Name Per

UNIT	NOTES	
1	1.5	*Atoms, Elements, Ions, Acids, and Bases*

Objectives

- List several elements and their element symbol.
- Explain how ions form from atoms.
- Explain what acids and bases are.
- Determine if a solution is acidic or basic.
- Describe how acids and bases react with each other.

The BIG Idea

- Solutions can be acidic, basic, or neutral as a result of the solution's atomic makeup.

Key Concepts

- Atoms are made of particles that determine the atom's electric charge.
- Acids and bases are the result of ions.

All matter is made of atoms.

- Every day you encounter many different substances. Are all of these substances the same? Of course not! But, how many different substances can there be?
- The answer may surprise you. In total, there are only <u>117</u> elements that make up all substances. Of these, <u>94</u> exist naturally and account for almost all matter. Each element is assigned a number on the periodic table. Interestingly, element 117 has yet to be discovered. However, element 118 has been!
- Recall that an element is a <u>**pure**</u> chemical substance consisting of one <u>**type**</u> of <u>**atom**</u>.
- Each element has a <u>**name**</u> and <u>**symbol**</u>. For some elements, the symbol is simply the first letter of its name: Hydrogen (<u>H</u>), Sulfur (<u>S</u>), and Carbon (<u>C</u>). Other elements use the first letter plus one other letter of the element's name. Notice that the first letter is <u>**capitalized**</u> but the <u>**second**</u> letter is not: Aluminum (<u>Al</u>), Platinum (Pt), Cadmium (Cd), and Zinc (<u>Zn</u>).
- Some elements have unusual symbols. For example, the element gold has the symbol <u>Au</u>. The symbol refers to gold's name in Latin, *aurum*.
- Other elements have been named after famous scientists: Einsteinium (Es) and Fermium (Fm).

Each element is made of a different atom.

- Over 2500 years ago, a Greek scientists proposed that if you continually divide a piece of matter in half, you would reach a point that you could no longer divide the matter in half because it would lose its **properties**.
- An atom is the smallest **particle** of a type of **matter** that has all of the same **characteristics** as that type of matter. It is the basic building block of all matter (including elements).
- Atoms are composed of three types of particles: negatively charged **electrons**, positively charged **protons**, and neutrally charged **neutrons**. The protons and neutrons are grouped together in the atom's center, called the **nucleus**. Because it contains the **protons**, it is **positively** charged. Surrounding the nucleus are the electrons.

CHECK YOUR NOTES

What is an element? ______________________________

What is an atom? ______________________________

____

What three particles make atoms? How is each charged?

____

____

CRITICAL THINKING

Why do scientists consider the atom to be the smallest particle of a type of matter? ______________________________

____

____

Atoms form ions.

- An atom has an equal number of **electrons** and **protons**. (Although, the number of neutrons may vary). Since each electron has one negative charge and each proton has one positive charge, atoms have no overall **electrical** charge.
- An **ion** is formed when an atom loses or gains one or more **electrons**. Because the number of electrons in an ion is different from the number of protons, an ion does have an overall electrical charge.

- When an atom loses an electron, the overall electrical charge for the atom becomes **positive**. This is because there are more positive **protons** than negatively charged electrons.
- Likewise, when an atom gains an electron, the overall electrical charge for the atom becomes **negative**. Again, this is because there are more negatively charged **electrons** than there are positively charged protons.
- Ions are represented by the symbol for the element with a raised plus (+) or minus (-) sign. For example, a positive hydrogen ion would be represented as H^+.

CRITICAL THINKING

Why do ions have a positive or negative charge?

____

____

____

Acids and bases have distinct properties.

- Many solutions have certain **properties** that make us call them acids or bases.
- Acids are found in many foods. They taste slightly **sour** when dissolved in **water** and produce a **burning** or itchy feeling on the skin.
- Bases are the **chemical** opposites of acids. They tend to taste **bitter** and often feel **slippery** to the touch. Bases are found in common products such as **soap**, ammonia, and **antacids**.

Acids and bases are the result of ions.

- Generally, a compound that is an acid or a base acts as an acid or a base only when it is dissolved in **water**. In a water-based solution, these compounds produce **ions**.
- An acid can be defined as a substance that can **donate** a hydrogen ion—that is, a proton—to another substance. All acids release positive hydrogen ions (H^+) in water. For example, if we dissolve the compound hydrogen chloride (HCl) in water, the compound separates into **hydrogen** ions (H^+) and **chloride** ions (Cl^-). The hydrogen ions are free to **react** with other substances, so the solution is an acid.

