Heat Exchange

Heat Scales

- No device can directly measure the thermal energy given off or absorbed by an object
- The effect of heat must then be measured, so a unit of measure was made based on the effects of heat on water.

Heat Scales

- Units of measure
  - 1 calorie (cal)
    - the amount of heat needed to increase the temperature of 1g of water 1^{o}C.
  - 1 Calorie (Cal)
    - 1000 calories
  - 4.19 Joules
    - the amount of energy in 1 calorie
  - 1 Btu (British Thermal Unit)
    - the amount of heat needed to increase the temperature of 1lb of water 1F^{o}.

Heat Capacity

- Heat Capacity
  - The amount of heat needed to change the temperature of an object 1°C (J / °C)
- Specific Heat (c)
  - The heat capacity of a material per unit mass (J / kg • °C)
  - Table 11.1 on p 370 has a list of commonly used specific heats.

Heat

- The amount of heat needed to change the temperature of a body can be found using the equation:

$$Q = mc\Delta T$$

Heat Exchange

- Endothermic Process
  - process that absorbs heat
- Exothermic Process
  - process that gives off heat
- Law of Heat Exchange
  - in any heat transfer system, the heat lost by one substance must be equal to the heat gained by another substance.

$$Q_{lost} = Q_{gained}$$

Changes of Phase

- As a material changes from one phase of matter to another, the temperature remains constant, but energy is still absorbed and used to change state. This is usually called latent heat (L).
- Heat of fusion
  - the amount of heat required to change state from solid to liquid

$$Q = mL_F$$

L_F = Heat of fusion for 1 kilogram of material

Changes of Phase

- Heat of Vaporization
  - the heat required to change state from liquid to gas

$$Q = mL_V$$

L_v = Heat of vaporization for 1 kilogram of material

Note: See Table 11.2 on Page 375 for L_F and L_v numbers

Example

- Calculate the number of joules evolved when 4.00 kg of steam at 100ºC is condensed, cooled and changed to ice at 0.00ºC.

$$\begin{aligned} Q_{gained} &= Q_{lost} \\ &= m_s L_V + m_w c_w \Delta T_w + m_w L_F \\ &= 4.00kg(22.6x10^5 J/kg) + 4.00kg(4186 J/kg \bullet °C)(100.0°C) \\ &\quad + 4.00kg(3.30x10^5 J/kg) \\ &= 1.20x10^7 J \end{aligned}$$

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