

## PART E: PROPERTIES OF MATTER

- All **matter** has **physical properties**: characteristics that can be directly observed or measured
- Different kinds of matter have different properties and this allows us to tell them apart

Properties of Matter

Physical Property	Description
<b>Qualitative</b> ...using words (letters)	
State	Solid, liquid, gas
Colour	Colour (red, blue, etc...)
Malleability	Ability to be <b>beaten into sheets</b> eg. aluminum foil.
Ductility	Ability to be <b>drawn into wires</b> eg. copper wire
Crystallinity	Shape or appearance of <u>crystals</u>
Magnetism	Tendency to be attracted to a magnet
<b>Quantitative</b> ...using numbers	
Solubility	Ability to <b>dissolve in water</b> eg. sugar, salt
Conductivity	Ability to <b>conduct electricity or heat</b> eg. metals
Viscosity	Resistance to flow eg. molassass
Density	Ratio of a <b>material's mass to its volume</b>
Melting/freezing point	Temperature of melting/freezing
Boiling/condensing point	Temperature of boiling/condensing

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- Qualitative** properties answer yes or no questions; or, are descriptive.
- Quantitative** properties can be measured and have definite units.

eg. mass(g)  
length(cm)  
etc.

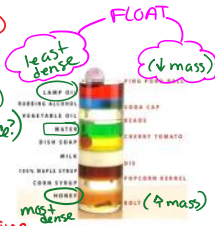
**Physical Properties of Matter**

- Physical properties may be observed, measured or calculated

**Examples:**

- solubility - does it dissolve
- Melting Point (solid → liquid)
- Boiling Point (liquid → gas)
- Density:** the ratio of a substance's mass to its volume.  

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{\text{(how much?)}}{\text{(how much space?)}}$$
  - A HIGH density means even a small piece of the substance will feel heavy (↑ mass)
- Malleability** refers to how a material deforms under compressive stress.
  - A malleable material can be flattened into thin sheets, eg. aluminum foil
- Ductility** refers to how a material deforms under tensile stress. (pulling)
  - A ductile material can be pulled into thin wires.
- Lustre** refers to the ability of a metal to reflect light (shiny)



Physical Properties describe Physical changes in matter: no chemical reaction, no new substance produced.

**Chemical Properties of Matter**

- Chemical properties describe the behavior of a substance as it changes into a new substance

**Examples:**

- Flammability** (can it catch fire?)
- corrosion**
- Reacts with acid/base



metal rusting



reactions with acid produce a gas (bubbles)

Chemical Properties describe Chemical changes in matter:

- DO have a new substance
- new substance has new properties

\* Cooking an egg is a chemical change. Boiling water is a physical change.  
 What do you think is the difference between a chemical change and a physical change?  
Boiling water is a change of state → physical  
Cooking an egg - irreversible, new product, new properties

**Physical & Chemical Changes**

- In a **physical change**, a substance changes in form but not in its chemical composition.
- NO new substances are formed. eg. ice cube melts ... still H<sub>2</sub>O ... same atoms
- Physical changes may cause a change in state.  
 e.g. solid → liquid → gas
- Chemical changes are those in which new substances are formed.  
 e.g. rusting
- In chemical changes the substances that react are called REACTANTS, and the new substances that are produced are called PRODUCTS.

⇒ LAB + QUIZ

**How can you tell if a change is chemical?**

Some chemical changes are easy to observe. When fireworks explode, energy is released in the form of light, sound, and heat. Other chemical changes may be more difficult to observe.

If you can make two or more of the following observations, then a chemical change has occurred

- Change in colour
- Production/consumption of heat, light, or sound (Energy produced/used)
- Formation of gas bubbles (Bubbles)
- Formation of a solid (called a precipitate) when two liquids are mixed ⇒ solid
- One or more of the starting materials (reactants) are used up

Evidence of a chemical change (reaction)

**PRACTICE**

Identify whether the example is a physical change or a chemical change.

