Physics 06 LACC Fa24 80/80 TEST4 Ch10-12' Name KEY

Ch10 - Fluids

1. (5 pts) A 80-kg person's two feet cover an area of 600 cm^2. (*a*) Determine the pressure exerted by the two feet on the ground. (*b*) If the person stands on one foot, what will be the pressure under that foot?

(a) $P = \frac{F}{A} = \frac{mg}{A} = \frac{(80kg)(9.8 m/s^2)}{600cm^2 \left[\frac{1m}{100cm}\right]^2} = \boxed{13.1 kPa}$

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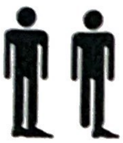

(b) Pressure doubles as area is cut in ½

$\boxed{26.2 kPa}$

2. (5 pts) Consider two identical pails of water filled to the brim. One pail contains only water, the other has a piece of wood floating in it. They weigh the same. Explain why?

weigh the same since weight of spilled water is that displaced by the wood's weight ((Archimedes' Principle))

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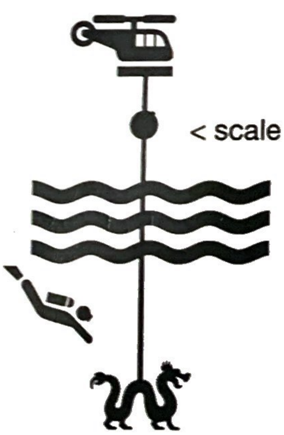
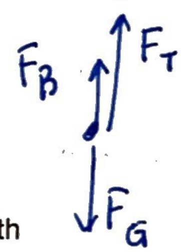
3. (10 pts) A 50-kg ancient statue lies at the bottom of the sea. Its volume is 2.0x10^4 cm^3. How much force is needed to lift it (without acceleration)? Seawater, ρ = 1.025x10^3 kg/m^3

(i) Diagram



(ii) Force diagram



(iii) Newton's Law

$\sum F = 0$ since "a" ≈ 0

$F_B + F_T - F_G = 0$

want $\boxed{F_T = F_G - F_B}$

(iv) Do the math

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$F_T = mg - (\rho_{water} V_{water\ displaced}\, g)$

$= [50kg - (1.025\times10^3 kg/m^3)(2\times10^4 cm^3)\left[\frac{1m}{100cm}\right]^3](9.8 m/s^2)$

$= 490N - 200.9N$

$= \boxed{289. N}$

4. (10 pts) Water circulates throughout a house in a hot-water heating system. If the water is pumped at a speed of 0.30 m/s through a 3.0-cm-diameter pipe in the basement under a pressure of 3.0 atm, what will be the pressure in a 2.2-cm-diameter pipe on the second floor 4.0 m above if its flow speed there is 0.56 m/s? Use Bernoulli's Eqn. (1atm = 1.0.x10[5] N/m, Water = 1000kg/m[3])

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Room: $P_2 = ?$

$v_2 = 0.56\,m/s$

$h_2 = 4.0\,m$

$r_2 = 2.2\,cm/2$

Bernoulli

$$P_1 + \frac{1}{2}\rho_1 v_1^2 + \rho_1 g y_1 = P_2 + \frac{1}{2}\rho_2 v_2^2 + \rho_2 g y_2$$

$\rho_1 = \rho_2$

Boiler: $P_1 = 3\,atm$

$v_1 = 0.3\,m/s$

$h_1 = 0\,m$

$r_1 = 3.0/2\,cm$

$$\Rightarrow P_2 = P_1 + \frac{1}{2}\rho(v_1^2 - v_2^2) + \rho g(h_1 - h_2)$$

$$P_2 = 3\times10^5\,\frac{N}{m} + \frac{1}{2}(10^3\,kg/m)\left[(0.3\tfrac{m}{s})^2 - (0.55\tfrac{m}{s})^2\right] + (10^3\,kg/m)(9.8\,m/s)(4.0-0.0)\,m$$

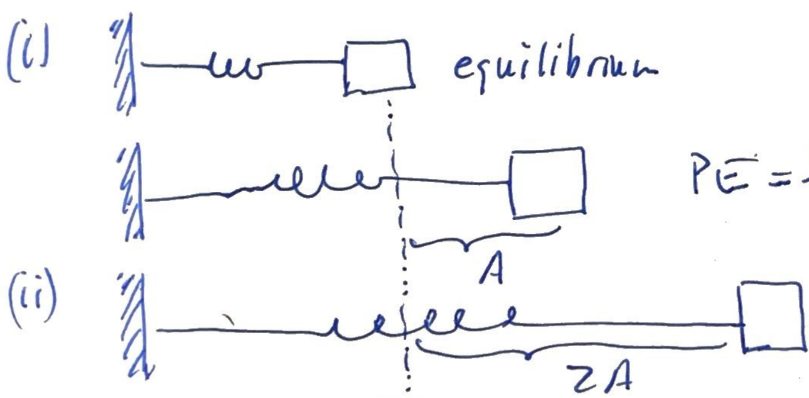
$$= (300{,}000 - 110 - 39.2)\,Pa$$

$$= \boxed{265{,}000\ Pa}$$

or $\boxed{2.6\,atm}$

Ch11 - SHO

5. (10 pts) Suppose the spring in a horizontal spring-mass is stretched twice as far (to x = 2A compared to just x = A). What happens to (a) the energy of the system, (b) the maximum velocity of the oscillating mass? Do they double?



