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Assignment 1

Physics

Phy 105

Section : A

Date - 31-8-2021

তারিখ : .....

Ans to the qsn No: 1

Given $t = 0.25$ S

$d = 36$ cm $= 0.36$ m

(a)

Period:

$$t = \frac{T}{2}$$

$$T = 2t$$

$$= 2 \times 0.25 = 0.5 \text{ S}$$ Ans:

(b)

Freqency:

$$f = \frac{1}{T} = \frac{1}{0.5} = 2 \text{ Hz}$$

Ans:

(c)

Amplitude of the Motion:

$$A = \frac{d}{2} = \frac{0.36}{2} = 0.18 \text{ m}$$

Ans:

Ans to the qun No. 2

$m = 0.12\ kg$

$A = 8.5\ cm = 8.5 \times 10^{-2}\ m$

$T = 0.20\ S$

(a)

What is the magnitude of the maximum force acting on it?

maximum force,

$F_{max} = m\, a_{max}$

$= m(A\omega^2)$

$= mA \cdot \left(\frac{2\pi}{T}\right)^2$

$= 0.12 \times 8.5 \times 10^{-2} \left(\frac{2\pi}{0.20}\right)^2$

$= 10\ N$ (Ans)

Ans:

maximum acceleration

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

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

(b)

IF the oscillations are produced by a spring, what is the spring constant.

Spring Constant:

$$K = \frac{F_{max}}{A}$$

$$= \frac{10}{8.5 \times 10^{-2}}$$

$$= 117.65 \text{ N/m}$$

Ans:

Ans to the qn No: 3

$m = 2kg$

$k = 100 N/m$

$t = 1s$

$x = 0.129 m$

$v = 3.415 m/s$

$x = x_m \cos(\omega t + \phi)$ — (i)

$v = -\omega x_m \sin(\omega t + \phi)$ — (ii)

(a)

$$\frac{v}{x} = -\omega \tan(\omega t + \phi$$

$$\omega t + \phi = \tan^{-1}\left(\frac{-v}{\omega x}\right)$$

$$\omega t + \phi = \tan^{-1}\left(\frac{-3.415}{7.07 \times 0.129}\right)$$

$$= -1.31 \text{ rad.}$$

angular Freqwency.

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

$$= \sqrt{\frac{100}{2}} = 7.07 \text{ rads}^{-1}$$

$\therefore (7.07 \times 1) + \phi = -1.31 \text{ rad}$

$\phi = -8.38 \text{ rad}$

$x_m = \dfrac{x}{\cos(\omega t + \phi)}$

$= \dfrac{0.129}{\cos(-1.31)} = 0.500 \text{ m}$

(b)

Position

$x = x_m \cos(\omega(0) + \phi)$

$= x_m \cos(\phi)$

$= (0.5) \times (-8.38)$

$= -0.251 \text{ m}$

(c)

Velocity of the block at $t = 0$ s?

$v = -\omega x_m \sin(\omega(0) + \phi)$

$= -\omega x_m \cos(\phi)$

$= (-7.07)(0.500) \sin(-8.38) = 3.05 \text{ m s}^{-1}$ Ans

Ans to the Qsn No: 4

$k = 400\ N/m$

$x = 0.100\ m$

$v = -13.6\ ms^{-1}$

$a = -123\ ms^{-2}$

(a)

the frequency of oscillation.

$$f = \frac{1}{2\pi}\sqrt{-\frac{a}{x}}$$

$$= \frac{1}{2\pi}\sqrt{-\frac{-123}{0.100}}$$

$$= 5.58\ Hz$$

(b)

the mass of the block

$$m = \frac{x_m}{a_m}k$$

$$= \frac{0.1}{123} \times 400$$

$= 0.325 \text{ kg}$

(c)

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

$$x_m = \sqrt{\frac{mv^2 + kx^2}{k}}$$

$$= \sqrt{\frac{0.325 \times (-13.6) + 400 \times 0.1}{400}}$$

$$= 0.298$$

Ans:

Ans to the qsn NO:5

$m = 25\,gm = 0.025\,kg$

$k = 400$ dynes / cm

$= 400 \times 10^{-3}$ N/m

$= 0.4$ N/m

$A = 10\,cm = 10 \times 10^{-2}\,m$

$= 0.1\,m$

(i)

the time period

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

$$= 2\pi \sqrt{\frac{0.025}{0.4}}$$

$= 1.57\,S$

Ans.

(ii)

Frequency

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

(ii)

$$\text{Frequency} = \frac{1}{T} = \frac{1}{1.57} = 0.637 \text{ Hz}$$

Ans:

(iii)

angular frequency

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{0.4}{0.025}}$$

$$= 4 \text{ rad/s}$$

Ans.

(iv)

maximum velocity

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

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

$$= A\sqrt{\frac{0.4}{0.025}}$$

$$= 0.1 \sqrt{} \times 4$$

$$v = 0.4 \text{ m/s}$$

Ans.

