Physics 10154 - Exam #5A

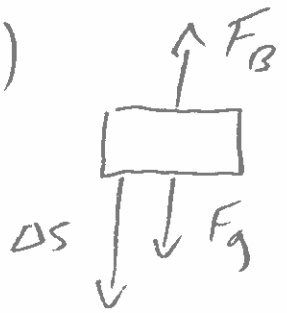
Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A 12.0-kg rock specimen is estimated to have a density of 2240 kg/m^3.

a) If this rock is immersed in water, how long will it take (in seconds) to fall 3.00 meters to the bottom of a container?

b) While immersed in water, the rock is placed on a scale to measure its apparent weight. What weight shows on the scale?

a)



$V_o = m_o/\rho_o = .00536\,m^3$

$\Sigma F_y = F_g - F_B = ma$

$mg - \rho_f V_o g = ma$

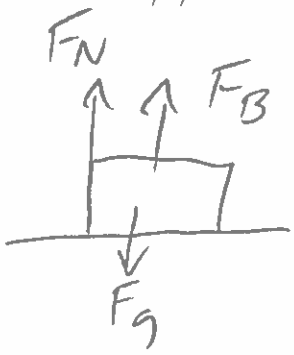
$117.6 - 52.5 = 12a$

$a = 5.425\ m/s^2$

$3.0 = 0 + \frac{1}{2}(5.425)t^2$

$\boxed{t = 1.05\ s}$

b) Apparent weight $= F_g - F_B = \boxed{65.1\ N}$ or 6.64 kg



or $\Sigma F_y: F_N + F_B - F_g = 0$

scale reading $\rightarrow F_N = F_g - F_B$

2. (30 pts) 56 grams of ice at a temperature of -25°C is dropped into a 230-gram aluminum container which has an initial temperature of 65°C.

What is the final temperature of the system? If the final temperature of the system is 0, how much ice melts?

The specific heat of aluminum is 900 J/kg °C. Other constants needed are on your formula sheet.

To melt ice:

$\Delta Q = (.056)(2090)(25) + (.056)(333000)$

$= 21574\ J$

To cool Al:

$\Delta Q = (.230)(900)(-65) = -13455$

not all ice melts, $\boxed{T_F = 0°C}$

$\Delta Q_{ice} + \Delta Q_{Al} = 0$

$2926 + m(333000) - 13455 = 0$

$m = \frac{10529}{333000} = \boxed{.032\ kg}$

3. (20 pts) A double-paned square window measures 34 cm on a side. The window has two panes of glass (0.75 cm thick for each pane) that sandwich a 0.50 cm layer of air between them. If the temperature outside is 42°F and the temperature inside is 68°F, determine how much money is spent to replace the heat energy lost by the window in one day.

Assume the thermal conductivity of glass is 0.85 W/m K and the thermal conductivity of air is 0.0350. Assume the cost of energy is 12 cents per kilowatt-hour. Answer to the nearest cent.

$$R\text{-value} = \frac{l_1}{k_1} + \frac{l_2}{k_2} + \frac{l_3}{k_3}$$

$$\frac{.0075}{.85} + \frac{.0050}{.0350} + \frac{.0075}{.85} = 0.1605$$

$$P = \frac{A\,\Delta T}{R\text{-value}} \qquad \Delta T = 26°F = 14.4°C$$

$$P = \frac{(.34)^2(14.4)}{0.160} = 10.4\ W$$

$$E = P \cdot t = (10.4361)(86400\ s)$$

$$= 9.0168 \times 10^5\ J$$

$$= 0.250\ kW \cdot hr, \quad \frac{12¢}{kW \cdot hr}$$

$$= \boxed{3¢}$$

4. (20 pts) If you move 3.0 times further away from a source of sound (assume it radiates uniformly in all direction), by how many dB does the loudness change?

$$\frac{I_1}{I_2} = \frac{1}{9} \quad \text{since } I \propto \frac{1}{r^2}$$

$$\Delta B = 10 \log\left(\frac{1}{9}\right) = \boxed{-9.5\ dB}$$