$PE = \frac{1}{2}kA^2,\ KE = 0$

$PE = \frac{1}{2}k(2A)^2 = \frac{1}{2}kA^2 * 4$

5 (a) PE quadruples

5 (b) No formula for v_{max}? $E_{TOT} = KE_{TOT} + PE \to 0 = \frac{1}{2}mv_m^2$, with $E_{TOT} = \frac{1}{2}kA^2$

$\frac{1}{2}kA^2 = \frac{1}{2}mv_m^2 \Rightarrow \boxed{v_{max} = \sqrt{\frac{k}{m}}A}$ So when $A \to 2A$ $\boxed{v_{max} \to 2v_{max}\ \text{Doubles}}$

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6. (5 pts) A spacewoman uses a simple pendulum that has a length of 27.10 cm and a frequency of 0.7190 Hz on Planet X. What is the acceleration due to gravity on this planet?

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$T = 2\pi\sqrt{l/g}$ → $g = 4\pi^2 l / T^2$

$\left(\frac{T}{2\pi}\right)^2 = \frac{l}{g}$

$g = \frac{4\pi^2 (0.271\,m)}{\left(\frac{1}{0.719\,Hz}\right)^2}$

$g = 5.53\ m/s^2$

7. (10 pts) A wave whose wavelength is 0.10 m is traveling down a 220-m-long wire whose total mass is 15 kg. If the wire is under a tension of 1500 N, what are (a) the speed and (b) the frequency of this wave?

λ → v

5 (a) $v = \sqrt{\frac{F_T}{\mu}} = \sqrt{\frac{1500\,N}{(15\,kg/220\,m)}} = 148.3\ m/s$

5 (b) $v = \lambda f$ so $f = v/\lambda = \frac{148.3\,m/s}{0.10\,m} = 1483\ Hz$

8. (5 pts) The intensity of an earthquake P-wave traveling *through* the Earth and detected 80 km from the source is 2.0×10^6 W/m^2. What is the intensity of that wave if detected 330 km from the source? {Assume a 3-D environment, i.e. an inverse square decay.}

$I \propto \frac{1}{r^2}$ ⇒ $\frac{I_2}{I_1} = \frac{r_1^2}{r_2^2}$ → $I_2 = \left(\frac{r_1}{r_2}\right)^2 I_1$

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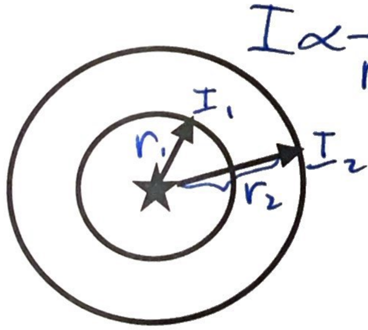

$= \left(\frac{80\,km}{330\,km}\right)^2 (2\times10^6\ W/m^2)$

$= 1.17\times10^5\ W/m^2$

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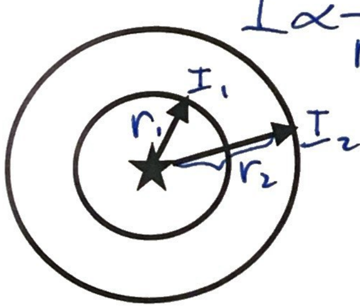

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$\frac{I_2}{I_1} = \frac{r_1^2}{r_2^2} \rightarrow I_2 = \left(\frac{r_1}{r_2}\right)^2 I_1$

$= \left(\frac{80\,km}{330\,km}\right)^2 (2 \times 10^6\ W/m^2)$

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Ch12 - Sound

9. (5 pts) At a busy street corner, the sound level is 61 dB. What is the intensity of sound there?

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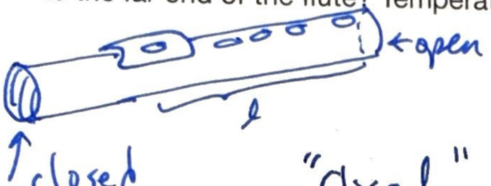
$\beta = 10\log\left(\frac{I}{I_0}\right)$ → use $a = \log(b)$ then $b = 10^a$

$\frac{\beta}{10} = \log\left(\frac{I}{I_0}\right)$ → $\frac{I}{I_0} = 10^{\beta/10}$

$I = I_0 10^{\beta/10} = (10^{-12}\,\frac{W}{m^2})(10^{61/10}) = \boxed{1.3\times10^{-6}\,\frac{W}{m^2}}$

10. (10 pts) A flute is designed to play middle C (262 Hz) as the fundamental frequency when all the holes are covered. Approximately how long should the distance be from the mouthpiece to the far end of the flute? Temperature is 20°C {the flute is an open tube}



$f_1 = 262\,Hz$ @ 20°C, $V_{sound} = 343\,m/s$

"closed" {half-open} follows:

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$f_1 = \frac{V}{4l} \Rightarrow l = \frac{V}{4f_1} = \frac{343\,m/s}{4(262/s)} = \boxed{32.7\,cm}$

11. (5 pts) A tuning fork produces a steady 330-Hz tone. When this tuning fork is struck and held near a vibrating guitar string, twenty beats are counted in five seconds. What are the possible frequencies produced by the guitar string?

$f_{Beat} = f_1 - f_2$

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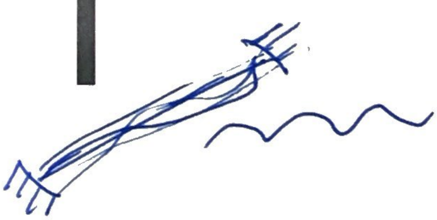
$f_1 = 330\,H$



$f_2 = ?$

$\pm\frac{20}{5}\,Hz = 330\,Hz - f_2$

$\Rightarrow \boxed{f_2 = 334\,Hz}$ or $\boxed{f_2 = 326\,Hz}$

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