Warm-Up | Solids and Plasmas

Lesson Objectives

By the end of this lesson, you should be able to:

- Use kinetic-molecular theory to compare and contrast atomic or molecular motion in solids and plasmas.
- Describe how kinetic-molecular theory explains the properties of solids, including compressibility, shape, and volume.
- Describe how kinetic-molecular theory explains the properties of plasmas.

Science Practice: Give examples of plasmas in nature and technology.

Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

amorphous solid	a solid matter whose particles are arranged in a nonuniform pattern
crystal	a solid in which the particles are arranged in a regular, repeating pattern
lattice	a regular arrangement of particles (atoms, ions, or molecules)
long-range order	a term for an arrangement of particles in which the particles are ordered over many multiples of the average particle diameter

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W2K

Words to Know

plasma	a high-energy state of matter characterized by [ionized] particles
solid	a low-energy state of condensed matter characterized by structural rigidity and [resistance] to changes of shape or volume
thermal equilibrium	a term describing a [temperature] equal to that of the surroundings

Instruction | Solids and Plasmas

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Lesson Question: How do scientists describe the behavior of particles in solids and plasmas?

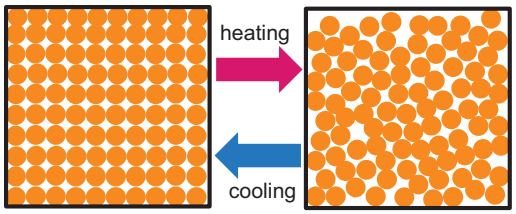
Slide 2

Solids and Kinetic-Molecular Theory

- Temperature decreases, kinetic energy decreases, and particle motion slows.
- Freezing: kinetic energy < intermolecular forces

Solids and Kinetic-Molecular Theory

Solid: a low-energy state of condensed matter characterized by structural rigidity and resistance to changes in shape or volume



Crystalline Solids

Crystal: solid characterized by an orderly periodic lattice of component particles

- Ordered
- Long-range order: describes an arrangement of particles in which the particles are ordered over many multiples of the average particle diameter

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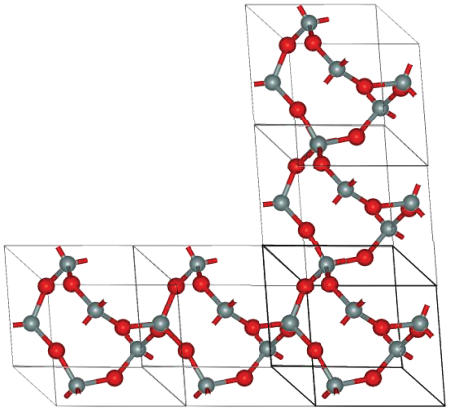
Slide 2

Crystalline Solids, Continued

Lattice: a regular arrangement of atoms, ions, or molecules

- Unit cell repeated to form crystal
- Incompressible, typically dense and hard
- Particles vibrate



Slide 4

Amorphous Solids

Amorphous solid: solid matter with particles that are arranged in a nonuniform pattern

- Rapid cooling doesn't allow for complete assembly of unit cells
- Long-range order absent
  - Particles ordered over many multiples of average particle diameter

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Properties of Plasmas

Plasma: a high-energy state of matter characterized by ionized particles

- Temperature may be thousands of degrees
- Conducts electricity
- Is compressible
- Has no definite shape or volume

Plasmas in Nature

Plasma will discharge those electrons at temperatures of almost 20,000 degrees Celsius.

- Lightning
- Stars
- Auroras

Human-Made Plasmas

- Fluorescent lights
- Ion thrusters
- Arc welders
- Plasma displays
- Plasma balls

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Slide 7

The Temperature of Plasma

Thermal **equilibrium**: Temperature is equal to the surroundings.

Plasmas can be cold when:

- Light electrons move fast (hot).
- Heavy nuclei are slow (cold).
- Electron kinetic energy is converted to light.
- Fewer than 1% of particles are ionized.
- They are non-thermal plasmas.

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Comparing Solids and Plasmas

Plasma	Solid
• Conducts electricity	• May or may not conduct electricity
• Has low density	• Has high density
• Fills available space	• Has fixed shape and volume
• Has high kinetic energy	• Has low kinetic energy
• Is made of electrons and cations	• Is made of neutral particles or cation-anion pairs

Summary | Solids and Plasmas

Lesson Question

How do scientists describe the behavior of particles in solids and plasmas?

Answer

(Sample answer) A solid is a low-energy phase of condensed matter characterized by rigidity, structure, and resistance to changes in shape or volume. Plasma is a high-energy phase of matter, and it contains ionized particles.

Slide 2

Properties of Solids

- Form at low [temperature]
- Have long-range order: particles fixed in place
- Have defined shape and volume
- Are a [low-energy] state of matter
- Are dense (incompressible)

Summary | Solids and Plasmas

Slide 2

Properties of Plasmas

- Form at high temperature
- Have short-range order: particles have little interaction
- Fill all available space; no fixed shape or volume
- Are the highest energy state of matter
- Are highly compressible
- Conduct electricity extremely well

Use this space to write any questions or thoughts about this lesson.