- (a) ice cream melting Physical
- (b) rust forming on a car Chemical
- (c) a tire inflating with air Physical
- (d) food digesting in the stomach Chemical
- (e) cutting a piece of paper into two pieces Physical
- (f) acid on limestone producing carbon dioxide gas Chemical

**ASSIGNMENT #6: Physical + Chemical Change Cut + Paste***This assignment is to be cut out the boxes on following page & paste below.*

<b>PHYSICAL CHANGE</b>	<b>CHEMICAL CHANGE</b>
<p><b>Definition:</b> a change in matter where no new molecules are formed</p> <p><b>Signs of this change:</b></p> <ul style="list-style-type: none"> <li>No change in: colour, odour, taste</li> <li>Temperature only changes if it has been heated or cooled</li> <li>May change state</li> <li>May become part of a mixture</li> <li>Usually can be reversed</li> </ul> <p><b>What happens:</b> the molecules don't change, they move farther apart, closer together or get mixed with another type of molecule</p> <p><b>Examples:</b></p> <ul style="list-style-type: none"> <li>Frost forming on a window</li> <li>Freezing a juice box</li> <li>Melting wax</li> <li>Oil paint drying</li> <li>Boiling water</li> <li>Heating oil for deep frying until it boils</li> <li>Melting butter in a hot pot</li> <li>Grating some cheese</li> <li>Dissolving sugar in hot tea</li> </ul>	<p><b>Definition:</b> a change where a new type of matter is formed with new properties and a new chemical formula</p> <p><b>Signs of this change:</b></p> <ul style="list-style-type: none"> <li>Change is: colour, odour, taste</li> <li>A gas is produced</li> <li>Temperature changes without being heated or cooled</li> <li>A precipitate is formed</li> <li>Often cannot be reversed (can be reversed sometimes)</li> </ul> <p><b>What happens:</b> atoms are rearranged to form new molecules with different chemical formulas</p> <p><b>Examples:</b></p> <ul style="list-style-type: none"> <li>Mixing cement with water and letting it dry</li> <li>Toasting bread</li> <li>Burning a log in your fireplace</li> <li>A rusting car</li> <li>Perming hair</li> <li>Burning a candle</li> <li>Frying an egg</li> <li>Baking a cake</li> <li>BBQ a steak</li> </ul>

**ASSIGNMENT #6: Physical + Chemical Change Cut + Paste***This assignment is to be cut out and glued on the previous page.***Physical vs. Chemical Change Cut and Paste**

<b>PHYSICAL CHANGE</b>	Example: toasting bread	Example: frying an egg
Example: frost forming on a window	Example: burning a log in your fireplace	Example: melting butter in a hot pot
Example: Freezing a juice box	Example: boiling water	<b>CHEMICAL CHANGE</b>
Example: melting wax	Example: a rusting car	Example: grating some cheese
Example: adding milk to coffee	Example: perming hair	Example: baking a cake
Example: mixing cement with water and letting it dry	Example: heating oil for deep-frying until it boils	Example: dissolving sugar in hot tea
Example: oil paint drying	Example: a burning candle	Example: BBQ a steak
<p><b>Signs of this change:</b></p> <ul style="list-style-type: none"> <li>Change is: colour, odour, taste</li> <li>A gas is produced</li> <li>Temperature changes without being heated or cooled</li> <li>A precipitate is formed</li> <li>Often cannot be reversed (can be reversed sometimes)</li> </ul>	<p><b>What happens:</b> the molecules don't change, they move farther apart, closer together or get mixed with another type of molecule</p>	<p><b>Signs of this change:</b></p> <ul style="list-style-type: none"> <li>No change in: colour, odour, taste</li> <li>Temperature only changes if it has been heated or cooled</li> <li>May change state</li> <li>May become part of a mixture</li> <li>Usually can be reversed</li> </ul>
<p><b>Definition:</b> a change where a new type of matter is formed with new properties and a new chemical formula</p>	<p><b>What happens:</b> atoms are rearranged to form new molecules with different chemical formulas</p>	<p><b>Definition:</b> a change in matter where no new molecules are formed</p>
Example: mixing sand and water	Example: a firecracker exploding	Example: mixing sugar and cinnamon

