Physical and Chemical Changes

Suggested time: 1.25 Hours

What's important in this lesson:
To be able to determine whether a substance is undergoing a physical or chemical change using evidence to support your answer. To consider two chemical changes important to our daily lives.

Complete these steps:

1. Complete the Student Handout: Physical and Chemical Changes and work through it at your own pace. You'll need a copy of a textbook for help in places. Check your answers with your teacher where needed.

2. Perform the Extension-Physical and Chemical Changes Lab A (in class or at home) or Lab B (this is to be done in class) if the teacher will allow.

3. Do the Assessment. Make sure you have about 10 -15 minutes to complete the test and give this to your teacher.

4. Complete the Reflection activity. Get this checked as being completed on your Course Checklist.

Hand-in the following to your teacher:

1. Student Handout
2. Student Handout: Extension - Physical and Chemical Changes Lab A or B if performed.
3. Assessment activity
4. Reflection activity

Questions for the teacher:

Student Handout: Unit 1 Lesson 2

Physical and Chemical Changes

Some of the most important uses for a substance are those that result from a change in the substance. We experience many changes in substances every day e.g., burning gasoline in a car, cooking a hamburger and fries, and freezing water to make ice cubes. Recognizing and understanding what occurred during the change is an important first step to making use of changes.

Physical Changes

These are **changes in the condition of the material** in which the molecules of a substance remain the same even though the substance may have changed state or form. Changes of state, breaking things or grinding them are all physical changes.

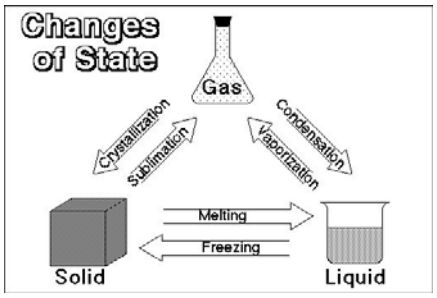

Fig. 1: The changes of state

Dissolving molecules such as sugar or salt in water, is another type of physical change. You can tell the molecules are still the same because you can taste the sugar or salt in the water, even though you cannot see them. This is because the molecules are too small to see, and in solution they are found individually.

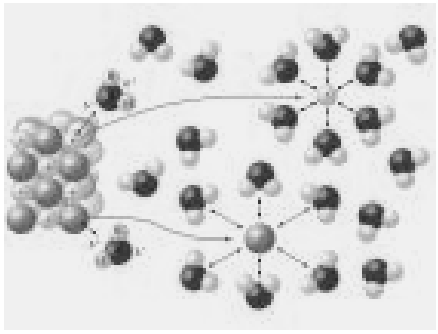

Fig. 2: Salt (NaCl) dissolving in water (H_2O)

Most physical changes are fairly easy to reverse. For example in a sugar or salt water solution when the water is boiled away the sugar or salt is left behind. Ice cubes are easily made by placing the water back into a freezer where it will freeze.

Chemical Changes

When chemists are trying to see if new molecules have been formed, they look for changes in the properties of the matter they are studying.

A change in matter where new kinds of molecules with new properties are formed is called a **chemical change**. Many chemical changes happen when you bring two or more different substances together and are very difficult to reverse.

Student Handout: Unit 1 Lesson 2

For each chemical change, a chemical equation can be written that shows what the original substance, or substances, are ultimately changed to. The starting materials, called reactants, undergo a chemical change and produce the products.

Reactants → Products

The arrow that separates the reactants from the products is a symbol that means "yield" or "produce." In chemical reactions, the reactants combine to yield the products.

Examples:

1. Water can be divided into two substances: hydrogen and oxygen using electricity in the process called hydrolysis. Water is a liquid which puts out fire. Hydrogen and oxygen are gases which can burn. The properties have changed, so this is a chemical change.

Water → oxygen + water

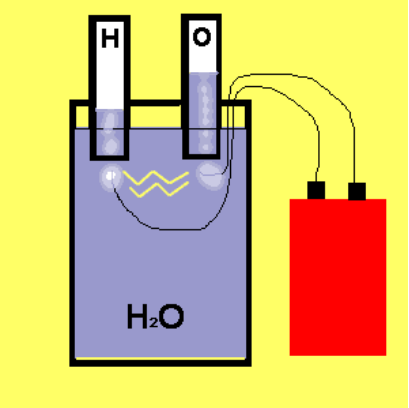

Fig. 3: Hydrolysis of Water

2. When iron rusts, oxygen in the air is combining with the iron. A shiny, bendy gray metal turns into a reddish brown powdery substance which is crumbly. A new substance has formed and a chemical reaction has happened.

