Week(4) [ch23]

Final disscussion of ch23

45
7 20

A uniformly charged insulating rod of length 14.0 cm is bent into the shape of a semicircle as shown in figure P23.45. The rod has a total charge of −7.50 μC. Find:

(a) The magnitude and (b) the direction of the electric field at O, the center of semicircle

$q = -7.50\ \mu C$

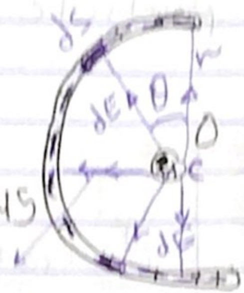

Figure P23.45

$L = \pi r = 0.14\ m$

$r = \frac{0.14}{3.14}$

$=$

$2dE\sin\theta$

$dE\cos\theta$ يلغوا بعض
can cell each other

$dE_c = 2dE\sin\theta(-\hat{i})$

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

$dq = \lambda ds$
$= \lambda r\, d\theta$

$E_c = \frac{2k}{r^2}\int dq \sin\theta\,(-\hat{i})$

$= \frac{2k}{r^2}\int \lambda r \sin\theta\, d\theta$

$= \frac{2k\lambda}{r}\int_0^{\frac{\pi}{2}} \sin\theta\, d\theta$

$= \frac{2k\lambda}{r}(-\hat{i})(-\cos\theta)\Big|_0^{\frac{\pi}{2}}$

$= \frac{2k\lambda}{r}(-\hat{i})$

$= \frac{2k}{r}\cdot\frac{q}{\pi r}$

$= \frac{2kq}{\pi r^2}$

$= \frac{2kq}{\pi\left(\frac{L}{\pi}\right)^2}$

$= \frac{2kq\pi}{L^2}$

$= 21.6\times 10^{6}\,\hat{i}\ N/C$

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An electron and a proton are each placed at rest in a uniform electric field of magnitude 520 N/C. Calculate the speed of each particle 48.0 ns after being released

$m_e = 9.11 \times 10^{-31}$ kg

$m_p = 1.67 \times 10^{-27}$ kg

$E = 520$ N/C

$t = 48$ ns

$= 48 \times 10^{-9}$ sec

proton

$F_E = F$

$qE = ma$

$a = \frac{qE}{m}$

$= \frac{1.6 \times 10^{-19} \times 520}{1.67 \times 10^{-27}}$

$= 498 \times 10^{8}$ m/s²

$v_f = v_i + at$

$= 0 + 498 \times 10^{8} \times 48 \times 10^{-9}$

$= 2391$ m/s

$= 2.39 \times 10^{3}$ m/s

electron

$a = \frac{qE}{m}$

$= \frac{1.6 \times 10^{-19} \times 520}{9.11 \times 10^{-31}}$

$= 9.13 \times 10^{13}$ m/s²

$v_f = v_i + at$

$= 0 + 9.13 \times 10^{13} \times 48 \times 10^{-9}$

$= 4.38 \times 10^{6}$ m/s

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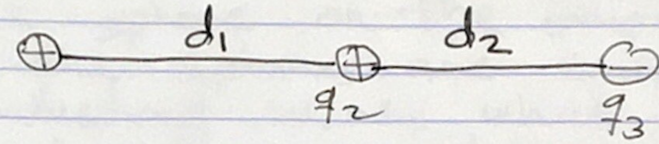
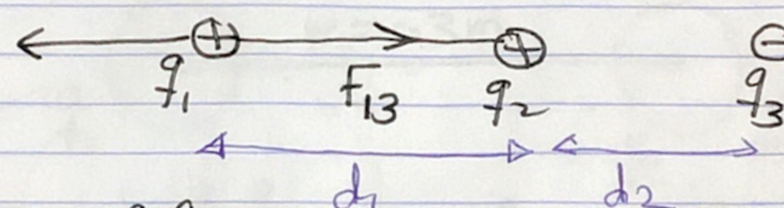
Three point charges lie along a straight line as shown in Figure $q_1 = 6\ \mu C$, $q_2 = 1.5\ \mu C$ and $q_3 = -2\ \mu C$, $d_1 = 3$ cm and $d_2 = 2$ cm. Calculate the magnitude and the direction of the net electric force on (a) q_2 (b) q_2 (c) q_3



