PUNJAB GROUP OF COLLEGES

FAISALABAD

Chapter # 07

Chapter Name ,, Oscillations

(Short Answers and Numericals)

Notice By ,

Zia-Ullah Munir Chaudhry

M.phil Physics (U.A.F)

Lecturer, Punjab Group of Colleges Faisalabad Daewoo Road Campus

CH# 07

Short Answers

7.1:- (i) Acceleration is directly proportional to the displacement.

$a \propto -x$

(ii) Total Energy of System is conserved in S.H.M.

(iii) Direction of Acceleration towards the Mean position.

7.2:- No, it does not depends upon Amplitude.

In Simple Pendulum,

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{l}}$$

In S.H.M:-

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$$

The eq's shows that frequency of Simple Harmonic oscillator is independent of Amplitude.

7.3:- No, we Cannot Realize an Ideal Simple Pendulum.

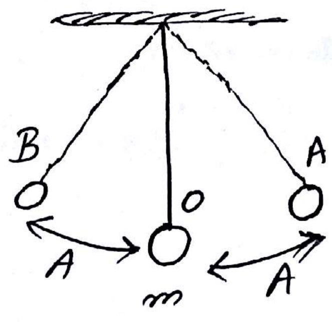
An Ideal Simple Pendulum has,

(i) Bob of very small ~~side~~ size be used.

(ii) Inextensible String.

(iii) Frictionless and Rigid Support.

7.4. The total distance covered by the body is 4A.



$O \rightarrow A = A$

$A \rightarrow O = A$

$O \rightarrow B = A$

$B \rightarrow O = A$

Total $= 4A$

7.5:- Ans:- $T = 2\pi\sqrt{\frac{l}{g}}$

(i) when length become double:

$\because l = 2l$

Then, $T' = 2\pi\sqrt{\frac{2l}{g}} \Rightarrow T' = \sqrt{2}\left(2\pi\sqrt{\frac{l}{g}}\right)$.

$T' = \sqrt{2}\, T$

Hence, when the length is doubled the Time Period increases $\sqrt{2}$ times.

(ii) when the Mass double the Time period Remains same. Because Time period independent of Mass.

7.6 No, Acceleration does not Remains Constant.

$a \propto -x$

Becaus, displacement "x" change, Acceleration also change.

(i) AT Mean position, $x = 0$ so $a = 0$

(ii) AT extreme position, $x = x_0$ so $a_{max.} = \omega^2 x_0$

7.7 (i) Phase Angle specifies the displacement as well as the direction of Motion of the Point performing S.H.M.

$\theta = \omega t$

(ii) It does not defines angle b/w Maximum displacement and the driving force.

7.8 S.H.M must,

(i) Have same frequency.

(ii) Be parallel.

(iii) Same initial speed.

(iv) Same Nature.

7.9:- Ans:

$a = -\omega^2 x$, $v = \omega\sqrt{x_0^2 - x^2}$

AT Mean position, $x = 0$

$a = -\omega^2(0)$, $v = \omega\sqrt{x_0^2 - (0)^2}$

$a = 0$, $v = \omega x_0$

$a =$ Minimum , $v =$ Maximum.

AT extreme position; $x = x_0$.

$a = -\omega^2(x_0)$, $v = \omega\sqrt{\cancel{x_0^2} - \cancel{x_0^2}}$

$a = -\omega^2 x_0$, $v = \omega(0)$

$v = 0$

$a =$ Maximum , $v =$ Minimum.

7.10:- (i) $y = A \sin(\omega t + \phi)$

$y =$ Instantaneous displacement.

$A =$ Amplitude

$\phi =$ Phase Angle

wave form of S.H.M is Sinusoidal.

(ii) $a = -\omega^2 x$

$a =$ instantaneous Acceleration.

$\omega =$ Angular frequency.

$x =$ Instantaneous displacement.

Acceleration of S.H.M is directly Proportional to displacement and Directed towards Mean Position.

7.11 · When frictional forces are not present ④ the total Energy of body Remains Constant. However P.E and K.E interchanged. AT extreme Position P.E is Maximum and K.E is Minimum and Vice versa.

$$E_{Total} = K.E + P.E = Constant$$

7.12 · Resonance plays important role in the following;

① Tuning of Radio ② Musical Instruments. ③ Microwave oven ④ Soldier March.

