UNIT CR

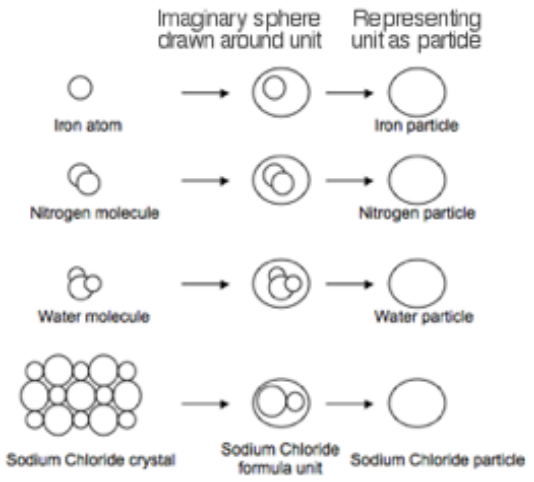
LESSON 1: Physical Changes vs Chemical Reactions

Purpose and Key Questions

In the Physical Changes unit, we investigated several kinds of processes, including expansion and contraction during warming and cooling, and changes of state during melting, boiling, evaporation, etc. In all these cases, the particles of the material stayed the same, and only the spacing between particles or their configuration (arrangement) changed. These kinds of processes are called **physical changes**.

At the macroscopic and particle levels, physical changes are accompanied by conservation of mass. Those properties of a material that can be observed or measured without altering the composition of the material are called **physical properties**. Examples include temperature, mass, density, pressure, etc.

In this unit, we will be looking at processes where the ending materials are different from the starting materials. We will explain these processes, called **chemical reactions**, in terms of the small particle theory. It is likely that in your previous study of science you learned that all materials consist of atoms, which can combine to form molecules or formula units. Until now, we have only been concerned with particles—that is, molecules or formula units— not their internal structure. This idea is illustrated in the accompanying drawings.



In this lesson we will be investigating changes to matter and making inferences about the composition of the particles that make up the different type of materials.

The key questions for this lesson are:

1. ***How can we identify physical changes and chemical reactions?***
2. ***What are useful ways to categorize the types of matter that exist?***

Predictions, Observations and Making Sense

PART 1: Mixing sulfur and iron versus heating sulfur and iron together

In this part you will watch three movies featuring two materials, iron and sulfur. In addition to seeing the appearance of both materials, you will see experiments where the materials react with other substances. This will allow you to explore a new kind of property called a **chemical property**, which is how a substance reacts with another substance. In this case, the **chemical property** we will be investigating is the reaction with hydrochloric acid (HCl). If the reaction produces bubbles, we call it a **positive reaction**.

 Watch **UCR L1 Mov1**. As you watch the movie, note the appearance of the iron filings and record your observations in Table 1. Look for some physical properties, such as color, luster, and shape. Also note how the iron filings react in the presence of the magnet, and how they react with HCl. Then record your observations in Table 1. Next, watch **UCR L1 Mov2** and **UCR L1 Mov3**. Make the same observations for the sulfur, and for the iron and sulfur mixture, and then record them.

Table 1: Iron and sulfur separately and after mixing (before heating)

	Appearance	Magnified appearance	Magnet	Reaction with HCl
Iron				
Sulfur				
Iron and Sulfur mixture				

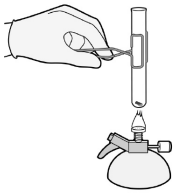
Now consider all three movies and answer the following questions

Does the appearance of the iron change when it is mixed with the sulfur? If so, describe the change.

Does the iron react differently to the magnet? To the HCl?

Is there evidence that a new material with different properties from the original materials was formed? Cite as much evidence as possible to support your claim.

Next, you will watch **UCR L1 Mov4**, where the iron sulfur mixture is heated. The material that forms is called a product. Finally, in **UCR L1 Mov5** you will observe tests being done on the product.



Record your observations in the table below.

Table 2: Iron and sulfur mixture after heating

	Appearance	**Magnified appearance**	**Magnet**	**Reaction with HCl**
Iron and Sulfur mixture after heating				

Does the appearance of the iron change when it is heated with the sulfur? If so, describe the change.

Does the product react differently to the magnet than the iron did? If so, describe the change.

Does the product react differently to the HCl than the sulfur or the iron did? If so, describe the change.

Is there evidence that a new material with different properties from the original materials was formed? Cite as much evidence as possible to support your claim.

CQ 1-1: Consider the mixture of iron and sulfur, the process of heating the mixture, and the final product. Which of the following are accurate?

i. After heating, the product has different properties than either the iron or the sulfur.
ii. A gas is given off during the heating process.
iii. After heating, the materials can be easily separated.

a. i. only
b. ii. only
c. i. and ii.
d. ii. and iii.
e. All three.

