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General Physics-I, Quiz-3
PHYS1000AA, AB, AC, Fall Semester-106
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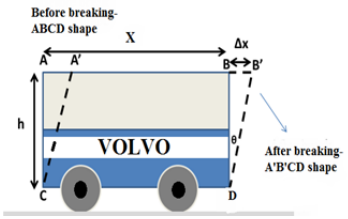
St. ID:_____, Name:_____

Chapter: 12-15, Serway; ABSOLUTELY NO CHEATING!
Please write down the answers on the blank space or on the back of this paper. Answer should be in english. [ ] indicates the question points.

Q1. VOLVO is designing new generation Truck with automatic emergency breaking system using AI (Artificial Intelligence) to avoid unexpected accident. Suppose a VOLVO truck starts journey from Taipei to Hualien with a speed 100 km/hr and for a emergency breaking if the upper part of the truck is tilted Δx = 50 cm as shown in figure with respect to the base, what will be the "Shear Stress", Shear Strain" and "Shear Modulus" for the deformation? Let the length of the truck L= 15 m, hight, h = 5m and during the break there has been 500 N force produced in the horizontal direction. [30 %]



Solution:

The total area of the truck body? $\sigma = (20\times 5)\ \text{m}^2 = 100\ \text{m}^2$,

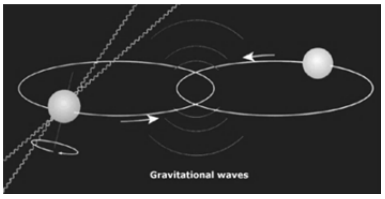
F= 500 N which is applied to the area, σ

We know, Shear stress $= \dfrac{\text{Applied Force}}{\text{Area}} = \dfrac{F}{\sigma} = \dfrac{500}{100} = 10\ \text{N/m}^2$

Shear strain $= \Delta x/h = 0.5/5 = 0.1$

Shear Modulus, $K = \dfrac{\text{Shear stress}}{\text{Shear strain}} = \dfrac{10\ \text{N/m}^2}{0.1} = 100\ \text{N/m}^2$

Q2. The gravitation wave is produced when two star systems merge/collide each other. If the two star systems of mass $M_1 = 2\text{x}10^{50}$ kg and $M_2 = 3\text{x}10^{50}$ kg are orbiting in their own orbitals as shown in figure below and if they experience $6\text{x}10^{25}$ N force during the generation of gravitational wave, Find out the separation distance between them? [30%]



Solution:

The gravitational force is defined by

$F = G\dfrac{M_1M_2}{r^2}$, where G is gravitational constant $= 6.674\times10^{-11}\ m^3\cdot kg^{-1}\cdot s^{-2}$

we can write the separation distance,

$$r = \sqrt{G\frac{M_1M_2}{F}} = \sqrt{6.674\times10^{-11}\ m^3\cdot kg^{-1}\cdot s^{-2}\ \frac{2\times10^{50}\,kg\times3\times10^{50}\,kg}{6\times10^{25}\,\text{N}}}$$

Therefore , $r = 2.58\times10^{8}$m

Q3. (a) If the gravitational wave is in simple harmonic motion and expressed by $y(x,\ t) = 4\ cos\ (\frac{8\pi}{20}x + \ 60\pi t + \phi)$, find-out the (i) wavelength (ii) frequency (iii) period and (iv) amplitude of the motion. (Let, '*x*' and't' are in kilometer and second) (b) (i) Write down the Bernoulli's equation. (ii) Give two practical applications of Bernoulli's principle. [20 +20 = 40%]

Solution:

(a) By comparing the the equation $y(x,\ t) = 4\ cos\ (\frac{8\pi}{20}x + \ 60\pi t + \phi)$

with the standard wave equation $y(x,\ t) = A\ cos\ (\frac{2\pi}{\lambda}x + \omega t + \phi)$

We can write ,

i) $\frac{2\pi}{\lambda} = \frac{8\pi}{20}$, therefore , the wavelength $\lambda = 5km$

ii) $\omega = 60\pi$

$\Rightarrow 2\pi f = 60\pi$

Therefore, $f = 30Hz$

iii) Period , $T = \frac{1}{f} = \frac{1}{30Hz} = 3.3\times10^{-2}$ sec

iv) $Amplitude, A = \ 4\ km$

(*b*)

i) $P + \frac{1}{2}\rho v^2 + \rho g y = \text{Constant}$

where , P = pressure , ρ= density, v = velocity and y = lifting hight of the fluid

ii) Bernoulli's principle is used in Aircraft lifting , Carborator of the petrol/ desel engine of Car / Bus etc.