Warm-Up | Properties of Acids and Bases

Dissociation, Ionization, and Dissolution

- Dissociation: [Ionic] substance separates into ions.
  - $NaCl(s) \rightarrow$ [Na^+] $(aq) + Cl^-(aq)$
- Ionization: Nonionic substance reacts with [water] to form ions.
  - $NH_3(g) \rightarrow$ [H_2O] $(l) \rightarrow NH_4^+(aq) + OH^-(aq)$
- Dissolution: [Substance] does not form ions.
  - $C_6H_{12}O_6$ [(s)] $\rightarrow C_4H_{12}O_6(aq)$

Lesson Objectives

By the end of this lesson, you should be able to:

- Describe the observable properties of acids.
- Describe the [observable] properties of bases.
- Describe [applications] of acids and bases.

Science Practice: Determine the meaning of the key terms *acid* and *base* as they are used in chemistry.

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Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

base	a compound that ionizes to form hydroxide ions; a chemical substance that decreases H^+ concentration in aqueous solution or that increases OH^- concentration in solution
acid	a compound that ionizes to form hydrogen ions; a chemical substance that increases H^+ concentration in aqueous solution
salt	an ionic compound formed from the reaction of an acid and a base

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Lesson Question

How does the concentration of specific ions affect the properties of a solution?

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Acids

- **Acid:** a substance that increases the concentration of H^+ (H_3O^+) ions in [solution]
  - H^+: hydrogen ion
  - H_3O^+: [hydronium] ion
- Examples include:
  - Hydrochloric acid (HCl)
  - Sulfuric acid [(H_2SO_4)]
  - [Acetic] acid (HCH_3COO)
  - Oxalic acid [(H_2C2O_4)]
  - [Carbonic] acid (H_2CO_3)

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Salts and Neutralization Reactions

A **salt** is an [ionic] compound formed by combining an acid and a base.

When an acid reacts with a base, a salt and [water] are formed.

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Salts and Neutralization Reactions

Examples include:

- Antacids
- Agricultural lime added to acidic soil

The reaction of the soil acid with [lime] is also an example of an acid [carbonate] reaction.

Physical and Chemical Properties of Acids

Acids

- have a [sour] taste.
- turn blue [litmus] paper red.
- turn methyl orange solution [red].
- react with [carbonates] and bicarbonates.
- are [neutralized] by bases.
- react with metals.

Reactions of Acids with Bicarbonate and Carbonate

- Acid reacts with carbonate or bicarbonate compound to form [CO_2], H_2O, and a salt.

Examples include:

- $HCH_3COO + NaHCO_3 \rightarrow NaCH_3COO + H_2O + CO_2$
- [2HCl] $+ CaCO_3 \rightarrow CaCl_2 + CO_2 +$ [H_2O]

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Metal Reactions

- Acid reacts with metal to form a [salt] and hydrogen [gas].

The general formula is a metal is added to an acid to form a metal [oxide] and [H_2], hydrogen gas.

Examples include:

- Metal etching
- Acid rain damage (for example, to vehicles)

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Bases

- **Base:** a chemical substance that decreases H^+ concentration in aqueous solution or that increases [OH^-] concentration in solution

Examples include:

- Ammonia [(NH_3)]
- Sodium hydroxide (NaOH)
- Potassium [hydroxide] (KOH)
- [Calcium] carbonate ($CaCO_3$)

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Physical and Chemical Properties of Bases

Bases

- taste bitter.
- are slippery.
- turn red litmus paper [blue].

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Physical and Chemical Properties of Bases

- turn colorless phenolphthalein [pink].
- [neutralize] acids.
- may react with some metal salts.
- may react with carbon [dioxide].

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Reactions of Bases with Metal Salts

- Base reacts with [soluble] metal salt to form [insoluble] metal hydroxide.

Examples include:

- $CuSO_4(aq) +$ [2NaOH] $(aq) \rightarrow Cu(OH)_2(s) + Na_2SO_4(aq)$
- $AlCl_3(aq) + 3KOH(aq) \rightarrow Al(OH)_3(s) +$ [3KCl] (aq)

Reactions of Bases with Carbon Dioxide

- Base reacts with carbon dioxide to form [carbonate].

Examples include:

- $2LiOH(aq) + CO_2(g) \rightarrow Li_2CO_3(aq) +$ [H_2O] (l)
- $Ca(OH)_2(aq) +$ [CO_2] $(g) \rightarrow CaCO_3(s) + H_2O(l)$

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Acids in Food

Examples include:

- Benzoic acid: preservative
- Carbonic acid: carbonated drinks
- Acetic acid: vinegar
- Tartaric acid: soft drinks, tartness to food
- Citric acid: tartness, citrus fruits, preservative

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Acids and Bases in Cleaning

Examples include:

- Hydrochloric acid: household cleaners and swimming pool maintenance
- Sodium and potassium hydroxides: manufacture of soaps, detergents, and cleaners; drain cleaner
- Sodium hypochlorite: bleach, disinfectant
- Ammonia: window cleaner, household cleaner

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Acids and Bases in Medicine, Health, and Cosmetics

Examples include:

- Aluminum hydroxide, magnesium hydroxide, calcium carbonate: antacids
- Magnesium hydroxide: antiperspirant/deodorant
- Hydrochloric acid: stabilizer for many medications
- Carbonic acid: regulator of acidity in blood

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Acids and Bases in Manufacturing

Examples include:

- Hydrochloric acid: used in electroplating and leather processing
- Nitric acid: used in the production of fertilizers and explosives; used to etch metals and purify gold
- Ammonia: used in the production of fertilizers and the manufacture of nitric acid; used to neutralize acid in petroleum and in the production of latex

Summary | Properties of Acids and Bases

Lesson Question

How does the concentration of specific ions affect the properties of a solution?

Answer

(Sample answer) In the presence of an acid, the concentration of hydrogen ions increases in a solution, and in the presence of a base, the concentration of hydrogen ions decreases in a solution.

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Properties of Acids and Bases

- An acid is a substance that increases the concentration of H^+ ions in an aqueous solution.
- A base is a substance that decreases the concentration of H^+ ions in an aqueous solution.
- Acids have a sour taste, turn [blue] litmus red, and react with metals, carbonates, and bases.
- Bases have a bitter taste, feel slippery, turn [red] litmus blue, and react with metal salts, carbon dioxide, and acids.

Applications of Acids and Bases

- Acids are commonly used in [foods] to provide tartness and retard spoilage.
- Acids and bases are used in many cleaning products.
- Many [medications] and other health products include acids or bases.
- Manufacturing relies on acids and bases in a variety of ways.

Summary | Properties of Acids and Bases

Use this space to write any questions or thoughts about this lesson.