Physical Changes versus Chemical Reactions

You saw that we could separate the iron and sulfur mixture using a magnet. The product formed by heating iron with sulfur is called iron (II) sulfide. Using just the magnet, we are not able to separate the iron (II) sulfide back into iron and sulfur. However, it is possible, though difficult, to separate them using other means. Iron, sulfur, the iron/sulfur mixture and the iron (II) sulfide are all *matter* but are different *materials*. Mixing the iron and sulfur together (before heating) is an example of a physical change (mixing) because the there is no new material formed. **Physical changes** include changes of state (melting, boiling, evaporation, condensation), shape, temperature, or size. Mass is conserved during a physical change. By contrast, when the mixture of iron and sulfur was heated, a new substance with different properties was formed; therefore, we call that process a **chemical reaction**. Evidence for a chemical reaction includes formation of a solid (or precipitate), formation of a gas, or color change accompanying the production of a new material. Examples of chemical reactions include digestion of food, leaves changing color, and combustion of fuel in your car's engine.

PART 2: Physical Changes versus Chemical Reactions

Consider the different kinds of evidence for physical changes and chemical reactions, and then answer the following questions.

CQ 1-2: Which of the following are chemical reactions?

i. Cyanalume™ sticks ('glowsticks') glow after they are activated
ii. Copper objects like the Statue of Liberty form a green patina over time
iii. A wood log burns
iv. Acid rain corrodes limestone and marble monuments
v. Paper is shredded into small pieces

a. ii and iv
b. i, ii, and iv
c. i, ii, iii, and iv
d. i, ii, iii, iv, and v are all chemical changes

CQ 1-3 Which of the following are physical changes?

i. freezing water
ii. dissolving salt in water
iii. baking a cake
iv. melting wax
v. burning coal

a. ii and iv
b. i, ii, and iv
c. i, ii, iii, and iv
d. i, ii, iii, iv, and v are all physical changes

Dissolving may have been difficult to categorize. It is helpful to determine whether a physical change or a chemical reaction would be required to undo the change and return to the starting materials. For instance, is there a physical change that would let us separate the salt and water? Or would a chemical reaction be required?

Next you will see two examples where a material is separated into constituents. First, watch **UCR L1 Mov6**, where saltwater that has been placed on a hotplate and heated for some time.

 What happens to the salt water?

 What kind of change (physical or chemical) is taking place?

Next, watch **UCR L1 Mov7**, where a container of oil and vinegar is first shaken and then left to stand.

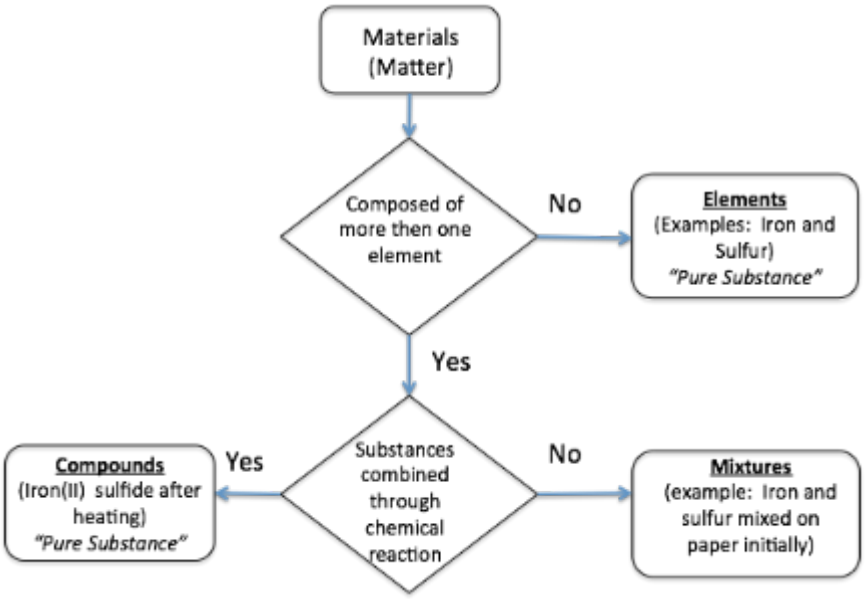
 What happens when the oil and vinegar sit undisturbed?

 What kind of change (physical or chemical) is taking place?

