Chapter 17 Homework in notes.

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Ex. 8 Convert the following Kelvin temperatures $\rightarrow$ °C, $\rightarrow$ °F

(a.) $400K \rightarrow 400 - 273 = \underline{127°C}$

$400K \rightarrow 127°C \frac{9}{5} + 32° = \underline{\underline{261°F}}$

(b.) 95K (c.) 1.55×10^7 K Follow the same procedure.

Ex. 7

$P_{tr_{H_2O}} = 1.35$ atm. $T_{tr} = 273.16°K$

$p = ??$ $T = 195K$

$\frac{P}{T} = \frac{P_{tr}}{T_{tr}}$ $P = P_{tr}\left(\frac{T}{T_{tr}}\right) = 1.35\,\text{atm}\left(\frac{195}{273}\right) = 0.964\,\text{atm}$

$\boxed{p = 0.964 \text{ atm}}$

Ex. 14 Ensuring a Tight Fit

Hole: D = diameter = 4.500 mm (23°C) Aluminum

Rivet: $D_{Rivet} = ??$ (−78°C)

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

final diameter $\rightarrow D = 4.500\,\text{mm}\left(1 + 2.4 \times 10^{-5}(C°)^{-1}(23-(-78))C°\right)$

$\boxed{D = 4.511 \text{ mm}}$

Ex. 22 A brass rod $L_o = 185$ cm $D_o = 1.60$ cm

120°C $\rightarrow$ 10°C $Y = 9.0 \times 10^{10}$ Pa

$\frac{F}{A} = -Y\alpha\,\Delta T$ $\alpha = 2.0 \times 10^{-5}(C°)^{-1}$

$F = -Y\alpha\,A\,\Delta T = -Y\alpha\left(\frac{\pi D^2}{4}\right)(10°C - 120°C)$

$F = -9.0 \times 10^{+10}\,\text{Pa}\left(2.0 \times 10^{-5}(C°)^{-1}\right)\frac{\pi(1.60 \times 10^{-2}\,\text{m})^2}{4}(-110\,C°) = 39800\,N$

$\boxed{3.98 \times 10^4 \text{ N}}$

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Other Homework Problems Chapter 17.

17.24 a.) How much heat must be added to the water

Power = 200 W $\quad 22°C \rightarrow 81.5°C \quad m = .300\,kg$

$$Q = mc\,(T_f - T_i) = 0.300\,kg\left(4190\,\frac{J}{kg\cdot K}\right)(81.5°C - 22°C)$$

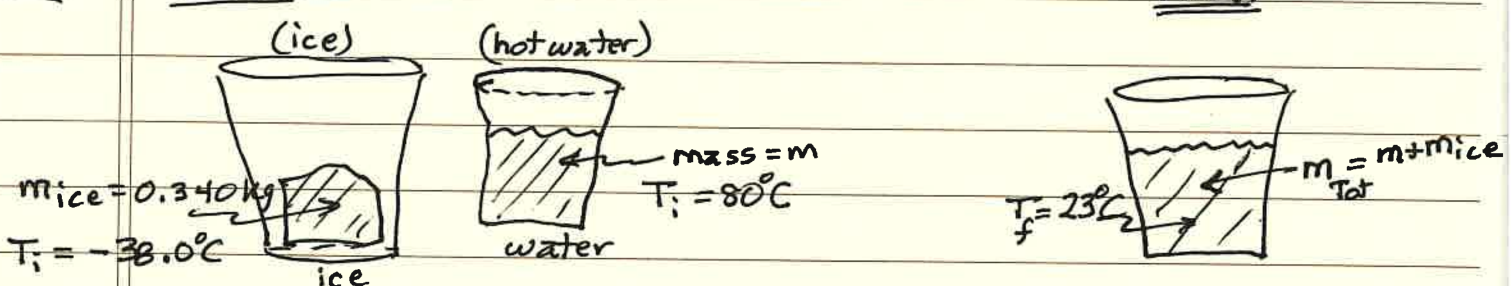
$$\boxed{Q = 7.48 \times 10^4\ J}$$

b.) How much time is required to heat the water

$$\text{Power} = \frac{Q}{\Delta t} \Rightarrow \text{time} = \Delta t = \frac{Q}{\text{Power}} = \frac{7.48 \times 10^4\ J}{200\ J/sec}$$

