Physics 151 Class Exercise: Exam 3 Review - KEY

1. A portable radio is sitting at the edge of a balcony 5.1 m above the ground. The unit is emitting sound uniformly in all directions. By accident, it falls from rest off the balcony and continues to play on the way down. A gardener is working in a flower bed directly below the falling unit. From the instant the unit begins to fall, how much time is required for the sound intensity level heard by the gardener to increase by 10.0 dβ.

First note that for the intensity level to increase by 10.0 dβ, the intensity must increase by a factor of 10. That is easily seen from the following equation.

$$\beta_2 - \beta_1 = 10\log_{10}\left(\frac{I_2}{I_1}\right) = 10\log_{10}\left(\frac{10I_1}{I_1}\right) = 10\log_{10}(1) = 10$$

Thus, we want the intensity of the sound to increase by a factor of 10. Note that the power (the energy per second produced by the radio) does not change. Let's use the subscript of 1 for the original position and a subscript of 2 for the final position.

$$I = \frac{P}{A} = \frac{P}{4\pi r^2}$$

$$I_1 r_1^2 = I_2 r_2^2$$

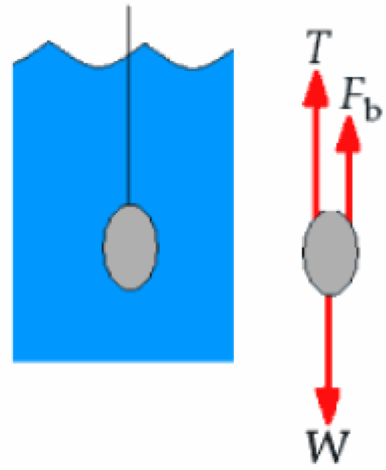
$$\frac{I_2}{I_1} = 10 = \frac{r_1^2}{r_2^2}$$

$$r_2 = \sqrt{\frac{r_1^2}{10}} = \sqrt{\frac{(5.1m)^2}{10}} = 1.6m$$

Thus, the radio falls a distance of 3.5 m. This takes a time of:

$$t = \sqrt{\frac{2y}{g}} = \sqrt{\frac{2(3.5m)}{\left(9.81\frac{m}{s^2}\right)}} = 0.84s$$

2. A lead weight with a volume of 0.82×10^{-5} m^3 is lowered on a fishing line into a lake to a depth of 1.0 m. **(a)** What tension is required in the fishing line to give the weight an upward acceleration of 2.1 m/s^2? **(b)** If the initial depth of the weight is increased to 2.0 m, does the tension found in part a) increase, decrease, or sty the same? Explain. **(c)** What acceleration will the weight have if the tension in the fishing line is 1.2 N. Give both direction and magnitude.



Let's apply Newton's 2nd Law and solve for the tension.

$$\Sigma F_y = T + F_b - mg = ma$$

Let's solve for the tension and include the density of lead.

$$\begin{aligned}
T &= mg + ma - F_b \\
&= \rho_{lead} Vg + \rho_{lead} Va - \rho_{water} Vg \\
&= V\left[\rho_{lead}(g+a) - \rho_{water} g\right] \\
&= \left(0.82\times10^{-5} m^3\right)\left[\left(11{,}300\frac{kg}{m^3}\right)\left(9.81\frac{m}{s^2} + 2.10\right)\frac{m}{s^2} - \left(1{,}000\frac{kg}{m^3}\right)\left(9.81\frac{m}{s^2}\right)\right] \\
&= 1.02 N
\end{aligned}$$

b) Stay the same – Neither the force of buoyancy nor the tension depends on pressure.

c)

$$\Sigma F_y = T + F_b - mg = ma$$

$$\begin{aligned}
a &= \frac{T + F_b - mg}{m} = \frac{T + \rho_w Vg}{\rho_{lead} V} - g \\
&= \frac{(1.20N) + \left(1{,}000\frac{kg}{m^3}\right)\left(0.82\times10^{-5} m^3\right)\left(9.81\frac{m}{s^2}\right)}{\left(11{,}300\frac{kg}{m^3}\right)\left(0.82\times10^{-5} m^3\right)} - \left(9.81\frac{m}{s^2}\right) \\
&= 4.01\frac{m}{s^2}
\end{aligned}$$

Upward. The weight would experience a downward acceleration when the tension is less than 0.83 N.