Iron + oxygen → iron oxide (rust)

3. Another example of a reaction is fire, or combustion. Paper is tough, crisp, and solid. When the paper is done burning all that is left is some crumbly gray-black ashes and some gas in the air which will not burn. The chemical reaction between the paper and the oxygen in the air produced two new substances with different properties.

Paper + oxygen → carbon dioxide + ash

How can you tell that a chemical change has occurred and not a physical one?

First one must observe the physical properties of the reactants, and then considering the physical properties of the products. If a chemical change has truly taken place, some or all the physical properties of the products are different from those of the reactants.

There are five clues listed on the top of the following page that can help you decide. But you must be careful since they all suggest that a new substance has been produced but any one of them could also occur during a physical change. You therefore must observe several of the following clues to be able to determine that a chemical change has occurred.

1. The reaction produced a **change in temperature**. The temperature could go up (gets hotter) or the temperature could go down (gets colder). Note: reactions that produce heat are known as exothermic reactions whereas reactions that absorb heat are known as endothermic reactions.
2. **Formation of gas** bubbles or an odour
3. **Formation of a solid** (precipitate).
4. **A change in colour**. You may start with two colourless solutions but when they are mixed you might see a coloured solution.
5. **Light is produced**. (ex. Glow sticks)

Physical & Chemical Changes

Identify which of the following are physical changes (P) and which are chemical changes (C). **Include a reason** for each of your answers.

*** A good rule of thumb if you cannot easily reverse the process it is a chemical change.**

CHANGE	P or C	REASON
1) Toasting bread		
2) Evaporating water		
3) Burning a candle		
4) Frost on a car window		
5) Baking a potato		
6) Boiling water		
7) Baking a cake		
8) Breaking a stick		
9) Wax melting		

10) Frying an egg		
11) A bomb exploding		
12) Bread going mouldy		
13) A firefly glowing		
14) Silver tarnishing		
15) Sanding a piece of wood		

Use a highlighter while reading the following section to help you select information that will answer the following questions.

a. What is combustion?
b. Why are other products formed when fossil fuels burn?
c. What is corrosion?
d. How is iron oxide formed?
e. What are ways man uses to protect a metal from corrosion?

Everyday Chemical Changes:

Humans are very good at utilizing the knowledge gained through various chemical changes. For example it is known that when baking soda is heated carbon dioxide is produced. We used this knowledge in baking, as the carbon dioxide bubbles cause the baked goods to rise.

Several chemical changes that are very important in our daily lives are combustion and corrosion.

Combustion (or burning) is a chemical change in which a substance reacts rapidly with oxygen and releases energy. The energy is observed as heat and light. Fossil fuels such as wood, kerosene, gasoline and diesel oil burn readily in air. Thanks to technology humans have developed engines that can use the energy produced through combustion to power vehicles.

Student Handout: Unit 1 Lesson 2

To represent the combustion of these fossil fuels the following word equation may be used:

Fossil fuels + Oxygen → Carbon dioxide + Water

Under ideal conditions when the fuels are burned with oxygen the two new substances made are carbon dioxide and water. Fossil fuels are rarely pure substances instead they are mixtures of many different compounds. When these molecules burn other products such as sulphur dioxide and nitrogen oxides may be produced. If there is not enough oxygen available to burn the fossil fuels, two other products may be produced: carbon monoxide and carbon. All of these other products can harm people and the environment. In fact combustion is the major source of air pollution in the environment.

Corrosion is a slow chemical change that occurs when a metal reacts with oxygen from the air to form a new substance called an oxide.

Rusting is a specific example of corrosion. It involves the reaction between iron with oxygen from the air, water and other chemical substances that are dissolved in the water. The product is iron oxide or rust. Every year millions of dollars of damage occurs to building structures, vehicles and other products that contain iron. Others metals also corrode eg. Copper turns green and silver tarnishes but this corrosion does not seem to be as damaging as that which occurs on iron.

