ASSIGNMENT :. 03

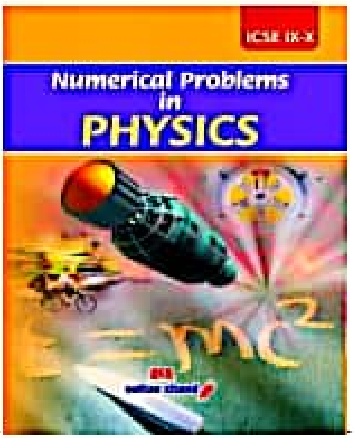
PHYSICS

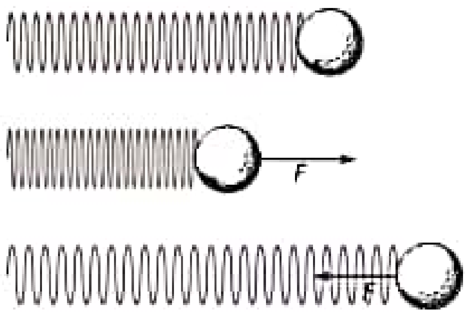
SUBMITTED BY

MUHAMMAD. SHERJEEL. AKHTAR
20P0101

SUBMITTED TO

Honorable SIR. MUSTAFA. HAIDER





A

B

C

①

Date:

Pb = 01

Data:-

Mass $= 50kg$

$a_{max} = 15m/sec^2$, $v_{max} = 3.5\ m/sec^2$

Soln:

ⓐ **Angular Frequency:**

$a_{max} = A\omega^2$

$v_{max} = A\omega$

$\Rightarrow \frac{a_{max}}{v_{max}} = \omega$

$\omega = 4.295$

ⓑ **Spring Constant:**

$\omega = \sqrt{\frac{k}{m}}$

$k = m\omega^2$

$\Rightarrow \boxed{k = 0.92\ N/m}$

ⓒ **Amplitude of the motion:-**

$v^2_{max} = A^2\omega^2$

$a_{max} = A\omega^2$

$\frac{v^2_{max}}{a_{max}} = A$

$\boxed{A = 0.82m}$

Pb = 02

Data:-

mass $= m = 2kg$

$F = 20N$

$A = 0.2m$

Soln:- ⓐ Solve equation for **k** where x is the amplitude A:

$k = \frac{F}{A}$

putting the values

$k = \frac{20}{0.2}$

$k = 100\ N/m$

②

Date:

(b) Frequency:-

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

$$f = \frac{1}{2\pi}\sqrt{\frac{100}{2}}$$

$$f = \frac{1}{2\pi}\sqrt{50}$$

$$\boxed{f = 1.13\ Hz}$$

(c) Maximum Speed

$$V_{max} = \omega A$$

$$V_{max} = \sqrt{\frac{k}{m}}\ A$$

putting the value

$$V_{max} = \sqrt{\frac{100}{2}}\ (0.2)$$

$$= 1.41\ m/sec$$

And the maximum speed occurs at equilibrium position $\boxed{\text{at } x = 0m}$

(d) Maximum Acceleration:-

$$a_{max} = \omega^2 A$$

$$a_{max} = \left(\frac{k}{m}\right) A$$

putting values:

$$a_{max} = \left(\frac{100}{2}\right)(0.2)$$

$$= \boxed{10\ m/sec^2}$$

(e) Total energy:-

$$E = \frac{1}{2}(k)(A^2)$$

putting values:

$$E = \frac{1}{2}(100)(0.2)^2$$

$$\boxed{E = 2}$$

(f) Speed:-

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

putting $x = \frac{A^2}{3}$

$$v = \sqrt{\frac{k}{m}\left[A^2 - \left(\frac{A}{3}\right)^2\right]}$$

$$\Rightarrow \sqrt{\frac{100}{2}\left(\frac{8}{9}(0.2)^2\right)}$$

$$= \sqrt{\frac{k}{m}\left(A^2 - \frac{A^2}{9}\right)}$$

$$\boxed{v = 1.33\ m/sec}$$

$$= \sqrt{\frac{k}{m}\left(\frac{8}{9}A^2\right)}$$

putting values:-

The maximum acceleration occurs at extreme turning point.

(3)

Date:

(g) acceleration:

$a = \left(\frac{k}{m}\right) x$

$a = \left(\frac{k}{m}\right)\left(\frac{A}{3}\right)$

putting values

$a = \frac{(100)(0.2)}{3(2)}$

$\boxed{a = 3.33 \ m/sec^2}$

period after $t=0$ at $t = \frac{3T}{4}$

$\boxed{= 0.5 \ sec}$

Pb 03:-

Soln:- The period of the oscillation is:

$T = \frac{1}{f} = \frac{1}{1.50} = \frac{1}{\frac{3}{2} s^{-1}} = \frac{2}{3}$

(a) At $t=0$, $x=0$ and v is positive (to the right). therefore this situation responds to $x = A \sin \omega t$ and $v = v_i \cos \omega t$.