(a) on q_1

q_2, q_3 نرسم القوى المؤثرة على q_1 والناتجة من



$$f_{12} = \frac{k q_1 q_2}{r_{12}^2} = \frac{9\times10^9 \times 6\times10^{-6} \times 1.5\times10^{-6}}{(3\times10^{-2})^2}$$

$$\vec{F}_{12} = 90\ N\,(-\hat{i})$$

$$f_{13} = \frac{k q_1 q_3}{r_{13}^2} = \frac{9\times10^9 \times 6\times10^{-6} \times 2\times10^{-6}}{(0.05)^2}$$

$$\vec{f}_{13} = 32.4\ N\,(\hat{i})$$

$$\vec{F}_1 = \vec{F}_{12} + \vec{F}_{13}$$

$$= (-90 + 32.4)\,\hat{i}$$

$$= +57.6\ N\,(-\hat{i})$$

$\vec{f}_3$ ، $\vec{F}_2$ بنفس الطريقة نجد

$$\vec{F}_2 = \vec{F}_{21} + \vec{F}_{23}$$

$$\vec{F}_3 = \vec{F}_{31} + \vec{F}_{32}$$

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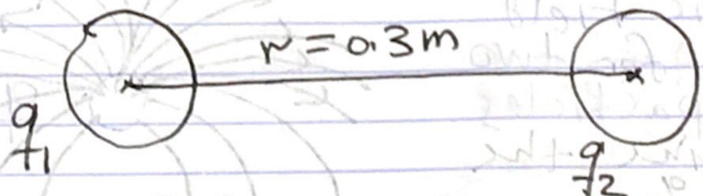
7/8

Two identical conducting small spheres are placed with their centers 0.3 m apart.
One is given a charge of 12 nC and the other a charge of −18 nC.
(a) Find the electric force exerted by one sphere on the other
(b) if the spheres are connecting by a conducting wire what are the charg on each sphere and the force between them during connection

(a)

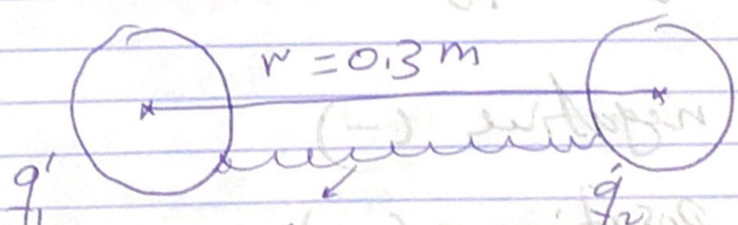


$$F = \frac{k\, q_1 q_2}{r^2} = \frac{9\times10^{9} \times 12\times10^{-9} \times 18\times10^{-9}}{(0.3)^2}$$

$$= 2.16\times10^{-5}\ N\ \text{(attractive)}$$ تجاذب

after connection

$$q_1' = q_2' = \frac{12-18}{2} = -3\ nC$$



$$F' = \frac{k\, q_1' q_2'}{r^2} = \frac{9\times10^{9} \times (3\times10^{-9})(3\times10^{-9})}{(0.3)^2}$$

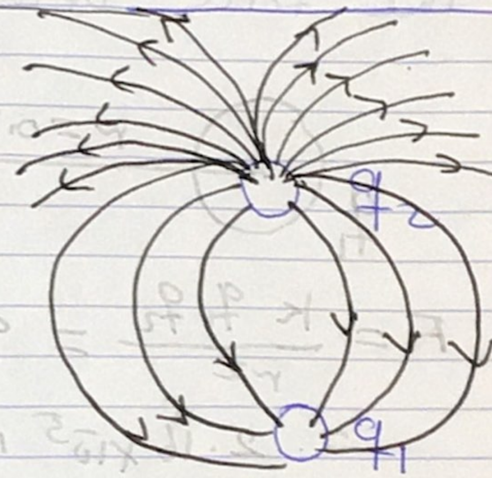
$$= 9\times10^{-7}\ N\ \text{(Repulsive)}$$ تنافر

