Q.1 $A = i - 2k \qquad B = -j + \frac{k}{2}$

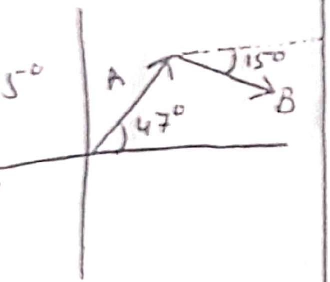
(a) $2A - 6B + 3C = 2\hat{j}$

$2i - 4k + 6j - 3k + 3C = 2j$

$3C = -2i - 6j + 2j + 7k$

$$\boxed{\vec{C} = -\frac{2}{3}i - \frac{4}{3}j + \frac{7}{3}k}$$

(b) $R_x = A\cos 47 + B\cos 15°$



$R_y = A\sin 47 - B\sin 15°$

$R_x = \qquad R_y =$

$R = R_x\hat{i} + R_y\hat{j}$

$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right) =$

Q.2 (a) $x = 3t - 4t^2 + t^3$

(i) $x(2) = 3(2) - 4(2)^2 + (2)^3 = -2$

(ii) $x(3) = 0$

(iii) $x(4) = 12$

(iv) $\Delta x = x(4) - x(0) = 12 - (-2$

$\boxed{\Delta x = 14m}$

(v) $\Delta v = \frac{\Delta x}{\Delta t} = \frac{14}{2} = \boxed{12 m/s = \Delta v}$

Q.2

(b) $h = 50m$

At max height $v_f = 0$

$v_f = v_i - gt \Rightarrow \boxed{v_i = gt}$ — ①

Also, $v_f^2 - v_i^2 = 2gh$

$v_i = \sqrt{2gh}$

$v_i = \sqrt{2 \times 9.8 \times 50}$

$\boxed{v_i = 31.3 m/s}$

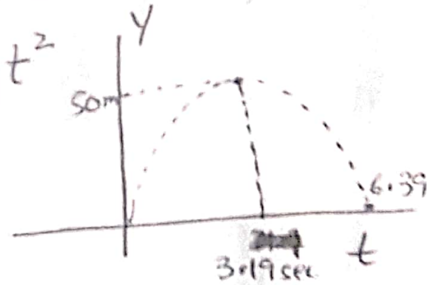
from eq ① $t = \frac{v_i}{g}$ time to reach "h"

Total time

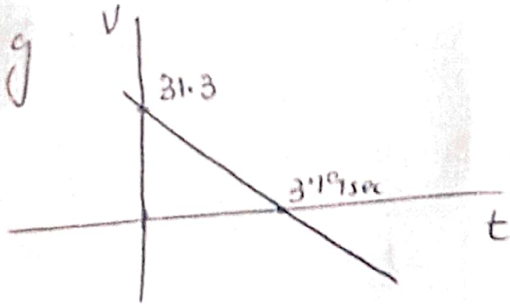
$t = \frac{2v_i}{g} = \frac{2(31.3)}{9.8}$ at

$\boxed{t = 6.39 sec}$

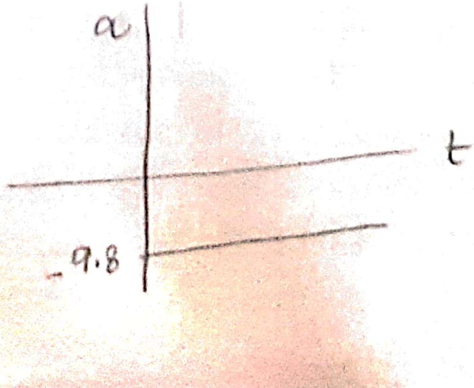
$y = v_i t - \frac{1}{2}gt^2$



$v_f = v_i - g$

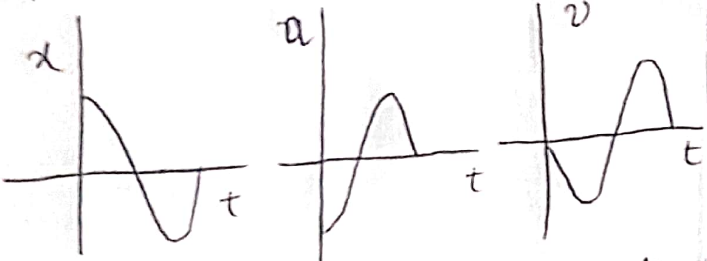


$a = -g$



Q.3 (a)

