

Changes of State

As you may recall from earlier studies, the process of melting is an example of a **change of state**, which occurs when the physical state of a substance is transformed into another state. Figure 4.3 shows changes of state. The change from solid to liquid is called **melting**, and the change from liquid to gas is called **vaporization**. These changes of state occur when the substance is heated and the particles of the substance gain energy. If you were to cool the substance, the reverse changes of state would occur because the particles lose energy. The change from gas to liquid is called **condensation**, and the change from liquid to solid is called **freezing**.

An unusual change of state occurs when a solid turns into its gaseous state without going through the liquid state. This change of state is known as **sublimation**. An example of sublimation occurs when dry ice is used at a rock concert — a chunk of frozen carbon dioxide (a solid) gains energy and gives off a thick cloud of fog (carbon dioxide gas). Figure 4.4 shows this change of state. The change from a gas directly to a solid is called sublimation as well. An example of this occurs when frost forms on windows on bitterly cold days (water vapour in the air loses energy rapidly and forms snowy ice).

Figure 4.3
Changes of state

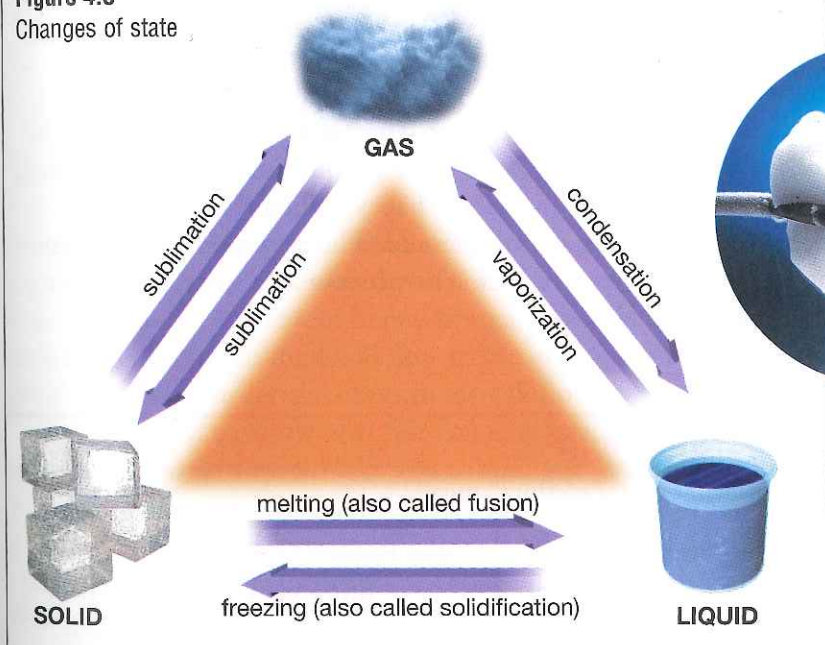


Figure 4.4 Solid carbon dioxide is called dry ice because it does not become a liquid before it becomes a gas. Dry ice is much colder than regular ice, so a fog of condensed water vapour forms as air surrounding it cools. This result is often used for special effects in television, film, and theatre.

Pause & Reflect

How do raindrops form? If clouds contain water vapour and remain suspended in the sky, try to explain what you think happens inside the clouds to form rain. Using the word “condensation,” write an explanation in your Science Log. You may draw a sketch to illustrate your answer.

Word CONNECT

What if you wanted to describe the change of state from liquid to solid for a metal, such as copper, or a non-metal, such as wax? Neither one of these substances can be said to “freeze” back into a solid. What verb would you use to describe this change of state? Look for a clue in Figure 4.3.

Did You Know?

What is the difference between a gas and a vapour? A substance is called a gas if it exists as a gas at room temperature (for example, oxygen gas or carbon dioxide gas). The same substance is called a vapour if it normally exists as a solid or a liquid at room temperature (for example, water vapour or perfume vapour).



Off the Wall

Did you know that science fiction script writers often feature changes of state in imaginary ways? “Morphing” has become one of the most popular special effects developed for science fiction movies. By means of computer-generated graphics, characters on screen appear to metamorphose, or morph, into someone or something else. In some movies, for example, solid beings appear to morph into a liquid that can creep under doors, or slip through cracks, and then quickly resolidify. Morphing has also become a popular feature of music videos, television programs, and commercials.

Word CONNECT

In your Science Log, write a short story that involves “morphing.” Include an illustration of the morphing process that occurs in your story.

Evaporation is slow vaporization. It occurs over a wide range of temperatures. A wet towel will dry even if the air temperature is not high. On a cool day it will simply take longer for the water to evaporate from the towel.

Boiling is rapid vaporization. It occurs at a specific temperature, called the **boiling point**. The boiling point of water is 100°C (at sea level). Similarly, every substance has its own **freezing point and melting point**. The freezing point of water, for example, is 0°C (at sea level). This is the temperature at which liquid water freezes. It is also the temperature at which ice melts — its melting point. Figure 4.5 illustrates the melting point of two other substances: paraffin (wax) and silver. The pictures show how the properties of a substance, such as the melting point, can have valuable uses. When normally solid substances are melted, the liquid can be poured into moulds of various shapes. When the substance is cooled, it solidifies and takes the shape of the mould. The result can be a wax candle, a silver teapot, and many other products. The processes pictured here make good use of flowing liquids and viscosity.

Paraffin melts between 50°C and 57°C .



Figure 4.5 Every substance has its own melting point.

Check Your Understanding

- In your own words, what does “to flow” mean?
- Classify the following items as fluids or as non-fluids.

shampoo	pencil	honey	thumbtacks	hairspray
thread	sap	paper	nail polish	balloon
blood	air	molten lava	smoke	perfume
sugar	natural gas	ash	gravel	snow
- How could you test whether or not a substance is a fluid?
- A substance has a definite volume but an indefinite shape. Is the substance a solid, a liquid, or a gas?
- Apply** Use the particle theory to explain why ice cubes form in your freezer.
- Thinking Critically** Describe a place or a situation in which you could find water as a solid, a liquid, and a gas all at the same time.
- Thinking Critically** Which substances could you use to demonstrate “morphing”? Are these substances fluids? For each substance, explain your answer.