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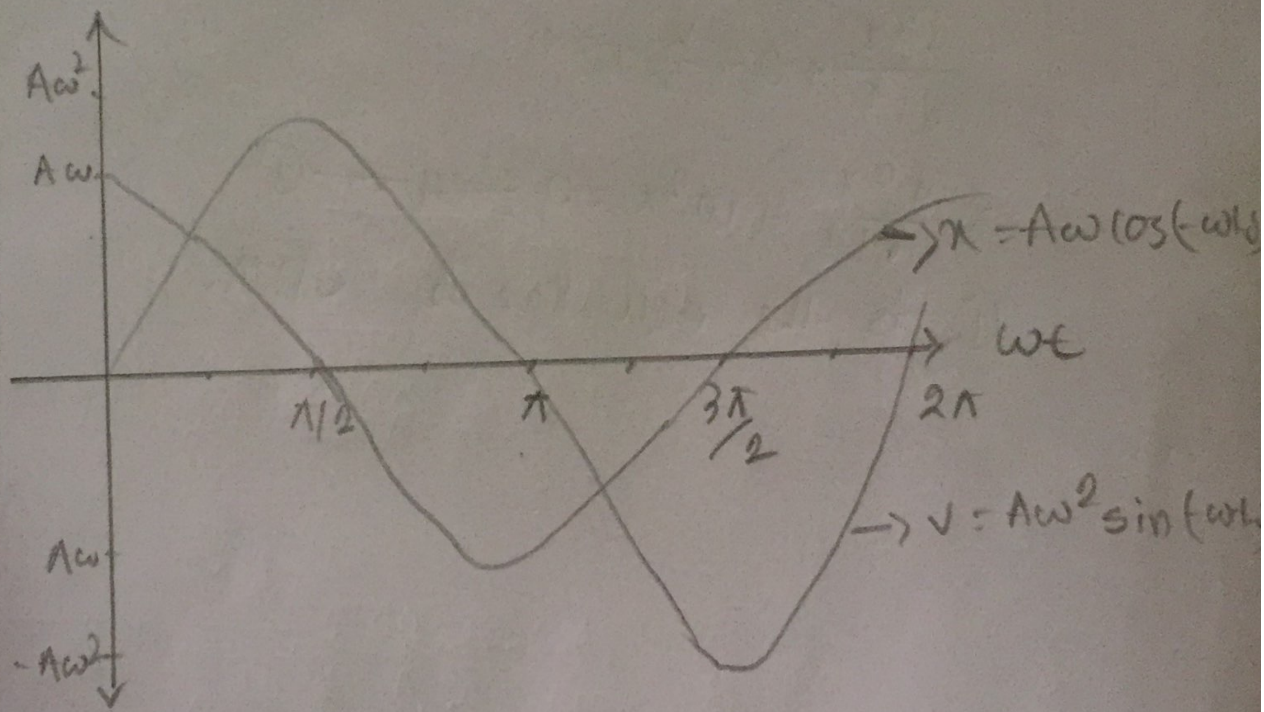
ID: 011201321, Course: Phy 105/ Phy 2105, Sec: D

1.