$$\boxed{\text{time} = \Delta t = 374 \text{ seconds}}$$

17.40 Initial $\qquad\qquad$ Final



Conservation of Energy

$$Q_{ice}(-38°C \rightarrow 0°C) + Q_{ice}\overset{\text{melting}}{(0° \rightarrow 0°C)} + Q_{ice}(0° \rightarrow 23°)$$
$$+ Q_{water}(80°C \rightarrow 23°) = 0$$

0.340 kg $\quad$ 2100 $\quad$ 0.340 $\quad$ 334×10^3 $\quad$ 0.340 $\quad$ 4190

$$m_{ice}\, c_{ice}\,(0 - (-38°C)) + m_{ice}\, L^{ice}_{fusion} + m_{ice}\, c_w\,(23°C - 0°C)$$
$$+ m\, c_w\,(23°C - 80°C) = 0$$

?? $\quad$ 4190

$$m = \frac{m_{ice}\left[c_{ice}\,(38C°) + L^{ice}_{fusion} + c_w\,(23°)\right]}{c_w\,(57C°)}$$

$$\boxed{m = 0.726\ kg}$$

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Ex. 31 While painting the top of an antenna 225 m in height.

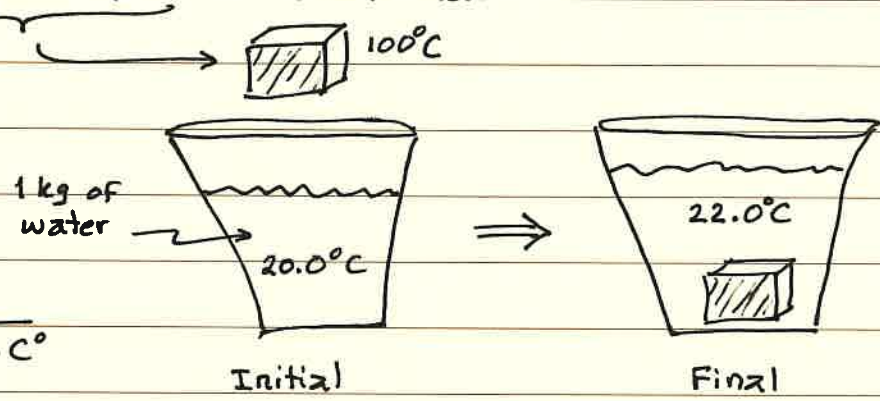
1.00 L of water.

$\boxed{\text{Cons. of Energy}}$ $\qquad \underbrace{mgh}_{=\frac{1}{2}mv^2 \text{ when it hits the ground}} = mc\,\Delta T \qquad c_w = 4190\ \frac{J}{kg\cdot K}$

$$\Delta T = \frac{gh}{c} = \frac{(9.8\ m/s^2)(225\ m)}{4190\ \frac{J}{kg\cdot K}} = 0.526\ C^\circ$$

$$\boxed{\Delta T = 0.526\ C^\circ}$$

Ex. 35 A $\underbrace{\text{500-g chunck}}$ of an unknown metal



$C_w = 4190\ \frac{J}{kg\cdot C^\circ}$ $\qquad c_B = ??$

B = block $\quad$ W = water

(a.) $Q_w + Q_B = 0 \Rightarrow m_w C_w \Delta T_w + m_B C_B \Delta T_B = 0$

$$m_w c_w (2C^\circ) + m_B C_B (22-100) = 0$$

$$C_B = \frac{-m_w c_w (2C^\circ)}{(-78\ C^\circ)\, m_B} = \frac{1.00\ \cancel{kg}}{0.500\ \cancel{kg}}\ \frac{2}{78}\left(4190\ \frac{J}{kg\cdot C^\circ}\right) = \boxed{214.9\ \frac{J}{kg\cdot C^\circ}}$$

