

P 25. Calculate the amount of energy, in joules, required to completely melt 130 g silver initially at 15 C°.

$$T_R \approx T^{\circ}C + 273.15$$

- 25. The melting point of silver is 1235 K, so the temperature of the silver must first be raised from 15.0° C (= 288 K) to 1235 K. This requires heat

$$Q = cm(T_f - T_i) = (236 \text{ J/kg} \cdot \text{K})(0.130 \text{ kg})(1235^{\circ}\text{K} - 288^{\circ}\text{K}) = 2.91 \times 10^4 \text{ J.}$$

- Now the silver at its melting point must be melted. If L_F is the heat of fusion for silver this requires

$$Q = mL_F = (0.130 \text{ kg})(105 \times 10^3 \text{ J/kg}) = 1.36 \times 10^4 \text{ J.}$$

- The total heat required is ($2.91 \times 10^4 \text{ J} + 1.36 \times 10^4 \text{ J}) = 4.27 \times 10^4 \text{ J.}$

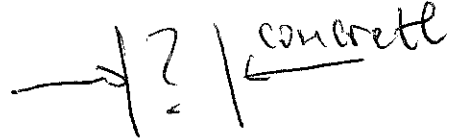
A window with area of 2 m^2 is made of 4 mm thick glass. If it is $20 \text{ }^\circ\text{C}$ colder outside than inside, what is the heat flow rate, H , through the window ?

By definition $H = k \cdot A \cdot (\Delta T / \Delta x)$

In our case thermal conductivity of glass $k = 0.8 \text{ W}/(\text{C}^\circ \cdot \text{m})$, $A = 2 \text{ m}^2$, $\Delta T = 20 \text{ }^\circ\text{C}$ and $\Delta x = 0.004 \text{ m}$

Therefore, $H = (0.8) \cdot (2) \cdot (20) / (0.004) = 8000 \text{ W}$

Boon



So $R_c = R_{\text{wood}} (1.8 \text{ cm})$

94. ORGANIZE AND PLAN We are asked to compare the insulation provided by two materials. In Problems 13.78 through 13.81, we were introduced to the R -value of a material, which is defined as the thickness divided by the thermal conductivity: $R = \Delta x / k$. To find the R -values for concrete and wood walls, we'll need their respective thermal conductivities from Table 13.4:

$k_c = 1.28 \text{ W/}^\circ\text{C}\cdot\text{m}$ and $k_w = 0.12 \text{ W/}^\circ\text{C}\cdot\text{m}$.

KNOWN: $\Delta x_w = 1.8 \text{ cm}$.

$\frac{\Delta x_c}{k_c} = \frac{\Delta x_{\text{wood}}}{k_{\text{wood}}} = R$

SOLVE For a concrete wall to have the same R -value of a piece of wood, its thickness would need to be:

$$\Delta x_c = \Delta x_w \frac{k_c}{k_w} = (1.8 \text{ cm}) \frac{(1.28 \text{ W/}^\circ\text{C}\cdot\text{m})}{(0.12 \text{ W/}^\circ\text{C}\cdot\text{m})} = 19.2 \text{ cm}$$

REFLECT To get the same insulation as a piece of wood, the thickness of a concrete wall has to be over ten times thicker. That's because concrete lets heat escape faster than wood does. Think of a cold concrete floor vs. a warm wooden one.

$$k_c \frac{A \Delta T}{\Delta x_c} = H = k_w \frac{A \Delta T}{\Delta x_w}$$

$$\frac{k_c}{\Delta x_c} = \frac{k_w}{\Delta x_w}$$

$$\Delta x_c = \Delta x_w \frac{k_c}{k_w}$$

A sphere of surface area 2 m^2 and emissivity of 0.5 is at temperature of $300 \text{ }^\circ\text{C}$.
What is the rate at which the sphere radiates heat into empty space ?

The rate, P , at which an object at temperature T radiates energy is:

$$P = e \cdot \sigma \cdot A \cdot T^4, \text{ where } \sigma = 5.67 \times 10^{-8} \text{ W}/(\text{m}^2 \cdot \text{K}^2)$$

$$\text{In our case } e = 0.5, A = 2 \text{ m}^2 \text{ and } T = 300 + 273.15 = 573.15 \text{ K}$$

Therefore,

$$P = (0.5) \cdot (5.67 \times 10^{-8}) \cdot (2) \cdot (573.15)^4 = 6118 \text{ W}$$

Boone



$$R_{\text{sun}} = 6.96 \times 10^8 \text{ m}$$

$$T_{\text{sun}} = 5800 \text{ K}$$

82. ORGANIZE AND PLAN The Stefan-Boltzmann law (Equation 13.8) tells us the rate at which a body radiates energy: $P = e\sigma AT^4$. Saying the Sun is a blackbody means that its emissivity is one, i.e.: $e = 1$. The Stefan-Boltzmann constant is: $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4$, and the surface area of a sphere is: $A = 4\pi r^2$.

Known: $r = 6.96 \times 10^8 \text{ m}$, $T = 5800 \text{ K}$.

SOLVE Substituting the values into the Stefan-Boltzmann law:

$$P = e\sigma AT^4 = (1)(5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4)(4\pi(6.96 \times 10^8 \text{ m})^2)(5800 \text{ K})^4 = 3.91 \times 10^{26} \text{ W}$$

REFLECT Currently, the world uses somewhere around 15 TW ($1.5 \times 10^{13} \text{ W}$) of power. In comparison, the Sun emits over 10 quadrillion times the energy we use.