Position $x = x_m \cos(\omega t + \phi)$
Velocity $v = -x_m \omega \sin(\omega t + \phi)$
acceleration $a = -x_m \omega^2 \cos(\omega t + \phi)$
For $\phi = 0$



(i) ~~Same direction~~ with 90° phase difference
(ii) 90° Phase difference.
(iii) out of phase with differen $\Delta\phi = 180^\circ$

(b) $x = 5\text{cm} \cos(2t + \pi/6)$

$x(0) = 5\text{cm} \cos(2(0) + \pi/6)$

(i) $\boxed{x(0) = 4.33\text{cm}}$ at $t = 0$

$v = \frac{dx}{dt} = -5\text{cm} \times 2 \sin(2t + \pi/6)$

$= -10\text{cm} \sin(2t + \pi/6)$

$V(0) = -10\text{ cm} \sin(0 + \pi/6)$

(ii) $\boxed{V(0) = -5\text{ cm/s}}$

$a = \frac{dv}{dt} = -10 \times 2 \cos(2t + \pi/6)$

$a = 20 \cos(2t + \pi/6)$

$a(0) = 20 \cos(0 + \pi/6)$

(iii) $\boxed{a(0) = -17.3\text{ cm/s}^2}$

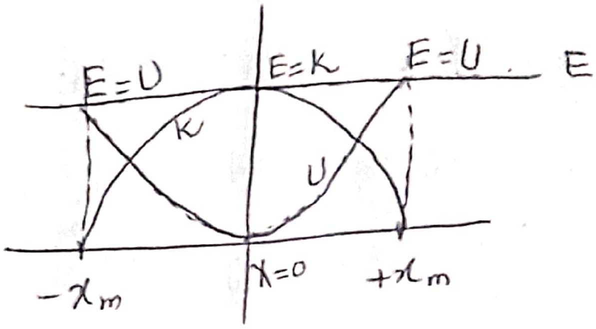
(iv) $T = \frac{2\pi}{\omega} = 3.14$

$\boxed{T = 3.14\text{ sec}}$

(v) Amplitude x_m

$\boxed{x_m = 5\text{cm}}$

Q.3 (c)

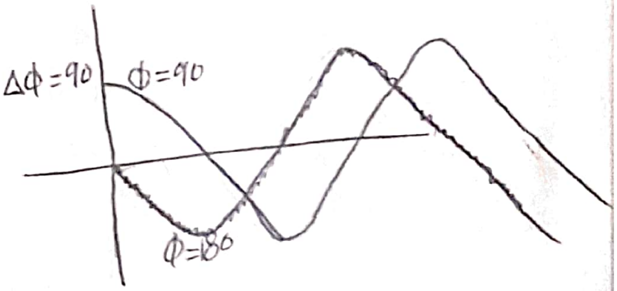


(d) Damped Oscillation

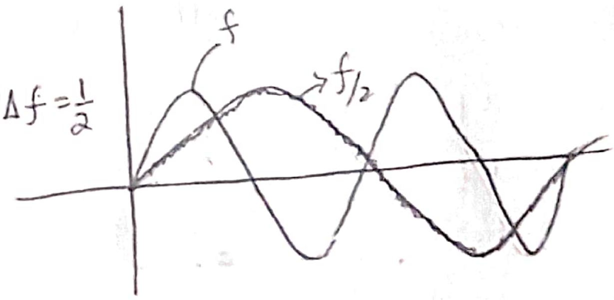
$b > 2m\omega_0$ (Overdamped) $\omega_0 = \sqrt{\frac{K}{m}}$
$b = 2m\omega_0$ (Critical damped)
$b < 2m\omega_0$ (under damped)

(e)

