Chapter 17: Temperature & Heat

Group Members:

1. Temperature Scales

   a. Your normal body temperature is at $37^{\circ}C$. Covert it to the Fahrenheit $^{\circ}F$ and Kelvin K scales.

$$T_C = 37^{\circ}C$$

$$T_F = T_C \cdot \frac{9}{5} + 32^{\circ}F = 98.6^{\circ}F$$

$$T_K = T_C + 273.15K = 310.\ K$$

   b. When you have a fever, your body temperature is now increased by $2^{\circ}C$. How much is your body temperature increase in the Fahrenheit $^{\circ}F$ and Kelvin K scales? $\Delta T_C = 2.0^{\circ}C$

$$\Delta T_F = \frac{9}{5}\Delta T_C$$

So,

$$\Delta T_F = \frac{9}{5}(2.0^{\circ}C) = 3.6^{\circ}F$$

$$1\ \Delta T_K = 1\ \Delta T_C$$

$$\Delta T_K = 2\ K$$

2. Specific Heat and the Heat of Fusion and Vaporization

a. In an experiment, a student is asked to raise the temperature of $0.250kg$ of water from room temperature $20.0^{\circ}C$ to nearly boiling $100.^{\circ}C$. What is amount of heat needed? ($c_{water} = 4190.J/kg \cdot K$)

$m = 0.250kg$ $T_i = 20.0^{\circ}C$, $T_f = 100^{\circ}C$

$Q = m C_w \Delta T$ $\Delta T = 100^{\circ}C - 20^{\circ}C = 80^{\circ}C = 80K$

$= (0.250kg)(4190 J/kg.k)(80k)$

$= 8.38 \times 10^4 J$

b. To continue the experiment, the student needs to heat the nearly boiling water at $100.^{\circ}C$ to steam at $110.^{\circ}C$. What is the additional amount of heat needed? $(L_v = 2.256 \times 10^6 \, J/kg$, $c_{steam} = 2010.J/kg \cdot K)$

need heat to varporize 100°C water to 100°C steam first.

$Q_1 = m L_v = (0.250kg)(2.256 \times 10^6 J/kg)$

$= 5.64 \times 10^5 J$

Then, need more heat to raise T of 100°C steam to 110°C

$\Delta T = 110^{\circ}C - 100^{\circ}C = 10^{\circ}C = 10K$

$Q_2 = m \, C_{steam} \Delta T$

↖ need to be C_{steam} (not liquid water anymore)

$= (0.250kg)(2010 J/kg.k)(10k)$

$= 5.03 \times 10^3 J$

$Q_{tot} = Q_1 + Q_2 = 5.69 \times 10^5 J$

Example 17.9

① Identify all phase change points:

melting point / freezing point of ice at 0°C.

② Apply $Q = mc\Delta T$ or $Q = mL$ for all individual processes involved:

let m_i be the mass of ice needed.

heat exchange processes for ice	heat exchange processes for cola
(ice raising T −20°C → 0°C) + (ice melting at 0°C)	+ (cola cooling from 25°C → 0°C) = 0

★ Note: - sign conventions
- c_i & c_w

③ $\Sigma Q = 0$

$$m_i c_i\,(0°C - (-20°C)) + m_i L_f + m_c c_w\,(0°C - 25°C) = 0$$

$$m_i\,(20°C \cdot c_i + L_f) = -\,m_c c_w(-25°C)$$

$$m_i = \frac{(0.25\,kg)(4190\,J/kg\cdot°C)(25°C)}{(20°C)(2.1\times10^3\,J/kg\cdot°C) + 3.34\times10^5\,J/kg}$$

$$\boxed{m_i = 0.070\,kg}$$