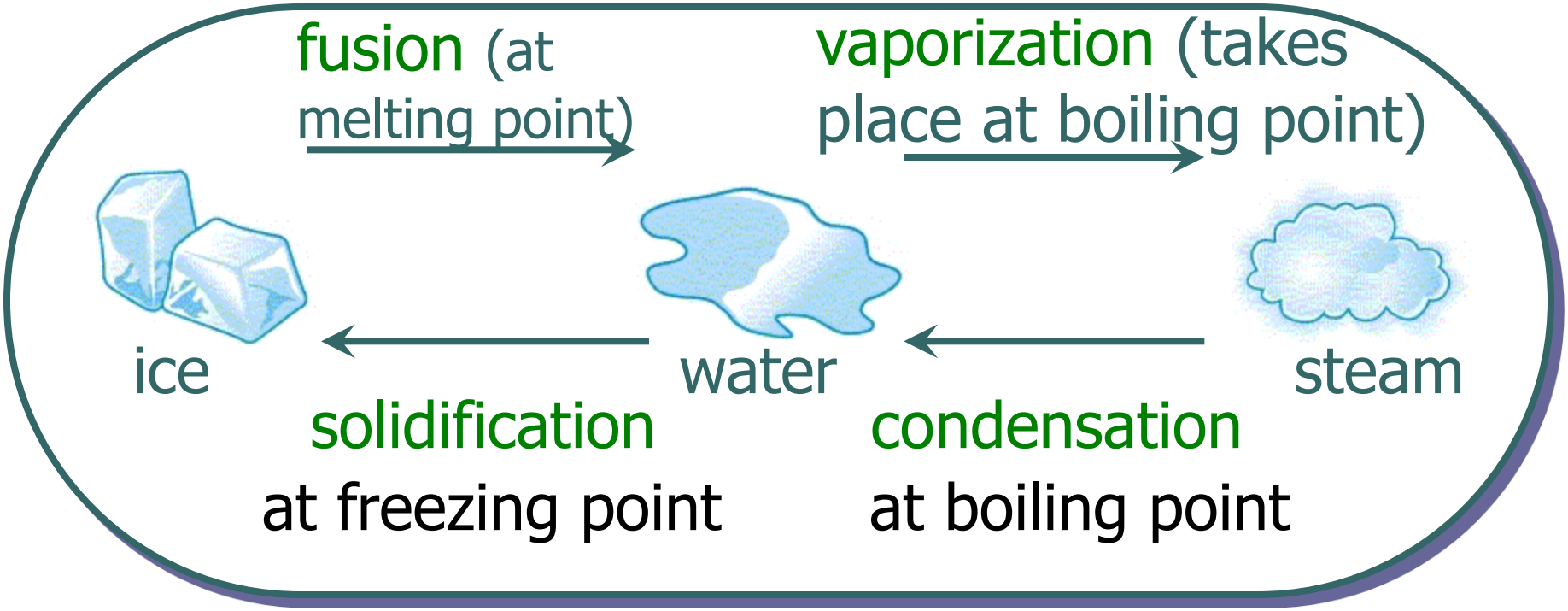
Latent Heat

Change of State

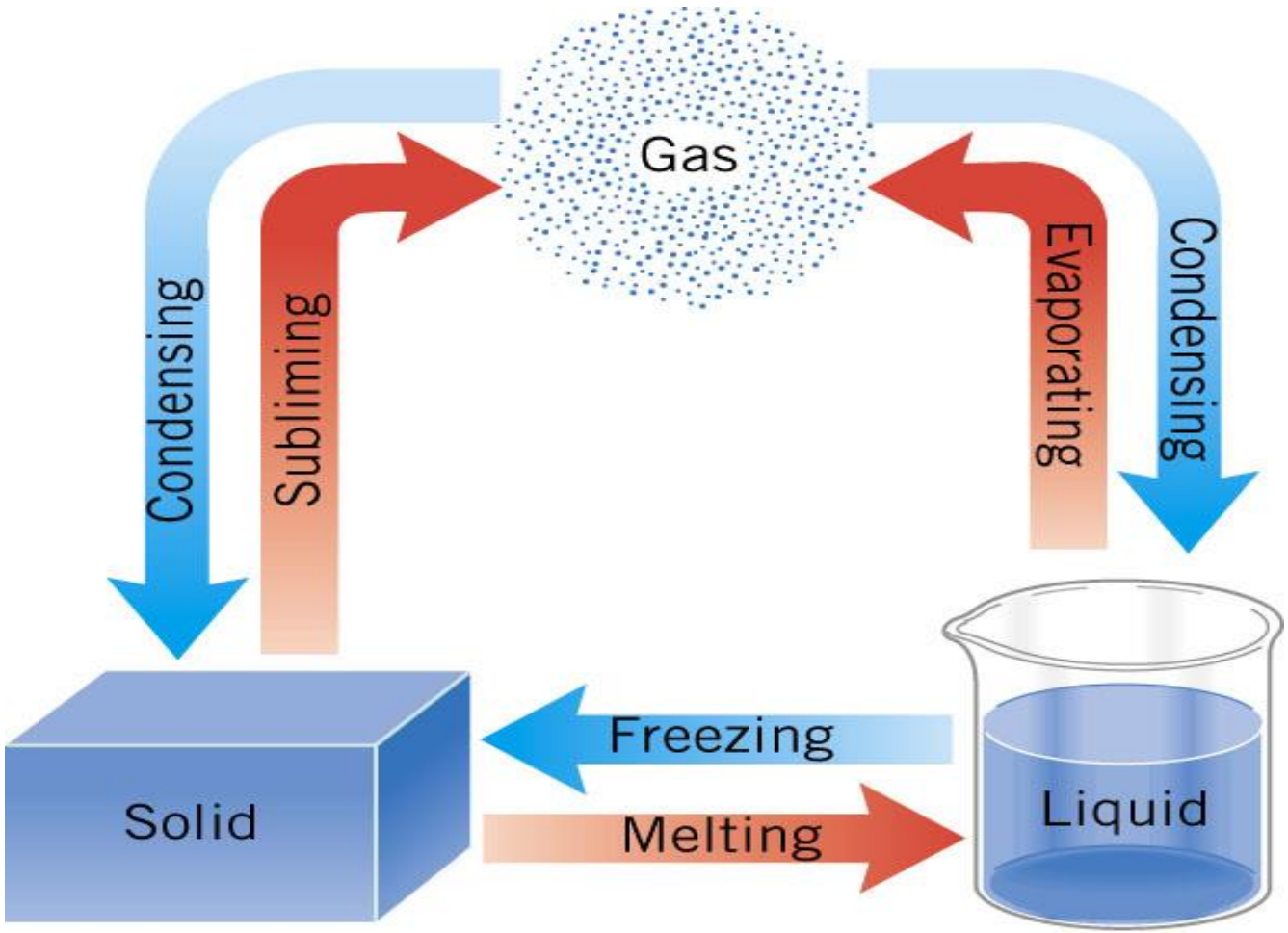
Matter exists in 3 states:

- Solid
- Liquid
- Gas

Consider water:



Phase Changes




D
Sublimation of CO_2
Dry Ice

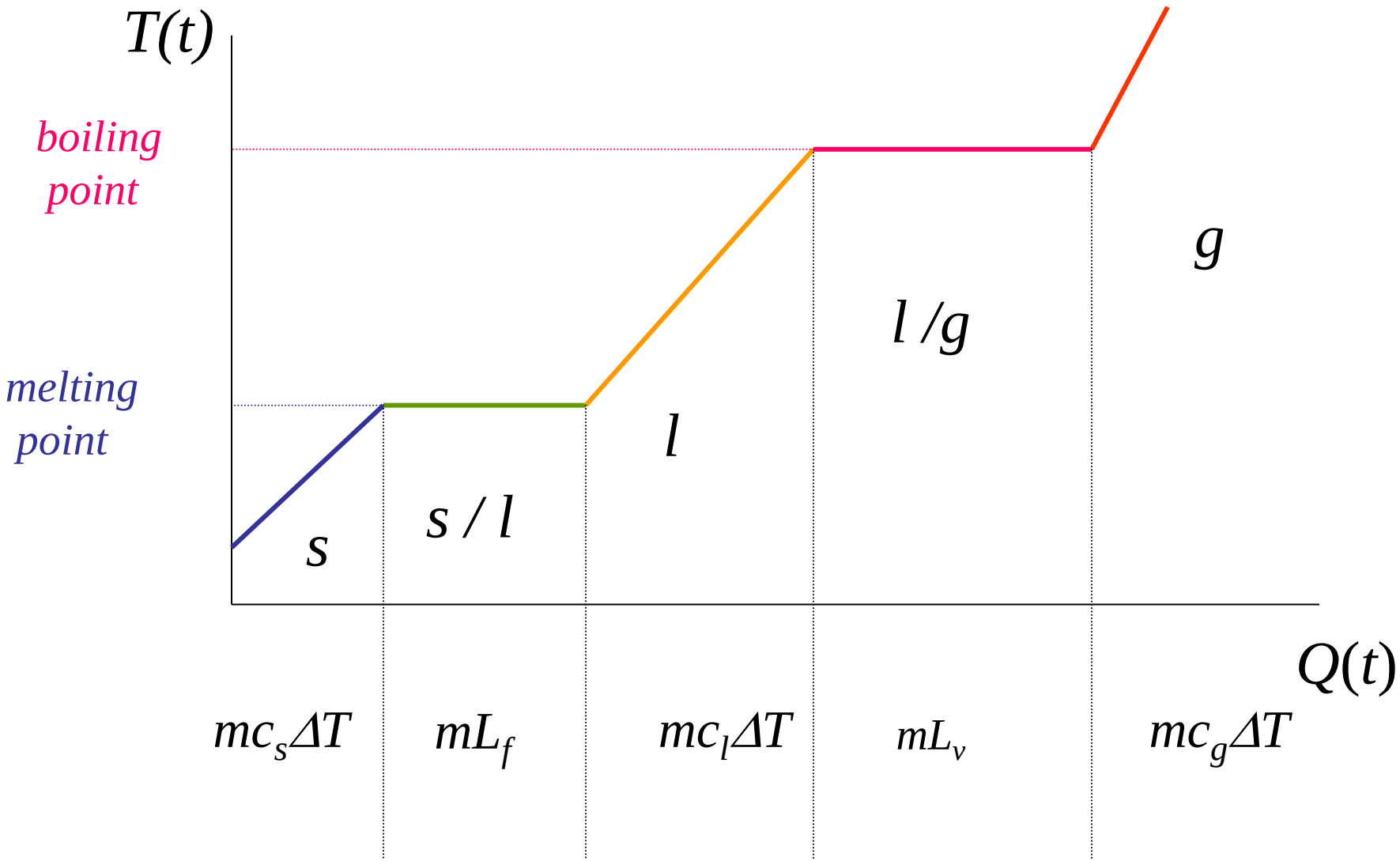
Heats of Transformation

- When energy is absorbed as heat by a solid or liquid, the temperature of the object does not necessarily rise.
- The thermal energy may cause the mass to change from one phase, or state, to another.
- The amount of energy per unit mass that must be transferred as heat when a mass undergoes a phase change is called the heat of transformation, L.

