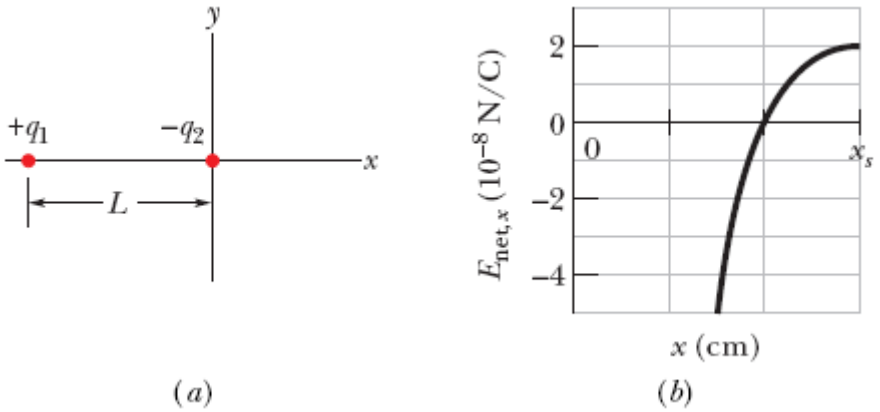
Answer on Question #64912-Physics-Other

Part (a) of the figure below shows two charged particles fixed in place on an x axis with separation L. The ratio q1/q2 of their charge magnitudes is 36.0. Part (b) of the figure shows the x component Enet,x of their net electric field along the x axis just to the right of particle 2. The x axis scale is set by xs = 30.0 cm.

(a) At what value of x > 0 is Enet, x maximum? (The maximum is not at x = xs.)cm

(b) If particle 2 has charge −q2 = −3e, what is the value of that maximum?



Solution

The electric field from a point charge q is

$$E = k \cdot \left(\frac{q}{r^2}\right) \cdot e_r$$

$$k = 8.988 \cdot 10^9 \frac{Nm^2}{C^2}$$

$$E_1 = \frac{kq_1}{\left(x-(-L)\right)^2} = \frac{kq_1}{(x+L)^2}$$

$$E_2 = -\frac{kq_2}{(x-0)^2} = -\frac{kq_2}{x^2}$$

The total electrical field is

$$E_{net,x} = E_1 + E_2 = \frac{kq_1}{(x+L)^2} - \frac{kq_2}{x^2} = kq_2\left(\frac{36}{(x+L)^2} - \frac{1}{x^2}\right)$$

From the sketch (b) the electrical field at $x = \frac{2}{3}x_s = \frac{2}{3}30 = 20\ cm = 0.2\ m$ is zero.

$$E_{net,x} = 0 = kq_2\left(\frac{36}{(0.2+L)^2} - \frac{1}{0.2^2}\right)$$

$$\frac{36}{(0.2+L)^2} = \frac{1}{0.2^2}$$

$$L = 1\ m.$$

(a) For maximum:

$$\frac{dE_{net,x}}{dx} = 0$$

$$\frac{d}{dx}\left[kq_2\left(\frac{36}{(x+1)^2}-\frac{1}{x^2}\right)\right] = 2\left(\frac{1}{x^3}-\frac{54}{(x+1)^3}\right) = 0$$

$$\frac{1}{x^3} = \frac{54}{(x+1)^3}$$

$$\frac{x+1}{x} = \sqrt[3]{54}$$

$$x_{max} = \frac{1}{\sqrt[3]{54}-1} = 0.360\ m.$$

(b)

$$\mathrm{E_{net,max}} = kq_2\left(\frac{36}{(x+1)^2}-\frac{1}{x^2}\right) = 8.988\cdot 10^9\cdot 3\cdot 1.602\cdot 10^{-19}\left(\frac{36}{(0.360+1)^2}-\frac{1}{0.360^2}\right)$$
$$= 5.07\cdot 10^{-8}\frac{V}{m}.$$