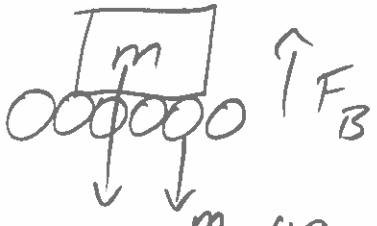
Physics 10154 - Exam #4B

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) Logs can be approximated as cylinders of radius 0.075 meters and length of 2.50 meters. The volume of a cylinder, like any rectangular solid, is the cross-sectional area multiplied by the length (or height). The density of the logs is 770 kg/m3. What is the smallest number of whole logs that can be used to build a raft that will carry a crew of seven people with a total mass of 540 kg?

Assume logs immersed, so $V_0 = V_f$



$\Sigma F_y = F_B - (540)(g) - m_{raft}(g) = 0$

$\rho_f V_0 g - (540)(g) - \rho_0 V_0 (g) = 0$

$(1000)V_0 - 540 - (770)V_0 = 0$

$230 V_0 = 540$

$V_0 = 2.35\ m^3$

$V_{log} = \pi(.075)^2(2.50) = .0442\ m^3$

$V_0 = N V_{log} \Rightarrow N = \frac{2.35}{0.0442} = 53.2$ need more

$\boxed{54 \text{ logs}}$

2. (25 pts) A 2.50 kg aluminum pot is heated to a temperature of 361 °C, and then 215 mL of water is poured into the pot. The water has an initial temperature of 24.0 °C.

Determine the final temperature of the system. If the final temperature is 100.0 °C, then determine how many grams of water are converted into steam.
The specific heat of aluminum is 900 J/kg °C.

Cool Al to 100°C = $(2.5)(900)(-261)$ =

$= -587250$

$m_w = \rho_w V_w = (1000 \frac{kg}{m^3})(215 \times 10^{-6} m^3) = 0.215 kg$

heat water to 100°C = $(.215)(4186)(76) = 68399$

vaporize $= (.215)(2.26 \times 10^6) = 485900$

554299

Since $587250 > 554299$, all water vaporizes

+ turns to steam, $T_F > 100°C$.

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

$(2.5)(900)(T_F - 361) + 554299 + (.215)(2010)(T_F - 100) = 0$

$2250T_F + 432.2T_F - 812250 + 554299 - 43215 = 0$

$2682.2T_F = 301166$

$\boxed{T_F = 112°C}$

3. (25 pts) A person eats a 335 Calorie dessert and wishes to "burn it off" using the body's natural radiation. This person has a body temperature of 37.0 °C and enters a room with a temperature of 14.0 °C. The person's body has an average emissivity of 0.750 and a surface area of 1.40 m^2. How much time does it take, in hours, for the body to burn off 335 Calories? Assume 1 Calorie = 4186 Joules.

$$P = e\sigma(T^4 - T_{env}^4) * Area$$

$$= (.750)(5.67\times10^{-8})(310^4 - 287^4)(1.40)$$

$$= 145.9 \text{ Watts}$$

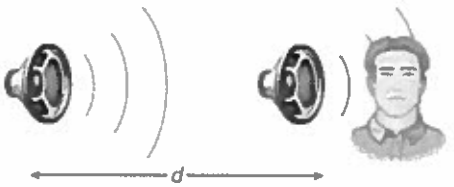
$$E = P \cdot t$$

$$335 \text{ Cal} = 145.9 \text{ W} * t$$

$$1.40\times10^6 \text{ J} = \frac{145.9 \text{ J}}{\text{s}} \cdot (t)$$

$$t = 9611 \text{ s} = \boxed{2.67 \text{ hrs}}$$

4. (25 pts) Two speakers, one directly behind the other, are generating a sound wave of frequency 244 Hz. Assume the speed of sound is 343 m/s.



a) What is the smallest distance, d, between the speakers that will produce destructive interference for the listener standing in front of them?

b) If the speakers are separated by 4.22 meters, will the listener hear constructive or destructive interference? Justify your answer.

a) Need $d = \frac{\lambda}{2}$ for D.I.

$\lambda = \frac{v}{f} = 1.405\,m$

$d = \frac{\lambda}{2} = \boxed{0.703\,m}$

b) $4.22\,m \cdot \frac{1\,wave}{1.405\,m} = 3.00\,waves$

so $\Delta\phi = 3\lambda \Rightarrow \boxed{C.I.}$