- A base can be defined as a substance that can **accept** a hydrogen ion from another substance. All bases release negative hydroxide ions (OH^-) in water. For example, if we were to dissolve the compound sodium hydroxide (NaOH) in water, the compound separates into **sodium** ions (Na^+) and **hydroxide** ions (OH^-). The hydroxide ions are free to accept **protons** from other substances, so the solution is a base.
- On the atomic level, the difference between acids and bases is that acids **donate** protons and basses **accept** protons.

CHECK YOUR NOTES

Compounds only act as acids and bases when dissolved in what substance? ______________________________

A(n) __________ can donate a hydrogen ion and a(n) __________ can accept a hydrogen ion.

CRITICAL THINKING

How are protons related to acids and bases? ________________
____
____

Characteristics of Acids

- Tasting or touching an unknown chemical is extremely dangerous. Therefore, methods are needed to tell weather a solution is an acid. One safe way to test for an acid is to place a few drops of a solution on a compound that contains a **carbonate** (CO_3). For example, when an acid touches a piece of limestone, it bubbles and produces carbon dioxide gas.
- Acids also react with most **metals**. The reaction produces **hydrogen gas**.
- However, the feature of acids most used to identify them is their ability to change the **colors** of certain compounds known as acid-base **indicators**.
- One common indicator is **litmus**, which is often prepared on slips of paper. When a drop of an acid is placed on litmus paper, it turns **red**.

Characteristics of Bases

- As with acids, tasting and touching are not safe ways of testing whether a solution is a base. In fact, some strong bases can burn the skin as badly as strong acids.
- Bases feel soapy or slippery because they react with acidic molecules in your skin called **fatty acids**. This reaction is how soap is made.
- Like acids, bases change the colors of acid-base indicators. Bases turn litmus paper **blue**. A base will counteract the effect that an acid has on an acid-base indicator.

CHECK YOUR NOTES

What are three tests you can conduct to determine if a substance is an acid? ____

____

Which color will litmus paper become when you add a base to it?

____

CRITICAL THINKING

An unknown liquid is in a container in front of you. Your lab partner says, "If we touch it and it feels slippery, then it must be a base." Is this a safe way to determine if the substance is a base? Why? ____

The strengths of acids and bases can be measured.

- Some acids and bases are stronger than others. For example, battery acid is very acidic and causes burns when touched. However, citrus acid is not very acidic and can be safely ingested. What makes a solution a stronger acid or base?
- Strong acids break apart completely into **ions**. That is to say, none of the original substance remains. For example, if we dissolve hydrogen chloride (HCl) into water, no hydrogen chloride remains in the solution. Instead, we find the solution is filled with hydrogen ions and chloride ions.
- A weak acid does not form many **ions** in a solution.
- The same is true of bases: strong bases completely break apart into ions. Weak bases have very few ions.

We measure acidity using the pH scale.

- The acidity of a solution depends on the **concentration** of H+ ions in the solution. This concentration is often measured on the **pH scale**.
- On this scale, a **low** number indicates a high H+ concentration, and a **high** number indicates a low H+ concentration.
- The scale ranges from **zero** to **fourteen**, but numbers outside the range are possible. The middle number, **seven**, represents a neutral solution. A neutral solution is neither acid nor a base. An example of this is pure **water**.
- Numbers below 7 indicate **acidic** solutions. A concentrated strong acid has a low pH value. For example, the pH of concentrated hydrochloric acid is less than **zero**.
- Numbers above 7 indicate a **basic** solution. A concentrated strong base has a high pH value. For example, the pH of concentrated sodium hydroxide is greater than **fourteen**.

Acids and bases neutralize each other.

- Acids **donate** hydrogen ions, and bases **accept** hydrogen ions. Therefore, it should be no surprise that acids and bases react when they come into contact with each other. Let's see an example.
- Suppose we take a solution of sodium hydroxide (NaOH) and mix it with a solution of hydrochloric acid (HCl). The negative ion of the acid (Cl-) will join with the positive ion of the base (Na+). This forms **salt**. Then, the positive hydrogen ion of the acid joins with the negative hydroxide ion of the base forming **water**. Because both these substances are neutral, our solution is **neutral**.
- It is common to have salts (most commonly a **metal** element attached to a non-metal or **gas** element) form.
- We use this to our advantage. For example, your stomach lining produces hydrochloric acid. It has a pH of about **1.5**. Sometimes, your stomach produces more acid than what is needed and you may feel a burning sensation. To fix this, you take an antacid tablet. This tablet is **high** on the pH scale. By combining the base with the acid in your stomach, you will raise the pH and stop the burning. As a result **water** and **salt** are produced.

CHECK YOUR NOTES

What happens to strong acids and bases when they dissolve?

____

What does the pH scale measure? _______________________

____

CRITICAL THINKING

What determines acid and base strength? __________________

____

What is the relationship between positive hydrogen ions and pH?

____