

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°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°.

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

$$Q = mL_V$$

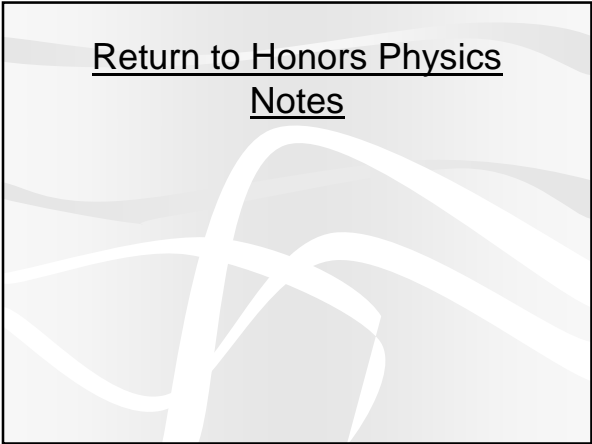
L_V = Heat of vaporization for 1 kilogram of material

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 100°C is condensed, cooled and changed to ice at 0.00°C.

$$\begin{aligned} Q_{\text{gained}} &= Q_{\text{lost}} \\ &= m_s L_V + m_w c_w \Delta T_w + m_i L_F \\ &= 4.00 \text{ kg} (22.6 \times 10^5 \text{ J / kg}) + 4.00 \text{ kg} (4186 \text{ J / kg} \cdot \text{°C}) (100.0 \text{ °C}) \\ &\quad + 4.00 \text{ kg} (3.30 \times 10^5 \text{ J / kg}) \\ &= 1.20 \times 10^7 \text{ J} \end{aligned}$$



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Notes