Ans to the qon NO: 6

$m = 1.68 \times 10^{-27}$ kg

$f = 10^{14}$ Hz

$A = 10^{-10}$ m

$F_{max} = ?$

$F_{max} = m\, a_{max}$

$= m \cdot (A\omega^2)$ $\quad \omega = 2\pi f$

$= mA(2\pi f)^2$

$= (1.68 \times 10^{-27}) \times 10^{-10} \times (2\pi \cdot 10^{14})^2$

$= 6.63 \times 10^{-8}$ N

Ans.

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Ans to the qnn No: 7

$V_{max} = 1 \ m s^{-1}$

$a_{max} = 1.57 \ m/s^2$

$V_{max} = A\omega$ ——— (i)

$a_{max} = A\omega^2$ ——— (ii)

(ii) ÷ (i)

$$\frac{A\omega^2}{A\omega} = \frac{1.57}{1}$$

$\omega = 1.57 \ rad/s$

Now,

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

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

$$\therefore T = \frac{2\pi}{1.57}$$

$= 4 S$

Time period of oscillation is 4S.

Ans to the Qn No: 8

$A = 5m$

$x = 3m$

$a = 48\ m/s^2$

$a = -\omega^2 x$

but on the mean position

$a = \omega^2 x$

$\omega = \sqrt{\frac{a}{x}} = \sqrt{\frac{48}{3}} = 4\ rad/s$

(i)

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

$= 4\sqrt{5^2 - 3^2} = 16\ m/s$ Ans:

(ii)

time period.

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

$T = \frac{2\pi}{\omega} = \frac{2\pi}{4} = 1.57\ S$ Ans:

তারিখ : .....

(iii)

maximum velocity

$V_{max} = A\omega$

$= 5 \times 4 = 20 \text{ m/s}$

Ans.

তারিখ : .....

Ans to the qm NO.9

$A = 4.00\,m$

$f = 0.5\,Hz$

$\delta = \frac{pi}{4} = \frac{\pi}{4}$

(i)

period $T = \left(\frac{1}{\delta}\right) s$

$= \left(\frac{1}{0.5}\right)$

$= 2\,s$

Ans:

(ii)

$\omega = 2\pi f$

$\omega = 2\pi \times 0.5 = 3.1416$

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

$= 4\cos\left(3.1416\,t + \frac{\pi}{4}\right)$

Ans.

(iii)

$$x = 4.00 \cos\left(3.1416 + \frac{\pi}{4}\right)$$

$$v = (-4 \times 3.1416) \sin\left(3.1416t + \frac{\pi}{4}\right)$$

$$v = (-4 \times 3.1416) \sin\left(3.1416 \times 5 + \frac{\pi}{4}\right)$$

$$v = -3.57\ m^{-1}$$

$$\dot{v} = -4.00 \times 3.1416 \sin\left(3.1416t + \frac{\pi}{4}\right)$$

$$a = -4.00 \times 3.1416 \times 3.1416 \cos\left(3.1416 \times 5 + \frac{\pi}{4}\right)$$

$$a = -37.85$$

A2

Ans to the qm No: 10

$m = 2\,kg$

$k = 196\,N/m$

$A = 5\,cm$

$= 5 \times 10^{-2}\,m$

(a)

Angular Frequency

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

$= \sqrt{\frac{196}{5 \times 10^{-2}}} = 9.899\,\pi\,rads^{-1}$

$\therefore \omega = 2\pi f$

Frequency f

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

$= \frac{9.899}{2\pi} = 1.57\,Haz$

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

$= \frac{1}{1.57} = 0.64\,S$ Ans

(b)

