Introduction to Physical Science

Latent Heat

Presented by Robert Wagner

Heat in Phase Changes

- Not all heat transfers involve a temperature change
  - Can involve a phase change
  - Ice melts —> Liquid water
- Energy is required for melting
  - Need to break apart molecular bonds
- Energy needed:
  - (melting/freezing)
  - (vaporization/condensation)
  - - Determined experimentally (See Table 14.2)

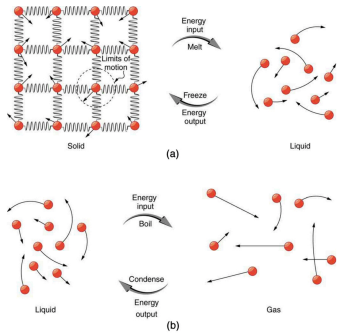
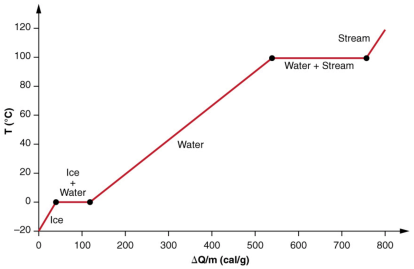


Image Credit: OpenStax College Physics - Figure 14.7 CC BY 4.0

Latent Heat Coefficients

- Latent heat
  - Units: J/kg
- Latent heat coefficients
  - Latent - invisible because no temperature change occurs
- Phase changes
  - Need to look at in parts



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Example

- Three ice cubes are used to chill a soda at 20°C with a mass of soda of 0.25 kg. The ice is at 0°C. The ice cubes each have a mass of 6.0 g. Ignore heat loss and assume the heat capacity of soda is the same as that of water. What is the final temperature?
  - Draw a sketch
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve

$T_{soda} = 20.0^oC\ ;\ m_{soda} = 0.25\ kg\ ;\ T_{ice} = 0^oC\ ;\ m_{ice} = 0.018\ kg$

$$Q_{ice} = -Q_{soda}$$

$$Q_{ice} = m_{ice}L_f + m_{ice}c_w(T_f - 0^oC)$$

$$Q_{soda} = m_{soda}c_w(T_f - 20.0^oC)$$

$$T_f = \frac{m_{soda}c_w(20.0^oC) - m_{ice}L_f}{(m_{soda} + m_{ice})c_w}$$

$$T_f = \frac{(0.25\ kg)(4186\ J/kg\cdot^oC)(20.0^oC) - (0.018\ kg)(334000\ J/kg)}{(0.25\ kg + 0.018\ kg)(4186\ K/kg\cdot^oC)}$$

$$T_f = \frac{20930\ J - 6012\ J}{1122\ J/^oC} = 13^oC$$

Sublimation

- Direct transition from solid —> gas
  - Example: Dry ice
- Latent heat of sublimation:
  -
- Sublimation requires energy - makes dry ice an effective coolant

Heat Transfer - Problem Solving Strategies

- Examine situation
  - Change in temperature or phase?
  - Heat transfer in or out of system?
- Identify what changes temperature or phase
- Identify given quantities and unknowns
- Solve the equation for the quantity to be determined
- Substitute in values to determine numerical answer
- Check to see if the answer is reasonable

Summary

- Heat transfer can result in an increase in temperature or a phase change
- Latent heat tells the energy needed for a change in phase
- Sublimation is the direct change from solid to gas without passing through the liquid phase