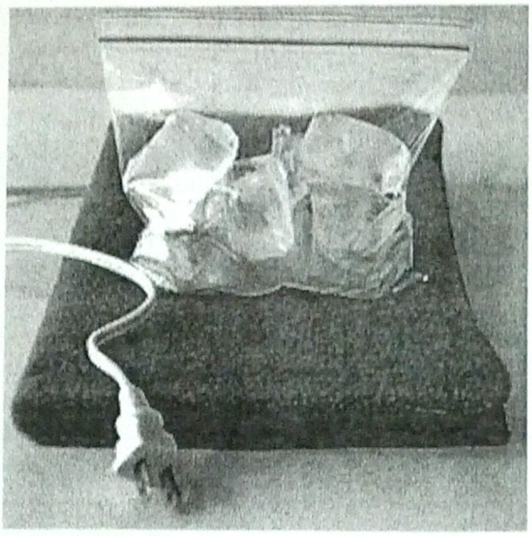
Name KEY

Period ________ Date ____________

16 · Thermochemistry

16.3 NOTES—HEATING CURVE

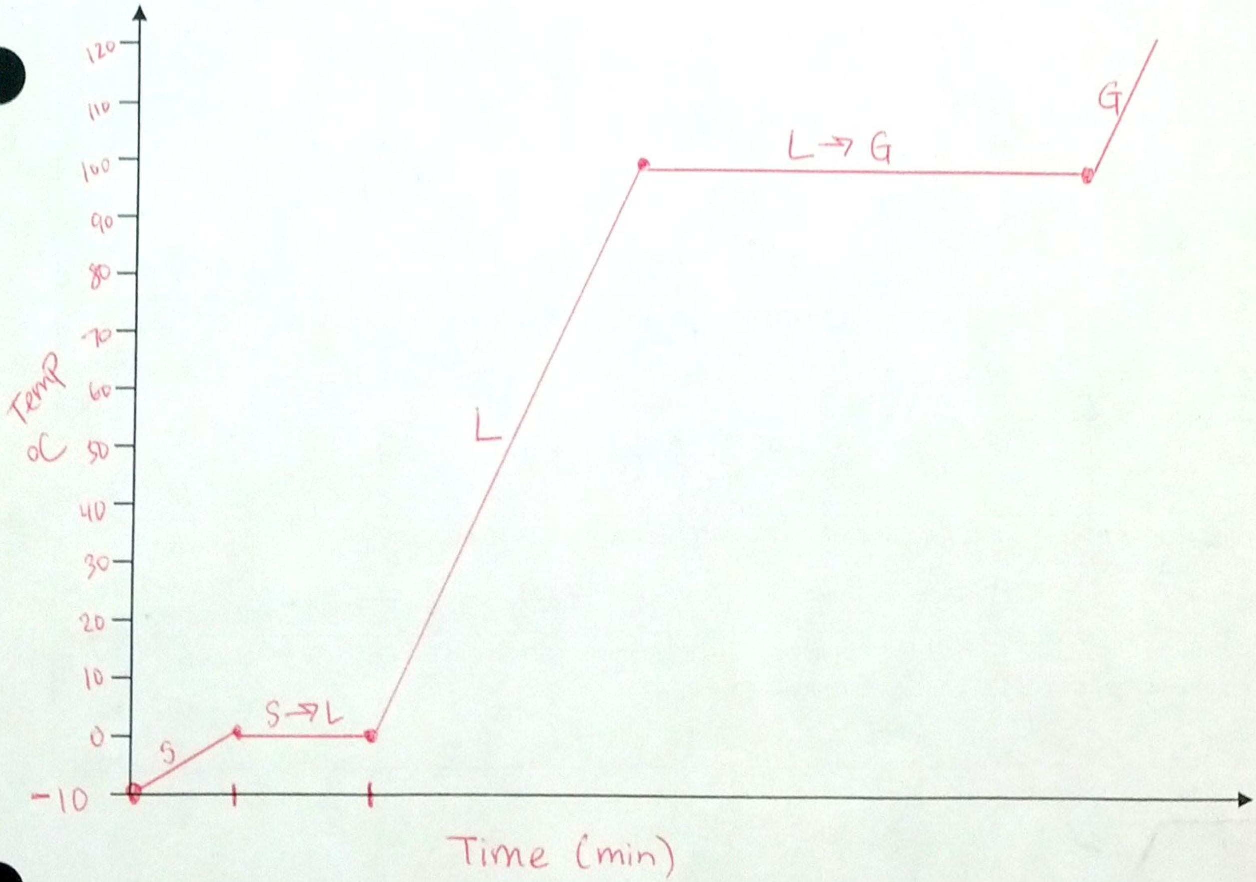


You are going to heat up some ice at -10°C. What will happen?