Humans have used their knowledge of corrosion to find ways of preventing it. Each method involves protecting the metal surface from oxygen. The first method is to paint any metal surfaces that are exposed to air. As long as the painted surface is not broken or cracked, oxygen cannot get at the metal. The same reasoning can be used for spraying the bottom and inside surfaces of cars with oil to protect them. Another method of preventing corrosion is to use materials such as plastics that will not undergo corrosion. Car bumpers and panels are being made more with these types of products. The third method involves coating or mixing the iron with a metal or several metals that will undergo corrosion faster than the iron and thus protecting it. An example of this is galvanizing steel by coating it with zinc.

16) What is combustion?

17) Why are other products formed when fossil fuels burn?

18) Why should you never operate a gas or charcoal barbecue inside a building?

19) What is corrosion?

20) How is iron oxide formed?

21) a) Describe three ways to protect a metal from corrosion.

b) Which parts of a car corrodes the most? Why?

c) How can car owners help to reduce the effects of corrosion?

Student Handout: Unit 1 Lesson 2

Extension - Physical & Chemical Changes Lab A

Purpose: To observe and differentiate between physical and chemical changes

Materials:

- Hand lens
- 5 powders, about 1 tablespoon of each, in paper cups or zip- lock baggies labeled A-Baking soda, B-Cornstarch, C-Plaster of Paris , D–Sugar, E-Salt
- Iodine (can purchase at a drugstore)
- Water
- Vinegar
- 3 eye droppers
- 5 sheets of aluminum foil

Safety:

- **Some household chemicals may form dangerous products when mixed together. Check with your teacher before mixing any substances other than those directed in the procedure that follows.**
- **Wear goggles and gloves when using iodine solution**

Procedure:

1. Take 5 pieces of aluminum foil and using a marker or piece of masking tape label each piece of foil for one of the powders that will be used.
2. Place a small amount of each powder, about 1/4 teaspoon, in three locations on the aluminum foil.
3. Describe the physical properties using a hand lens if available of each powder and record data on worksheet.
4. Test 1: Place 1-2 drop of iodine on one sample of each powder. Note any color changes.
5. Test 2: Place 1-2 drops of water on one of the remaining samples of each powder. Note any changes.
6. Test 3: Place 1-2 drops of vinegar on one of the remaining samples of each powder. Note any changes.

Student Handout: Unit 1 Lesson 2

Observations:

1. Complete the table below that shows the observed properties and result of each test with the five powders.

Powder	Physical Properties	Iodine Added	Water added	Vinegar added
Baking Soda				
Corn Starch				
Plaster of Paris				
Sugar				
Salt				

2. Complete the following table to classify whether the powders have undergone a physical or chemical change in each of the tests. Give specific evidence for this choice.

Step #	Physical or Chemical Change
Baking Soda	
Corn Starch	

Plaster of Paris	
Sugar	
Salt	

3. What are the five different indicators used to determine whether a physical or chemical change has occurred? Hint: See your earlier reading.

Conclusion: As a summary, what if the difference between a physical and a chemical change?

Extension - Physical & Chemical Changes Lab - B

Purpose: To observe and differentiate between physical and chemical changes

Materials:

- Copper (II) Sulphate (bluestone)
- Limewater
- Cobalt Chloride solution
- Sodium chloride (salt)
- Steel wool
- Copper (II) chloride solution
- Water
- Test-tubes (4)
- Test-tube rack
- Mortar and pestle
- Crushed chalk
- Vinegar

Safety

- **Some household chemicals may form dangerous products when mixed together. Check with your teacher before mixing any substances other than those directed in the procedure that follows.**
- **Wear goggles and gloves when using iodine solution**

Procedure:

1. Get 1 large crystal of copper (II) sulphate (a.k.a. Bluestone). Make some observations. Thoroughly crush the crystal using a mortar and pestle. Fill in the observation table. Dispose of the powder into container provided.

2. Put approximately 5 mL of limewater in a clean test tube. Using an eye dropper, add a few drops of the cobalt chloride solution to the test tube. Allow the mixture to stand for 5 minutes. Complete your observation table.

3. Put approximately 5 mL of water in a clean test tube. Add a small amount of salt (sodium chloride) to the test tube. Shake the test tube to dissolve the salt. Record any observations.