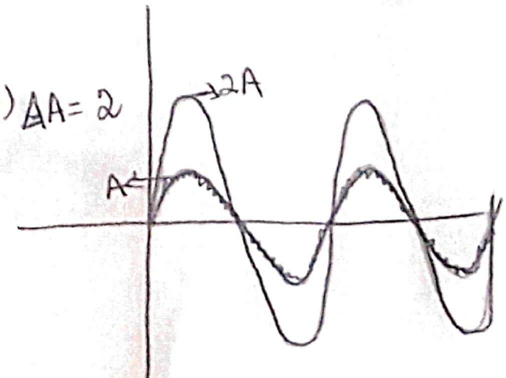
(i)



(ii) $\Delta f = \frac{1}{2}$



(iii) $\Delta A = 2$



Q.4 (b)

$$Y = 2mm \sin\left[(20 mm^{-1})x - (600 s^{-1})t\right]$$

$Y_m = 2mm$ $\quad k = 20\ mm^{-1}$ $\quad \omega = 600 s^{-1}$

(i) $\lambda = \frac{2\pi}{K} = \frac{\cancel{2}\pi}{\cancel{20}} = \frac{\pi}{10} \Big/ mm^{-1}$

$$\boxed{\lambda = \frac{\pi}{10}\ mm}$$

(ii) $T = \frac{2\pi}{\omega} = \frac{\cancel{2}\pi}{\cancel{600}_{300}} = \frac{\pi}{300}$

$$\boxed{T = \frac{\pi}{300}\ sec}$$

(iii) $v = \frac{\lambda}{T} = \frac{\pi}{10} \Big/ \frac{\pi}{300} = \frac{\cancel{\pi}}{\cancel{10}} \times \frac{\cancel{300}}{\cancel{\pi}}$

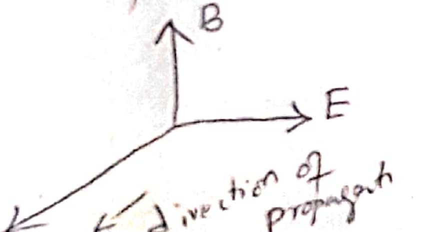
$$\boxed{v = 30\ mm/s}$$

(iv) $f = \frac{1}{T}$

$$\boxed{f = \frac{300}{\pi}\ Hz}$$

(V) $\boxed{K = 20\ rad/mm}$

(c) Because its magnetic and electric components are perpendicular to each other and also perpendicular to the direction of propagation of wave.



Q.4

(d) $Y_m' = 2Y_m \cos\frac{1}{2}\phi$

$Y_m = 15mm$

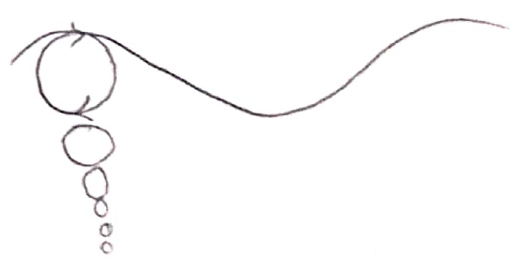
$Y_m' = 2\times 15 \cos\frac{120^\circ}{2}$

$\boxed{Y_m' = 15mm}$ (Intermediate Interference)

$Y_m' = 2\times 15 \cos\frac{180^\circ}{2}$

$\boxed{Y_m' = 0}$ (Destructive Interference)

(a) Water waves are not longitudinal neither transverse. It is basically combination of both. b/c of circular motion of particle

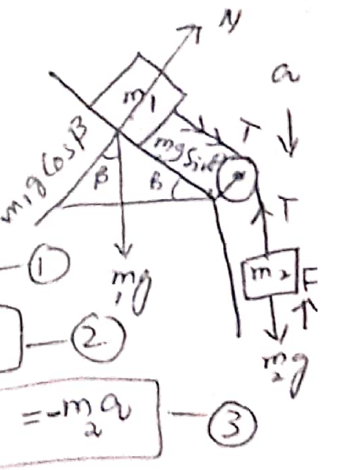


Q.5 $a = 5.5 m/s$

(a) $m_1 = 1 kg$

$m_2 = 2kg$

$F = 2N$



$m_1 \Rightarrow \boxed{N - m_1 g\cos\beta = 0}$ — (1)

$\boxed{T + m_1 g\sin\beta = m_1 a}$ — (2)

$m_2 \Rightarrow \boxed{T - m_2 g + F = -m_2 a}$ — (3)