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

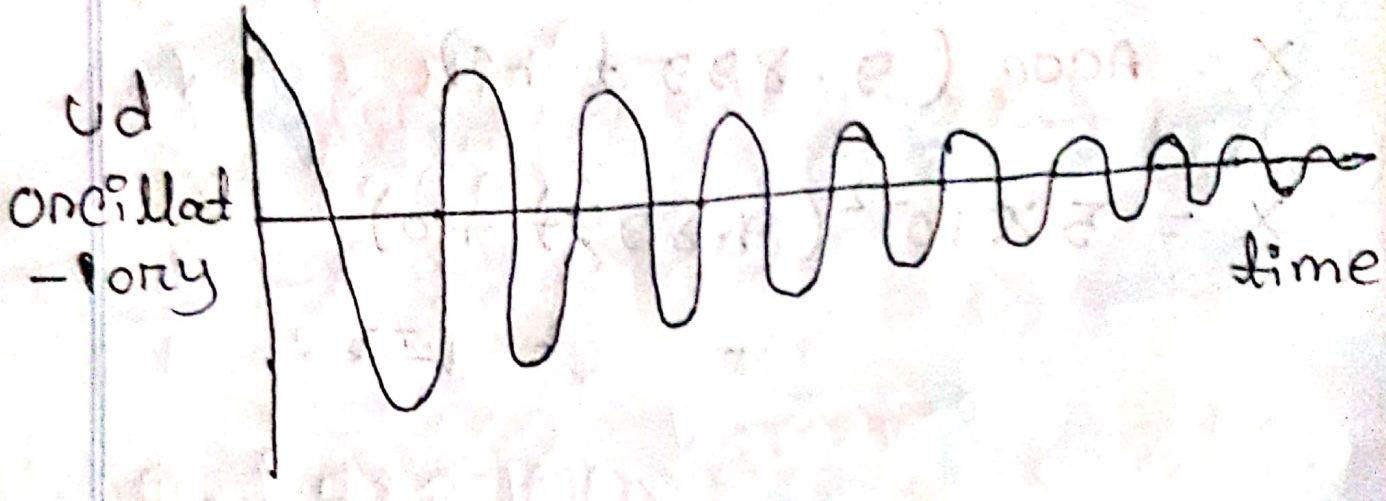
$$x = A\cos(9.899\,t + 0)$$

$$x = 5 \times 10^{-2}(9.899\,t + 0)$$

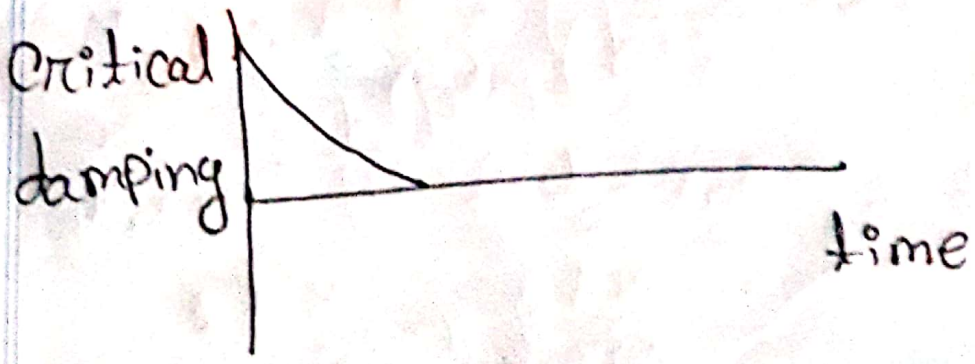
Ans

Ans to the Qsn No: 11

$\omega/\gamma = 10$



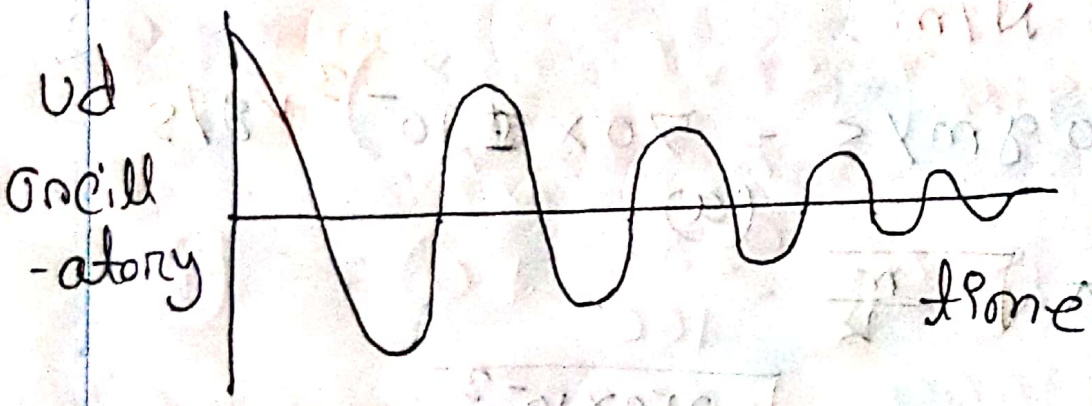
$\frac{\omega}{\gamma} = 0.5$



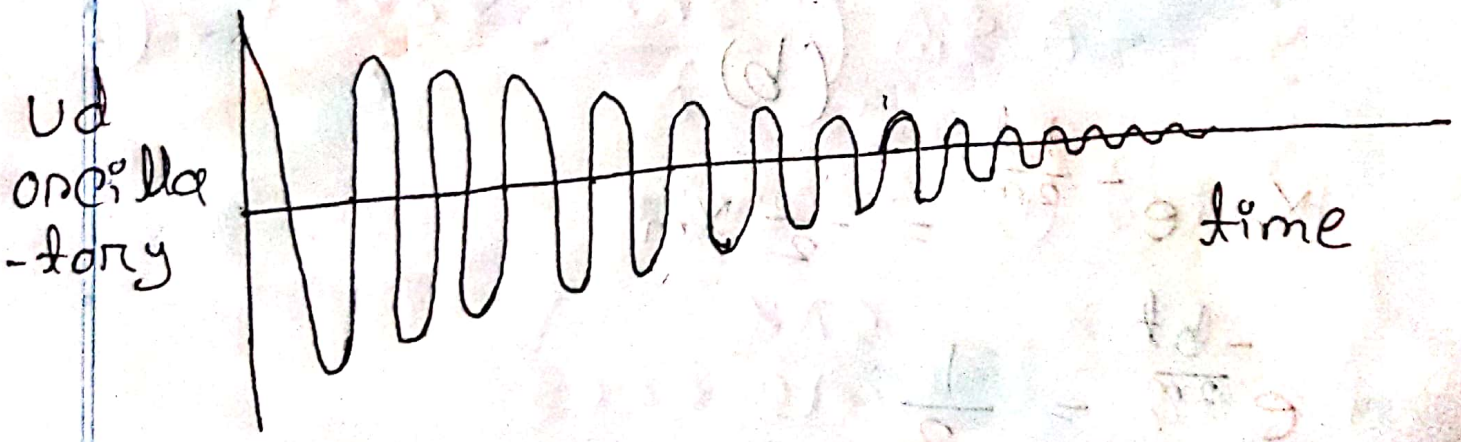
$\frac{\omega}{\gamma} = 0.03$

Ans to the qsn No: 12

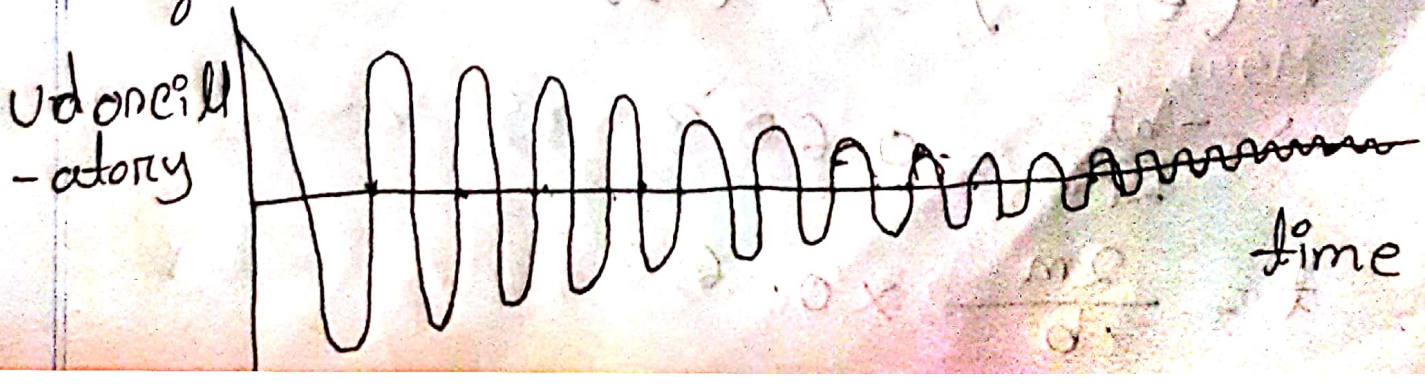
$\frac{\omega}{\gamma} = 5$



$\frac{\omega}{\gamma} = 15$



$\frac{\omega}{\gamma} = 20$



Ans to the qun No: 13

$L = 0.4\ h$

$C = 0.0020\ \mu f$

$= 2 \times 10^{-9}\ f$

$R = ?$

$\omega_0^2 > \left(\frac{R}{2L}\right)^2$

So, $\frac{1}{LC} > \frac{R^2}{4L^2}$

$\Rightarrow \frac{1}{C} > \frac{R^2}{4L}$

$\Rightarrow R^2 < \frac{4L}{C}$

$$\Rightarrow R \leq \sqrt{\frac{4 \times 0.4}{2 \times 10^{-9}}}$$

