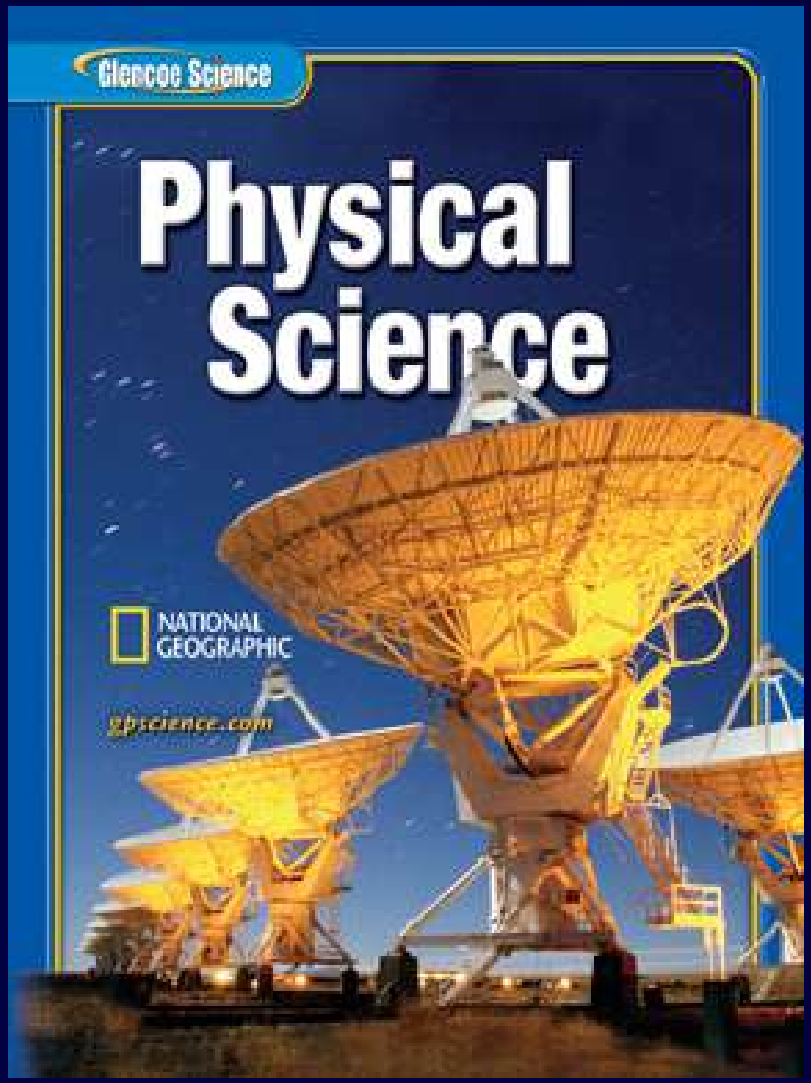
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Unit 4: The Nature of Matter

15.1

Pure Substances

- Materials are made of a pure substance or a mixture of substances.
- A pure **substance**, or simply a substance, is a type of matter with a fixed composition.
- A substance can be either an element or a compound.

15.1

Elements

- All substances are built from atoms. If all the atoms in a substance have the same identity, that substance is an **element**.
- The graphite in your pencil point and the copper coating of most pennies are examples of elements.

15.1

Elements

- About 90 elements are found on Earth.
- More than 20 others have been made in laboratories, but most of these are unstable and exist only for short periods of time.

