indicators

Information:

Acid – a compound that yields $H^+_{(aq)}$, hydrogen ions (or hydronium ions, $H_3O^+_{(aq)}$) as positive ions in aqueous solution

Base – a compound that yields $OH^-_{(aq)}$, hydroxide ions as negative ions in aqueous solution

Neutral solution – contains hydrogen (or hydronium) ions and hydroxide ions in equal concentrations.

Spectator ions – present in acidic and basic solutions, but do not participate in the neutralization reaction between the $H^+_{(aq)}$ (hydrogen ions) and $OH^-_{(aq)}$ (hydroxide ions). Spectator ions can be positive or negative, and they are present in quantities needed to produce electrically neutral solutions.

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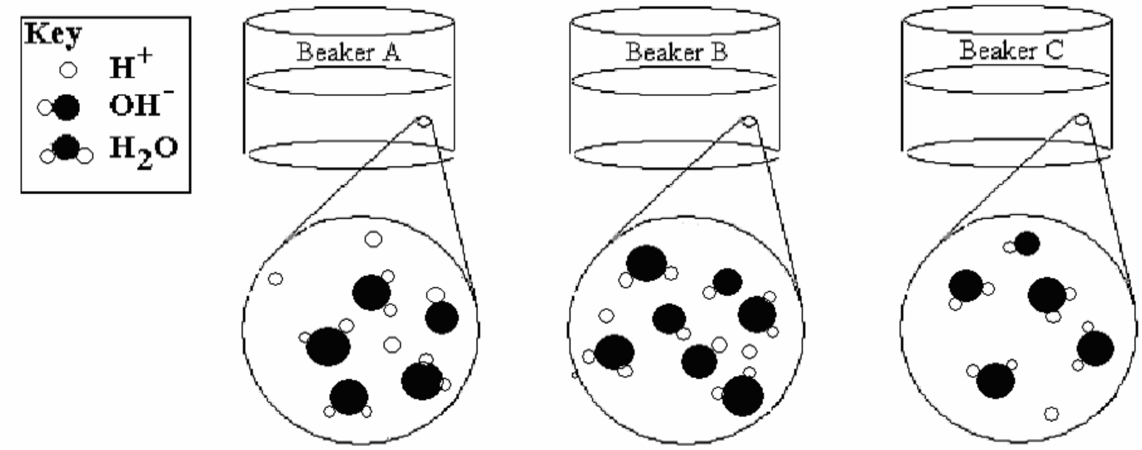
Model:



Enlarged views of three liquid systems

Note: spectator ions are not shown in this model, but they are present in each solution.

Key Questions

1. How does the concentration of H^+ compare to the concentration of OH^- in solution A?

2. How does the concentration of H^+ compare to the concentration of OH^- in solution B?

3. How does the concentration of H^+ compare to the concentration of OH^- in solution C?

4. Identify the acidic solution in the model.

5. Identify the basic solution in the model.

6. Identify the neutral solution in the model.

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Exercises

1. Based upon the information presented in the key of the Model, draw reactants and products that form when an H^+ ion is added to an OH^- ion.

2. What would happen if solution A and solution B were mixed? Explain your answer.

3. Classify the solution that forms in Exercise 2 as acidic, basic, or neutral and justify your classification in terms of the concentration of H^+ ions and OH^- ions.

4. Can a neutral solution contain H^+ and/or OH^- ions? Explain.

Problems

1. How many moles of H^+ ions are present in one liter of 2 M HCl?

2. How many moles of OH^- ions are needed to completely neutralize one liter of 2 M HCl?

3. How many moles of OH^- ions are present in one liter of 0.5 M NaOH?

4. How many moles of H^+ ions are needed to completely neutralize one liter of 0.5 M NaOH?

5. How many moles of OH^- ions are needed to completely neutralize 0.50 liter of 2 M HCl

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Given the following information, solve the practice problems below.

In a neutral solution the Moles of H^+ = Moles of OH^-.
Moles = Molarity x Volume (# Moles = M·V)
In a neutral solution $M_AV_A = M_BV_B$ (where M_A=Molarity of the hydrogen ion, V_A = volume of the acidic solution, M_B = Molarity of the hydroxide ion and V_B = volume of the basic solution).

6. How many mL of 2.0 M NaOH are required to exactly neutralize 100.mL of 3.0 M solution of HBr?

7. How many mL of 2.0 M HBr are needed to exactly neutralize 20.mL of 4.0 M KOH?

8. If 50.0 milliliters of 3.0 M HNO_3 completely neutralized 150.0 milliliters of KOH, what was the molarity of the KOH solution?

Applications

In laboratory situations chemists often need to neutralize acids or bases that do not have one H^+ or one OH^- per molecule. Before applying the equation used in the Problems, remember to adjust the molarity in order to account for the different number of hydrogen or hydroxide ions found in the compounds.

1. How many mL of 2.0 M $Mg(OH)_2$ are required to exactly neutralize 100. mL of 3.0 M solution of HBr?

2. How many mL of 2.0 M HBr are needed to exactly neutralize 30. mL of 4.0 M $Mg(OH)_2$?

3. If 50.0 milliliters of 3.0 M H_3PO_4 completely neutralized 150.0 milliliters of $Mg(OH)_2$, what was the molarity of the $Mg(OH)_2$ solution?

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