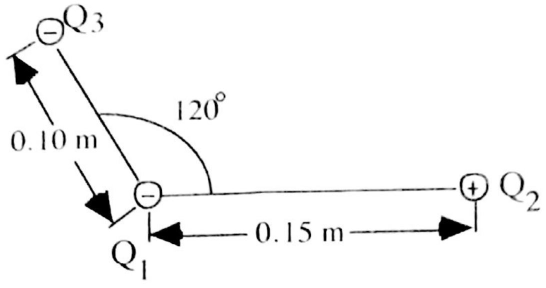
Course Name: PYL 111
Electrodynamics
Total Marks 40, Time 2 hrs.
Part-I (Marks 12)

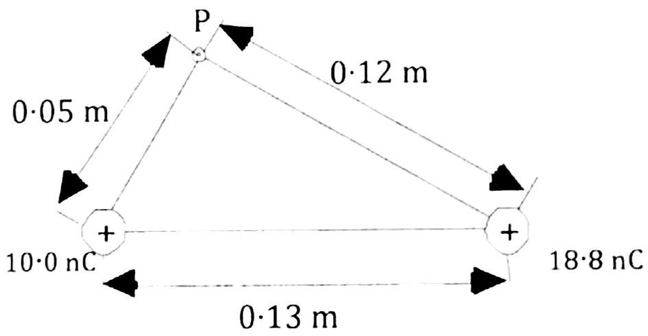
Answer all below:

1. The diagram below shows three charges fixed in the positions shown.



$Q_1 = -1{\cdot}0 \times 10^{-6}$ C, $Q_2 = +3{\cdot}0 \times 10^{-6}$ C and $Q_3 = -2{\cdot}0 \times 10^{-6}$ C.
Calculate the resultant force on charge Q_1. 2

2. The diagram shows two charges of +10·0 nC and +18·8 nC separated by 0·13 m.

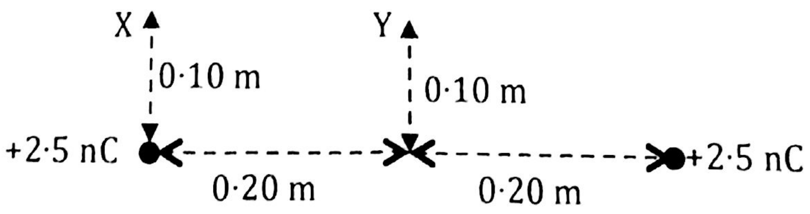


(a) Calculate the magnitude of the resultant electric field strength at the point P.

(b) Make a sketch like the one above and show the direction of the resultant electric field strength at the point P. 2+2

3. Two point charges of + 4·0 nC and −2·0 nC are situated 0·12 m apart. Find the position of the point where the electrostatic potential is zero. 2

4. Two point charges each of +2·5 nC are situated 0·40 m apart as shown below.



(a) (i) Calculate the electrostatic potential at point X.
(ii) Calculate the electrostatic potential at point Y.

(b) Determine the potential difference between points X and Y. 2+2

Part-2 (Marks 28)

1. A point charge q is situated at a distance s from the centre of a grounded conducting sphere of radius ρ.

(i) Find the potential V(r,θ) outside the sphere. Where r, θ are the usual spherical polar co-ordinates, with z-axis is along the line through q.

(ii) Find the induced charge on the sphere, as a function of θ. Integrate this to get the total induced charge. What should it to be?

(iii) Calculate the energy of this configuration. 3+3+3

2. Show that the monopole, dipole and quadropole terms of multipole explansion are given by:

$$V_{mon} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

$$V_{dip} = \frac{1}{4\pi\varepsilon_0}\frac{\sum \hat{r}_i.\vec{p}_i}{r^2}$$

$$V_{quad} = \frac{1}{4\pi\varepsilon_0}\frac{\frac{1}{2}\sum \hat{r}_i.\hat{r}_j Q_{ij}}{r^3}$$

Where $Q_{ij} = \int |3r_i'3r_j' - (r')^2\partial_{ij}|\rho(r')d\tau'$ 1+2+6

3. (a) What is radiation?

(b) Two tiny metal spheres separated by a distance s and connected by a fine wire; at a time t the charge on the upper sphere is q(t) and the charge in the lower sphere is –q(t). Suppose that we derive the charge back and forth through the wire, from one end to the other at an angular frequency ω: $q(t)=q_0Cos(\omega t)$. Including the following approximations i.e. (i) the separation distance to be extremely small and (ii) is negligible compared to wavelength (λ) of the EM wave find an expression for V(r, θ, t) at r >> λ.

(c) Find an expression for the total power radiated from such a system. 1+3+5

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