①

**Problem 1: (11-01-50)**

How much does the Eiffel tower lengthen when $\Delta T = 15.0\ ^\circ C$

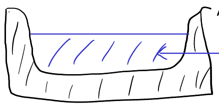
Table 1.2 steel $\longrightarrow$ $\alpha = 12 \cdot 10^{-6}\ 1/^\circ C$

$L = 321\ m$

$$\Delta L = \alpha \cdot L \cdot \Delta T$$

$$= 12 \cdot 10^{-6} \cdot 321 \cdot 15\ m = 0.058\ m = \underline{5.8\ cm}$$

**Problem 2: (11-01-84)**



Al, $M = 0.250$ kg

Soup, $m = 0.800$ kg ($H_2O$)

at $T_0 = 25.0\ ^\circ C$

put in freezer and $Q = 388$ kJ taken away from the system, find the final temperature $T_f$

②

First, assume no freezing (we might be wrong on this point, but try)

$$Q = \left\{ mC_{H_2O} + M \cdot C_{Al} \right\} \Delta T$$

$$\longrightarrow \Delta T = \frac{Q}{mC_{H_2O} + M \cdot C_{Al}} = \frac{388 \cdot 10^3\ J}{0.8\ kg \cdot 4186 \frac{J}{kg\,^\circ C} + 0.25\ kg \cdot 900 \frac{J}{kg\,^\circ C}}$$

$$\simeq 109\ ^\circ C$$

.. so the no freezing is a silly assumption, try with freezing, but same specific heat for water and ice (correct that later)

$$Q = \left\{ m \cdot C_{H_2O} + M \cdot C_{Al} \right\} \Delta T + m L_f^{H_2O}$$

$$\longrightarrow \Delta T = \frac{\left\{ Q - m L_f^{H_2O} \right\}}{m C_{H_2O} + M \cdot C_{Al}} = \frac{388 \cdot 10^3\ J - 0.8\ kg \cdot 334 \cdot 10^3\ J/kg}{\text{as before}}$$

$$\simeq 33.8\ ^\circ C$$

$$\longrightarrow \underline{T_f} = (25 - 33.8) \simeq \underline{-8.8\ ^\circ C}$$

③

Specific heat of ice is only 2090 J/(kg·K) See Table 1.3 in vol II

$$\longrightarrow Q = \left[ mC_{H_2O} + MC_{Al} \right] \cdot \Delta T_1 + m L_f^{H_2O} + \left\{ mC_{ice} + MC_{Al} \right\} \cdot \Delta T_2$$

where

$$\Delta T_1 = 25.0\ ^\circ C$$

but we need to find $\Delta T_2$

$$\Delta T_2 = \frac{Q - \left\{ mC_{H_2O} + MC_{Al} \right\} \Delta T_1 - m L_f^{H_2O}}{mC_{ice} + MC_{Al}}$$

$$= 20.5\ ^\circ C$$

thus the final temperature of the soup and the pot in the freezer will be

$$\underline{T_f = -20.5\ ^\circ C}$$

④

**Problem 3: (11-02-44)**

$v_{rms} = 514$ m/s

$N_2$ p?

$V = 6.56\ m^3$

$n = 4.86 \cdot 10^4$ mol

$$v_{rms} = \sqrt{\frac{3k_B T}{m}} = \sqrt{\frac{3RT}{M}}$$

$$p = \frac{nRT}{V} \longrightarrow T = \frac{pV}{nR} \quad \text{ideal gas}$$

$$\longrightarrow (v_{rms})^2 = \frac{3R}{M}\left(\frac{pV}{nR}\right) = \frac{3pV}{nM}$$

$$\longrightarrow p = \frac{(v_{rms})^2\, nM}{3V} \qquad M = 28.0\ g/mole = 28.0 \cdot 10^{-3} \frac{kg}{mole}$$

$$\longrightarrow p = \frac{(514)^2 \cdot 4.86 \cdot 10^4\ mol \cdot 28.0 \cdot 10^{-3} \frac{kg}{mol}}{3 \cdot 6.56\ m^3} = 1.83 \cdot 10^7 \frac{kg}{m s^2}$$

but remember

$$1\,Pa = 1\,\frac{N}{m^2} = 1\,\frac{kg\;m/s^2}{m^2} = 1\,\frac{kg}{m\,s^2}$$

$$\rightarrow\quad p = 1.83 \cdot 10^7\ Pa$$

Problem 4: (11-02-58)

How much Q (heat) is needed to raise $T_0 = 25.0\,°C \;\text{-->}\; 33.0\,°C = T_f$

a) for air $n = 1.5$ mol, diatomic, Table 2.3 : $C_V = 2.5R$

$$Q^{air} = nC_V\,\Delta T \approx n(2.5R)\Delta T \approx 1.5\,mole\left(2.5 \cdot 8.31\,\frac{J}{mol \cdot K}\right) \cdot 8 \simeq 250\,J$$

b) For Xenon, ideal gas $C_V = \frac{3}{2}R$

$$\rightarrow\quad Q^{Xenon} = n(1.5R)\,\Delta T \approx 150\,J$$