(1) Data :

$A = 5\,cm$

$T = 2\,s$

$v|_{a=\frac{a_{max}}{2}} = ?$

Solution :

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

$\therefore a = \frac{a_{max}}{2} = \frac{\omega^2 A}{2}$

$\therefore \omega^2 x = \frac{\omega^2 A}{2}$

$\therefore x = \frac{A}{2}$

$v = \omega\sqrt{A^2 - x^2}$

$\therefore v = \omega\sqrt{A^2 - \frac{A^2}{4}}$

$\therefore v = \frac{2\pi}{2}\sqrt{5^2 - \frac{5^2}{4}}$

$v = \pi\sqrt{25 - \frac{25}{4}}$

$v = \pi\sqrt{\frac{75}{4}}$

$v = \frac{\pi}{2} \times 5\sqrt{3}$

$\therefore v = 13.6\,cm/s$

(2) Data :

$T = 12\,s$

$A = 8\,cm$

$t = 0 \;;\; x = +A$

$t = ?$ When $x = 2\,cm$.

Solution :

$x = A\cos\omega t$

$\therefore 2 = 8\cos\left(\frac{2\pi}{12} \times t\right)$

$\frac{1}{4} = \cos\left(\frac{\pi}{6} \times t\right)$

$75°31' = \frac{180}{6} \times t$

$75°31' = 30° \times t$

$\frac{75 + \frac{31}{60}}{30} = t$

$2.517\,s = t$

(3) Data :

$x = A/3$

$KE/TE = ?$

$PE/TE = ?$

Solution :

$TE = \frac{1}{2}kA^2$

$PE = \frac{1}{2}kx^2$

$\therefore \frac{PE}{TE} = \frac{x^2}{A^2} = \frac{(A/3)^2}{A^2} = \frac{1}{9}$

$\therefore \frac{KE}{TE} = 1 - \frac{PE}{TE} = 1 - \frac{1}{9} = \frac{8}{9}$

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(4) $x = 6\sin\left(3\pi t + \frac{5\pi}{6}\right)$

$A = 6\text{m}.$

$2\pi f = 3\pi$

$\therefore f = \frac{3}{2} = 1.5\ \text{Hz}$

$\alpha = \frac{5\pi}{6}^c$

Data:

(5) $T_2 = 1.2\,T_1$

$l_2 = l_1 + 44\text{cm}$

Solution:

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

$\therefore T \propto \sqrt{l}$

$\therefore \frac{T_2}{T_1} = \sqrt{\frac{l_2}{l_1}}$

$\frac{1.2\,T_1}{T_1} = \sqrt{\frac{l_1+44}{l_1}}$

$1.44 = \frac{l_1 + 44}{l_1}$

$1.44\,l_1 = l_1 + 44$

$1.44\,l_1 - l_1 = 44$

$0.44\,l_1 = 44$

$l_1 = \frac{44}{0.44}$

$\therefore l_1 = 100\text{cm} = 1\text{m}.$

$\therefore l_2 = l_1 + 44 = 100 + 44$

$= 144\text{ cm}.$

$T_1 = 2\pi\sqrt{\frac{l_1}{g}}$

$= 2 \times 3.14\sqrt{\frac{1}{9.8}}$

$= 2.006\text{ s}$

(6) Data:

$T_1 = 2\text{s}$

$l_2 = 1.01\text{m}$

Solution

In a day we have 24 hours

$\therefore 24 \times 3600\text{ s}$

ie $\frac{24 \times 3600}{2}$ osc

[$\because$ 1 osc is of 2's]

$\therefore 43200$ osc. in a day

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$\therefore T_2 = 2\pi\sqrt{\frac{l_2}{g}}$

