Particle-Level Reasoning Practice

1. A sample of gas is heated from 300 K to 400 K while the volume remains constant. Explain, at the particle level, why the pressure of the gas increases.

2. The temperature of a reaction is increased. Explain, at the particle level, why the reaction occurs at a faster rate.

3. The concentration of hydrochloric acid is increased while reacting with magnesium. Explain, at the particle level, why the reaction occurs faster.

4. Two equal masses of calcium carbonate react with hydrochloric acid. One sample is a large piece, while the other is powdered. Explain, at the particle level, why the powdered sample reacts faster.

5. A gas is compressed into a smaller container while its temperature remains constant. Explain, at the particle level, why the pressure increases.

6. Two samples of the same substance are at different temperatures. Explain what is different about the particles in the warmer sample.

7. A solid is heated until it melts. Explain, at the particle level, what happens to the particles and the intermolecular forces between them.

8. A liquid is heated until it boils. Explain, at the particle level, why some particles are able to escape from the liquid and become a gas.

9. A gas is cooled until it condenses into a liquid. Explain, at the particle level, what happens to the motion and arrangement of the particles.

Answer Key

1. Temperature

Increasing temperature increases the average velocity and kinetic energy of the gas particles. The faster particles collide with the container walls more frequently and with greater energy, increasing the pressure.

2. Temperature and Reaction Rate

Increasing temperature increases the average velocity of the particles. The particles collide more frequently and have greater average kinetic energy. Therefore, a greater fraction of collisions have enough energy to overcome the activation energy, resulting in more successful collisions per unit time.

3. Concentration

Increasing the concentration puts more reactant particles in the same volume. This increases the frequency of collisions between reactant particles, resulting in more successful collisions per unit time and a faster reaction.

4. Surface Area

The powdered calcium carbonate has more surface area exposed to the hydrochloric acid. More reactant particles are therefore available to collide with particles in the acid, increasing the frequency of collisions and the number of successful collisions per unit time.

5. Pressure

Compressing the gas puts the same particles into a smaller volume. The particles have less distance to travel before reaching the walls, so they collide with the walls more frequently. This increases the pressure.

6. Temperature and Particle Motion

The particles in the warmer sample have greater average kinetic energy and therefore move faster on average than the particles in the cooler sample.

7. Melting

As the solid is heated, its particles gain average kinetic energy and move more vigorously. The increased particle motion allows the particles to move farther apart and weakens or overcomes some of the intermolecular attractions holding them in fixed positions. The particles are then able to move more freely as a liquid.

8. Boiling

As the liquid is heated, the particles gain average kinetic energy and move faster. Some particles have enough kinetic energy to overcome the intermolecular attractions holding them in the liquid, allowing them to separate from neighboring particles and enter the gas phase.

9. Condensation

As the gas is cooled, the particles lose average kinetic energy and move more slowly. The particles move closer together, allowing intermolecular attractions to become more significant and causing the particles to form a liquid.