Heat of Fusion

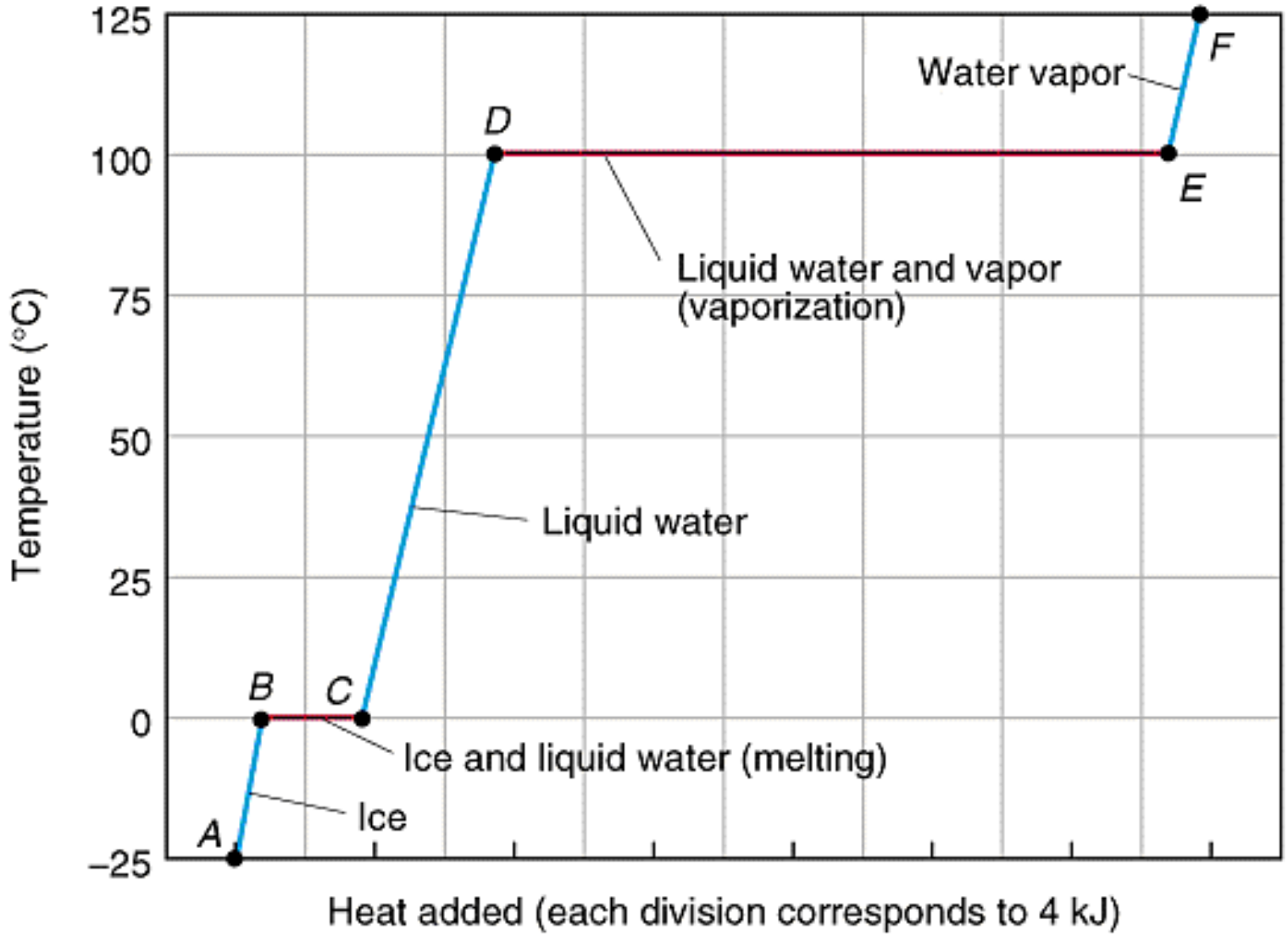
- To melt a solid means to change its from the solid state to the liquid state. This process requires energy because the molecules of the solid must be freed from their rigid structure.
- To freeze a liquid to form a solid is the reverse of melting and requires that energy be removed from the liquid so that the molecules can settle into a rigid structure.

Simple model for heating a substance at a constant rate



Phase Changes

Heating Curves



Heat of Fusion

- When the phase change is from solid to liquid, the sample must absorb heat; when the phase change is from a liquid to solid, the sample must release heat.
- The heat of transformation for these phase changes is called the heat of fusion, L_f.

$$\mathbf{Q = m \cdot L_f}$$

- Water: $L_f = 334$ J/kg

Sample Problem 1

- How much energy is needed to melt 0.225 kg of lead so that it can be used to make a lead sinker for fishing? The sample has an initial temperature of 27.3 C and is poured in the mold immediately after it has melted. (pg. 381 # 3)

