2. $m = 1.50\,kg$

$C_{cadmium} = 230\ J/kg\,°C$

$T_i = 20.0°C$

$T_f = 150°C$

$\Delta T = T_f - T_i = 130°C$

$Q = mc\Delta T$

$= (1.50kg)(230\ J/kg°C)(130°C)$

$= 4.49 \times 10^4\ J$

6. $m = 55\,Kg$

a) $Q = 540\,kcal\left(\frac{4186\,J}{1\,kcal}\right) = 2.3 \times 10^6\,J$

b) $h = 15cm = 0.15\,m$

$(mgh) \times N = 2.3 \times 10^6\,J$

where N = # of stairs

$(55kg)(9.8\,m/s^2)(.15m)\,N = 2.3 \times 10^6\,J \therefore N = 2.8 \times 10^4$ stairs

c) 25% efficiency $\therefore .25\,(2.3 \times 10^6\,J) = 5.75 \times 10^5\,J$

$5.75 \times 10^5\,J = N(55kg)(9.8\,m/s^2)(.15m) \therefore N = 7.1 \times 10^3$ stairs

12. $m = 1.5\,kg$

$V_0 = 3.0\,m/s$

$V_f = 0$

$0.85\,KE_0 = Q$

$C_{cu} = 387\ J/kg°C$

a) $KE_0 = \frac{1}{2}mv_0^2 = \frac{1}{2}(1.5\,kg)(3.0\,m/s)^2 = 6.75\,J$

$\therefore .85\,KE_0 = 5.74\,J$

$5.74\,J = mc_{cu}\Delta T = (1.5\,kg)(387\ J/kg°C)\,\Delta T$

$\Delta T = 9.9 \times 10^{-3}\ °C$

b) The remaining energy is absorbed by the horizontal rough surface that the block slides on.

16.

$m_p = 1.00g = 1.00 \times 10^{-3}\,kg$

$T_{i_p} = 200°C$

$m_w = 500g = 0.500kg$

$T_{iw} = 20.0°C$

$T_f = 25.0°C$

$c_p = 128\ J/kg°C$

$c_w = 4186\ J/kg°C$

$Q_{Loss} = Q_{gain}$

$N[m_p c_p \Delta T_p] = m_w c_w \Delta T_w$

$N[(1.00 \times 10^{-3})(128)(175)] = (.500)(4186)(5.00)$

$\therefore N = 467$ pellets

17. $T_i = 27°C$, $m_w = 225\,g$, $m_{cu} = 40\,g$, $m_{Al} = ?$

$m_{Ag} = 400g$, $T_i = 87°C$

$T_f = 32°C$

$c_{Al} = 0.215\ cal/g°C$

$c_w = 1.00\ cal/g°C$

$c_{cu} = .0924\ cal/g°C$

$c_{Ag} = .056\ cal/g°C$

Conservation of Energy ∴

$$Q_{\text{loss by silver}} = Q_{\text{gain by cup, stirrer + water}}$$

$$m_{Ag}c_{Ag}\Delta T_{Ag} = m_w c_w \Delta T_w + m_{cu}c_{cu}\Delta T_{cu} + m_{Al}c_{Al}\Delta T_{Al}$$

$$(400g)(.056\,cal/g°C)(55°C) = (225g)(1.00\,cal/g°C)(5°C) + (40g)(.0924\,cal/g°C)(5°C) + m_{Al}(.215\,cal/g°C)(5°C)$$