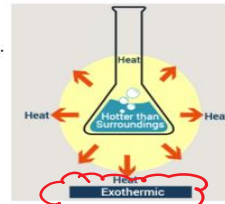
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**Energy Changes**

- Chemical and physical changes can either produce or consume ENERGY.
- We usually see this energy as a change in temperature. (measure)

**Exothermic Changes** EX = EXIT = "energy out"

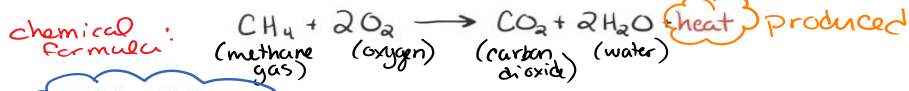
- If a reaction releases energy, it is called EXOTHERMIC.
- These changes can be:
  - physical changes that reduce the kinetic energy of a substance. For example, gas to liquid, Liquid to solid - in these changes matter is cooling down and the excess energy is given to their surroundings as Heat.



↓ temp = ↓ kinetic energy

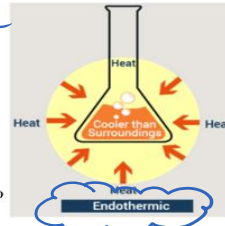
- A hot pan placed on a counter will heat the counter as the pan cools.
- chemical changes that release energy to the surroundings, for example burning wood. Energy is a product.

- Exothermic changes feel HOT because heat is released into the environment

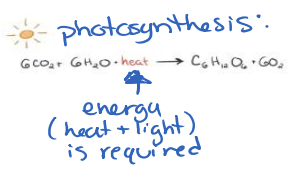


**Endothermic Changes** needs energy to react

- If a reaction absorbs energy, it is called ENDOTHERMIC.
- These changes can be:
  - physical changes that increase the kinetic energy of a substance. For example, solid to liquid, liquid to gas (melting, evaporating)
  - chemical changes that must absorb energy in order to proceed, for example baking cookies
- Endothermic changes feel COLD because heat is absorbed into the substances.



↑ temp = ↑ KE

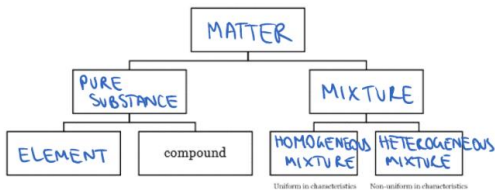


**Complete the Following Review Questions.**

Match the following:

- |                          |   |
|--------------------------|---|
| 1. <u>B</u> mass         | A. Amount of mass in a certain volume of a substance              |
| 2. <u>E</u> ductile      | B. Amount of matter in a substance                                |
| 3. <u>A</u> density      | C. Forms thin sheets  |
| 4. <u>G</u> state        | D. Cannot be broken down into simpler types of matter             |
| 5. <u>C</u> malleability | E. Forms thin wires   |
| 6. <u>F</u> conductivity | F. Measures how easily electricity or heat moves through a sample |
| 7. <u>D</u> element      | G. Can be solid, liquid or gas                                    |

8. Which of the following changes of state require the removal of energy?
- |                   |                |
|-------------------|----------------|
| I. Sublimation    | IV. Boiling    |
| II. Evaporation   | V. Solidifying |
| III. Condensation | VI. Melting    |
- A. I only.  
B. I, II and VI only.  
C. II, III and V only.  
D. III and V only.
9. Which of the following describes what happens when energy is added to a substance?
- A. Particles lose kinetic energy and vibrate faster.  
B. Particles gain kinetic energy and vibrate slower.  
C. Particles lose kinetic energy and vibrate slower.  
D. Particles gain kinetic energy and vibrate faster.
10. Fill in the classification of matter chart.



**Investigating matter**

Match each Term on the left with the best Descriptor on the right. Each Descriptor may be used only once.