(a) $x = A\omega \cos(-\omega t - \delta)$

$v = \frac{dx}{dt} = \frac{d}{dt}(A\omega \cos(-\omega t - \delta))$

$= A\omega^2 \sin(-\omega t - \delta)$



(b) the two waves are no in phas

$x = A\omega \cos(-\omega t - \delta)$

$v = A\omega^2 \sin(-\omega t - \delta)$

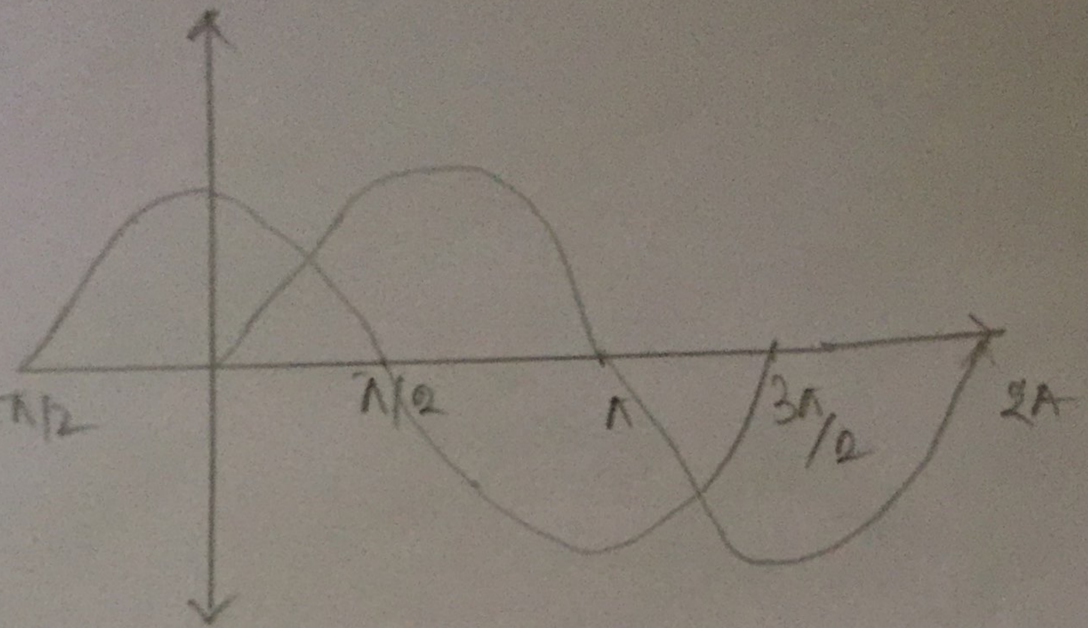
Taking $\delta = 0$ and adding $\pi/2$ to the phase of x:

$x = A\omega \cos(-\omega t)$

$= \cos(-\omega t + \pi/2)$

$= -\sin(-\omega t)$

where $\sin(-\omega t)$ is the phase of v when taking $\delta = 0$



(1b) graph: Difference betweel two phase.

c.

To get back from DHM to SHM. the damping factor has to be zero.

$$\therefore \frac{d^2x}{dt^2} + \gamma \frac{dx}{dt} + \frac{k}{m}x = 0$$

when $\gamma = 0$

$$\frac{d^2x}{dt^2} + 0 + \frac{k}{m}x = 0$$

$$\therefore \frac{d^2x}{dt^2} + \omega^2 x = 0 \quad Eq \text{ --- } (1)$$

(1) is the equation of SHM.

2.

(a)

(I) amplitude $A = \frac{10\times10^{-3}}{2}$

$= 5\times10^{-3}$ m

(II) $v_{max} = A\omega$

$= 2\pi f . A$

$= 2\times\pi\times120\times5\times10^{-3}$

$= 3.77\ ms^{-1}$

(III) $|a_{max}| = |A\omega^2|$

$= |5\times10^{-3}\times(2\pi f)^2|$

$= 5\times10^{-3}\times(2\times3.1416\times120)^2$

(IV) $= 2842.46\ ms^{-2}$

$E = \frac{1}{2}KA^2$

$= \frac{1}{2}\times7\times(3.77)^2$

$= \cancel{49.75\ J} = 8.75\times10^{-5}\ J$

(V)

$K_e = \frac{1}{2}mv^2$

$= \frac{1}{2}\times0.5\times\omega\sqrt{A^2-x^2}$

$= \frac{1}{2}\times0.5\times2\pi\times120\sqrt{14.21-0.000004}$

$= \frac{1}{2}\times0.5\times2\pi\times120\times3.77$

$= 710.56\ J$ (Ans)

(2)
(b)

$m = 700\,gm$ $\quad A = 30\,cm$ $\quad T = 0.80\,s$

$= 0.7\,kg$ $\quad = 30\times10^{-2}$

$\omega = \frac{2\pi}{T} = \frac{2\times3.1416}{0.80} = 7.85\ rad\,s^{-1}$

(i)

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

$\Rightarrow 180\times10^{-2} = 7.85\sqrt{A^2 - x^2}$

$\Rightarrow 0.23 = \sqrt{A^2 - x^2}$

$\Rightarrow 0.05 = A^2 - x^2$

$\Rightarrow x = 0.2\ m.$ (Ans)