$$R \leq 28284.27\,\Omega$$

maximum R must be less than or equal $28284.27\,\Omega$ to be oscillatory

Am to the qm no: 14

$m = 250\,gm$

$= 0.25\,kg$

$k = 85\ N/m$

$b = 70\,gm/s = 70 \times 10^{-3}\,m/s$

(a)

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

$$= 2\pi\sqrt{\frac{0.25}{85}}$$

$$= 0.34\,S$$

Am.

(b)

$$e^{-\frac{rt}{2}} = \frac{1}{2}$$

$$-\frac{bt}{2m} = \ln\left(\frac{1}{2}\right)$$

$$= \frac{-(70\times10^{-3})\times t}{2\times0.25}$$

$$= \ln(0.5)$$

$$t = \frac{\ln(0.5)}{-0.14} = 4.95\,S$$

Ans.

(iii) (c)

$$T = \frac{t}{n}$$

$$n = \frac{t}{T} = \left(\frac{4.95}{0.34}\right)$$

$$= 14.56$$

Ans.

(d)

$$\alpha = \frac{b}{2m}$$

$$= \frac{70 \times 10^{-3}}{2 \times 250 \times 10^{-3}}$$

$$= 0.14$$

$$\text{life time} = \frac{1}{\alpha}$$

$$= \frac{1}{0.14}$$

$$= 7.14 \text{ s}^{-1}$$

Ans.

