Application A 1-Km-long section of steel railroad track changes its length between winter and summer

$\alpha_{steel} = 1.2 \cdot 10^{-5} K^{-1}$ $T_{winter} = -40°C$ (-40 F)

$T_{summer} = +40°C$ (104 F)

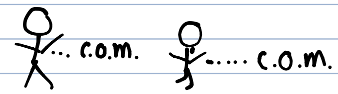
$\Delta L = L_0 \alpha \Delta T = (1.0 \cdot 10^3 m)(1.2 \cdot 10^{-5} K^{-1})(80 K) = 0.96 m$

54.html

a NO b NO $\beta_{Hg} > \beta_{glass}$ c Differential expansion

55.html

Energy to stand up = $mg\Delta Y$



Say $\Delta Y = 0.5m$ $mg\Delta Y = 80kg \; 9.8\frac{m}{s^2} \; 0.5m = 392 J$

Compare to $\frac{1}{100}$ of a candy bar (penny = \$0.01) 2 Calories = 2,000 calories = 2,000 cal $\frac{4.186 J}{cal}$

= 8372 J

→ yes, worth the effort!

1 cal = 4.186 J

1 kcal = 1 Calorie = 4186 J

1 calorie raises 1g of H_2O by 1°C

$Q = m \; c \; \Delta T$

Heat [J] mass [kg] specific heat $[\frac{J}{Kg\,K}]$ Temp change [K]

$dQ = mc\,dT$

dQ is not the heat contained in a body, but the heat required to raise T

specific heats

water 4190 J/kg·K

air 716·1000

iron 470

ice 2100

Phase changes also require heat gas ↔ liquid ↔ gas

$Q = \pm mL_f$ = heat required to change solid ↔ liquid

$Q = \pm mL_v$ = heat required to change liquid ↔ gas

56.html

Takes a lot of energy to change T of H_2O and $C_{H_2O} > C_{soil}$

Problem In a hot water heating system, water is delivered to radiators at 70.0C and leaves at 28.0°C. A steam system involves steam condensing in the radiators and the condensed steam leaves radiators at 35.0°C. How many kg of steam will supply the same heat as was supplied by 1.00 Kg of Hot Water in the first system?

$Q_{water} = Q_{steam\,water}$

$Q_{water} = m_{water} c_{water} \Delta T_{water}$

$Q_{steam\,water} = m_{steam} c_{water} \Delta T'_{water} + m_{steam} L_{v steam}$

$m_{water} = 1.00 kg$ $c_{water} = 4190 \frac{J}{kg \cdot k}$ $\Delta T_{water} = 70.0 - 28.0 = 42.0 °C$

$\Delta T'_{water} = 100.0°C - 35.0°C = 65.0°C$ $L_{v steam} = 2256 \cdot 10^3 J/kg$

$$m_{steam}/m_{water} = \frac{c_{water} \Delta T_{water}}{c_{water} \Delta T'_{water} + L_{v steam}} = \frac{4190 \; 42.0}{4190 \cdot 65.0 + 2256 \cdot 10^3} = 0.0696$$

<u>Ch01 Group problem</u> $\Delta Q_{tot} = Q_{ice\ accepts} + Q_{Kool\ aid\ yields} = 0$

$$m_{ice} c_{ice} (T_f - T_{o,ice}) + m_{ice} L_{v,ice} + m_{kool} c_{kool} (T_f - T_{o,kool}) = 0$$

$$T_F = \frac{-m_{ice} L_{v_{ice}} + m_{ice} c_{ice} T_{o,ice} + m_{kool} c_{kool} T_{o,kool}}{m_{ice} c_{ice} + m_{kool} c_{kool}} = 277.9 k \neq 273.15 k$$

<u>Thermal Conductivity</u>

Rate of heat flow $H = \frac{dQ}{dt} = KA \frac{T_H - T_c}{L}$

L = distance between T_H, T_c

A = Area ⊥ to heat flow

K = thermal conductivity