(b.) Which is more useful for storing heat? Water → it has a higher heat capacity → $4190\ \frac{J}{kg\cdot K}$ compared to $215\ \frac{J}{kg\cdot K}$

(c.) $Q_w + Q_B + Q_{sty} = 0 \qquad Q_w + (m_B C_B \Delta T_B) + Q_{sty} = 0$

$Q_1 \qquad\qquad Q_2$

In part (a.), $m_B C_B \Delta T$ had to provide Q_1 alone. In part (c.), $m_B C_B \Delta T$ must provide Q_1 & Q_2, so its heat capacity (C_B) must be larger than it was in part (a.)

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Ex. 45 What must the initial speed of a lead bullet . . .

$$C_{Pb} = 130 \frac{J}{kg \cdot K} \qquad \underset{\uparrow \text{fusion}}{L_f^{Pb}} = 24.5 \times 10^3 \frac{J}{kg}$$

m = mass of the bullet

$$\overset{(K_f - K_i)}{\underset{-\left(\frac{1}{2} m v_i^2\right)}{Q_{bullet}}} + \underbrace{m C_{Pb} (\overset{327.3\,°C}{T_f} - \overset{25°C}{T_i})}_{\text{Q required to raise it to the melting point temp.}} + \underbrace{m L_f^{Pb}}_{\text{Q required to melt it completely}} = 0$$

$$-\frac{1}{2} v_i^2 + C_{Pb} (302.3\, C°) + 24.5 \times 10^3 \frac{J}{kg} = 0$$

$$v_i = \sqrt{2\left[130 (302.3) + 24.5 \times 10^3\right]} = \boxed{357.2\ m/s}$$

Ex. 52 A 4.00 kg silver ingot $T_i = 750°C$

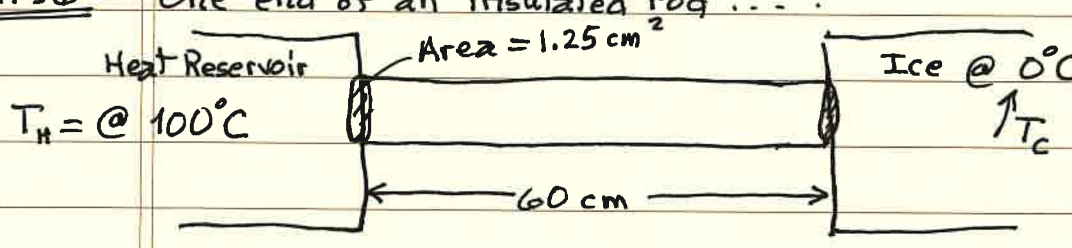
Block of ice @ 0°C How much ice is melted.

m_{Ag} = mass of silver m = mass of ice that is melted.

$$Q_{Ag} + Q_{ice} = 0 \qquad m_{Ag} \overset{234 \frac{J}{kg \cdot K}}{C_{Ag}} (0°C - 750°C) + m \overset{334 \times 10^3}{L_f^{ice}} = 0$$

$$m = \frac{-m_{Ag} C_{Ag} (-750\, C°)}{L_f^{ice}} = + \frac{4.00\, kg \; 234 \frac{J}{kg \cdot K} (750\, K)}{334 \times 10^3 \frac{J}{kg}} = \boxed{2.10\ kg}$$

Ex. 56 One end of an insulated rod . . .



$$\frac{m}{\Delta t} = \frac{0.0085\, kg}{(60 \frac{s}{min}) 10 min}$$

$$\frac{m}{\Delta t} = 1.417 \times 10^{-5} \frac{kg}{sec}$$

$$H = kA \frac{(T_H - T_C)}{Length} \qquad k = \frac{H (Length)}{A (T_H - T_C)} = \frac{\left(\frac{m L^{fus}}{\Delta t}\right)(Length)}{A (100\, C°)}$$