Ans to the qsn No: 15

$$y = A\sin\frac{2\pi}{\lambda}(vt - x)$$

$$y = A\sin\left(\frac{2\pi vt}{\lambda} - \frac{2\pi x}{\lambda}\right)$$

$$y = 4\sin\left(\frac{2\pi x}{100} + 0\right) \quad \text{(i)}$$

Find the displacement equation when $t = 3s$

$$y = -A\sin\left(\frac{2\pi x}{\lambda} - \frac{2\pi vt}{\lambda}\right) \quad \text{(ii)}$$

(ii) and (i) compare

$$\frac{2\pi x}{\lambda} = \frac{2\pi x}{100}$$

$$\lambda = 100$$

Now,

$\lambda = 100$, $t = 3s$, $v = 0.3\ m$

$$y = -4 \sin\left(\frac{2\pi x}{100} - \frac{2\pi \times 0.3 \times 3}{100}\right)$$

$$y = -4 \sin\left(\frac{2\pi x}{100} - \frac{2\pi \times 0.9}{100}\right)$$

Ans

Ans to the qnn No: 16

$L = 0.2$

$C = 1 \times 10^{-6}$ $\quad R = 800\,\Omega$

$$\omega = \sqrt{\frac{1}{LC}}$$

$$\alpha = \frac{R}{2L}$$

$$\omega^2 = \left(\frac{1}{0.2 \times 10^{-6}}\right)$$

$$\omega^2 = 500000 \text{ rad s}^{-1}$$

$$\alpha^2 = \left(\frac{R}{2L}\right)^2$$

$$= \left(\frac{800}{2 \times 0.2}\right)^2 = 4000000$$

$\omega > \alpha$

In the circuit oscillatory, we know $\omega' = \omega$

$$\omega' = \sqrt{\omega^2 - \alpha^2}$$

$$= \sqrt{5000000 - 4000000}$$

$$= 1000 \qquad \omega = 2\pi f$$

$$2\pi f = 1000$$

natural frequency:

$$f = \frac{1000}{2\pi}$$

$$f = 159.15 \text{ Hz}$$

Ans:

Resonant frequency:

$$\omega = \sqrt{\frac{1}{LC}}$$

$$\omega = \sqrt{\frac{1}{0.2 \times 10^{-6}}}$$

$$= 2236.07 \text{ rad/s}$$

Ans

Ans to the Qsn No: 17

Period $T = 5\,s$

Length

We have $T = 2\pi\sqrt{\frac{L}{g}}$

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

$$\frac{L}{g} = \frac{T^2}{4\pi^2}$$

$$L = \frac{T^2 g}{4\pi^2} = \frac{(5)^2 \times 9.8}{4\pi^2}$$

$$= 6.206\,m$$

Ans:

Frequency $f = \left(\frac{1}{T}\right)$

$$= \frac{1}{5}$$

$$= 0.2\,s^{-1}$$

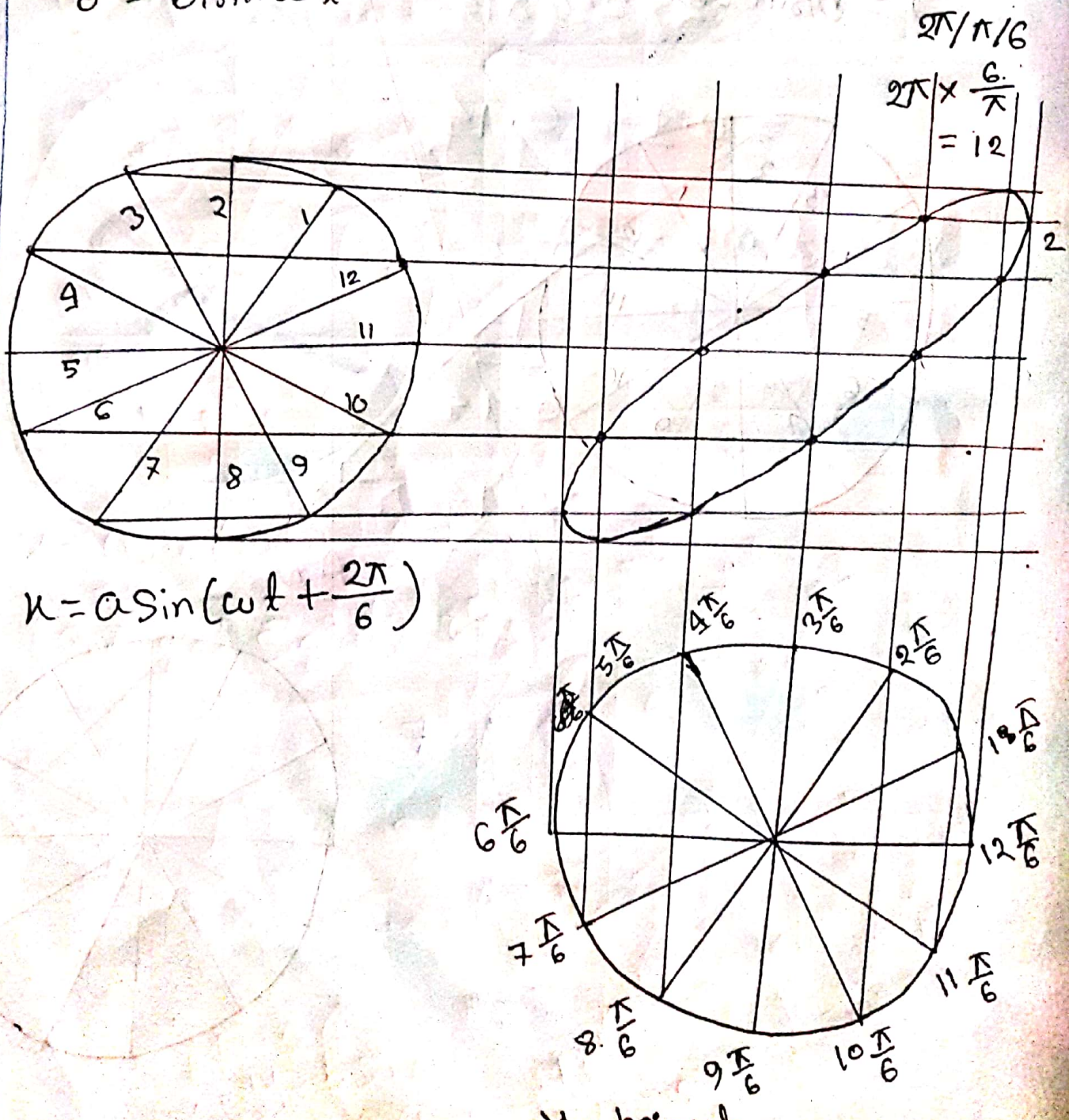
Ans.

