Date 29/11/2023

APPLIED PHYSICS

ASSIGNMENT #05

Q1: $A_r = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos(\phi)}$

$A_1 = 3.2$ cm , $A_2 = 4.19$ cm , $\phi = \pi/2$ rad

$A_r = \sqrt{(3.2)^2 + (4.19)^2 + 2(3.2)(4.19)\cos\left(\frac{\pi}{2}\right)}$

$A_r = 7.4 \times 10^{-2}$ m Ans

Q2: (a) $y = (0.15)\sin[(0.79)x - (13)t]$

$y(x, t) = A\sin(kx - \omega t + \phi)$

$y(2.3, 0.16) = 0.15\sin(0.79 \times 2.3 - 13 \times 0.16)$

$= -3.9 \times 10^{-2}$ m

(b) $y_{opp} = (0.15)\sin[-(0.79 \times 2.3) - (13 \times 0.16)]$

$= -0.010194$ m Ans

* For standing waves, you need a wave travelling in the opposite direction so it has negative sign.

(c) Displacement :

$y_{res} = y + y_{opp}$

$y_{res} = -0.01088$ m Ans.

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Q3: $y = (0.52)\sin[(1.14)x][\cos(137)t]$

(a) $y = A\sin(kx)\cos(\omega t)$

$= (0.520)\sin[(1.14 \times 1.47)]\cos[(137 \times 1.36)]$

$= -0.01511$ cm

(b) $\lambda = \frac{2\pi}{k} \Rightarrow d = \frac{\cancel{2}\pi}{2k} = \frac{\pi}{k} = \frac{3.14}{1.14} = 2.75$ cm

(c) $V = \omega A$

$V = 137 \times 0.520 = 71.24$ cm/s

Q4: $E = \frac{kQ}{r^2} \cdot \hat{r}$

$E_{net} = E_1 + E_2 + \ldots + E_N$

$E_{net} = E_1 + E_2 + E_3 = \frac{kQ_1}{r_1^2} + \frac{kQ_2}{r_2^2} + \frac{kQ_3}{r_3^2}$

$= k\left(\frac{Q_1}{r_1^2} + \frac{Q_2}{r_2^2} + \frac{Q_3}{r_3^2}\right)$

$= (8.99 \times 10^9)\left(\frac{5}{7^2} + \frac{5}{5.8^2} + \frac{2}{2.8^2}\right)$

$= 4.537 \times 10^9$ V/m Ans.

Q5: Charges in equilibrium:

charges $= q$

$\frac{kq}{x^2} = \frac{K(4q)}{(L-x)^2}$

$Q = \frac{-4q}{9}$

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Q6: $E_i = \frac{kq}{r^2}$

$d_i = \sqrt{9(\sqrt{2})^2 + x^2}$

$d_i \approx 9\sqrt{2} + \frac{x^2}{2a\sqrt{2}}$

$E_i = \frac{kq}{\left(a\sqrt{2} + \frac{x^2}{2a\sqrt{2}}\right)^2}$

$E = 2E_i$

$= \frac{2kq}{\left(a\sqrt{2} + \frac{x^2}{2a\sqrt{2}}\right)^2}$

$\approx \frac{2kq}{2a^2 + x^2}$

Q7: $F_{12} = \frac{kq_1q_2}{r^2}$

$F_{13} = \frac{kq_1q_3}{r^2}$

$F_{net} = F_{12} + F_{13}$

$= \frac{kq_1q_2}{r^2} + \frac{kq_1q_3}{r^2}$

$F = 0.262q^2/\epsilon_0 a^2$

$Net\ F = \sqrt{F_{net}^2 + F_{net}^2 + F_{net}^2} = 0.262\frac{q^2}{\epsilon a^2}$

Q8: $d = \sqrt{(k/2)^2 + z^2}$

$F_i = \frac{kqQ}{d^2}$

$F_{net} = 4F_i$

$= 4\frac{kqQ}{d^2}$

~~E = 2Q~~

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Q9: $F_e = F_g$

$$\frac{kqQ}{r^2} = mg\sin\theta$$

$$q = \frac{(0.265)(9.8)\sin 38^\circ (22)^2}{(8.99\times10^9)(5\times10^6)}$$

$$q = 1.72\times10^{-4}\,C$$

Q10: $x=0$, $y = y_m \sin(kx - \omega t + \phi)$

$$y = y_m \sin(-\omega t + \phi)$$

$$\frac{dy}{dt} = \frac{d}{dt}\left[y_m \sin(-\omega t + \phi)\right] \quad \therefore t=0$$

$$= -y_m \omega\cos(-\omega t + \phi) \quad \text{at } t=0$$

$$-\cos\phi > 0$$

At $t=0$ $y = 2.0mm$
after t, $y_m = 6.0\,mm$

$$y = y_m \sin(-\omega t + \phi)\Big|_{t=0}$$

$$\phi = \sin^{-1}\left(\frac{1}{3}\right)$$

$$\phi = 0.34\,rad \quad \text{or} \quad 2.8\,rad$$

$$\sin \theta = \sin\theta(\pi - \phi) \Rightarrow 2.8\,rad$$

$\boxed{\text{Second Quadrant}}$