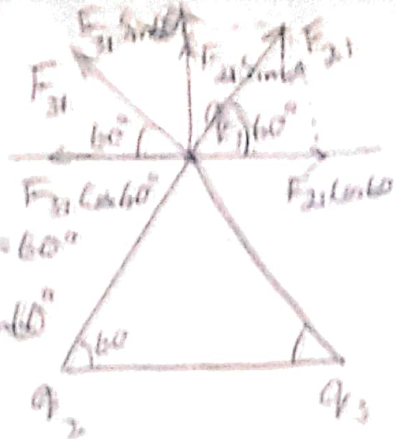
$T = m_2 g - F - m_2 a$

$T = 2(9.8) - 6 - 2(5.5) = 2.6N$

eq(2) $\Rightarrow m_1 g\sin\beta = m_1 a - T$

$$\boxed{\beta = 17.2}$$

Q.6 (a)



$$F_x = F_{21}\cos 60 - F_{31}\cos 60^\circ$$

$$F_y = F_{31}\sin 60 + F_{21}\sin 60^\circ$$

$$F_{21} = \frac{k q_1 q_2}{r_{12}^2} = \frac{k q^2}{L^2}$$

$$F_{31} = \frac{k q_1 q_3}{r_{13}^2} = \frac{k q^2}{L^2}$$

$$F_x = \frac{k q^2}{L^2}\cancel{\cos 60^\circ} - \frac{k q^2}{L^2}\cancel{\cos 60^\circ}$$

$$\boxed{F_x = 0}$$

$$F_y = \frac{k q^2}{L^2}\sin 60 + \frac{k q^2}{L^2}\sin 60^\circ$$

$$= 2\frac{k q^2}{L^2}\sin 60^\circ = 2(0.519)\sin 60$$

$$\boxed{F_y = 0.900}$$

$$\boxed{\vec{F} = F_x\hat{i} + F_y\hat{j}}$$

$$\boxed{\vec{F} = 0\hat{i} + 0.9\hat{j}}$$

$$\boxed{F = 0.9\hat{j}}$$

Q.6 (c) $q_1 = 26\ mC$

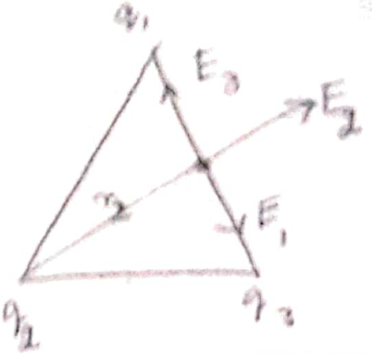
$q_2 = 47\ mC$

$F = 5.7N$

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

$$r = \frac{9\times10^9 (26\times10^{-3})(47\times10^{-3})}{5.7} = \boxed{r = 1.388\ km}$$

Q.7 a



$$E_x = E_1 - E_3$$

$$E_y = E_2$$

$r_1 = r_3 = \frac{L}{2} = 0.658m$

$r_2 = 1.47m$

$$r_2 = \sqrt{\left(\frac{L}{2}\right)^2 + L^2}$$

$$E_x = \frac{k q_1}{r_1^2} - \frac{k q_3}{r_3^2}$$

$$= \frac{9\times10^9 (10\times10^{-6})}{(0.658)^2} + \frac{9\times10^9 (10\times10^{-6})}{(0.658)^2}$$

$$\boxed{E_x =}$$

$$E_y = \frac{k q_2}{r_2^2} = \frac{9\times10^9 (10\times10^{-6})}{(1.47)^2}$$

$$\boxed{E_y =}$$

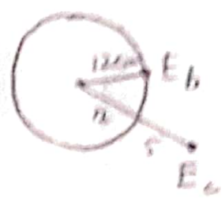
$$E = E_x\hat{i} + E_y\hat{j}$$

$$\boxed{E = \quad \hat{i} + \quad \hat{j}}$$

Q.7 b)

(i) $E = 0$

(ii) $E_b = \frac{k q}{r^2} = \frac{9\times10^9 \times 49\times10^{-6}}{(0.12)^2}$