15.1

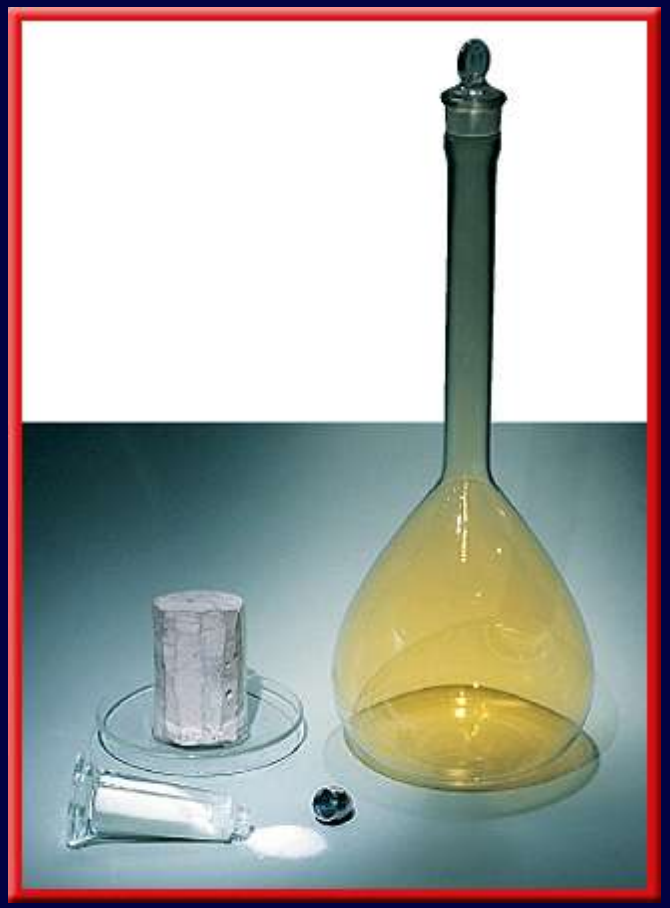
Compounds

- Can you imagine yourself putting something made from a slivery metal and a greenish-yellow, poisonous gas on your food?

15.1

Compounds

- Table salt is a chemical compound that fits this description. Even though it looks like white crystals and adds flavor to food, its components—sodium and chlorine—are neither white nor salty.



15.1

Mixtures

- A mixture, such as the pizza or soft drink shown, is a material made up of two or more substances that can be easily separated by physical means.

15.1

Heterogeneous Mixtures

- Unlike compounds, mixtures do not always contain the same proportions of the substances that make them up.

- A mixture in which different materials can be distinguished easily is called a **heterogeneous** (he tuh ruh JEE nee us) **mixture**.

15.1

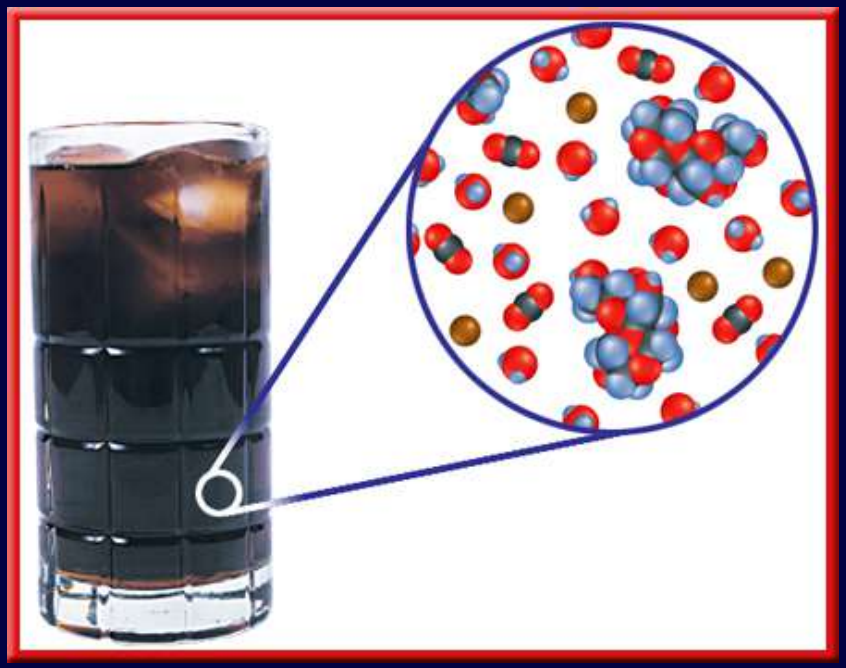
Heterogeneous Mixtures

- Most of the substances you come in contact with every day are heterogeneous mixtures. Some components are easy to see, like the ingredients in pizza, but others are not.
- For example, the cheese in pizza is also a mixture, but you cannot see the individual components.

