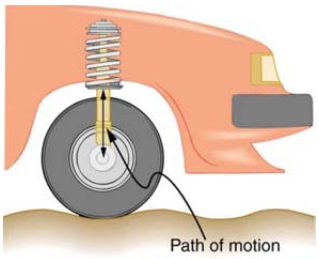
國立東華大學
Department of Physics
National Dong Hwa University, 1, Sec. 2,
Da Hsueh Rd., Shou-Feng, Hualien, 97401, Taiwan

General Physics-I, Quiz 4 Sol.
PHYS1000AA, AB, AC, Fall Semester-106
2017-12-26

St. ID:_____, Name:_____

Chapter15-16, 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. (a) Write down the equation of motion (second order differential) for damping oscillation of a spring and its possible solution. (b) It is well known that most cars have the shock absorber used as a damped oscillator to balance the car while you travel through a zigzag path. For a strong jerking if the spring is in damped oscillation, calculate the frequency for that oscillation. Let the damping coefficient b = 3N.s/m, the mass of the spring m= 20 kg and spring constant k= 2.0×10^5 N/m. [10+10+30=50]
(The question is similar to P.47 in Book)



Solution:

(a) $\sum F_x = -kx - bV_x = ma_x$

$$m\frac{dx^2}{dt^2} = -kx - b\frac{dx}{dt} \Big\} \rightarrow \text{(damping term)}$$

Possible solution is $x = Ae^{-\frac{b}{2m}t}\cos(\omega t + \phi)$

Where, A= Amplitude of wave , b=damping constant ,

ω = frequency of damping oscillation

(b) We know that,

$$\omega_0 = \sqrt{\frac{k}{m}} = \sqrt{\frac{2.0\times10^5}{20}} = 100Hz$$

With damping oscillation, the frequency is given by

$$\omega = \sqrt{\omega_0^2 - \left(\frac{b}{2m}\right)^2} = \sqrt{(100Hz)^2 - (\frac{3N.m/s}{2\times20kg-s})^2} = 99.9 \approx 100Hz$$

So the frequency will be , $f = \frac{\omega}{2\pi} = \frac{100}{2\times3.14} = 15.9Hz \approx 16Hz$

Q2. (a) What is the difference between transverse and longitudinal wave? Give an example for each of the wave. (b) When you play a Guitar, you produce the transverse wave in the string. Suppose a string length is 1 m and for your plucking at the end of the string if a transverse pulse is produced and it makes 4 trips down and back along the string by 1s, what will be the tension in the string? Let the string has the mass of 0.2 kg. [10+10+ 30]
(Question is similar to P.25 in Book)

Solution:

(a) Transverse wave : The medium moves parpendicular to the traveling of the wave

Example : Guiter string wave , Ocean wave etc.

Longgitudinal wave : The medium moves parallel to the traveling of the wave

Example : Sound wave , P-wave of earthquake

(*b*) The down and back distance is, $x = (1\,m\ +\ 1\,m)\ =\ 2\,m$

So the speed of the wave is, $v = \frac{x}{t} = \frac{2}{1} = 2\ m/s$

We know that the speed of standing a wave on string is

$v = \sqrt{\frac{T}{\mu}}$, where T= tension produced at the end of string ,

μ= mass per unit lenght of string

Therefore , $T=v^2 \times \mu = 2^2 m^2/s^2\, 0.2kg/m = 0.8N$