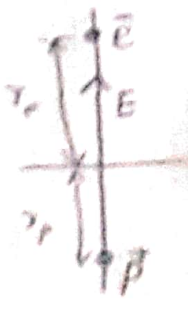


$$\boxed{E_b = 3.06\times10^7 N/C}$$

(iii) $E_c = \frac{k q}{r^2} = \frac{9\times10^9 \times 49\times10^{-6}}{(0.12+0.05)^2}$

$$\boxed{E_c = 1.53\times10^7 N/C}$$

(c) $E = \frac{k q}{r^2} \Rightarrow r = \sqrt{\frac{kq}{E}}$



$$\boxed{r = 0.59\times10^{-6}}$$

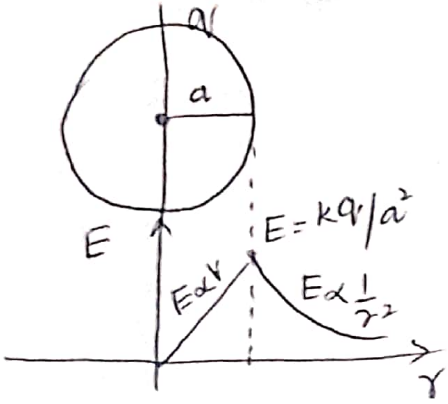
$\vec{r}_p = -0.59\times10^{-6}\ m\ \hat{j}$

$\vec{r}_e = +0.59\times10^{-6}\ m\ \hat{j}$

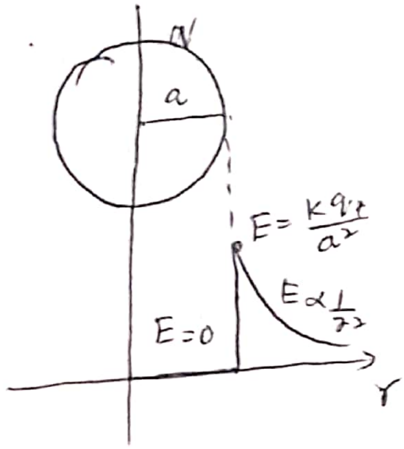
Q.8

(a)

Spherical



thin shell



(b) $\Phi = \frac{q}{\epsilon_0}$

$= \frac{-3}{8.85 \times 10^{-12}}$

$\boxed{\Phi = -0.34 \times 10^{-12}\ Nm^2/C}$

Not changed

(c) $E = \frac{\lambda}{2\pi\epsilon_0 r} = 2k\frac{\lambda}{r}$

$\lambda = \frac{Er}{2k}$

$= \frac{4.52 \times 10^4 \times 1.96\,m}{2 \times 9 \times 10^9}$

$\boxed{\lambda = }$

(d) $\Phi = 0$

(i) $q_{net} = 0$

(ii) No, not necessary E = 0 at all point

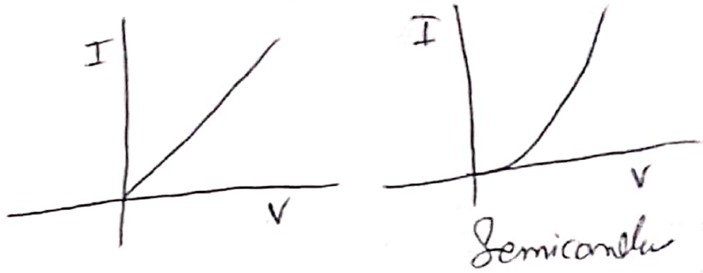
for e.g

For dipole
But $q_{net} = 0$
$E \neq 0$

Q.9

(a) B/c direction just associated with the direction of $\vec{e}$ in wire.

(b) -



Conductor
Ohmic

Semiconductor
Non-Ohmic

(c)

(d) $V = 3.55\, i^2$

$i = 2.4\,mA$

$\cancel{V} = 3.55 \left(\frac{V^{\cancel{2}}}{R^2}\right)$

$R^{\cancel{2}} = 3.55\,V = 3.55\, iR$

$R = 3.55\, i$

$= 3.55 \times 2.4 \times 10^{-3}$

(i) $\boxed{R = 8.52 \times 10^{-3}\,\Omega}$

if $R = 16\,\Omega$

(ii) $i = \frac{R}{3.55}$

$= \frac{16}{3.55}$

$\boxed{i = 4.5\,A}$