$$E_x = E_1 \cos 30 - E_2 + E_3 \cos 30$$
$$= 16.875 \times 10^3 \cos 30 - 11.25 \times 10^3 + 16.875 \times 10^3$$
$$= 22.5 \times 10^3$$

$$E_y = -E_1 \sin 30 + E_3 \sin 30$$
$$= 0 \qquad E_1 = E_3 \;(\because)$$

$$\therefore \vec{E}_c = 22.5 \times 10^3 \ \hat{i}$$

49/720 Fig shows the electric Field lines for two charged particles



(a) Determine the ratio $\frac{q_1}{q_2}$

(b) what is the sign of q_1 and q_2

(a) $\frac{q_1}{q_2} = \frac{N_1}{N_2} = \frac{6}{18} = \frac{1}{3}$

(b) q_1 : negative (−)

q_2 : positive (+)

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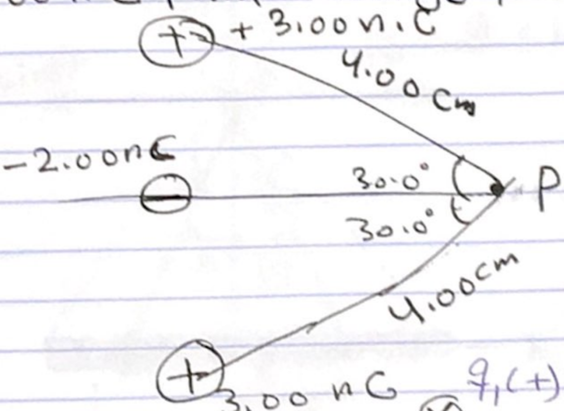
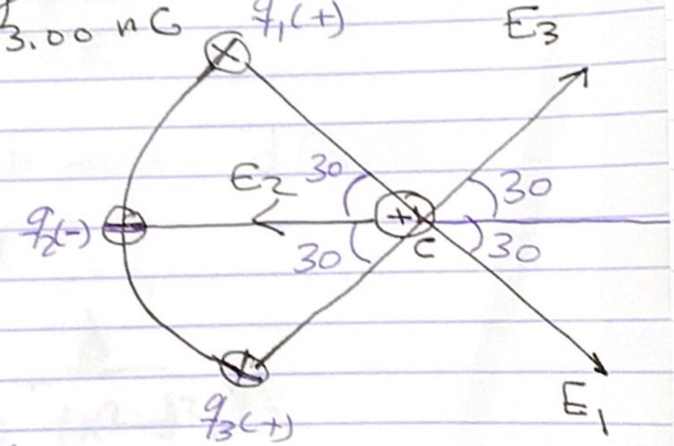
Three point charges are located on a circular arc as shown in figure P23.31

(a) what is the total electric field at P, the center of the arc?

(b) Find the electric force that would be exerted on a −5.00 nC point charge placed at P.





$$E_1 = \frac{Kq}{r^2}$$

$$= \frac{9\times10^9 \times 3\times10^{-9}}{(0.04)^2}$$

$$= 16.875\times10^3 \ N/C$$

$$E_2 = \frac{9\times10^9 \times 2\times10^{-9}}{(0.04)^2}$$

$$= 11.25\times10^3 \ N/C$$

$$E_3 = \frac{9\times10^9 \times 3\times10^{-9}}{(0.04)^2} = 16.875\times10^3 \ N/C$$

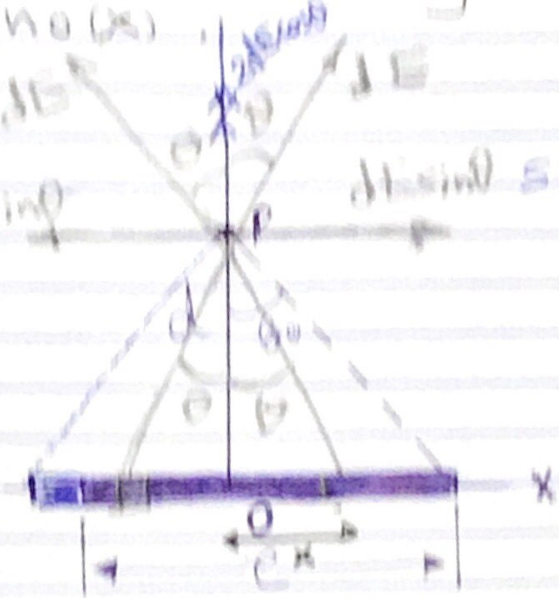
$$\vec{E}_1 = E_1 \cos 30 \ \hat{i} - E_1 \sin 30 \ \hat{j}$$

