

## DENSITY VARIES WITH TEMPERATURE

(Review the *Kinetic Molecular Theory* before proceeding.)

Most substances, whether solids, liquids, or gases, expand slightly when heated. That means that the volume of the substance is being increased but its mass is not changing. Looking at the formula for density  $D=M/V$ , if the volume of the substance is increasing and the mass stays the same, the density of the substance must be decreasing. Therefore, it can be said that, in general, when a substance is heated, its density decreases.

### I. What Happens At The Molecular Level When A Solid Substance Is Heated?

#### Reviewing the kinetic molecular picture of a solid

Molecules that are almost touching because they are strongly attracted to each other are vibrating. Even though the molecules are vibrating, they maintain the same set of nearest neighbors.

As heat is applied to the solid, the range (amplitude) of vibration increases. This means that, as it is heated, the solid material is extending itself farther into the space around it; i.e., the volume of the solid is increasing but the mass stays constant.

### II. What Happens At the Molecular Level When A Liquid Substance Is Heated?

#### Reviewing the kinetic molecular picture of a liquid

Molecules are about one diameter apart. These molecules are in motion. Because they are only weakly attracted to each other, they are constantly exchanging nearest neighbors as they move about from one location to another in the confined space of the container that holds the liquid.

When heat is applied to the liquid, the molecules move about faster and get a little farther apart from the neighboring molecules that they are constantly exchanging. This means that, as it is heated, the liquid extends itself farther into the space around it; i.e., the volume of the liquid is increasing but the mass stays constant.

### III. What Happens At The Molecular Level When A Gaseous Substance Is Heated?

#### Reviewing the kinetic molecular picture of a gas

Molecules are about ten diameters apart. Because of the distance between them, these molecules are not attracted to each other. They are simply moving rapidly in space in aimless motion.

When heat is applied to the gas, the speed of the molecules increases and they move even farther apart from each other. This means that, as it is heated, the gas extends itself farther into the space around it; i.e., the volume of the gas is increasing but the mass stays constant.