-10°C —warm up→ 0°C melts

You probably said (correctly) that it will warm up and melt. But those two things do not happen at the same time. The ice warms up (changes temperature) and later melts (but doesn't change temperature). The water left after the ice melts will warm up.

1. We are going to draw a "heating curve" for H_2O.
   - Label the y-axis as Temperature (°C). Number the lines from -10°C to 120°C.
   - Label the x-axis as Heating Time. Draw a light horizontal pencil line at 0°C and 100°C.

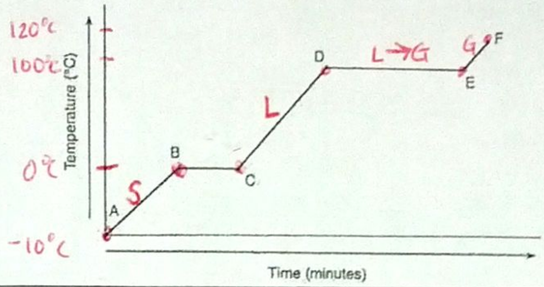


2. For each segment, what phase(s) are present? What is happening to the molecules?
   How do we calculate Q? ($Q = m \cdot \Delta T \cdot Cp$ or $Q = m \cdot \Delta H$)

   S, L, G (diagnols) — (horizontals) ΔH_{fus}, ΔH_{vap}

Consider the following heating curve:

Follow the heating of 1 gram of water from ice at -10°C to steam at 120°C.



For water, ΔH_{fus} = 333 J/g ΔH_{vap} = 2260 J/g

$C_{p,ice}$ = 2.10 J/g·°C $C_{p,water}$ = 4.18 J/g·°C $C_{p,steam}$ = 2.08 J/g·°C

2. How much heat is required to increase the temperature of a 1 g piece of ice from -10°C to 0°C?

VARIABLES: Q = m = C_p = ΔT =

WORK: $q = mC\Delta T$

$= 1g\left(\frac{2.10 J}{g°C}\right)(10°C) = 21.0 J$

ANSWER: 21.0 J

3. How much heat is required to melt a 1 g piece of ice?

VARIABLES: Q = m = ΔH_{fus} =

WORK: $q = m\Delta H_{fus}$

$= 1g\left(\frac{333 J}{g}\right) = 333 J$

ANSWER: 333 J

4. How much heat is required to increase the temperature of a 1 g sample of water from 0°C to 100°C?

VARIABLES: Q = m = C_p = ΔT =

WORK: $q = mC\Delta T$

$= (1g)\left(\frac{4.18 J}{g°C}\right)(100°C) = 418 J$

ANSWER: 418 J

5. How much heat is required to vaporize a 1 g sample of water?

VARIABLES: Q = m = ΔH_{vap} =

WORK: $q = m\Delta H_{vap}$

$= (1g)\left(\frac{2260 J}{g}\right) = 2260 J$

ANSWER: 2260 J

6. How much heat is required to increase the temperature of a 1 g sample of steam from 100°C to 120°C?

VARIABLES: Q = m = C_p = ΔT =

WORK: $q = mC\Delta T$

$= 1g\left(\frac{2.08 J}{g°C}\right)(20°C) = 41.6 J$

ANSWER: 41.6 J

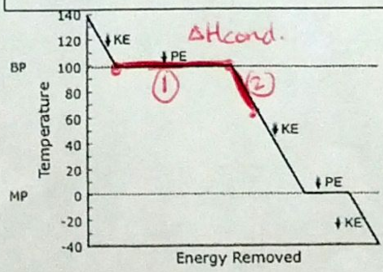
7. How much heat is needed for a 1 g piece of ice at -10°C to become steam at 120°C?

21.0 + 333 + 418 + 2260 + 41.6 = 3,073.6 J = 3.07 kJ

ANSWER: 3073.6 J or 3.07 kJ

8. How much heat is released when 1.0 g steam at 100°C condenses to water at 60°C? Show on the heating curve the change involved.

ANSWER: -2427.2 J or -2.4 kJ



① $q = m\Delta H_{cond.}$

$= (1.0g)\left(-\frac{2260 J}{g}\right) = -2260 J$

② $q = mC\Delta T$

$= (1.0g)\left(\frac{4.18 J}{g°C}\right)(60°C - 100°C) = -167.2 J$

-2427.2 J