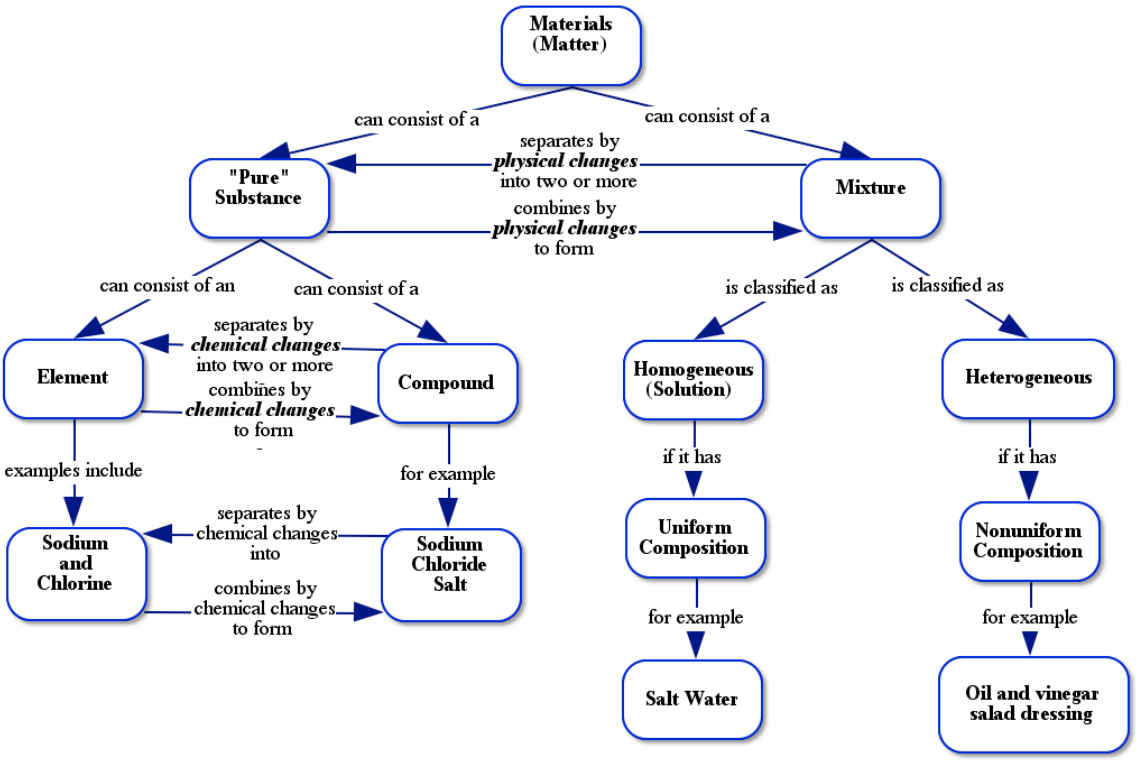
PART 3: Classifications of materials

In this lesson, you have seen several examples of changes where two materials are combined into one, or where one material is separated into two. Sometimes this separation happens through a physical change. In other cases, it happens through a chemical reaction. Some materials cannot be further separated.

Whether or not a material can be separated into components, and if so, which mechanisms (physical or chemical) are needed, can be used to classify materials. We can think of this classification in terms of either how materials combine or separate. Below is a flow chart for sorting materials on this basis.



The following concept map is another way to represent the classification or description of materials' macroscopic composition.



Examine the concept map and answer these questions.

Compounds and mixtures are more complex forms of matter that are "combinations" of other matter. How are compounds different from mixtures?

How is a homogenous mixture different from a heterogeneous mixture?

White sands in many tropical coastal areas consist of silicon dioxide. Silicon dioxide can be heated with carbon at extremely high temperatures to produce silicon. How would you classify sand—element, compound, or a mixture? Why?

Soil consists of sand, gravel, clay and humus (living and dead organic material). The components of soil can be separated by density and particle size. How would you classify soil—element, compound, or a mixture? Why?

Raisin bread has raisins suspended throughout the bread. Is raisin bread a homogeneous mixture or heterogeneous mixture? Why?

Elements cannot be broken down into simpler materials through chemical changes and are therefore, considered the "building blocks" of matter. There are 92 different elements in nature here on Earth and at least 26 additional elements "synthesized" in the laboratory. Most of the natural 92 elements combine with other elements or compounds during chemical changes to make new compounds.

Summarizing Questions

Review the differences between elements, compounds, and mixtures or solutions, and then answer the following questions.

S1. While making cinnamon rolls, a chef combines cinnamon and sugar to sprinkle over the rolls before baking them.

a. Is this combination of cinnamon and sugar a compound or a mixture? Give evidence to support your rationale.

b. Is it possible to separate the combination of cinnamon and sugar? If yes, provide a possible procedure. If no, explain why not.

S2. Answer the following questions.

CQ 1-4: Which material(s) is an element?

i. lead
ii. carbon dioxide
iii. apple juice (filtered)
iv. helium
v. sand in water
vi. sodium bicarbonate (baking soda)

a. i and iv
b. ii and vi
c. iii
d. v

CQ 1-5: Which material(s) is a compound?

i. lead
ii. carbon dioxide
iii. apple juice (filtered)
iv. helium
v. sand in water
vi. sodium bicarbonate (baking soda)

a. i and iv
b. ii and vi
c. iii
d. v

CQ 1-6: Which material(s) is a homogenous mixture, or solution?

i. lead
ii. carbon dioxide
iii. apple juice (filtered)
iv. helium
v. sand in water
vi. sodium bicarbonate (baking soda)

a. i and iv
b. ii and vi
c. iii
d. v