Ans to the Qsn No. 18

(i)

$x = a\sin\left(\omega t + \frac{2\pi}{6}\right)$

$y = b\sin\omega t$

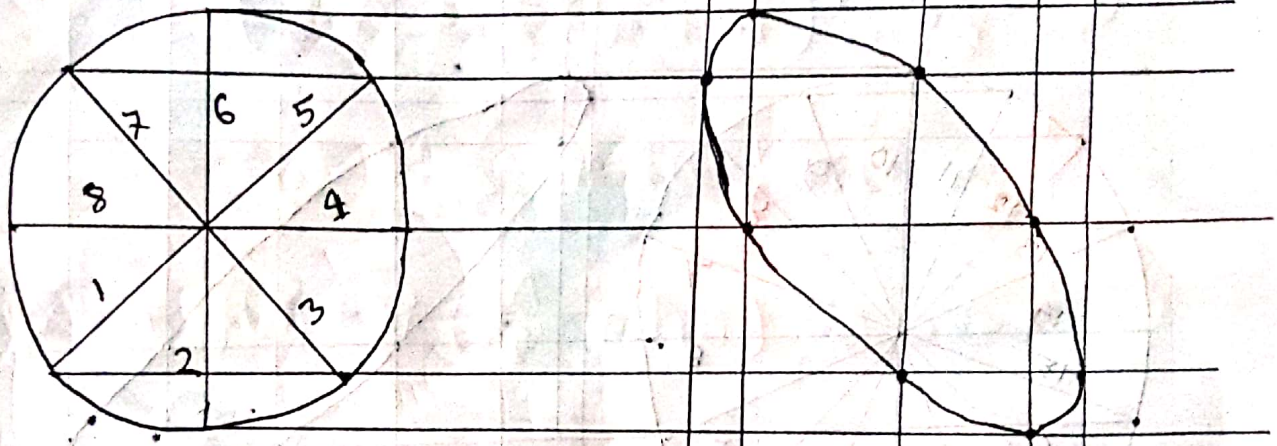


(ii)

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

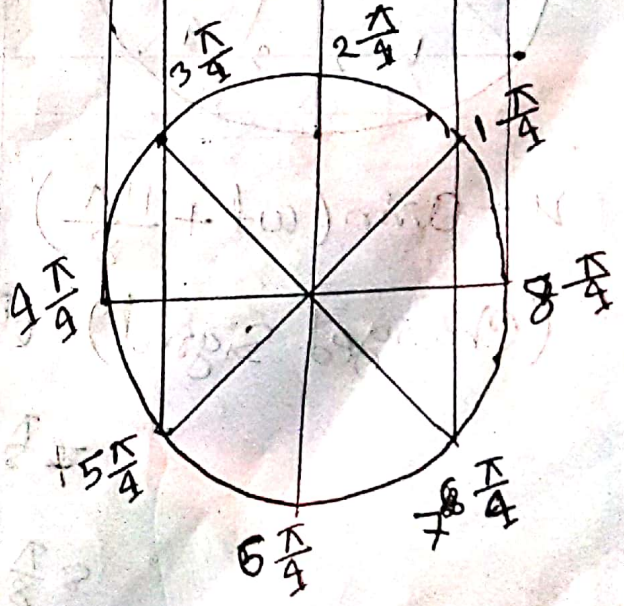
$y = b\sin(\omega t)$

$\frac{2\pi}{\frac{\pi}{4}} = 2\pi \times \frac{4}{\pi} = 8$



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

(Changed signal)



$y = b\sin(\omega t)$

(Reference Signal)