(ii)

$v_{max} = A\omega$

$= 30\times10^{-2}\times7.85$

$= 2.35\ ms^{-1}.$

(2)(c)

$x = 10\cos\left(3\pi t + \frac{\pi}{3}\right)$

$\frac{dx}{dt} = -10\sin\left(3\pi t + \frac{\pi}{3}\right).3\pi$

$= -10.3\pi\sin\left(3\pi.t + \frac{\pi}{3}\right)$

$= -10.3\pi\sin\left(3\pi.3 + \frac{\pi}{3}\right)$ $\quad [t=3]$

$=$ [illegible]

$= -46.15\ J$

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3. (a)

$y = 10 \sin\left(10t - \frac{\pi}{6}x\right) = 10 \sin \frac{2\pi}{\frac{\pi}{6}}\left(\frac{10}{\frac{\pi}{6}}t - x\right)$

(i) Amplitude $= 10$ m

(ii) $v = \frac{\pi}{6}$

(iii) $10 \sin\left(10t - \frac{\pi}{6}x\right)$

$= 10 \sin \frac{2}{2}\frac{\pi}{6}\left(\frac{10t}{\frac{\pi}{6}} - \cancel{6}\frac{x}{\cancel{6}}\right)$

$= 10 \sin \frac{2\pi}{\frac{\frac{2}{\cancel{\pi}1}}{6}}\left(\frac{10}{\frac{\pi}{6}}t - x\right)$

$= \lambda = \frac{\frac{2}{\cancel{\pi}1}}{6}$

$= \lambda = 12$

$\therefore \lambda = 12$

(iv) ~~$= t$~~

$v = \frac{\lambda}{f}$

$f = \frac{\lambda}{v}$

$= \frac{\frac{12}{\pi}}{\frac{10}{\frac{\pi}{6}}} = \cancel{12} \times \cancel{2} = \frac{\frac{12}{\pi}}{\frac{60}{\pi}} = \frac{12}{\pi} \times \frac{\pi}{60} = 1/5$ (Ans)

(v) $T = \frac{1}{f} = 5$ (Ans)

(b)

The atom Na has 11 proton and a 4g penny has $= \frac{4}{23} \times 6 \times 10^{23}$ atom

$= 1.04 \times 10^{23}$ atoms.

Total change $= 11 \times 1.04 \times 10^{23} \times 1.6 \times 10^{-19}$

$= 1.8 \times 10^{5}$ C

we know that,

$$F = k \frac{q_1 q_2}{d^2}$$

$= 10^{10} \times (1.8 \times 10^{5})$

$= \cancel{1.83.0}$

$= 1.8304 \times 10^{15}$ N

(c) $L = 0.2$ mH

$= 0.2 \times 10^{-3}$ H

$C = 1$ mF $= 1 \times 10^{-3}$ F $\qquad R = 800\ \Omega$

$\frac{R^2}{4L} = \frac{800}{4(0.2)^2}$

$\omega_0 = \frac{1}{LC} = \frac{1}{0.02 \times 10^{-3} \times 1 \times 10^{-3}}$

$(\frac{r}{2})^2 > \omega_0$, so its oscillatory.

$f = \frac{1}{2\pi}(\sqrt{\omega_0 - (\frac{r}{2})^2}) = \frac{\omega}{2\pi}$

$= 7.11 \times 10^{-5}$.

(4)

(a)

