Answers – Week 4

4-1 In an $\underset{\rightarrow}{E}$ - field a stationary charge q experiences a Force $\underset{\rightarrow}{F}_E = q\underset{\rightarrow}{E}$. Therefore, attach q to the Force measuring device which can measure both magnitude and direction of Force. If in some region q experiences a force you know that it is located in an $\underset{\rightarrow}{E}$ - field.

4-3 $\underset{\rightarrow}{E} = \frac{k_e q}{r^2}\hat{r}$

$\underset{\rightarrow}{E}(y) = \underset{\rightarrow}{E}_+ + \underset{\rightarrow}{E}_-$

y – components cancel

x – components add

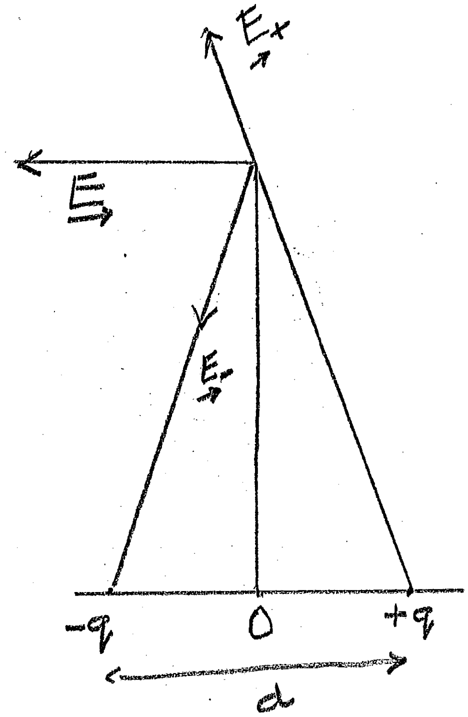
$$\underset{\rightarrow}{E} = \frac{-2k_e q \frac{Sin\theta}{2}\hat{x}}{y^2 + \frac{d^2}{4}} = -\frac{k_e q d}{\left(y^2 + \frac{d^2}{4}\right)^{3/2}}\hat{x}$$

y >> d

$$\underset{\rightarrow}{E} = -\frac{k_e q d}{y^3}\hat{x}$$

Dipole moment $\underset{\rightarrow}{p} = q\,d\,\hat{x}$

So $\underset{\rightarrow}{E}(y) = -\frac{k_e \underset{\rightarrow}{p}}{y^3} = -\frac{1}{4\pi\varepsilon_0}\frac{\underset{\rightarrow}{p}}{y^3}$



4-5 (i) $\underset{\rightarrow}{a} = 9x10^{12}\,m/s^2\,\hat{y}$

(ii) $\underset{\rightarrow}{V} = 10^7\,m/s\,\hat{x} + 1.35x10^5\,m/s\,\hat{y}$

(iii) $\underset{\rightarrow}{r} = 0.15\,m\,\hat{x} + 1.01x10^{-3}\,m\,\hat{y}$

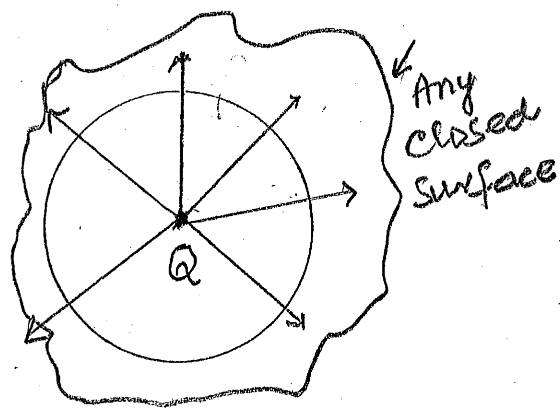
(iv) y = 1.45 x 10^{-2} m

4-7 Put Q at center of a sphere at r = 0.

$$\underset{\rightarrow}{E} = \frac{Q}{4\pi\varepsilon_0 r^2}\hat{r}$$

FLUX THROUGH SPHERICAL SURFACE

$$\Phi_E = \sum_C \underset{\rightarrow}{E}.\Delta\underset{\rightarrow}{A} = \frac{Q}{\varepsilon_0}$$



All the $\underset{\rightarrow}{E}$ field lines must head to infinity so same total flux must go through any closed surface surrounding Q.

4-9 Total flux is zero.

We DONOT KNOW $\underset{\rightarrow}{E}$ - field at any point on surface.

4-11 ON THE SURFACE OF CONDUCTOR. UNDER STATIONARY CONDIITONS, CHARGES MUST BE AT REST SO $\underrightarrow{E}$ - field at any point inside conductor must be zero.

4-13 $\sigma = 9 \times 10^{-10}$ C/m^2

4-15 In a conservative force work done is Independent of the path. It is determined only by the end points. Weight $\underrightarrow{F}_G = -M g \hat{y}$ is a conservative force.