Since $f = 1.50 Hz$ $\omega = 2\pi f = 3.00\pi$ and $A = 2.00 cm$

$x = 2.00 \cos(3.00\pi t - 90°) = 2.00 \sin 3.00\pi t$

where x is cm and it is s

(b) $v_{max} = v_i = A\omega = 2.00(3.00\pi) = 6.00\pi \ m/s$

$\boxed{= 18.8 cm/s}$

$a_{max} = A\omega^2 = 200(3.00\pi)^2 = 18.0\pi^2 \ cm/s^2$

$\boxed{= 178 \ cm/s^2}$

(c) The positive value of maximum acceleration first occurs when the particle is its direction on ~~the negative x-axis, three~~ quarter at a

Date:

Pb =04

Soln:-

In case of frequency,

$f = 600\,Hz$

$Period = \frac{1}{f} = \frac{1}{600}$

$\boxed{= 0.001675}$

Pb -05

Soln:- Heart beat is 150 beats per minute

1 minute = 60 s

Heart rate = $\frac{150 s}{60 s}$ = 2.5 beats per second.

Pb-06

Soln:- Period of tuning fork $T = 2.5 \times 10^{-3} s$

Frequency is defined as the inverse of time period. This

Frequency $f = \frac{1}{T} = \frac{1}{2.50 \times 10^{-3}}$

$\boxed{f = 400\,Hz}$

Pb =07:

Soln:- $T = 8.00\,10^{-5} s$

$f = \frac{1}{T} = \frac{1}{8.00 \times 10^{-5}}$

$\boxed{12500\,Hz}$

$\boxed{12.5\,kHz}$

Date:

Pb_8

Soln:- (a) $v_{max} = \sqrt{\frac{k}{m}}\, x$

$x = 0.200 \times 10^{-2} m$

$v_{max} = \sqrt{\frac{k}{m}}\, x \Rightarrow \sqrt{\frac{1.50 \times 10^{6} N/m}{850 kg}}\,(0.200 \times 10^{-2} m)$

$\Rightarrow \boxed{0.266 m/s}$

(b) $P.E = \frac{1}{2} kx^2 = \frac{1}{2}(1.50 \times 10^{6} N/m)(0.200 \times 10^{-2} m)^2$

$= \boxed{3.00 J}$

$$\boxed{\begin{aligned} v_{max} &= 0.266 m/s \\ P.E &= 3.00 J \end{aligned}}$$

Pb_9

Soln:- The spring constant is defined in the equation $F_x = -kx$ consider the 100 gram mass it exists a force of $F = mg$

$(0.1 kg)(9.8 kg m/s^2) = 0.98 N$ on the spring

$k = \frac{F}{x} = \frac{0.98}{0.098} = 10 N/m$

You would get the same result if you considered the 200 grams mass and its compression

Pb-10:

Solution :-

$T = 2\pi \sqrt{\frac{m}{k}} \rightarrow (1)$

Date:

To solve for the time period T, we need to know the rates of $\frac{m}{k}$

$$mg = k\left(\frac{d}{2}\right)$$

$$\frac{m}{k} = \frac{d}{2g}$$

put eq (1)

$$T = 2\pi\sqrt{\frac{d}{2g}} \Rightarrow \frac{\pi}{\sqrt{10}} = 0.99\,sec$$

Since ~~d~~ 4.9 cm, and we have used $g = 9.8\,m/sec^2$ Look like we had enough information after all.

Pb - 11

Soln:- (a) $E = \frac{1}{2}mv^2$

putting values.

$$E = \frac{1}{2}(1.500\,kg)(0.700\,m/sec^2) = 0.365\,J$$

$$\boxed{E = 0.365\,J}$$

(b)

$$E_{tot} = \frac{1}{2}kA^2 \Rightarrow A = \sqrt{\frac{2E_{Tot}}{}}$$

$$A = \sqrt{\frac{2(0.365)\,J}{500\,Nm}}$$

$$\boxed{A = 3.83\,cm}$$

Date:

Pb-12

Soln:- $E_{tot} = -\frac{1}{2}kx + \frac{1}{2}mv^2$

$-kx = ma \Rightarrow k = -\frac{ma}{x}$

where $x = -A$, $a = a_{max}$ Thus

$k = -\frac{Ma_{max}}{-A} = \frac{ma_{max}}{A}$

$E_{tot} = \frac{1}{2}\frac{Ma_{max}}{A}x^2 + \frac{1}{2}mv^2$

$E_{tot} = \frac{1}{2}(3.0kg)(3.5\,m/sec^2)(0.08cm)$

$\boxed{= 0.42J}$

Pb-13

Soln:- $T = 2\pi\sqrt{\frac{I}{Mgd}} \Rightarrow (1)$

$= I_{cm} = \frac{1}{2}mL^2$

Express the moment of inertia of the matter, stick about an x-axis through its centre of mass.