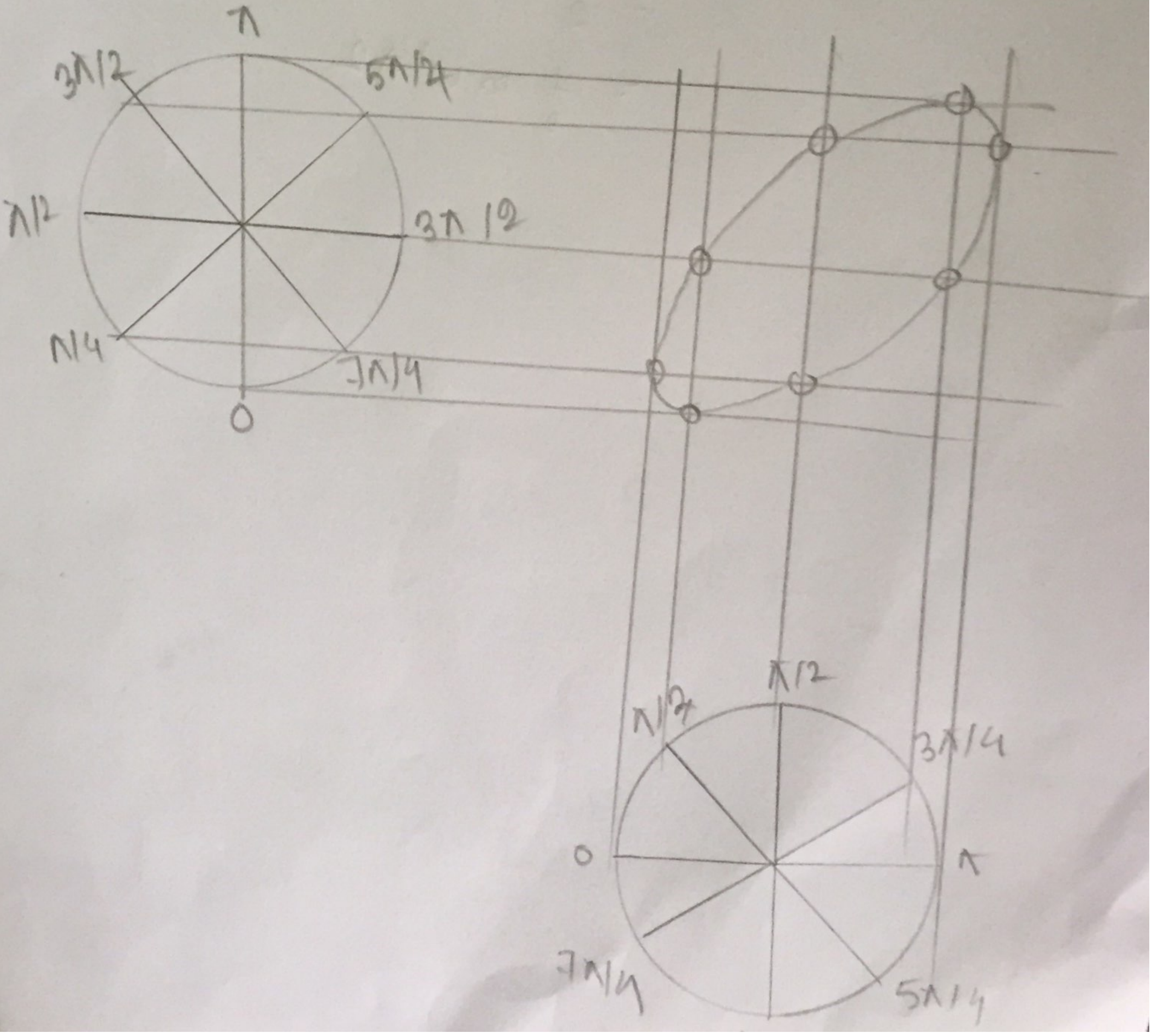
$$x = a \sin(\omega t + \pi/4)$$

$$y = b \cos(\omega t + \cancel{\pi/} 5\pi/4)$$

$$y = b \sin (\pi/2 (\omega t + \tfrac{5\pi}{4})\}$$

$$= b \sin (\omega t + \frac{5\pi + 2\pi}{4})$$

$$= (b \sin \omega t + \frac{7\pi}{4})$$



(7)
(b)

$x = a\sin(\omega t + 45)$

$v = \omega a \cos(\omega t + 45)$

Total Energy = KP + KE

$= \frac{1}{2}kx^2 + \frac{1}{2}mv^2$

$= \frac{1}{2}ka^2\sin^2(\omega t + 45) + \frac{1}{2}ma^2\omega^2\cos^2(\omega t + 45)$

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

$= \frac{1}{2}m\omega^2A^2$