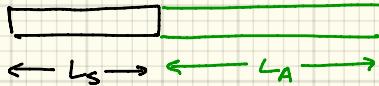


HW2 THERMODYNAMICS

CH17: 44, 52,

CH18: 29, 32, 34, 37, 51, 55

17.44



$$\begin{cases} L_S = 1\text{m} \\ L_A = 2\text{m} \end{cases} \quad \left. \begin{array}{l} \\ \end{array} \right\} T_0 = 22^\circ\text{C}$$

$T \rightarrow T = 200^\circ\text{C}$, then.

what is the total length change, ΔL ?

$$\Delta L_i = \alpha_i L_i \Delta T_i \text{ for each}$$

$$\alpha_S = 1.3 \times 10^{-5} \text{ K}^{-1}$$

$$\alpha_A = 2.2 \times 10^{-5} \text{ K}^{-1}$$

$$\Delta L_S + \Delta L_A = \Delta L$$

$$L_S = L_{S_0} + \Delta L_S \quad L_A = L_{A_0} + \Delta L_A$$

$$\Delta L = L_{S_0} + \Delta L_S + L_{A_0} + \Delta L_A - L_{S_0} - L_{A_0}$$

$$= \Delta L_S + \Delta L_A$$

$$= \alpha_S L_S \Delta T + \alpha_A L_A \Delta T$$

$$= \Delta T (\alpha_S L_S + \alpha_A L_A)$$

$$= (200 - 22) [(1.3 \times 10^{-5})(1) + (2.2 \times 10^{-5})(2)]$$

$$\Delta L = 0.01015 \text{ m}$$

17.52



$$P_0 = 1\text{s} \quad @ \quad T_0 = 20^\circ\text{C}$$



$$\alpha_A = 2.2 \times 10^{-5} \text{ K}^{-1}$$

$$T = 30^\circ\text{C}$$

$P?$ & time lost or gained
in a week?

a)

$$P_0 = 2\pi \sqrt{L_0/g} \quad \text{initially}$$

$$P = 2\pi \sqrt{L/g} \quad \text{finally.}$$

$$\Delta L = \alpha L_0 \Delta T$$

$$L = L_0 + \Delta L = L_0 + \alpha L_0 \Delta T = L_0(1 + \alpha \Delta T)$$

$$P = 2\pi \sqrt{\frac{L_0(1 + \alpha \Delta T)}{g}} = 2\pi \underbrace{\sqrt{\frac{L_0}{g}}}_{P_0} \sqrt{1 + \alpha \Delta T}$$

$$P = (1\text{s}) \sqrt{1 + (2.2 \times 10^{-5})(10)} \quad P = 1.00011\text{s}$$

b)



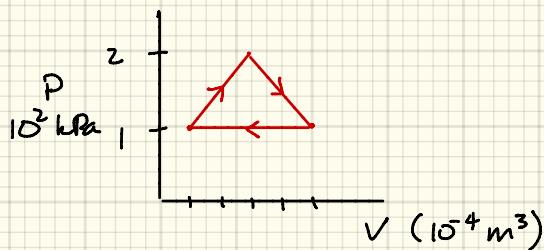
for n oscillations $t_0 = n P_0$ before
 $t = n P$ after

$$\Delta t_n = n(P - P_0) = n P_0 \left(\frac{P}{P_0} - 1\right) = t_0 \left(\frac{P}{P_0} - 1\right)$$

$$\Delta t = 1\text{w} \left(\frac{7\text{d}}{1\text{w}}\right) \left(\frac{24\text{h}}{1\text{d}}\right) \left(\frac{60\text{m}}{1\text{h}}\right) \left(\frac{60\text{s}}{1\text{m}}\right) \left(1\text{s}\right) \left(\frac{1.00011}{1} - 1\right)$$

$$\Delta t = 66.53\text{s}$$

18.29

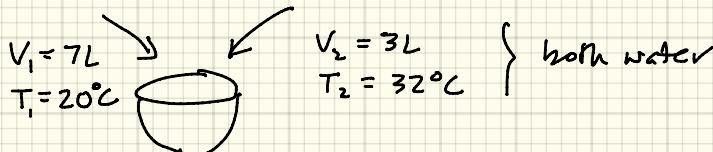


$$W = \text{area enclosed} = \text{area triangle}$$

$$\begin{aligned} W &= \frac{1}{2} (4 \times 10^4 \text{ m}^3) (2 \times 10^2 \text{ hPa}) & \text{Pa} = \frac{\text{N}}{\text{m}^2} \\ &= 4 \times 10^{-2} \times 10^3 \underbrace{\text{m}^3 \text{ Pa}}_{\text{m}^3 \frac{\text{N}}{\text{m}^2} = \text{N} \cdot \text{m} = \text{J}} & \text{so} \end{aligned}$$

$$W = 40 \text{ J}$$

18.32



final temperature?