7.13 :- oscillations of Mass-spring System stop due to presence of frictional force and damping force. These Resistive forces dissipate energy.

Scanned by CamScanner

CHAPTER. NO. 07

NUMERICALS :-

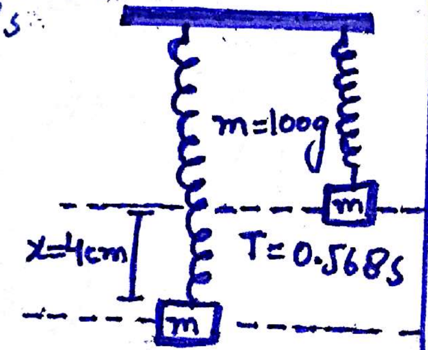
7.1 :- GIVEN DATA:

Mass $= m = 100g = 0.1kg$

Distance $= x = 4cm = 0.04m$

Time Period $= T = 0.568s$

$g = 9.8ms^{-2}$



• SOLUTION

$$\vec{F} = kx$$

$$\frac{\vec{F}}{x} = k \qquad (\because F = mg)$$

$$\frac{mg}{x} = k$$

$$k = \frac{(0.1)(9.8)}{0.04} = 24.5Nm^{-1}$$

$T = 2\pi\sqrt{\frac{m}{k}}$ Taking square.

$$T^2 = 4\pi^2\frac{m'}{k}$$

$$m' = \frac{T^2k}{4\pi^2}$$

$$m' = \frac{(0.568)^2(24.5)}{4(3.14)^2}$$

$$m' = 0.200kg$$

$\boxed{m' = 0.200kg}$ ANS

7.2 :- GIVEN DATA:

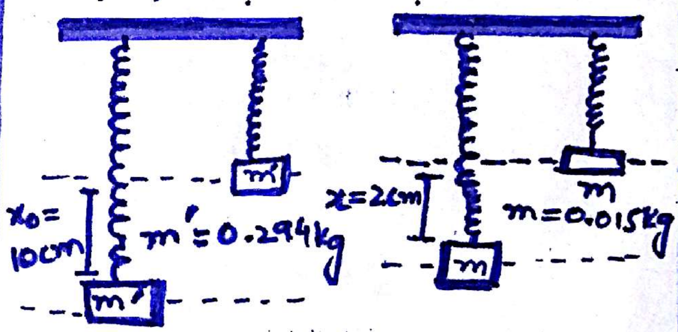
Mass $= m = 15g = 0.015kg$

displacement $= x = 2cm = 0.02m$

Mass of second object $= m' = 294g = 0.294kg$

Distance by second object $= x_0 = 10cm = 0.10m$

$T = ?$, $k = ?$, $v_0 = ?$



• SOLUTION :-

$\vec{F} = kx$, $\vec{F}/x = k$

$$k = \frac{mg}{x} \qquad \because (F = mg)$$

$$k = \frac{(0.015)(9.8)}{(0.02)} = 7.35Nm^{-1}$$

$$\boxed{k = 7.35Nm^{-1}}$$

$$T = 2(3.14)\sqrt{\frac{0.294}{7.35}} = 1.26s$$

$$\boxed{T = 1.26s}$$

$$V_0 = x_0\sqrt{\frac{k}{m}}$$

7.3: GIVEN DATA

Mass $= m = 8kg$

distance $= x = 30cm = 0.3m$

distance $= x_0 = 30cm = 0.3m$

Force $= F = 60N$,

$T = ?$, $a = ?$, $v = ?$, $K.E = ?$, $P.E = ?$

• SOLUTION:

$\vec{F} = kx$, $k = \vec{F}/x$

$k = \frac{60}{0.3} = 200Nm^{-1}$

$T = 2\pi\sqrt{\frac{m}{k}} = 2(3.14)\sqrt{\frac{8.0}{200}}$

$T = 1.256s$

$\boxed{T = 1.3s}$

$a = \omega^2 x$, $a = \frac{k}{m}x$

$(\omega^2 = \frac{k}{m})$

$a = \frac{200}{8} \times 0.12 = 3ms^{-2}$

$\boxed{a = 3ms^{-2}}$

$v = \omega\sqrt{x_0^2 - x^2}$ $(\omega = \sqrt{\frac{k}{m}})$

$v = \sqrt{\frac{k}{m}}\sqrt{x_0^2 - x^2}$

$v = \sqrt{\frac{200}{8}}\sqrt{(0.3)^2 - (0.12)^2} = 1.375ms^{-1}$

$\boxed{V = 1.375ms^{-1}}$

$K.E = \frac{1}{2}mv^2 = \frac{1}{2}(6)(1.375)^2 = 7.6J$

$\boxed{K.E = 7.6J}$

$P.E = \frac{1}{2}kx^2 = \frac{1}{2}(200)(0.12)^2$

$P.E = 1.44J$

$\boxed{P.E = 1.44J}$

$v_0 = (0.1)\sqrt{\frac{7.35}{0.294}}$

$v_0 = 0.5ms^{-1} = 50cms^{-1}$

$\boxed{V_0 = 50cms^{-1}}$

7.4: GIVEN DATA:

Mass $= m = 4kg$

spring constant $= k = 1960Nm^{-1}$

Height $= h = 0.80m$

$x_0 = ?$

• SOLUTION:

$P.E = \frac{1}{2}kx_0^2$

$2P.E = kx_0^2$

$\frac{2P.E}{k} = x_0^2$ $(\because P.E = mgh)$

$\frac{2(mgh)}{k} = x_0^2$

$\sqrt{x_0^2} = \sqrt{\frac{2(mgh)}{k}}$

$x_0 = \sqrt{\frac{2(4)(9.8)(0.80)}{1960}}$

$x_0 = 0.18m$

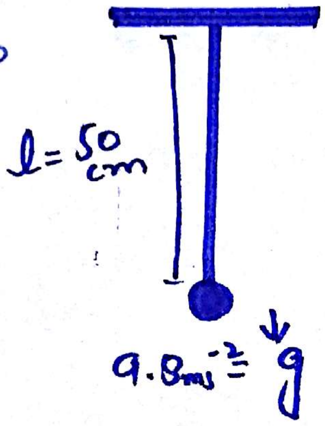
$\boxed{x_0 = 0.18m}$ ANS

7.5 :- GIVEN DATA :-

Length $= l = 50cm = 0.50m$

Gravitational acceleration $= g = 9.8ms^{-2}$

Frequency $= f = ?$



• SOLUTION :-

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

$$T = 2(3.14)\sqrt{\frac{0.50}{9.8}}$$

$$T = 1.44 \text{ secs}$$

$$f = \frac{1}{T} = \frac{1}{1.44} = 0.69 Hz$$

$$\boxed{f = 0.69Hz} \text{ ANS}$$

7.8 :- GIVEN DATA :-

$x = 0.25 \cos \frac{\pi}{8} t$ —— (1)

$t = 2 \text{ secs}$

$x_0 = ?$, $x = ?$, $f = ?$, $T = ?$

• SOLUTION :-

$$x = 0.25 \cos \frac{\pi}{8} t$$

$$x = 0.25 \cos \frac{\pi}{\cancel{8}4} (\cancel{2})$$

$$x = 0.25 \cos \frac{\pi}{4}$$

$$x = 0.25 \cos 45°$$

$$x = 0.18 m$$

As, $x = x_0 \sin \omega t$ —— (2)

By comparing eq (1) and (2), we get

$$x_0 = 0.25 m$$

$$\omega \cancel{t} = \frac{\pi}{8} \cancel{t}$$

$$\omega = \frac{\pi}{8} \quad (\because \omega = \frac{2\pi}{T})$$

$$\frac{2\pi}{T} = \frac{\pi}{8}$$

$$2\pi \times \frac{1}{T} = \frac{\pi}{8} \quad (f = \frac{1}{T})$$

$$2\pi f = \frac{\pi}{8}$$

$$\pi f = \frac{\pi}{8 \times 2} = \frac{\pi}{16}$$

$$\cancel{\pi} f = \frac{\cancel{\pi}}{16}$$

$$f = \frac{1}{16} Hz$$

$$\boxed{f = \frac{1}{16} Hz}$$