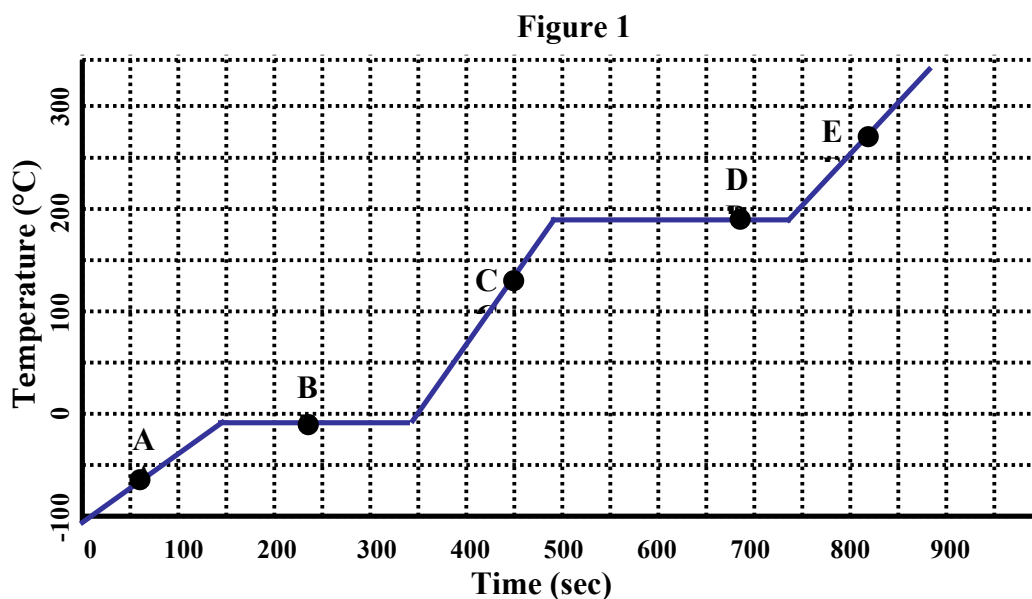


## Heating Curve

Most substances can exist in three different states – a solid, a liquid and a gas state. Changes from one state to another commonly occur by heating or cooling a sample of the substance.

**Melting** refers to the change of a sample from the solid to the liquid state at its melting point temperature. **Boiling** refers to the change of a sample from the liquid to the gaseous state at its boiling point temperature.

Consider a substance that is present in a sealed container in its solid state at a temperature well below its melting point. Over the course of about 15 minutes, the container is heated. At first, the application of heat causes the temperature of the substance to increase until it reaches its melting point temperature. At its melting point temperature, heat is continually added, causing the solid to transition to a liquid at a constant temperature. Once all the solid has melted, the substance is heated to its boiling point temperature. At its boiling point temperature, the addition of heat causes the liquid to transition to a gas at a constant temperature. Once all the liquid has boiled, the sample continues to be heated (cautiously), causing the temperature of the gas to increase. This process is depicted in **Figure 1**.

