PHY 131: REVIEW FOR EXAM 3:

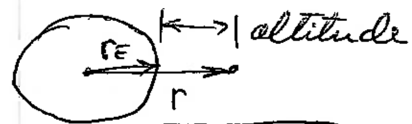
#1 m = your mass, M_E = Earth's mass, r_E = Earth's radius

Find where $\underbrace{\text{your weight}}$ is $\underbrace{\text{half of your weight at surface}}$

$$\frac{\cancel{GmM_E}}{r^2} = \left(\frac{1}{2}\right)\left(\frac{\cancel{GmM_E}}{r_E^2}\right)$$

$$\frac{1}{r^2} = \frac{1}{2r_E^2} \Rightarrow r^2 = 2r_E^2 \Rightarrow r = \sqrt{2}\,r_E$$

Then, subtract r_E to get altitude: FORMULA SHEET



$$\sqrt{2}\,r_E - r_E = (\sqrt{2}-1)\,r_E = (.4142)(6.37\times10^6\,m) = \boxed{2.64\times10^6\,m}\ \text{ANS}$$

#2 Conservation of angular momentum:

$$L_i = |\vec{r}\times\vec{p}| = rmv = (30\,m)(70\,kg)(8\,m/s) = 1.68\times10^4$$

$$L_f = (I\omega)_{VINE} + (I\omega)_{TARZAN} \quad \text{(Both have same } \omega\text{)}$$

$$I_V = \tfrac{1}{3}ML^2 = \tfrac{1}{3}(24\,kg)(30^2\,m) = 7200$$

$$I_T = mr^2 \quad \text{(point particle)} \quad = (70\,kg)(30^2\,m) = 63{,}000$$

$$L_i = L_f$$

$$1.68\times10^4 = 7200\,\omega + 63{,}000\,\omega$$

$$1.68\times10^4 = (7.02\times10^4)\,\omega \Rightarrow \omega = \frac{1.68\times10^4}{7.02\times10^4} = \boxed{.239\ \tfrac{RAD}{s}}$$

#3 From formula sheet: $v_{max} = \omega A = \sqrt{\frac{k}{m}}\,A$

Cons. of E: $\left(\frac{1}{2}mv^2 + \frac{1}{2}kx^2\right)_{\text{where } v = \frac{1}{2}\left(\sqrt{\frac{k}{m}}A\right)} = \left(\frac{1}{2}mv^2 + \frac{1}{2}kx^2\right)_{\text{at } x=A}$

$$\cancel{\tfrac{1}{2}}\cancel{m}\left[\tfrac{1}{2}\sqrt{\tfrac{k}{\cancel{m}}}A\right]^2 + \cancel{\tfrac{1}{2}}kx^2 = \cancel{\tfrac{1}{2}}m(0) + \cancel{\tfrac{1}{2}}kA^2$$

$$\tfrac{1}{4}\cancel{k}A^2 + \cancel{k}x^2 = \cancel{k}A^2$$

$$x^2 = \tfrac{3}{4}A^2 \Rightarrow \quad = \sqrt{\tfrac{3}{4}}\,(3\,cm) = \boxed{2.60\,cm}$$

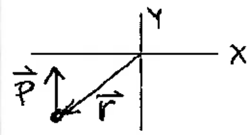
#4 $\beta = 10\log\left(\frac{I}{10^{-12}}\right) \Rightarrow 36\,dB = 10\log\left(\frac{I}{10^{-12}}\right) \Rightarrow 3.6 = \log\left(\frac{I}{10^{-12}}\right) \Rightarrow$

$$10^{3.6} = \frac{I}{10^{-12}} \Rightarrow 10^{-12}\,10^{3.6} = I \Rightarrow I = 3.98\times10^{-9}\,\tfrac{W}{m^2}$$

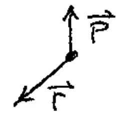
(at 3.0 m from buzzer.)

$$\frac{I_2}{I_1} = \frac{r_1^2}{r_2^2} \Rightarrow r_2 = r_1\sqrt{\frac{I_1}{I_2}} = (3\,m)\sqrt{\frac{3.98\times10^{-9}\,W/m^2}{1.0\times10^{-12}\,W/m^2}} = (3\,m)(63.1) = \boxed{189\,m}$$

5. a. $\underline{-z}$. $\vec{L} = \vec{r} \times \vec{p}$ where these are the radius and momentum vectors:



Put their tails together and apply the right hand rule.



b. Sound is a vibration of the material it passes through. Radio waves are electromagnetic.

c. When farthest from equilibrium. By F = ma, acceleration is the most where force is the most. By Hooke's law, force is the most farthest from equilibrium.

d. Half a year.

$$T^2 = \frac{4\pi^2}{G(m_1+m_2)} a^3$$

STAYS THE SAME

FOUR TIMES

$$T^2 = \frac{1}{4}\left(\text{actual } \frac{4\pi^2 a^3}{G(m_1+m_2)}\right)$$

$$T = \sqrt{\tfrac{1}{4}}\,(\text{what it is now})$$

e. Mention one of these two things: The molecules do not

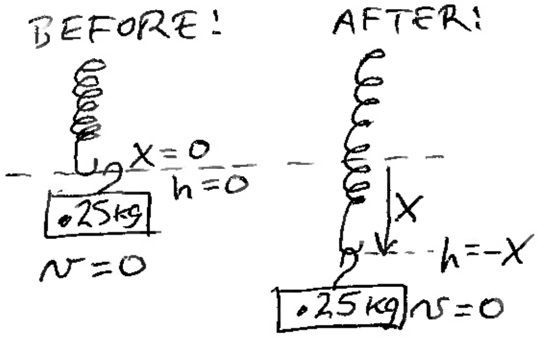
- attract or repel each other.
- take up any space. (They are pointlike.)