Heat of Vaporization

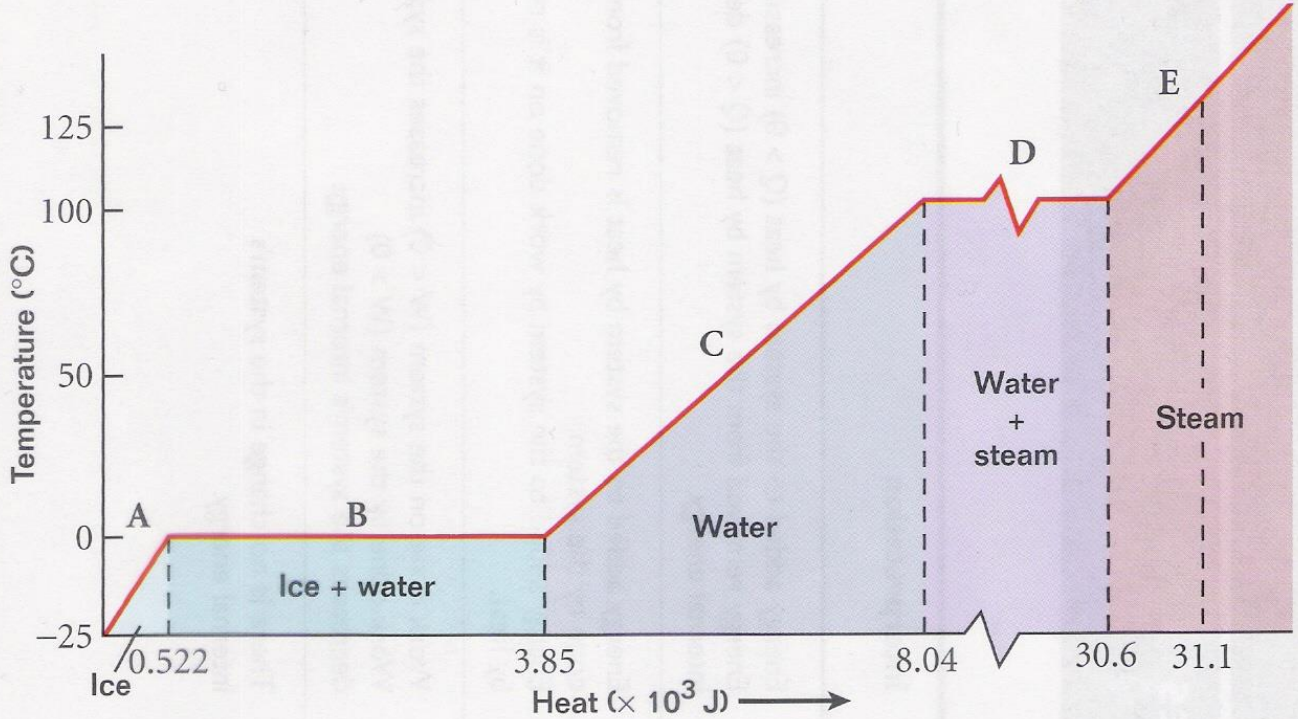
- To vaporize a liquid means to change it from the liquid state to the vapor or gas state. This process requires energy because the molecules must be freed from the liquid state.
- Condensing a gas to a liquid is the reverse of vaporizing; it requires that energy be removed from the gas so that the molecules can cluster together instead of flying away from each other.
- The heat of transformation for these phase changes is called the heat of vaporization, L_v.

$$\mathbf{Q = m \cdot L_v}$$

- Water: $L_v = 2.26 \times 10^{6}$ J/Kg

Sample Problem 2

- Liquid nitrogen, which has boiling point of -196.81 C, is commonly used to cool substances to low temperatures. How much energy must be removed from 1.0 kg of gaseous nitrogen at -196.81 C for it to completely liquefy? (pg. 381 # 2)



Changes occurring during the heating of 10.0 g of ice

Segment of graph	Type of change	Amount of energy transferred by heat	Temperature range of segment
A	temperature of ice increases	522 J	−25°C to 0°C
B	ice melts; becomes water	3.33×10^3 J	0°C
C	temperature of water increases	4.19×10^3 J	0°C to 100°C
D	water boils; becomes steam	2.26×10^4 J	100°C
E	temperature of steam increases	502 J	100°C to 125°C

Sample Problem 3

- Heat is added to 0.5 kg of water at 20° C. How many joules of heat energy are required to change the water to steam at 110° C?