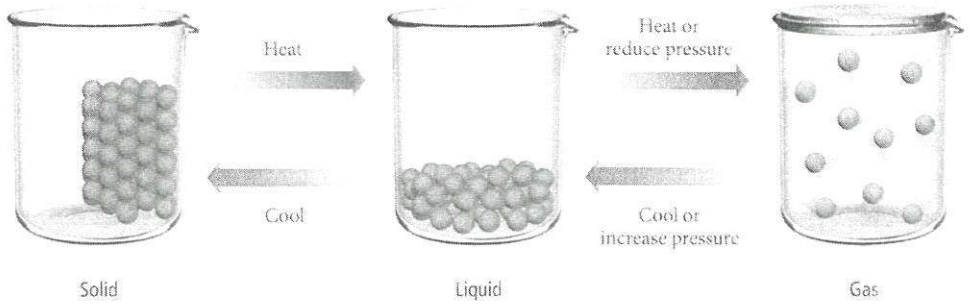
IMFs in Action = Heating Curves

KMT: The kinetic-molecular theory is based on the idea that particles of matter are always in motion.



KMT, IMFs and Changes of State: because attractive forces between the molecules are fixed, changing a material's state of matter require changing the amount of kinetic energy the particles have, or limiting their freedom.

1. **Gaseous state**: particles have Complete freedom of motion.
   a. Their kinetic energy overcomes the attractive forces between the molecules.
2. **Liquid state**: particles have limited freedom; they can move around a little within the liquid.
   a. They have enough kinetic energy to overcome Some of the attractive forces, but not enough to escape each other.
3. **Solid state**: particles are locked in place, they cannot move around.
   a. Although the particles vibrate, they do NOT have enough kinetic energy to overcome the attractive forces.

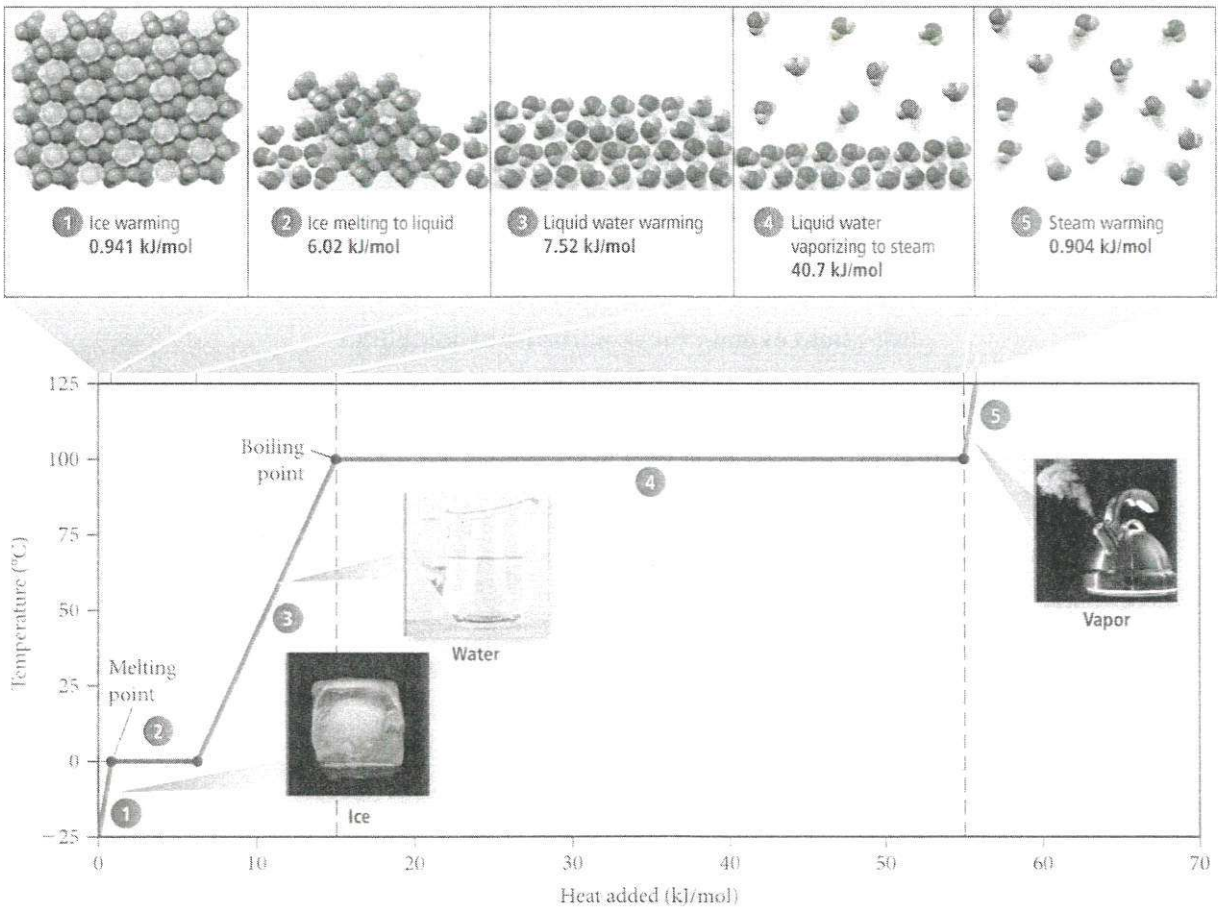
The strength of the attractive forces between particles of a substance determine its state!

- At room temperature, moderate to Strong attractive forces result in materials that are solids or liquids.
- The stronger the attractive forces, the higher the boiling/ melting point!

State	Density	Shape	Volume	Strength of Intermolecular Forces (Relative to Thermal Energy)
Gas	Low	Indefinite	Indefinite	Weak
Liquid	High	Indefinite	Definite	Moderate
Solid	High	Definite	Definite	Strong

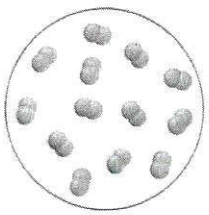
Heating and Cooling Curves

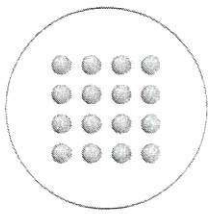
A graph of the temperature of the system versus the amount of heat added.

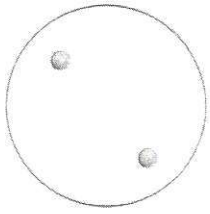


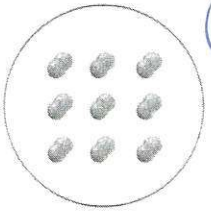
- In thermochemistry, our focus with heating and cooling curves is on how much heat energy is required to change from one state of matter to another.
- For this unit, our focus is on two things:
  - the relative amount of kinetic energy for each state of matter and
  - the strength of the intermolecular forces (IMFs) holding the particles together in that state

Let's Practice! If liquid nitrogen is shown in the image to the right, which of the images below best depicts nitrogen after it has boiled?



a) 

b) 

c) 

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