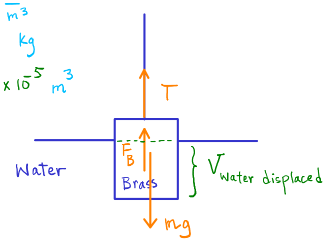
Physics 203 Summer 2015
Quiz 7
06/24/2015
Name:

1. A brass block with mass 0.50 kg and density 8000 kg/m^3 is suspended from a string. What is the tension in the string if the block is ¾ immersed in water (density = 1000 kg/m^3)?

The forces acting on the brass block : T, F_B, mg

$\rho_{Brass} = 8000 \frac{kg}{m^3}$, $m_{block} = 0.50$ kg $\Rightarrow V_{block} = 6.3 \times 10^{-5}\ m^3$

Equilibrium (statics) : $\sum \vec{F} = 0$ (x trivial; y: $T + F_B - mg = 0$), $\sum \tau = 0 \rightarrow$ trivial.



$\rightarrow T = mg - F_B = mg - \rho_W V_{water\ displaced}\, g$

$= (0.50\ kg - 1000 \times 4.7 \times 10^{-5}\ kg)(9.8 \frac{m}{s^2}) = 4.4\ N.$

$V_{water\ displaced} = \frac{3}{4} V_{block} = 4.7 \times 10^{-5}\ m^3$

2. A block of ice has a volume of 5.0 m^3. The temperature of the block is -10 ^oC. The density of ice is 917 kg/m^3. How much water at 27 ^oC is required to melt this ice? (Water: c = 4186 J/(kg ^oC). Ice: c = 2000 J/(kg ^oC). Heat of fusion: L = 3.35 * 10^5 J/kg.)

The block of ice brings up to $0°C$ $\rightarrow Q_1 = m_{ice} c_{ice} (0°C_{final} - (-10°C)_{initial}) = 9.2 \times 10^7\ J > 0$ (gets heat)

The $0°C$ ice melts giving $0°C$ water $\rightarrow Q_2 = m_{ice} L_f = 15.4 \times 10^8\ J > 0$ (gets heat)

If we use minimum amount (m_{water}) so that at the end we end up with $0°C$ water : $Q_3 = m_{water} c_{water} (0°C_{final} - 27°C_{initial}) = -1.13 \times 10^5\, m_{water} < 0$ (gives heat)

$\sum Q = 0 \rightarrow Q_1 + Q_2 + Q_3 = 0 \rightarrow 16.3 \times 10^8 - 1.13 \times 10^5\, m_{water} = 0$

$\rightarrow m_{water} = 1.44 \times 10^3\ kg.$

$m_{ice} = 5.0\ m^3 \times 917 \frac{kg}{m^3} = 4.6 \times 10^3\ kg$

11.53 (9th ed.)

$m_{glass} = 1.0\ kg$

$\rho_{glass} = 2.6 \times 10^3 \frac{kg}{m^3}$

$V_{glass} = \frac{m_{glass}}{\rho_{glass}} = \frac{4}{3}\pi(b^3 - a^3)$

$\rightarrow b^3 - a^3 = \frac{3}{4\pi} \times \frac{1.0}{2.6} \times 10^{-3}\ m^3 = 9.2 \times 10^{-5}\ m^3$. (i)

Equilibrium $\rightarrow \{\sum \vec{F} = 0, \sum \tau = 0\} \rightarrow F_B - m_{glass} g - m_{air} g = 0$ (m_{air} negligible)

$\rightarrow \rho_{water} V_{displaced\ water}\, g = m_{glass}\, g$

$\rightarrow \rho_{water} \frac{4}{3}\pi b^3 = m_{glass}$

$\rightarrow b^3 = \frac{3}{4\pi} \times \frac{1.0}{1.0} \times 10^{-3}\ m^3 = 2.4 \times 10^{-4}\ m^3$

$\rightarrow b = 6.2\ cm \xrightarrow{(i)} a = 5.3\ cm.$