$I = I_{cm} + mx^2$

$= \frac{1}{2}mL^2 + mx^2$ put in (1)

$T = 2\pi\sqrt{\frac{\frac{1}{12}mL^2 + mx^2}{mgx}}$

Date:

$$\frac{2\pi}{\sqrt{g}}\sqrt{\frac{l^2+12x^2}{12x}}$$

$$= \frac{12x^2-l^2}{24x^2\sqrt{\frac{l^2+12x^2}{12}}}$$

$$= \frac{12x^2-l^2}{24x^2\sqrt{\frac{l^2+12x^2}{12x}}} = 0$$

$$\Rightarrow 12x^2 - l^2 = 0.$$

$$x = \frac{l}{\sqrt{12}} = \frac{100cm}{\sqrt{12}} = 28.9 cm$$

The hole should be at

$d = 50 cm - 28.9 cm$

$\boxed{= 21.1 cm}$

P-14:-

Soln:- Mass of spring $= m = 450g = \frac{450}{1000} = 0.45kg$

frequency of oscillation : $\nu = 1.2Hz$

Total energy of the oscillation 0.5kg

Energy of oscillation $= E = \frac{1}{2} m\omega^2 A^2$

where $= 2\pi\nu =$ Angular frequency.

$A =$ Amplitude

$\pi = \frac{22}{7}$

Using the formula,

$$0.51 = \frac{1}{2} \times 0.45\left(2\times\frac{22}{7}\times 1.2\right)^2 A^2$$

$$A^2 = \frac{2\times 0.51}{0.45 \times \left(2\times\frac{22}{7}\times 1.2\right)^2}$$

Date:

$$A^2 = 0.0395$$

$$\boxed{A = \sqrt{0.0395} = 0.199}$$

Pb - 15

Soln:- (a) $T = 2\pi\sqrt{\dfrac{I}{m_{tot} g x_{cm}}}$

$$\frac{I}{x_{cm}} = \frac{T^2 g\, m_{tot}}{4\pi^2} \longrightarrow (1)$$

Moment of inertia = $I = I_{cm} + Md^2 = \frac{1}{3}mL^2 + \frac{1}{2}MR^2 + Md^2$

Putting values

$$I = \frac{1}{3}(0.800kg)(2.00m)^2 + \frac{1}{2}(1.20kg)(0.15)^2 + (1.20kg)d^2$$

$$= 1.0802\ kg.m^2 + (1.20kg)d^2$$

$$x_{cm} = \frac{(0.800kg)(1.00m) + (1.20kg)d}{2.00kg}$$

$x_{cm} = 0.400m + 0.600d$

putting values in eq (1)

$$\frac{1.0802\ kg.m^2 + (1.20kg)d^2}{0.400m + 0.600d}$$

$$= \frac{T^2 (9.8\ m/sec)(2.00kg)}{4\pi^2}$$

$$= (0.49698\ kg\ m/sec^2)T^2 \longrightarrow (2)$$

Date:

putting $T = 3.60s$ and solving for all yields

$\boxed{d = 1.63574\ cm}$

(b)

$1455T = 1440 T_{perfect} \Rightarrow T = \frac{1440}{1435} T_{perfect}$

$T = \frac{1440}{1435}(3.60s) = 3.51220s$

substitution $T = 3.51220s$ in eq (2) and solve for d to obtain

$\boxed{d = 3.4014m}$

~~d =~~ substitude $T = 3.50s$ in eq (2) and solve

$\boxed{d = 3.3736m}$

$d = d - d' = 3.4014m - 3.3736m$

$\boxed{= 2.31cm}$

P_16 :

Soln:- Express the total energy of the simple maximum displacement.

$E = U_{max}$ displacement $= mgh$

$h = l - l\cos\phi_0 = l(1-\cos\phi)$

$E = mgl(1-\cos\phi_0)$

From the process of series expansion for $\cos\phi$, for $\phi << 1$:-

$\cos\phi \simeq 1 - \frac{1}{2}\phi^2$

Substitude and simplify to obtain

$E = mgl\left[1-\left(1-\frac{1}{2}\phi_0^2\right)\right]$

$\boxed{= \frac{1}{2} mgl\phi_0^2}$

Date:

Solution (2)

(a) $mg = kx_1$

$(mg + m(g)) = k(x_1 + x_2)$

$mg = kx_2$

$k = \frac{mg}{x_0} \quad \frac{(0.3kg)(9.8m/sec^2)}{0.5m}$

→ Frequency of oscillation:

$f = \frac{w}{2\pi} = \frac{\sqrt{k/m_{tot}}}{2\pi} \Rightarrow \frac{\left(\frac{5.88 N/m}{0.120 + 0.3}\right)^{\frac{1}{2}}}{2\pi}$

$= \frac{\sqrt{34.2}}{2\pi} = 1.0 Hz = F$

(b)

Travelling from lowest point to highest points is half a period.

$T = \frac{1}{f} = 1 sec$, so time from low to high

$\boxed{T = 0.5s}$

(c)

$x = A\cos wt$

$a = w^2 A\cos wt = w^2 x t$

$E_{kin} = m x^2 A = (2\pi)^2 (0.12m) \times 0.3kg$

$\boxed{= 1.42 J}$