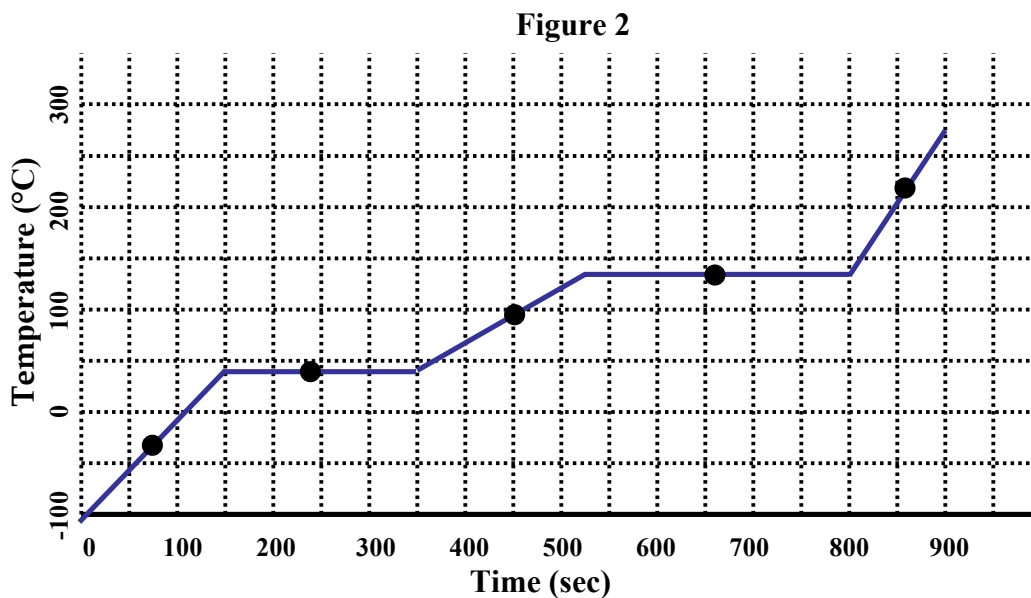




### Questions:

- According to **Figure 1**, in what state does the sample exist at a time of 100 seconds?
  - Solid state only.
  - Liquid state only.
  - Gas state only.
  - Both the solid and the liquid state.
  - Both the liquid and the gas state.
- According to **Figure 1**, in what state does the sample exist at a time of 600 seconds?
  - Solid state only.
  - Liquid state only.
  - Gas state only.
  - Both the solid and the liquid state.
  - Both the liquid and the gas state.
- According to **Figure 1**, at what temperature does the substance transition between the solid state and the liquid state?
  - Approximately  $-65^{\circ}\text{C}$
  - Approximately  $-7^{\circ}\text{C}$
  - Approximately  $135^{\circ}\text{C}$
  - Approximately  $190^{\circ}\text{C}$
- What is the sample of matter in **Figure 1** in the process of doing at a time of 310 seconds?
  - It's temperature is increasing.
  - It is changing from a solid to a liquid state.
  - It is changing from a liquid to a gaseous state.
  - More than two of the above are occurring.
- What is the sample of matter in **Figure 1** in the process of doing at a time of 760 seconds?
  - It's temperature is increasing.
  - It is changing from a solid to a liquid state.
  - It is changing from a liquid to a gaseous state.
  - More than two of the above are occurring.
- There are five labeled points on the line of the graph in **Figure 1**. What state(s) of matter would be observed in the sample at **point C**?
  - Solid state only.
  - Liquid state only.
  - Gas state only.
  - Both the solid and the liquid state.
  - Both the liquid and the gas state.
- According to **Figure 1**, what state(s) of matter would be observed in the sample when it is at a temperature of  $-50^{\circ}\text{C}$ ?
  - Solid state only.
  - Liquid state only.
  - Gas state only.
  - Both the solid and the liquid state.
  - Both the liquid and the gas state.
- Which one of the following statements are true of the sample of matter described by **Figure 1**?
  - As heat is added to the sample, its temperature always increases.
  - The solid state would be observed in the sample at both 100 seconds and 200 seconds.
  - The solid state would be observed in the sample at both 200 seconds and 400 seconds.
  - The sample is in the process of boiling between a temperature of about  $0^{\circ}\text{C}$  and  $190^{\circ}\text{C}$ .

9. There are five labeled points on the line of the graph in **Figure 1**. What changes, in order, are observed in the sample of matter between **point A** and **point B**?
  - a. First the sample melts; then its temperature stabilizes.
  - b. First the sample increases its temperature; then it melts.
  - c. First the sample melts; then its temperature increases; then it boils.
  - d. First the sample increases its temperature; then it melts; then its temperature increases.
  
10. There are five labeled points on the line of the graph in **Figure 1**. At which of the labeled points is the sample 100% liquid?
  - a. The sample is entirely (100%) liquid only at **point B**.
  - b. The sample is entirely (100%) liquid only at **point C**.
  - c. The sample is entirely (100%) liquid only at **point D**.
  - d. The sample is not 100% liquid at any of the labeled points; this occurs between points.
  
11. There are five labeled points on the line of the graph in **Figure 1**. At which of the labeled points is the sample a mixture of liquid and gas?
  - a. The sample is a mixture of liquid and gas at **point C**.
  - b. The sample is a mixture of liquid and gas at **point D**.
  - c. The sample is a mixture of liquid and gas at **point E**.
  - d. There could never be a mixture of both liquid and gas under these conditions.
  
12. Suppose that **Figure 1** represents the so-called *heating curve* for **Substance A**. **Figure 2** below represents the *heating curve* for **Substance B**.



What conclusion can be drawn regarding the melting points and boiling points of **Substance A** and **Substance B**?

- a. **Substance A** has a higher melting point and a higher boiling point than **Substance B**.
- b. **Substance B** has a higher melting point and a higher boiling point than **Substance A**.
- c. **Substance A** has the higher melting point but **Substance B** has the higher boiling point.
- d. **Substance B** has the higher melting point but **Substance A** has the higher boiling point.