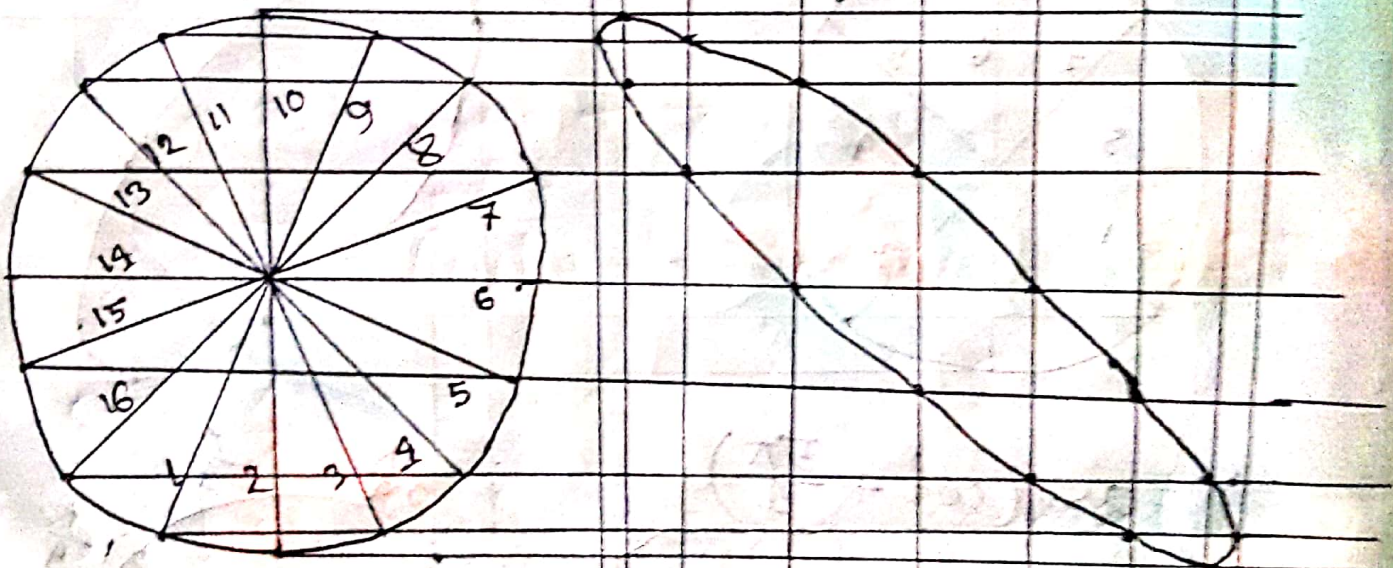
(000 / 111)

$$x = a\sin\left(\omega t + \frac{11\pi}{8}\right)$$

$$y = b\sin\omega t$$

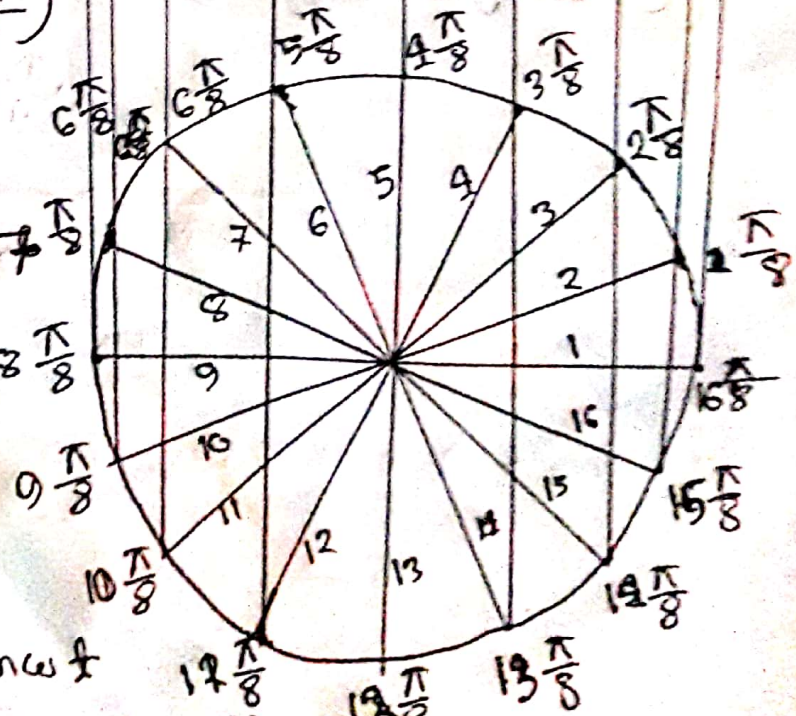
$$\frac{2\pi}{\frac{\pi}{8}} = 2\pi \times \frac{8}{\pi}$$

$$= 16$$



$$x = a\sin\left(\omega t + \frac{11\pi}{8}\right)$$

(Changed Signal)



$$y = b\sin\omega t$$

(reference signal)