15.1

Homogeneous Mixtures

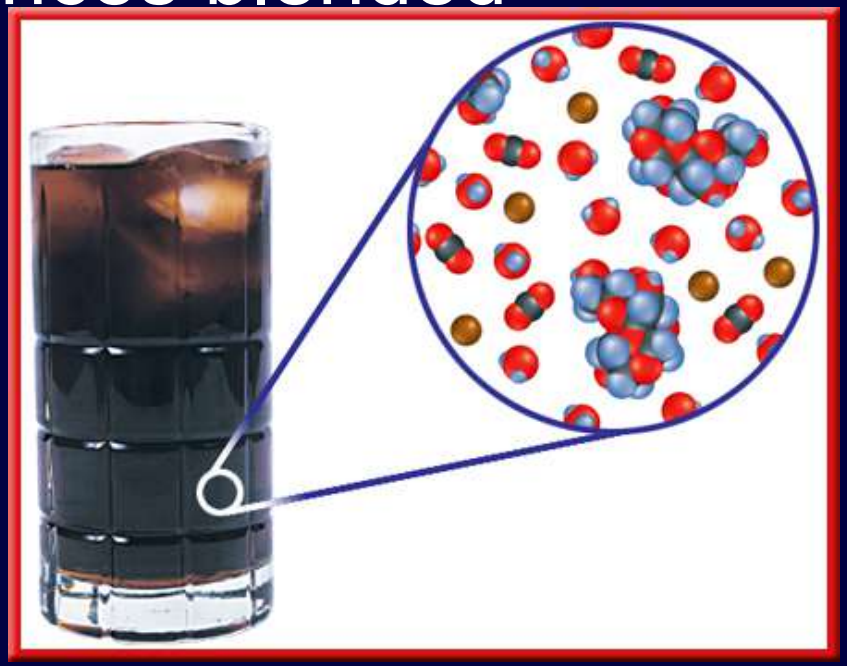
- Soft drinks contain water, sugar, flavoring, coloring, and carbon dioxide gas.
- Soft drinks in sealed bottles are examples of homogeneous mixtures.



15.1

Homogeneous Mixtures

- A **homogeneous** (hoh muh JEE nee us) **mixture** contains two or more gaseous, liquid, or solid substances blended evenly throughout.



