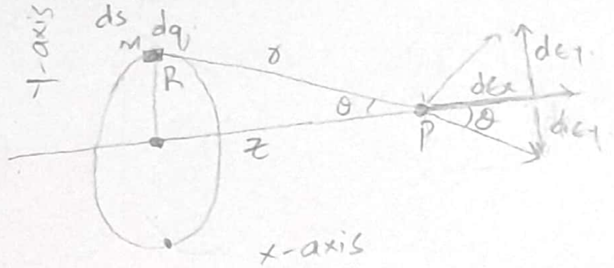
Electric field due to ring of charges:



where

R is the radius of the ring

z is the distance from the centre of ring to Point P.

we have to find electric field due to the ring at point P.

Linear charge density is defined as charge per unit length.

$$\lambda = \frac{\text{charge}}{\text{Length}}$$

$$\lambda = \frac{dq \rightarrow \text{charge}}{ds \rightarrow \text{Length}} \quad \text{Length element m.}$$

$$dq = \lambda\, ds \longrightarrow (A)$$

If we integrate it, we will find the total charge of ring

$$\int dq = \lambda \int ds$$

$$q = \lambda\, 2\pi r \longrightarrow (1)$$

Total / net charge of ring

→ All of the y-components are cancelled with each other as same in magnitude & opposite in direction.

→ So our total electric field will have only x-component

Therefore we can write

$$dE_x = dE\cos\theta \rightarrow (2) \qquad dE_y = 0$$

As we know that

$$dE = \frac{k\,dq}{r^2}$$

&

$$\cos\theta = \frac{z}{r}$$

putting these values in equation (2).

$$dE_x = \frac{k\,dq}{r^2} \cdot \frac{z}{r}$$

$$dE_x = \frac{k\,dq\,z}{r^3} \qquad r = (z^2+R^2)^{1/2}$$

Subsituting the value of dq from equation (A). The above expression can be written as.

$$dE_x = \frac{k\lambda\,ds\,z}{(z^2+R^2)^{3/2}}$$

Integrating both sides.

$$\int dE_x = \int \frac{k\lambda\,ds\,z}{(z^2+R^2)^{3/2}}$$

$$E = \frac{k\lambda z}{(z^2+R^2)^{3/2}} \int ds$$

$$= \frac{k\lambda z \cdot 2\pi r}{(z^2+R^2)^{3/2}}$$

$$\boxed{E = \frac{kzq}{(z^2+R^2)^{3/2}}}$$

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