Unit 3.2 Phases of Matter

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Objectives

- Particle diagrams
  - Elements
  - Compounds
  - Mixtures
- Solids
- Liquids
- Gases
- Phase changes
  - Melting and freezing
  - Boiling, evaporation and condensation
  - Sublimation

Particle Diagrams

- Elements and compounds can be represented using particle diagrams, which is a box in which colored balls are draw to represent atoms or molecules.
- These diagrams can represent elements and compounds, as well as their molecular composition by the types of balls and how they are connected.
Particle Diagrams - Elements

- The following are examples of two particle diagrams of elements

![A monatomic element](image1)

![A diatomic element](image2)

Particle Diagrams - Compounds

- Compounds have more than one element connected to one another

Particle Diagrams - Mixtures

- Particle diagrams can represent pure substances or mixtures.

![A pure compound](image3)

![A mixture of two elements](image4)
Solids

- A solid has a fixed volume and fixed shape.
- Atoms are in direct contact and there is very little movement except for atomic vibrations.
- There are two types of solids:
  - Crystalline solids have a regular repeating three-dimensional pattern of atoms or molecules.
  - Amorphous solids do not have a regular repeating pattern of atoms or molecules.

Particle Diagram of a Crystalline Solid

- The crystalline solid has a fixed shape and volume, as well as a regular repeating pattern of atoms.

Liquids

- A liquid has a fixed volume, takes the shape of its container, does not have a regular repeating pattern of atoms or molecules, the atoms or molecules are in constant motion, not all atoms are in direct contact and there may be a meniscus due to the intermolecular forces of attraction between the liquid and its container.
Gases

- Gases expand to fill and take the shape of their container.
- Gas molecules are not in direct contact, are in constant motion, have elastic collisions and most of the volume is empty space.

Phase Changes

- A phase change involves going from one state of matter to another under a given set of conditions of pressure and temperature.

The Common Phase Changes

- Melting is the change from solid to liquid which occurs at a specific temperature, the melting point, for a pure substance. For water the opposite process of going from a liquid to a solid is called freezing.
- Boiling is a change in which the liquid changes to the gas phase with the formation of bubbles and occurs at a specific temperature for a pure substance under a given set of conditions.
Other Phase Changes

• **Evaporation** is a process in which a liquid is converted to the gas phase without the formation of bubbles. Molecules with enough kinetic energy break through the surface tension and go into the gas phase. This can occur at any set of condition for the liquid.

• **Sublimation** is a process in which a solid is directly converted to a gas. This usually occurs under condition of low pressure. A good example is solid CO\textsubscript{2} or dry ice.

Discussion Questions

• Draw a particle diagram for each of the following
  – A mixture of two monoatomic elements in the gas phase
  – Steam or water (H\textsubscript{2}O) in the gas phase.
  – A mixture of steam and carbon dioxide (CO\textsubscript{2}) gas