Physics 10154 - Exam #4A

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. (25 pts) A rock specimen weighs 3250 N in air and 1920 N when completely immersed in water.

(a) What is the density of the rock?

(b) The specimen is partially hollow. We know the density of the rocky portion of the specimen is 3580 kg/m^3, what percentage of the rock is hollow?

Assume $V_o = V_f$ since rock is immersed.

$$\rho_o V_o g = 3250$$

$$\rho_o V_o g - \rho_f V_f g = 1920$$

so $\rho_f V_f g = 1330$

$$\rho_f V_o g = 1330 \Rightarrow V_o = \frac{1330}{(1000)(9.8)}$$

$$= 0.136\ m^3$$

$$\rho_o = \frac{3250}{V_o g} = \boxed{2440\ kg/m^3}$$

b) $M_{rock} = M_{tot}$

$$\rho_{rock} V_{rock} = \rho_{tot} V_{tot}$$

$$\frac{V_{rock}}{V_{total}} = \frac{\rho_{tot}}{\rho_{rock}} = \frac{2440}{3580} = 0.683$$

so rock is $1 - .683$

$= \boxed{31.7\%\ \text{hollow}}$

2. (25 pts) 185 grams of ice with an initial temperature of -15.0 °C is added to 850 mL of lemonade at an initial temperature of 25.0 °C. Assume the density of lemonade is the same as water (1000 kg/m3) and the specific heat is also the same as water (4186 J/kg °C). What is the final temperature of the system? If the final temperature is zero, how much ice melts?

Warm ice to 0°C = 5800 J
Melt ice = 61605 J
} 67405

$M_L = \rho_L V_L = (1000 \frac{kg}{m^3})(850 \times 10^{-6} m^3) = 0.850 kg$

Cool lemonade to 0°C = -88953 J

Takes more energy to cool lemonade

(88953 > 67405), so all ice melts. $T_F > 0$

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

$67405 + (.185)(4186)(T_F - 0) + (.850)(4186)(T_F - 25) = 0$

$67405 + 774.4 T_F - 88952.5 + 3558.1 T_F = 0$

$+21547.5 + 4332.5 T_F = 0$

$T_F = \frac{21547.5}{433.25} = \boxed{5.0°C}$

3. (25 pts) An ideal gas at a temperature of 27.0 °C and a pressure of 3.50 atm occupies a 27.0 Liter chamber.

a) How many moles of gas are present?

b) If the volume of the chamber is doubled and the temperature raised to 122 °C, what will be the pressure of the gas, in atm?

a) $PV = nRT$

$(3.50)(27.0) = n(.0821)(300\,K)$

$\boxed{n = 3.84 \text{ moles}}$

b) $\frac{P_2}{P_1} = \frac{\left(\frac{n_2}{n_1}\right)\left(\frac{R}{R}\right)\left(\frac{T_2}{T_1}\right)}{\left(V_2/V_1\right)} = \frac{(1)(1)\left(\frac{395}{300}\right)}{(2)}$

$= 0.6583$

$P_2 = (0.6583)(3.50 \text{ atm}) = \boxed{2.30 \text{ atm}}$

4. (25 pts) Suppose a speaker emits sound uniformly in all directions with no reflections. The loudness (dB) of the sound at a distance of 22 meters from the speaker is 75 dB.

a) What is the loudness (dB) at a distance of 62 meters from the speaker?

b) If we add multiple speakers next the original speaker, we can increase the loudness. How many speakers would be needed with the same power as the original speaker in order for the loudness to increase by 15 db at each location?

a) $\Delta\beta = 10 \log\left(\frac{P/4\pi(22)^2}{P/4\pi(62)^2}\right) = 10 \log\left[\left(\frac{62}{22}\right)^2\right]$

$= 9.00$

New $\beta = 75 - 9 = \boxed{66 \text{ dB}}$

b) $\Delta\beta = 15 = 10 \log\left(\frac{NI}{I}\right) = 10 \log(N)$

$1.5 = \log N$

$N = 10^{1.5} = \boxed{32 \text{ speakers}}$