Term	Descriptor
1. <u>D</u> volume	A. amount of mass in a certain volume of a substance
2. <u>A</u> density	B. amount of matter in a substance or an object
3. <u>F</u> state	C. cannot be broken down into simpler substances
4. <u>E</u> conductivity	D. amount of space that a substance or object takes up
5. <u>C</u> element	E. measure of how easily electricity or heat can pass through
	F. can be solid, liquid, or gas

Circle the letter of the best answer.

6. Which of the following describes mass?
- A. state of matter  
B. anything with mass and volume  
C. amount of matter in an object  
D. amount of space that an object occupies
7. Which of the following are the main points of the kinetic molecular theory?

I.	Particles are constantly moving.
II.	All matter is made up of very small particles.
III.	There are empty spaces between particles in a substance.

- A. I and II only  
B. I and III only

- C. II and III only  
D. I, II, and III
8. Which of the following describes what happens when heat is added to a substance?
- A. Particles lose kinetic energy and vibrate faster.  
B. Particles gain kinetic energy and vibrate faster.  
C. Particles gain kinetic energy and vibrate slower.  
D. Particles lose kinetic energy and vibrate slower.
9. Which of the following changes of state require the removal of heat?

I.	melting
II.	boiling

- A. I only  
B. II only  
C. both I and II  
D. neither I nor II
10. Which of the following is the temperature at which a solid changes into a liquid?
- A. boiling point  
B. melting point  
C. both A and B  
D. neither A nor B
11. Which of the following is the temperature at which a liquid changes into a gas?
- A. boiling point  
B. melting point  
C. both A and B  
D. neither A nor B

## Physical and chemical changes

Match each Term on the left with the best Descriptor on the right. Each Descriptor may be used only once.

Term	Descriptor
1. <u>E</u> physical change	A. heat is given off
2. <u>D</u> chemical change	B. heat is absorbed
3. <u>A</u> exothermic	C. does not involve heat
4. <u>B</u> endothermic	D. new products are formed
	E. appearance of substance changes

Circle the letter of the best answer.

5. Which of the following is an example of a physical change?

- A. a glacier melting
- B. a campfire burning
- C. an antacid tablet fizzing after it is placed in water
- D. carbon dioxide being produced in the engine of a running car

6. Which of the following is an example of a chemical change?

- A. a lake freezing over
- B. grinding rocks into gravel
- C. sugar dissolving in a cup of tea
- D. a candle burning

7. When an iron nail is left out in the rain, the iron combines with oxygen in the air to form iron (III) oxide, which is commonly known as rust. What do the iron and oxygen represent?

- A. the products
- B. the reactants
- C. the physical change
- D. the chemical change

8. A student adds a white powder to a clear liquid and the mixture begins to bubble. The student notices that the side of the container feels warm. What is this an example of?

I.	a physical change
II.	a chemical change
III.	an exothermic reaction
IV.	an endothermic reaction

- A. I and III only
- B. I and IV only
- C. II and III only
- D. II and IV only

9. Which of the following are evidence that a chemical change has occurred?

I.	a colour change
II.	a solid forms
III.	bubbles of gas form

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II, and III

## Endothermic or exothermic?

1. Define the following terms.

(a) exothermic A chemical process which releases (heat) energy

(b) endothermic \_\_\_\_\_

A chemical process which requires/uses (heat) energy

2. What type of process—exothermic or endothermic—is shown in each illustration?



(a) Exothermic (b) Endothermic

3. Identify each of the following changes as exothermic or endothermic by placing a checkmark in the correct box.

Description	Exothermic	Endothermic
(a) ice melting		<input checked="" type="checkbox"/>
(b) water boiling		<input checked="" type="checkbox"/>
(c) water freezing	<input checked="" type="checkbox"/>	
(d) dynamite exploding	<input checked="" type="checkbox"/>	
(e) fireworks lighting up the sky	<input checked="" type="checkbox"/>	
(f) trees burning during a forest fire	<input checked="" type="checkbox"/>	
(g) cold pack used for an injury		<input checked="" type="checkbox"/>
(h) gasoline burning in an engine	<input checked="" type="checkbox"/>	
(i) match burning after it is rubbed on a rough surface	<input checked="" type="checkbox"/>	