

A change in a substance that does not involve a change in the identity of the substance is called a **physical change**. Examples of physical changes include grinding, cutting, melting, and boiling a material. These types of changes do not change the identity of the substance present.

Melting and boiling are part of an important class of physical changes called changes of state. As the name suggests, a **change of state** is a physical change of a substance from one state to another. The three common states of matter are solid, liquid, and gas.

Matter in the **solid** state has definite volume and definite shape. For example, a piece of quartz or coal keeps its size and its shape, regardless of the container it is in. Solids have this characteristic because the particles in them are packed together in relatively fixed positions. The particles are held close together by strong attractive forces between them, and only vibrate about fixed points.

Matter in the **liquid** state has a definite volume but an indefinite shape; a liquid assumes the shape of its container. For example, a given quantity of liquid water takes up a definite amount of space, but the water takes the shape of its container. Liquids have this characteristic because the particles in them are close together but can move past one another. The particles in a liquid move more rapidly than those in a solid. This causes them to overcome temporarily the attractive forces between them, allowing the liquid to flow.

Matter in the **gas** state has neither definite volume nor definite shape. For example, a given quantity of helium expands to fill any size container and takes the shape of the container. All gases have this characteristic because they are composed of particles that move very rapidly and are at great distances from one another compared with the particles of liquids and solids.

At these great distances, the attractive forces between gas particles are much weaker than those in liquids and solids.

An important fourth state of matter is **plasma**. Plasma is a *high-temperature physical state of matter in which atoms lose their electrons* (which you may know about from your earlier work in general science). Plasma is found in a fluorescent bulb.

Melting, the change from solid to liquid, is an example of a change of state. Boiling is a change of state from liquid to gas. Freezing, the opposite of melting, is the change from a liquid to a solid. A change of state does not affect the identity of the substance. For example, when ice melts to liquid water or when liquid water boils to form water vapor, the same substance, water, is still present, as shown in Figure 1-6. The water has simply changed state, but it has not turned into a different compound. Only the distances and interactions between the particles that make up water have changed.

Chemical Properties and Chemical Changes

Physical properties can be observed without changing the identity of the substance, but properties of the second type—chemical properties—cannot. A **chemical property** relates to a substance's ability to undergo changes that transform it into different substances. Chemical properties are easiest to see when substances react to form new substances.

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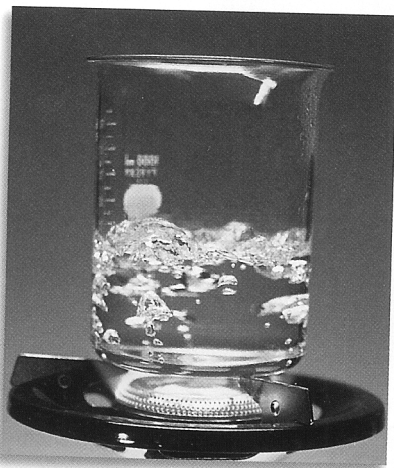


FIGURE 1-5 Water boils at 100°C no matter how much water is in the container. Boiling point is an intensive property.