15.1

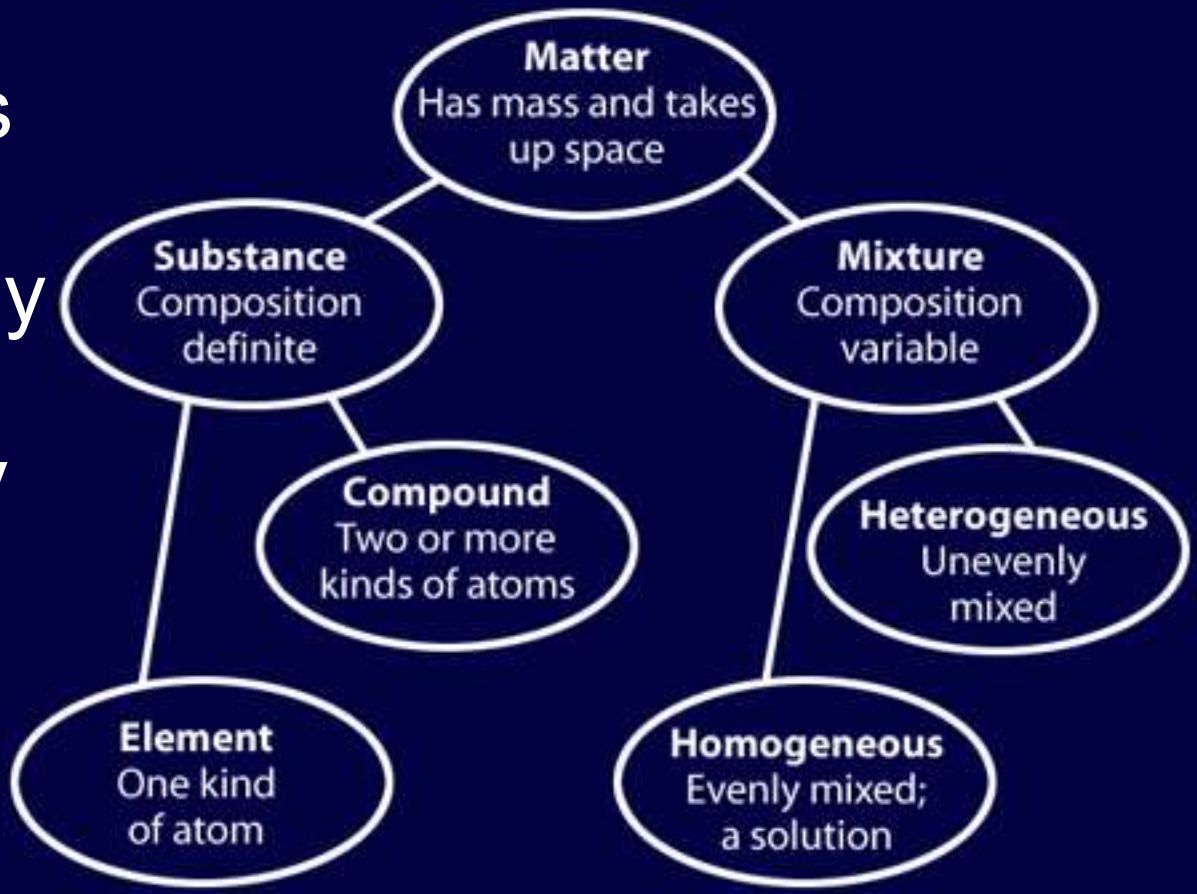
Homogeneous Mixtures

- Another name for homogeneous mixtures like a cold soft drink is solution.
- A **solution** is a homogeneous mixture of particles so small that they cannot be seen with a microscope and will never settle to the bottom of their container.

15.1

Homogeneous Mixtures

- Solutions remain constantly and uniformly mixed.



15.1

Colloids

- Milk is an example of a specific kind of mixture called a colloid.
- A **colloid** (KAH loyd) is a type of mixture with particles that are larger than those in solutions but not heavy enough to settle out.

15.1

Detecting Colloids

- One way to distinguish a colloid from a solution is by its appearance.
- Fog appears white because its particles are large enough to scatter light.
- Sometimes it is not so obvious that a liquid is a colloid.
- You can tell for certain if a liquid is a colloid by passing a beam of light through it.

15.1

Detecting Colloids

- A light beam is invisible as it passes through a solution, but can be seen readily as it passes through a colloid. This occurs because the particles in the colloid are large enough to scatter light, but those in the so
- This scattering of light by colloidal particles is called the **Tyndall effect**.

15.1

Suspensions

- Some mixtures are neither solutions nor colloids. One example is muddy pond water.
- Pond water is a **suspension**, which is a heterogeneous mixture containing a liquid in which visible particles settle.

15.1

Suspensions

- The table summarizes the properties of different types of mixtures.

Comparing Solutions, Colloids, and Suspensions

Description	Solutions	Colloids	Suspensions
Settle upon standing?	no	no	yes
Separate using filter paper?	no	no	yes
Particle size	0.1–1 nm	1–100 nm	>100 nm
Scatter light?	no	yes	yes

15.1

Question 1

A _____ is a type of matter with a fixed composition.

A. colloid
B. mixture
C. substance
D. solution

15.1

Answer

The answer is C. A substance can be either an element or a compound.

15.1

Question 2

How many elements are found on Earth?

A. 5
B. 10
C. 30
D. 90

15.1

Answer

The answer is D. About 90 elements are found on Earth, and more than 20 have been made in laboratories.

15.1

Question 3

How are compounds different from mixtures?

15.1

Answer

The atoms in compounds are combined in fixed proportions and cannot be separated by physical means. A mixture is made of two or more substances that can be easily separated by physical means.

