Topic: Chemical Combinations IV

Subtopics:

1. **States of Matter** – Solid, Liquid, Gas
2. **Kinetic Theory of Matter and its Applications**

Lesson Objectives:

At the end of this lesson, students should be able to:

- Describe the **three main states of matter** with detailed examples.
- State the basic ideas of the **Kinetic Theory of Matter**.
- Explain how the **kinetic energy of particles** affects the state of matter.
- Apply the **Kinetic Theory** to everyday physical changes (melting, boiling, diffusion, etc.).

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1. States of Matter

Matter exists in **three classical states**:

State	Examples
Solid	Ice, Wood, Iron, Salt, Stone
Liquid	Water, Oil, Milk, Mercury
Gas	Air, Oxygen, Carbon Dioxide, Steam

Characteristics of Each State

Property	Solid	Liquid	Gas
Shape	Fixed	No fixed shape (takes container's shape)	No fixed shape
Volume	Fixed	Fixed	No fixed volume

Property	Solid	Liquid	Gas
Particle Arrangement	Closely packed, orderly	Loosely packed, less orderly	Very far apart, random
Movement of Particles	Vibrate in place	Slide past one another	Move randomly and rapidly
Compressibility	Almost incompressible	Slightly compressible	Highly compressible
Diffusion	Very slow or none	Moderate	Rapid
Density	High	Moderate	Low

Changes in State of Matter

Matter can **change from one state to another** by adding or removing heat:

Change	Process Name
Solid → Liquid	**Melting**
Liquid → Gas	**Evaporation/Boiling**
Gas → Liquid	**Condensation**
Liquid → Solid	**Freezing**
Solid → Gas	**Sublimation** (e.g., Camphor, Iodine)
Gas → Solid	**Deposition** (e.g., Frost forming from water vapor)

Everyday Examples of State Changes

Process	Example
Melting	Ice turning into water
Boiling	Water turning into steam

Process	Example
Condensation	Water droplets on cold glass
Freezing	Water turning into ice
Sublimation	Camphor disappearing without melting

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2. Kinetic Theory of Matter

Basic Statement:

"All matter is made up of tiny particles (atoms, molecules, or ions) that are constantly in motion. The type of motion and the distance between the particles determine the state of matter."

Main Assumptions of Kinetic Theory:

1. **All matter is made of particles.**
2. These particles are in **constant motion**.
3. The **energy of the particles** depends on the temperature.
4. **Collisions between particles are elastic** (no energy is lost).
5. The **distance between particles** varies with the state of matter.

Particle Behavior in Different States

State	Particle Behavior
Solid	Particles vibrate in place; very little movement. Strong forces keep them together.
Liquid	Particles move freely but stay close; forces are weaker than in solids.
Gas	Particles move rapidly in all directions; no significant forces between them.

Diagrammatic Representation of Particles

Solid:

[•][•][•]
[•][•][•]
[•][•][•]
(Tightly packed)

Liquid:

[•] [•]
[•][•]
[•] [•]
(Loosely packed, moving past each other)

Gas:

[•] [•]
[•]
[•] [•]
(Far apart, moving randomly)

Effect of Temperature:

- **Heating** increases **kinetic energy** → particles move faster.
- **Cooling** decreases **kinetic energy** → particles move slower.

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3. Application of Kinetic Theory

Explaining the States of Matter

Property	Kinetic Explanation
Solid	Particles vibrate in fixed positions because kinetic energy is low and forces are strong.
Liquid	Particles have enough energy to move around but remain close together.
Gas	Particles have high kinetic energy, so they move freely and fill all available space.

Examples of Kinetic Theory in Action

1. Diffusion

Definition: The movement of particles from **an area of high concentration to an area of low concentration**.

Examples of Diffusion:

- **Perfume spreading** in a room.
- **Sugar dissolving** in water (diffusion of sugar molecules).
- **Smell of cooked food** reaching you in another room.

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2. Expansion and Contraction

- When heated, **particles move faster** and take up **more space** (expansion).
- When cooled, **particles slow down** and move **closer together** (contraction).

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3. Brownian Motion

- **Random zig-zag motion of particles** in a fluid, first observed by **Robert Brown**.
- This movement is caused by **collisions with invisible molecules**.
- Supports the kinetic theory because it proves particles in liquids and gases are **in motion**.

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4. Change of States

- **Melting**: Particles gain enough energy to **overcome attractive forces**.
- **Boiling**: Particles gain energy to **break free into gas**.
- **Freezing**: Particles **lose energy** and become fixed in place.
- **Sublimation**: Particles gain enough energy to go **directly from solid to gas**.

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4. Summary of Key Points

Concept	Meaning
Matter	Exists in solid, liquid, and gas states
Kinetic Theory	Particles are always moving
Diffusion	Spreading of particles
Brownian Motion	Random movement due to collisions
Change of State	Occurs due to changes in kinetic energy

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5. Importance of Kinetic Theory

- Explains the **properties of solids, liquids, and gases**.
- Helps understand **physical changes** (melting, boiling, condensation, etc.).
- Supports the **particle nature of matter**.
- Used in industries (e.g., refrigeration, air conditioning).