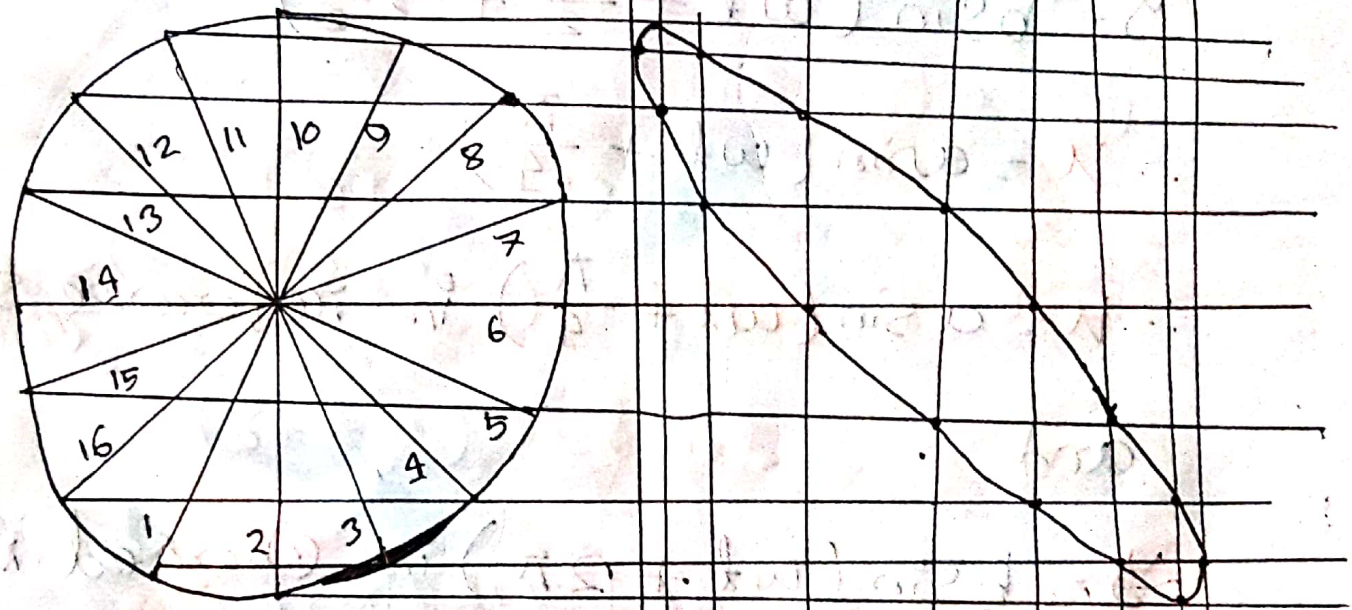
(iv)

$x = a\sin\left(\omega t + \frac{14\pi}{8}\right)$

$y = b\sin\omega t$

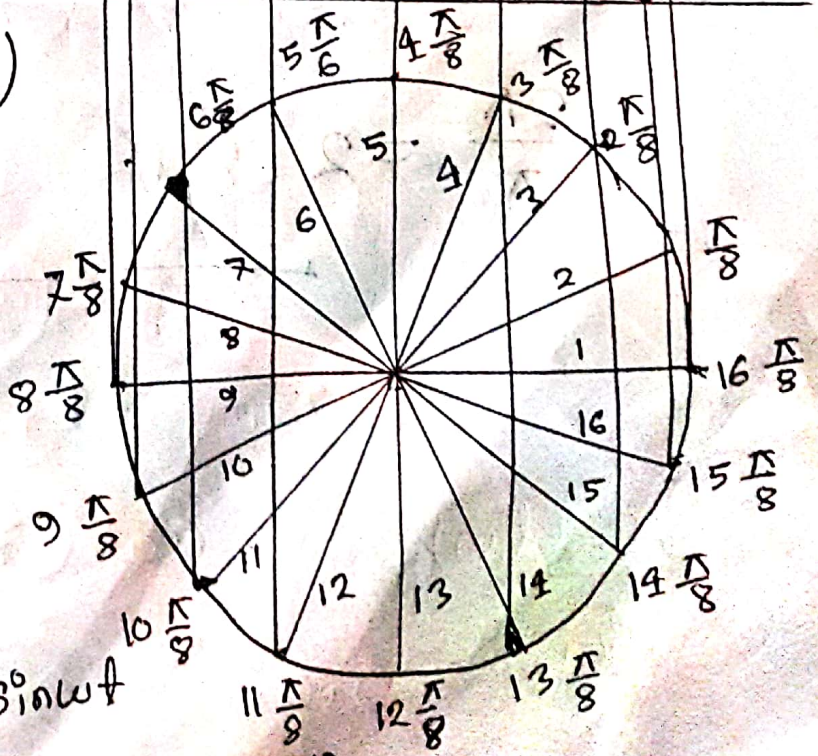
$\frac{2\pi}{\frac{\pi}{8}} = 2\pi \times \frac{8}{\pi}$

$= 16$



$x = a\sin\left(\omega t + \frac{14\pi}{8}\right)$

(Charged signal)



$y = b\sin\omega t$

(reference signal)

(v)

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

$y = b\cos(\omega t + 270)$

$y = b\sin(\omega t + \frac{\pi}{2} + 3\frac{\pi}{2})$

$\therefore x = a\sin(\omega t + \frac{\pi}{4})$

$\therefore x = a\sin(\omega t + \frac{\pi}{4})$ is reference signal

and

$y = b\sin(\omega t + 2\pi)$ is changed signal

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