$$1232 = 1125 + 18.48 + 1.075\,m_{Al}$$

$$\therefore m_{Al} = 82g$$

26. $L_f = 3.33 \times 10^5\ J/kg$, $m_i = 50g = .050kg$, $T_i = 0°C$

$m_w = 45g = .045\,kg$

$m_s = 5.0g = .0050\,kg$

$T_f = 100°C$

$L_v = 2.26 \times 10^6\ J/kg$

$$Q_1 = m_i L_f = (.050kg)(3.33 \times 10^5 J/kg) = 16,650\ J$$

$$Q_2 = m_w c_w \Delta T_w = (.050kg)(4186\ \tfrac{J}{kg°C})(100°C) = 20,930J$$

$$Q_3 = m_s L_v = (.0050\,kg)(2.26 \times 10^6 J/kg) = 11,300\ J$$

$$\therefore Q_{total} = 4.9 \times 10^4\ J$$

28. $40g = m_{ice}$

$T_{i_{ice}} = -10°C$

$T_{f_{steam}} = 110°C$

$C_{ice} = .500\ cal/g°C$

$C_w = 1.00\ cal/g°C$

$C_{steam} = .480\ cal/g°C$

$L_F = 79.7\ cal/g$

$L_v = 540\ cal/g$

$Q_1 = m_{ice}\, c_{ice}\, \Delta T_{ice}$

$= (40g)(.500\ \frac{cal}{g°C})(10°C) = 200cal$

$Q_2 = m_{ice} L_F = (40g)(79.7\ cal/g)$

$= 3,188\ cal$

$Q_3 = m_w C_w \Delta T_w = (40g)(1.00\ cal/g°C)(100°C)$

$= 4000\ cal$

$Q_4 = m_w L_v = (40g)(540\ \frac{cal}{g}) = 21,600\ cal$

$Q_5 = m_s C_s \Delta T_5 = (40g)(.480\ \frac{cal}{g°C})(10°C)$

$= 192\ cal$

$$Q_{total} = \Sigma Q = 29,180\ cal \left(\frac{4.186J}{1cal}\right)$$

$$= 1.22 \times 10^5 J \approx .12\ MJ$$

35. steam: $m_s = 10\,g$ at $100^\circ C$

a) ice: $m_i = 50\,g$ at $0^\circ C$

$$Q_{Lost} = Q_{Gain}$$

$$m_s L_V + m_{sw} c_w (100 - T_F) = m_i L_f + m_{iw} c_w (T_F - 0)$$

$$(.01\,kg)(2.26 \times 10^6\,J/kg) + (.01\,kg)(4186\,J/kg^\circ C)(100 - T_F) =$$

$$(.05\,kg)(3.33 \times 10^5\,J/kg) + (.05\,kg)(4186\,J/kg^\circ C)\,T_F$$

$$2.26 \times 10^4 + 4186 - 41.86\,T_F = 16{,}650 + 209.3\,T_F$$

$$T_F = 40.4^\circ C \approx 40^\circ C$$

b) ice: $m_i = 50\,g$ steam: $m_s = 1\,g$

$m_i L_f = (.05\,kg)(3.33 \times 10^5\,J/kg) = 16{,}650\,J$ needed to melt all of the ice

Q_{total} from 1g of steam:

$$m_s L_v = (.001\,kg)(2.26 \times 10^6\,J/kg) = 2260\,J$$

$$m_w c_w \Delta T = (.001\,kg)(4186\,J/kg^\circ C)(100^\circ C) = 418.6\,J$$

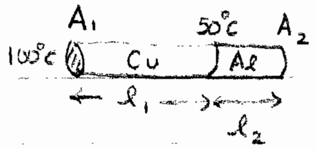
$\therefore Q_{total}$ available $= 2{,}678.6\,J$

Not enough heat energy to melt all the ice. There is an ice/water mixture at $0^\circ C$.

$$\frac{2{,}678.6\,J}{3.33 \times 10^5\,J/kg} = m_{i\,melted} = .00804\,kg \approx 8.0\,g \text{ of ice melted}$$

Only about 8.0g of the ice would melt.

Note: The amount of ice is much greater than the amount of steam in part b.

45. 

$k_{Cu} = 397\ J/s \cdot m \cdot °C$

$k_{Al} = 238\ J/s \cdot m \cdot °C$

$A_1 = A_2$ and $\Delta T_1 = \Delta T_2$

When the temperature at the junction stabilizes, the energy transfer rate is the same for each rod.

$\therefore\ P_{Cu} = P_{Al}$

$$\frac{k_{Cu} A_1 \Delta T_1}{l_1} = \frac{k_{Al} A_2 \Delta T_2}{l_2} \quad \therefore\ l_2 = \frac{l_1 k_{Al}}{k_{Cu}}$$

$$l_2 = \frac{(0.15m)(238)}{(397)} = 0.090m \text{ or } 9.0cm$$

46. $A = 0.80\,m^2$ $\qquad t = 8h\left(\frac{3600s}{h}\right) = 2.88 \times 10^4 s$

$l = 2.0cm = 0.020m$ $\qquad$ to melt 5.0 kg of ice

$T_1 = 5.0°C$, $T_2 = 25°C$ $\Big\}\ |\Delta T| = 20°C$ $\qquad k_{styrofoam} = ?$

$$\frac{\Delta Q}{\Delta t} = \frac{m_i L_f}{\Delta t} = \frac{(5.0kg)(3.33 \times 10^5 J/kg)}{(2.88 \times 10^4 s)} = 57.8\ J/s \approx 58\ J/s$$

$$\frac{\Delta Q}{\Delta t} = \frac{k A |\Delta T|}{l}$$

$$57.8\frac{J}{s} = \frac{k(.80m^2)(20°C)}{.020m}$$

$$\therefore\ k = .072\ \frac{W}{m°C}$$

50. $e = 0.90$ $\qquad$ $P_{net} = \sigma A e \left[T^4 - T_o^4\right]$

$A = 2.5 \times 10^{-5} m^2$

$P_{net} = 25 Watt$

$T_o = 22°C = 295 K$ (room)

$T = ?$ (object)

$\sigma = 5.67 \times 10^{-8} W/m^2 \cdot K^4$

$$25 W = (5.67 \times 10^{-8} W/m^2 K^4)(2.5 \times 10^{-5} m^2)(.90)\left[T^4 - (295)^4\right]$$

$$25 = 1.276 \times 10^{-12} T^4 - .009664$$

$$T^4 = 1.96 \times 10^{13}$$

$$T = 2.1 \times 10^3 K \text{ or } 1.8 \times 10^3 °C$$