$$Q_1(\text{change}) = -Q_2(\text{change}) \quad \text{since insulated.}$$

$$m_1 c_1 \Delta T_1 = -m_2 c_2 \Delta T_2$$

don't know masses, but

$$\rho_i = \frac{m_i}{V_i}$$

$$\cancel{\rho_1 V_1 \cancel{c_1} \Delta T_1 = -\rho_2 V_2 \cancel{c_2} \Delta T_2} \quad m_i = \rho_i V_i$$

$$V_1 \Delta T_1 = -V_2 \Delta T_2$$

$$V_1 (T_f - T_1) = -V_2 (T_f - T_2)$$

$$q_1 V_1 \Delta T_1 = -q_2 V_2 \Delta T_2$$

$$V_1 \Delta T_1 = -V_2 \Delta T_2$$

$$V_1 (T_f - T_i) = -V_2 (T_f - T_i)$$

$$V_1 T_f - V_1 T_i = -V_2 T_f + V_2 T_i$$

$$V_1 T_f + V_2 T_f = V_1 T_i + V_2 T_i$$

$$T_f = \frac{V_1 T_i + V_2 T_i}{V_1 + V_2} = \frac{(7)(20) + (3)(32)}{7+3}$$

$$T_f = \frac{140 + 96}{10} = 23.6 \text{ } ^\circ\text{C}$$

18.34

$$K_B \quad E_W + Q_B$$

\bullet

E
Q

$$m_B = 12 g$$

$$v_B = 250 \text{ m/s}$$

$$c_B = c_{pB} = 0.129 \times 10^3 \text{ J/kg K}$$

$$K_B = E_W + Q_B$$

$$= 0.25 K_B + 0.75 K_B$$

$\underbrace{\quad}_{\text{final T?}}$

$$Q_B = 0.75 K_B = m_B c_B \Delta T$$

$$\Delta T = \frac{0.75 K_B}{m_B c_B} = \frac{(0.75) \left(\frac{1}{2} m_B v_B^2 \right)}{m_B c_B} = \frac{\left(\frac{3}{8} \right) (v_B^2)}{c_B}$$

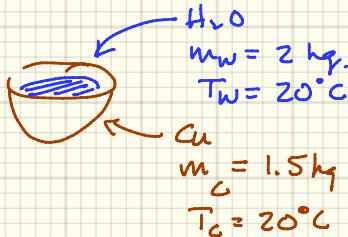
$$\Delta T = \frac{\left(\frac{3}{8} \right) (250 \text{ m/s})}{0.129 \times 10^3 \text{ J/kg K}} = 181.7 \text{ K}$$

18.37



$$m_B = 3 \text{ kg}$$

$$T_B = 300^\circ\text{C}$$



$$-Q_B = Q_W + Q_C = -m_B C \Delta T_B$$

$$-m_B C \Delta T_B = m_W C_W \Delta T_W + m_C C_C \Delta T_C$$

$$\Delta T_B \equiv T - T_B$$

$$\Delta T_W \equiv T - T_W$$

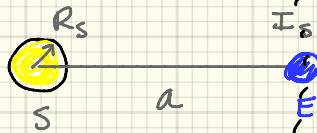
$$\Delta T_C \equiv T - T_C$$

$$C = \frac{m_W C_W (T - T_W) + m_C C_C (T - T_C)}{m_B (T_B - T)}$$

$$= \frac{[(2 \text{ kg})(4190 \text{ J/kg K}) + (1.5 \text{ kg})(386 \text{ J/kg K})]}{(3 \text{ kg})(300 - 31.7)} (31.7 - 20)$$

$$C = 130.2 \text{ J/kg K} \quad \sim \text{ lead?}$$

(8.51)



sphere at
earth orbit.

$$I_s = 1370 \text{ W/m}^2 \quad \therefore A_E = \pi a^2$$

$$a = 1.496 \times 10^8 \text{ km}$$

$$R_S = 6.963 \times 10^5 \text{ km} \rightarrow A_S = \pi R_S^2$$

Blackbody radiation — what is T_s ?

$$P = \sigma \epsilon A_s T_s^4 = \int I_s dA_E = I_s \pi a^2$$

$\underbrace{}$
at sun's
surface

$\underbrace{}$
sphere
@ earth

$\underbrace{}$
intensity
at earth

$$\sigma \epsilon \pi R_s^2 T_s^4 = I_s \pi a^2$$

\uparrow
= 1 fn
blackbody

$$\sigma R_s^2 T_s^4 = I_s a^2$$

$$T_s = \left(\frac{I_s a^2}{\sigma R_s^2} \right)^{1/4}$$

$$= \left[\frac{(1370)(1.496 \times 10^8 \text{ km})^2}{(5.67 \times 10^{-8})(6.963 \times 10^5 \text{ km})^2} \right]^{0.25}$$

$$T_s \approx 5780 \text{ K} \rightarrow 5507^\circ \text{C}$$