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

T K = T °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

$$Q = cm(T_f - T_i) = (236\,\mathrm{J/kg\cdot K})(0.130\,\mathrm{kg})(1235°\mathrm{K} - 288°\mathrm{K}) = 2.91\times10^4\ \mathrm{J}.$$

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

$$Q = mL_F = (0.130\,\mathrm{kg})(105\times10^3\ \mathrm{J/kg}) = 1.36\times10^4\ \mathrm{J}.$$

- The total heat required is (2.91×10^4 J + 1.36×10^4 J) = 4.27×10^4 J.

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

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

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

Therefore, $H = (0.8).(2).(20)/(0.004) = 8000\ W$

Boou → | ? | ← concrete   So $R_c = R_{wood}(1.8\ cm)$

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: $k_C = 1.28\ \mathrm{W/^\circ C \cdot m}$ and $k_W = 0.12\ \mathrm{W/^\circ C \cdot m}$.

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

Known: $\Delta x_W = 1.8$ cm.

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

$$\Delta x_C = \Delta x_W \frac{k_C}{k_W} = (1.8\ \mathrm{cm}) \frac{(1.28\ \mathrm{W/^\circ C \cdot m})}{(0.12\ \mathrm{W/^\circ C \cdot m})} = 19.2\ \mathrm{cm}$$

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.

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

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

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

A sphere of surface area 2 m^2 and emissivity of 0.5 is at temperature of 300 °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:

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

In our case e =0.5, A= 2 m^2 and T = 300 + 273.15 = 573.15 K

Therefore,

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

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

$T_{sun} = 5800$ 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: $\sigma = 5.67 \times 10^{-8}\ \mathrm{W/m^2K^4}$, and the surface area of a sphere is: $A = 4\pi r^2$.
Known: $r = 6.96 \times 10^8$ m, $T = 5800$ K.
SOLVE Substituting the values into the Stefan-Boltzmann law:

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

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