4. Put approximately 5 mL of vinegar in a clean test tube Add a small amount of crushed chalk to the test tube. Allow the mixture to stand for 5 minutes. Complete your observation table.

5. Place a small amount of steel wool in a test tube. Pour enough copper (II) chloride solution to cover the steel wool. Allow the reaction to stand for 5 minutes. Record any observations.

Observations:

1. Complete the table below that shows the observed properties and result of each test.

Step #	Names of Reactants	Observations of Reactants	Observations of Change
1	Copper (II) Sulphate		
2	Limewater and cobalt chloride		
3	Salt and Water		
4	Vinegar and crushed chalk		
5	Steel Wool and Copper (II) chloride solution.		

2. Create a second table to classify whether the reactants have undergone a physical or chemical change in each of the five tests. Give specific evidence for this choice.

Step #	Physical or Chemical Change
1	
2	
3	
4	
5	

3. What are the five different indicators used to determine whether a physical or chemical change has occurred?

Conclusion: As a summary, what if the difference between a physical and a chemical change?

Performance Task Rubric ~ Physical and Chemical Changes Report

Categories	Level 4	Level 3	Level 2	Level 1	R
Data Collection and Observation	Data tables have headings and efficiently organized data from individual experiments	Data tables have efficiently organized data from trials	Data tables contain all data from individual experiments.	Data from individual experiments has been recorded	Little or no data appears to have been recorded.
Analysis	Student accurately determines which experiments are physical or chemical changes	Student Correctly determines which experiments are physical or chemical changes	Student correctly determines which experiments are physical or chemical changes with some errors	Student determines which experiments are physical or chemical changes with some errors	Student determines which experiments are physical or chemical changes with some errors
Conclusion	Student accurately identifies affect and states conclusion with reference to experimental data	Student accurately identifies affect and states conclusion concisely	Student identifies affect and states conclusion	Student identifies and states an inaccurate trend	Student fails to identify any trend

Assessment and Evaluation

Modified True/False

Indicate whether the sentence or statement is true or false. If false, change the identified word or phrase to make the sentence or statement true.

____ 1) A new colour always indicates a chemical change.

____ 2) Combustion is the chemical reaction between a fuel and hydrogen.

____ 3) Corrosion is the reaction of a metal with oxygen in the air.

____ 4) In any chemical change, the structure of the particle does not change.

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

5) An example of a chemical change is
a. the crushing of stones
b. the formation of clouds
c. the separation of cream from milk
d. the burning of a candle

6) An example of a physical change is
a. toasting a piece of bread
b. the explosion of dynamite
c. boiling oil
d. the rusting of iron

7) Iron is widely used to build cars, bridges, and buildings. One of the major problems with iron is that it rusts under certain conditions. The reaction of iron to form rust is called
a. Combustion
b. Precipitate
c. a physical change
d. corrosion

8) During a physical change …
a. new substances are produced.
b. the particles are not changed.
c. heat is always released.
d. the products have different chemical properties from the reactants.

Short Answers

9) Physical and chemical changes.

A	B
____ i. Vinegar causes baking soda to fizz.	a chemical change
____ ii. A baby grows.	b physical change
____ iii. Steam rises from a lake on a cool morning.	
____ iv. A mud puddle disappears.	
____ v. A log on a fireplace burns.	

10) List the five clues you would consider when deciding whether a change is physical or chemical.

11) Explain why building codes require an external source of air for fireplaces in new homes.

12) List three objects in your home that can corrode. What steps can you take to protect these items from corrosion?

Reflection Activity: Unit 1 Lesson 2

1) In a sentence, explain why melting ice is a physical change and not a chemical change.

2) When you digest a meal, you take in food. The food gets changed with enzymes (digestive chemicals) into different types of molecules which your cells can use. Is digestion a chemical reaction or a physical change? Explain your answer.

3) A chemist added two clear, cold liquid substances together in a clear container. He stared at the container. No change in color. He stirred it. There was no solid matter in the bottom. It looked just the same as it had before. He started to pick it up, and suddenly dropped it, saying, "Ow, that's hot!" while running for some ice for his hand. Did a reaction or chemical change happen or not? Explain your answer.