$= 2 \times 3.14 \sqrt{\frac{1.01}{9.8}}$

$= 2.016$

Time lost per osc
$= 2.016 - 2$
$= 0.016\,s$

∴ Time lost in a day
$= 0.016 \times 43200$
$= 691.2\,s$

NOTE: Taking π as 3.142 gives a more accurate answer

(7) Data :
$m = 0.5\,kg$
$K = 10\,N/m$
$A = 3 \times 10^{-2}\,m$

(a) $TE = \frac{1}{2} kA^2$

$= \frac{1}{2} \times 10 \times 9 \times 10^{-4}$

$= 45 \times 10^{-4}\,J$

(b) $V_{max} = \omega A$

$= \sqrt{\frac{K}{m}} \times A$

$= \sqrt{\frac{10}{0.5}} \times 3 \times 10^{-2}$

$= \sqrt{20} \times 3 \times 10^{-2}$

$= 0.1342\,m/s$

(c) $V|_{x=2m} = \omega\sqrt{A^2 - x^2}$

$= \sqrt{\frac{K}{m}}\sqrt{A^2 - x^2}$

$= \sqrt{\frac{10}{0.5}}\sqrt{(3\times10^{-2})^2 - (2\times10^{-2})^2}$

$= \sqrt{20 \times 10^{-2}} \times \sqrt{9-4}$

$= \sqrt{20 \times 10^{-2}} \times \sqrt{5}$

$= \sqrt{100} \times 10^{-2}$

$= 10 \times 10^{-2}$

$= 0.1\,m/s$

(d) $PE = \frac{1}{2} kx^2$

$= \frac{1}{2} \times 10 \times (2 \times 10^{-2})^2$

$= 0.002\,J$

$KE = \frac{1}{2} k(a^2 - x^2)$

$= \frac{1}{2} \times 10 \left((3\times10^{-2})^2 - (2\times10^{-2})^2\right)$

$= 0.0025\,J$

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(8) Data :

$L = 0.51\,m$

$\theta = 10°$

$T = 1.44\,s$

Solution :

$\because \theta$ is small

$\therefore T = 2\pi\sqrt{\frac{l}{g}}$

$1.44 = 2\pi\sqrt{\frac{0.51}{g}}$

$\frac{1.44}{2\pi} = \sqrt{\frac{0.51}{g}}$

$g = \frac{0.51 \times 4 \times \pi^2}{1.44^2}$

$= 9.7\ m/s^2$

(9) Data :

$A = 10\,cm$

$T = 10\,s$

(i) $x = 5\,cm.$

$v = \pm\omega\sqrt{A^2 - x^2}$

$= \pm\frac{2\pi}{T}\sqrt{A^2 - x^2}$

$= \pm\frac{2\pi}{10}\sqrt{10^2 - 5^2}$

$v = \pm\frac{2\times3.14}{10}\sqrt{100 - 25}$

$= \pm 0.628\sqrt{75}$

$= \pm 5.44\ cm/s$

(ii) $x = 5\,cm$

$a = -\omega^2 x$

$= -\left(\frac{2\pi}{T}\right)^2 x$

$= -\left(\frac{2\times3.14}{10}\right)^2 \times 5$

$= -(0.628)^2 \times 5$

$= 1.972\ cm/s^2$

(10) Data :

$A = \frac{0.12}{2} = 0.06\,m$

$V_{max} = 0.12\,m/s$

$T = ?$

$V_{/x = \sqrt{3}\times10^{-2}m} = ?$

Solution :

$V_{max} = \omega A$

$0.12 = \frac{2\pi}{T} \times 0.06$

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

$\therefore T = \pi$

$= 3.1425$

$v = \omega\sqrt{A^2 - x^2}$

$= \frac{2\pi}{T}\sqrt{A^2 - x^2}$

$= \frac{2\pi}{\pi}\sqrt{(0.06)^2 - (\sqrt{3}\times 10^{-2})^2}$

$= 0.1149\ m/s$

(11) Data:

$T = 8s$

$t = ?$

$PE = \frac{TE}{2}$

Solution:

$PE = TE/2$

$\frac{1}{2}kx^2 = \frac{1}{2}\left(\frac{1}{2}kA^2\right)$

$\therefore x = 0.7071A$

$x = A\sin(\omega t)$

$0.7071A = A\sin\left(\frac{2\pi}{8}t\right)$

$\frac{1}{\sqrt{2}} = \sin\left(\frac{1}{4}\times 180\times t\right)$

$45 = 45\times t$

$\therefore t = 1s$

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