15.2

Physical Properties

- Any characteristic of a material that you can observe without changing the identity of the substances that make up the material is a **physical property**.
- Examples of physical properties are color, shape, size, density, melting point, and boiling point.

15.2

Appearance

- How would you describe a tennis ball? You could begin by describing its shape, color, and state of matter.
- You can measure some physical properties, too. For instance, you could measure the diameter of the ball.

15.2

Behavior

- Some physical properties describe the behavior of a material or a substance.
- Attraction to a magnet is a physical property of the subst
- Every substance has a specific combination of physical properties that make it useful for certain tasks.

15.2

Using Physical Properties to Separate

- The best way to separate substances depends on their physical properties.
- Size is one physical property often used to separate substances.

15.2

Using Physical Properties to Separate

- Look at the mixture of iron filings and sand shown.
- You probably won't be able to sift out the iron filings because they are similar in size to the sand particles. What you can do is pass a magnet through the mixture.

15.2

Using Physical Properties to Separate

- The magnet attracts only the iron filings and pulls them from the sand. This is an example of how a physical property, such as magnetic attraction, can be used to separate substances in a mixture.

15.2

Physical Change

The Identity Remains the Same

- A change in size, shape, or state of matter is called a **physical change**.
- These changes might involve energy changes, but the kind of substance—the identity of the element or compound—does not change.

15.2

The Identity Remains the Same

- Iron is a substance that can change states if it absorbs or releases enough energy—at high tempe
- Color changes can accompany a physical change, too.

15.2

The Identity Remains the Same

- For example, when iron is heated it first glows red. Then, if it is heated to a higher temperature, it turns white.

15.2

Using Physical Change to Separate

- Many such areas that lie close to the sea obtain drinking water by using physical properties of water to separate it from the salt.
- One of these methods, which uses the property of boiling point, is a type of distillation.

15.2

Distillation

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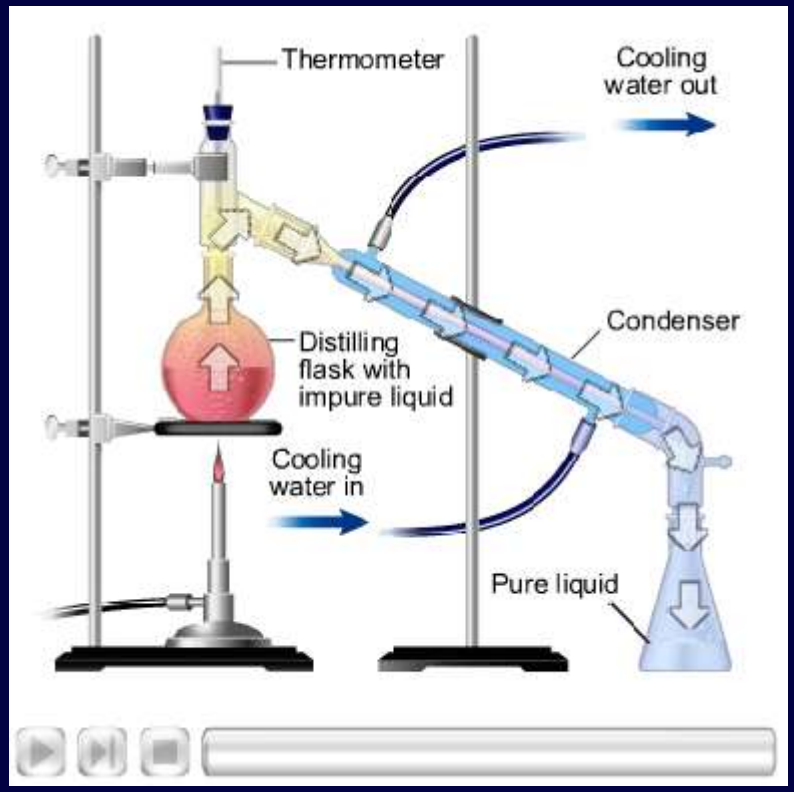
- The process for separating substances in a mixture by evaporating a liquid and recondensing its vapor is **distillation**.
- It usually is done in the laboratory using an apparatus similar to that shown.



