Learning Target: I can develop models to describe the movement of particles in solids, liquids, gases, and plasma.

FSI Physical Science Reading for Meaning – The Hidden Dance of Particles: Understanding States of Matter and Molecular Motion

Imagine a block of ice melting on a warm day. To the naked eye, it simply changes from a solid to a liquid. But beneath the surface, an invisible dance of molecules is taking place — a dance that determines the **state of matter**.

All matter is made of particles — atoms or molecules — that are in constant motion. The **speed and arrangement** of these particles depend on the **amount of thermal energy** they have.

Solids: The Locked Dancers

In solids, particles are packed tightly together in a fixed pattern. They don't move freely but vibrate in place. This close arrangement gives solids a **definite shape and volume**. When thermal energy increases, the particles vibrate faster, weakening the forces that hold them together.

Liquids: The Flowing Dancers

In liquids, particles are still close together but not in fixed positions. They **slide and flow** past each other, allowing liquids to take the **shape of their container** while maintaining a **constant volume**. As more heat is added, particle motion increases, and eventually, some particles gain enough energy to break free from the surface — turning into a gas through **evaporation** or **boiling**.

Gases: The Free Dancers

In gases, particles are **far apart** and move **freely and rapidly** in all directions. This high energy and random motion allow gases to **expand** and **fill any container**. The particles collide frequently, creating **pressure** on the container's walls.

Plasma: The Electrified Dancers

When enough energy is added, gases become **plasma**, a state of matter found in stars and lightning. In plasma, electrons are stripped from atoms, creating a mix of charged particles. Plasma behaves differently because it responds to **electric and magnetic fields**.

Molecular Motion and Temperature

The motion of particles increases as temperature rises. This relationship explains why heating a gas can increase pressure — faster-moving molecules hit the container walls more forcefully. Conversely, cooling matter slows down molecular motion, causing gases to condense into liquids or liquids to freeze into solids.

The Energy Connection

Changes in the state of matter are caused by **energy transfer** — specifically, the **absorption or release of heat**. When ice melts, it absorbs energy; when steam condenses, it releases energy. No matter the state, the same principle applies: **energy changes motion**, and **motion defines matter's behavior**.

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1. A scientist heats a sealed container of liquid water until it becomes steam. Which explanation best describes what happens to the particles during this change? (DOK 3)
A. The particles stop moving and become evenly spaced.
B. The particles move faster and overcome the attractions holding them together.
C. The particles slow down and form stronger bonds.
D. The number of water molecules decreases as energy increases.

2. When gas particles inside a container collide with the container walls more frequently, what can be inferred about the system? (DOK 3)
A. The container is losing energy.
B. The temperature has decreased.
C. The molecular motion has increased, raising the pressure.
D. The gas is changing into a liquid.

3. A student places a balloon in a freezer and observes that it shrinks. Which reasoning best explains this observation? (DOK 3)
A. The cold air pushes on the balloon.
B. The gas particles inside slow down and collide less often, decreasing pressure.
C. The particles inside stop moving completely.
D. The balloon material contracts when energy is added.

4. Compare molecular motion in plasma and gas. Which statement best differentiates the two? (DOK 3)
A. Plasma particles vibrate more slowly than gas particles.
B. Gas particles are charged while plasma particles are neutral.
C. Plasma consists of charged particles moving at higher energies than gases.
D. Both plasma and gas have particles fixed in place.

5. A solid is heated until it changes directly to a gas without becoming a liquid. Which model best represents the particle motion before and after the change? (DOK 3)
A. Particles remain tightly packed in both phases.
B. Particles vibrate in place, then move freely and rapidly apart.
C. Particles move closer together as temperature increases.
D. Particles stay at the same speed but rearrange.

6. During an investigation, students record that heating a gas increases both its temperature and pressure. Which conclusion best explains the relationship between molecular motion and pressure? (DOK 3)
A. The gas particles expand in size, pressing harder on the walls.
B. Faster-moving particles collide with container walls more often and with greater force.
C. The gas forms new chemical bonds under pressure.
D. The number of gas particles increases as heat is added.

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7. Two sealed containers hold equal volumes of gas: one at 50°C and one at 100°C. Predict how the molecular motion and pressure compare. (DOK 4)

A. The 100°C gas has slower molecules and lower pressure.
B. The 50°C gas has faster molecules and higher pressure.
C. The 100°C gas has faster-moving molecules and higher pressure.
D. Both have equal motion and pressure since the volume is constant.

8. In which scenario do particles have the strongest attractive forces between them? (DOK 3)

A. Steam in a boiling kettle
B. Rainwater in a puddle
C. Ice forming in a freezer
D. Lightning in a thunderstorm

9. If a solid's particles begin to move more freely and slide past each other, what energy transformation has occurred? (DOK 3)

A. Kinetic energy was lost to potential energy.
B. Thermal energy increased particle motion.
C. Electrical energy was absorbed.
D. Chemical energy changed into sound.

10. A teacher asks students to model how water molecules behave in the atmosphere. One student shows molecules colliding so forcefully that electrons are stripped away. Which state of matter and energy level does this represent? (DOK 3)

A. Gas; low energy
B. Liquid; moderate energy
C. Plasma; extremely high energy
D. Solid; no energy

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