By Tommy Willis
On 11 / 17 / 03

Conceptual questions

 # 10

CONVECTION is the most important process. For the bridge, the entire bridge is exposed to the cold air, which removes heat convectively so that thermal energy is removed from the top and bottom simultaneously. In contrast convection works only upon the top surface of the road, whereas the bottom surface of the road can be cooled only by conduction of heat into the earth, which is generally warmer than the air during cold weather. This is a much slower heat removal process than the convective currents of the air, so that the road cools at roughly half the rate of the bridge.

16.

$Q = mc\Delta T$ So use the fact that the energy lost by water has to equal that gained by air

And ΔT is same: Also use $m = \rho V$

$$M_a C_a \Delta T = M_w C_w \Delta T$$

So $m_a c_a = m_w c_w \Rightarrow \rho_w V_w c_w = \rho_a V_a c_a$

So
$$V_a = \frac{V_w \rho_w c_w}{\rho_a c_a} = \frac{(1\,m^3)\left(4186\ \frac{J}{C^\circ \cdot kg}\right)\left(1\times10^3\ \frac{kg}{m^3}\right)}{1.3\,kg/m^3 \quad 1000\,J/kg\cdot C^\circ} = 3.22\times10^3\ m^3$$

alot of air

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(17) use

$Q = mc\Delta T$

If the same Q goes into both systems then alcohol will have a ΔT that is twice that of water.

Problems:

(7.) 1 food Cal = 10^3 cal

1 cal = 4.186 J

So Energy stored in the cake is

$$E_{cake} = 500 \text{ Cal} \cdot \frac{10^3 \text{ cal}}{\text{Cal}} \cdot \frac{4.186 \text{ J}}{1 \text{ cal}} = 2 \times 10^6 \text{ J}$$

Now $mgh = E_{cake}$

$$h = \frac{E_{cake}}{mg} \cong 3 \text{ KM}$$

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(19) since the water doesn't change temp all of the energy given up by the copper is absorbed by the alumnum.

So $|Q|_{cu} = |Q|_{Al}$

$$m_{Al} c_{Al} |\Delta T_{Al}| = m_{cu} c_{cu} |\Delta T_{cu}|$$

I use the absolute value because I know that the magnitude here is important.

So $$m_{Al} = m_{cu} \frac{c_{cu}}{c_{Al}} \left| \frac{\Delta T_{cu}}{\Delta T_{Al}} \right| = \frac{387}{900} \frac{(85° - 25°)C}{(25° - 5°)C} (200g) =$$

$$\approx 2.6 \times 10^2 g$$

Graded problems.

(11.) The energy loss in one minute is

$$Q = (mc)_{water} \Delta T + (mc)_{cup} \Delta T = \left\{ (.800kg)\, 4186 \frac{J}{kg\,C°} + (.200kg)(900 \frac{J}{kg\,C°}) \right\} 1.5°C$$

$$= 5.3 \times 10^3 J$$

So $$P = \frac{Q}{\Delta t} = \frac{5.3 \times 10^3 J}{60s} = 88\,W$$

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(31) We need to figure out what the system will look like in equilibrium.

To do this
Notice the energy the steam (10 g) will give up as it condenses is $Q_{ST} = m_s L_v = 22.6\,kJ$

To melt 50g of ice it takes $Q_{ice} = M_{ice} L_f = 16.7\,kJ$

So the steam will melt the Ice

Will the water then boil?

To get it to 100°c we need $Q_{To\,boil} = M_{Ice} C_w (100°C) = 20.9\,kJ$

But we don't have that much energy left over from the steam. So system will be liquid. To find T_f

$$M_{ice}\left[L_f + C_w (T_f - 0°)\right] = M_{steam}\left[L_v + C_w (100°c - T_f)\right]$$ or

Solving for T_f, $T_f = 40°C$

b) Instead if we have 1g of steam,

$Q_{st} = m_s L_v = 2.26\,kJ$. This time it is not enough to melt all of the ice. ↓

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The steam gives up energy as it cools as well.

$$Q = m_s c_w \Delta T \overset{0\to100}{} = 419\ kJ$$

So now since all the Ice doesn't melt $T_f = 0°C$ and

$m L_f = Q_{st} + Q \Rightarrow m = 8.0g$ gives the mass of melted ice

(34) a)

$\Delta T = 20°F \Rightarrow \Delta T = 11°C$

$H = kA \frac{\Delta T}{L} = 5.0 \times 10^2 \frac{J}{s}$

b) $\Delta T = 70°F \Rightarrow \Delta T = 39°C$

Using same equation $H = 1.7 \times 10^3 \frac{J}{s}$

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(41)

$P_{net} = \sigma A e (T^4 - T_0^4)$ $e = 1$ for black body

$= 5.67 \times 10^{-8} \frac{W}{m^2 \cdot K^4} [4\pi (.06m)^2] [(473\,K)^4 - (295\,K)^4]$

$= 1.1 \times 10^2 W = .11\,kW$

(53.)

$(m_w c_w + m_c c_{gl})(T_f - 27°C) = m_{cu} c_{cu} (90° - T_f)$

↑ energy absorbed = ↓ energy given up

Solve for T_f

$T_f = 29°C$