15.2

Distillation

- Two liquids having different boiling points can be separated in a similar way.
- The mixture is heated slowly until it begins to boil.
- Vapors of the liquid with the lowest boiling point form first and are condensed and collected. Then, the temperature is increased until the second liquid boils, condenses, and is collected.

15.2

Chemical Properties and Changes

- The tendency of a substance to burn, or its flammability, is an example of a chemical property because burning produces new substances during a chemical change.
- A **chemical property** is a characteristic of a substance that indicates whether it can undergo a certain chemical change.

15.2

Detecting Chemical Change

- If you have a pan of chili cooking unattended on the stove for too long, your nose soon tells you that something is wrong.
- This burnt odor is a clue telling you that a new substance has formed.

15.2

The Identity Changes

- A change of one substance to another is a **chemical change**.
- The foaming of an antacid tablet in a glass of water and the smell in the air after a thunderstorm are other signs of new substances being produced.

Click image to view movie

15.2

The Identity Changes

- Clues such as heat, cooling, or the formation of bubbles or solids in a liquid are helpful indicators that a reaction is taking place.
- However, the only sure proof is that a new substance is produced.
- The only clue that iron has changed into a new substance is the presence of rust.
- Burning and rusting are chemical changes because new substances form.

15.2

Using Chemical Change to Separate

- One case where you might separate substances using a chemical change is in cleaning tarnished silver.
- Tarnish is a chemical reaction between silver metal and sulfur compounds in the air which results in silver sulfide.
- It can be changed back into silver using a chemical reaction.

15.2

Using Chemical Change to Separate

- You don't usually separate substances using chemical changes in the home.
- In industry and chemical laboratories, however, this kind of separation is common. For example, many metals are separated from their ores and then purified using chemical changes.

15.2

Weathering—Chemical or Physical Change?

- The forces of nature continuously shape Earth's surface. Rocks split, deep canyons are carved out, sand dunes shift, and curious limestone formations decorate caves.
- Do you think these changes, often referred to as weathering, are physical or chemical? The answer is both.

15.2

Physical

- Large rocks can split when water seeps into small cracks, freezes, and expands.
- However, the smaller pieces of newly exposed rock still have the same properties as the original sample.
- This is a physical change.

15.2

Chemical

- Solid calcium carbonate, a compound found in limestone, does not dissolve easily in water.
- However, when the water is even slightly acidic, as it is when it contains some dissolved carbon dioxide, calcium carbonate reacts.
- It changes into a new substance, calcium hydrogen carbonate, which does dissolve in water.

15.2

Chemical

- A similar chemical change produces caves and the icicle shaped rock formations that often are found in them.

15.2

The Conservation of Mass

- Suppose you burn a large log until nothing is left but a small pile of ashes.
- At first, you might think that matter was lost during this change because the pile of ashes looks much smaller than the log did.

15.2

The Conservation of Mass

- In fact, the mass of the ashes is less than that of the log.

15.2

The Conservation of Mass

- However, suppose that you could collect all the oxygen in the air that was combined with the log during the burning and all the smoke and gases that escaped from the burning log and measure their masses, too.
- Then you would find that no mass was lost after all.

15.2

The Conservation of Mass

- Not only is no mass lost during burning, mass is not gained or lost during any chemical change.
- According to the **law of conservation of mass**, the mass of all substances that are present before a chemical change equals the mass of all the substances that remain after the change.

15.2

Question 1

Which of the following is a chemical property?

A. boiling point
B. density
C. flammability
D. melting point

15.2

Answer

The answer is C. Flammability indicates whether a substance will undergo the chemical change of burning.

15.2

Question 2

A characteristic of a material that can be observed without changing the identity of the substances that make up the material is a _____.

15.2

Answer

The answer is physical property. Examples of physical properties include color, shape, and density.

15.2

Question 3

What is the law of conservation of mass?

15.2

Answer

According to the law of conservation of mass, the mass of all substances that are present before a chemical change equals the mass of all substances that remain after the change.

15

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