PHY 131

REVIEW OF 9-12

SOLUTIONS:

①



$E = \frac{1}{2}mv^2 + mgh + \frac{1}{2}kx^2$

$E_i = E_f$

$0 = 0 + mgh + \frac{1}{2}kx^2$

$0 = mg(-\cancel{x}) + \frac{1}{2}kx^{\cancel{2}}$

$mg = \frac{1}{2}kx$

$x = \frac{2mg}{k} = \frac{2(.25kg)(9.8)}{15} = \boxed{.327m}$

② "AVERAGE SEPARATION" IS A LESS PRECISE WAY OF SAYING THE ORBIT'S SEMIMAJOR AXIS.

$T^2 = \frac{4\pi^2}{G(m_1+m_2)}a^3 \Rightarrow a^3 = \frac{G(m_1+m_2)T^2}{4\pi^2}$

$a = \sqrt[3]{\frac{(6.67\times10^{-11})(2.3\times10^{30}kg)(7.86\times10^{6}sec)^2}{4\pi^2}}$ ← $(91d)\left(\frac{24h}{1d}\right)\left(\frac{3600s}{1h}\right)$

$a = \sqrt[3]{2.40\times10^{32}} = \boxed{6.22\times10^{10}\,m}$

③ $E = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 + mgh = \frac{1}{2}m(R\omega)^2 + \frac{1}{2}\left(\frac{2}{3}MR^2\right)\omega^2 + mgh$

$= \frac{1}{2}MR^2\omega^2 + \frac{1}{3}MR^2\omega^2 + mgh = \underline{\frac{5}{6}MR^2\omega^2 + mgh}$

$E_i + \underset{\text{WORK}}{W} = E_f$

$mgh_i + (-.25J) = \frac{5}{6}MR^2\omega^2$

$(.6kg)(9.8)(.2m) - .25 = \frac{5}{6}(.6kg)(.12m)^2\omega^2$

$.926 = .0072\omega^2 \Rightarrow \omega = \sqrt{\frac{.926}{.0072}} = \boxed{11.3\,\frac{RAD}{s}}$

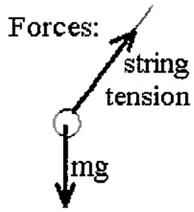
④ INSIDE: $\lambda = \frac{v}{f} = \frac{343\,m/s}{440\,Hz} = .7795\,m$

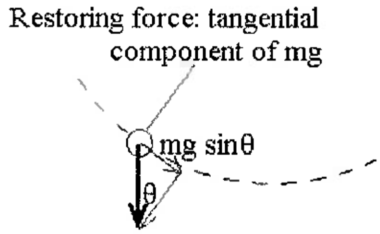
OUTSIDE: $v = f\lambda = (429\,Hz)(.7795\,m) = 334\,m/s$

$v = \sqrt{402T} \Rightarrow T = \frac{v^2}{402} = \frac{334^2}{402} = \boxed{278°\,KELVIN}\ (5°c)$

5. a. i. Same. Both are moving toward A at the same speed so both frequencies are raised the same amount.
ii. Lower than. B is going away from C which lowers the pitch. D is approaching C which raises the pitch.

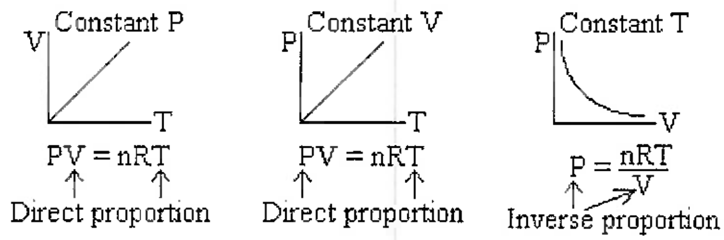
b.





c. $L = I\omega$. Jupiter's mass is so much farther from the axis around which it orbits that I is much larger in spite of the smaller mass. (If you are wondering about Jupiter's spin angular momentum, it is extremely small compared to its orbital angular momentum.)

d. If you drew the third graph touching either axis, this is incorrect. It is similar to $y = 1/x$ from algebra class and has asymptotes.



e. It's a trick question. There is nothing to compare. Sound can't go through a vacuum because there is nothing to vibrate. (I suppose you could argue that the speed of sound in a vacuum is zero, which makes the answer "faster in air." But, I wouldn't.)