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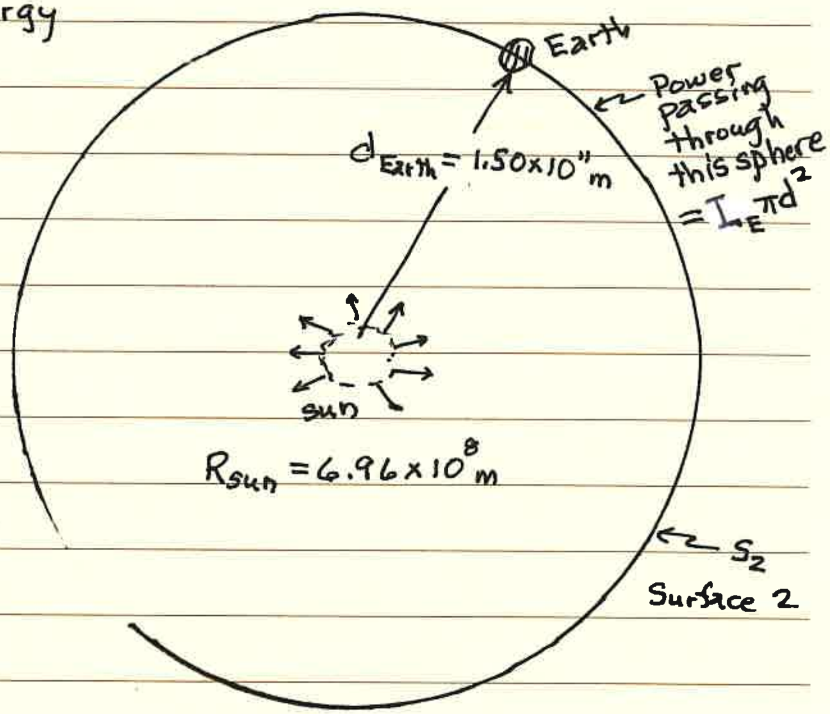
Ex. 56 continued

$$k = \frac{\left(1.417\times10^{-5}\,\frac{kg}{s} \times 334\times10^{3}\,\frac{J}{kg}\right)(0.60\,m)}{1.25\,cm^2\left(\frac{1\,m^2}{10^4\,cm^2}\right)(100\,C^\circ)} = \boxed{227.2\,\frac{W}{m\cdot K}}$$

Conversion to SI

Ex. 106 The rate of radiant energy from the sun reaching the upper atmosphere of the earth is $\sim 1.50\,kW/m^2$

$I_{Earth} = 1.50\,kW/m^2$



On the surface of the Sun:

$$P_{sun} = \underset{W/m^2}{I_s}\,\underset{m^2}{A_{sun}} = I_s\left(4\pi R_{sun}^2\right)$$

The power passing through the surface S_2:

$$P_{S_2} = I_E\,4\pi\left(d_{earth}\right)^2$$

Power through the surface of sun must equal the power through S_2.

I = intensity $\left[\frac{W}{m^2}\right]$

$$I_{sun}\left(4\pi R_{sun}^2\right) = I_E\left(4\pi d_{earth}^2\right) \qquad I_{sun} = I_E\left(\frac{d_{Earth}}{R_{sun}}\right)^2$$

$$I_{sun} = 1.50\,\frac{\overset{10^3 W}{kW}}{m^2}\left(\frac{1.50\times10^{11}\,m}{6.96\times10^{8}\,m}\right)^2 = \boxed{6.967\times10^{7}\,\frac{W}{m^2}}$$

b.) Temperature of the Sun

$$I_{sun} = \frac{H_{sun}}{A} = (e=1)\,\sigma T^4 \qquad T^4 = \frac{I_{sun}}{\sigma}$$

$$T = \sqrt[4]{\frac{6.967\times10^{7}\,W/m^2}{5.67\times10^{-8}\,\frac{W}{m^2 K^4}}} = \boxed{5920\,K}$$