$$E_2 = -E_2 \ \hat{i}$$

$$E_3 = E_3 \cos 30 \ \hat{i} + E_3 \sin 30 \ \hat{j}$$

44. A thin rod of length (ℓ) and uniform charge per unit length (λ) lies along the (x) axis as shown in figure P23.44.

(a). Show that the electric field at (P), a distance (d) from the rod along its perpendicular bisector, has no (x).



$dE_x = (dE\sin\theta - dE\sin\theta) = 0$

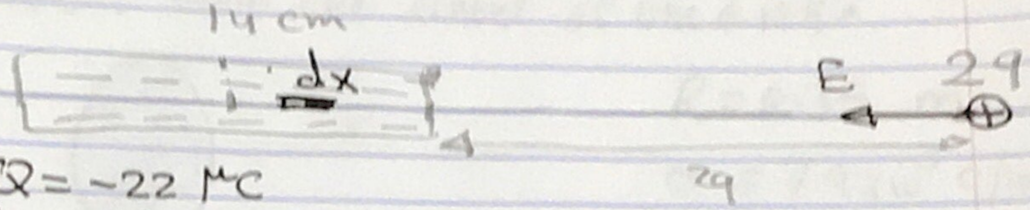
$$dE = 2\,dE\cos\theta$$

$$= 2\frac{K\,dq}{(x^2+d^2)} \cdot \frac{d}{(x^2+d^2)^{1/2}}$$

$$dE = 2K\lambda d \frac{dx}{(x^2+d^2)^{3/2}}$$

$$E = 2K\lambda d \int_0^{\ell/2} \frac{dx}{(x^2+d^2)^{3/2}} = \frac{2K\lambda\sin\theta_0}{d}$$

37. (771) A rod 14.0 cm long is uniformly charged and has a total charge of $-22.0\,\mu C$. Determine (a) the magnitude and (b) the direction of the electric field along the axis of the rod at a point 36.0 cm from its center



$Q = -22\,\mu C$

$L = 14$ cm

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$r_i = 29 = 0.29$ m

$r_f = 43 = 0.43$ m

$\lambda = \frac{22}{0.14} = 157\,\mu C/m$

$$E = k\int_{r_1}^{r_2} \frac{dq}{r^2}\,\hat{r}$$

$dq = \lambda\, dx = 157\, dx$

$$= k\int_{0.29}^{0.43} \frac{157\, dx}{x^2}$$

$$= 9\times10^9 \times 157\times10^{-6} \left(\frac{-1}{x}\right)\Bigg|_{0.29}^{0.43} (-\hat{i})$$

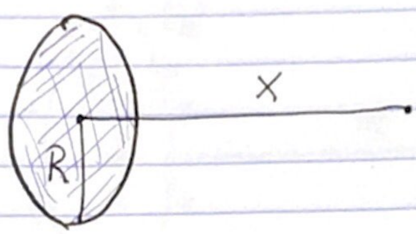
$$= 1413000 \left(\frac{1}{0.43} - \frac{1}{0.29}\right)$$

$$E = -1.59\times10^6\,\hat{i}\ N/C$$

$$= +1.59\ MN/C\ (-\hat{i})$$

38 / 7 99 a uniformly charged disk of radius 35.0 cm carries charge with a ~~destiny~~ density of $7.90 \times 10^{-3}\ C/m^2$.

Calculate the electric field on the axis of the disk at (a) 5.00 cm, (b) 10.0 cm, (c) 50.0 cm and (d) 200 cm from the center of the disk.



$R = 0.35\ m$

$\sigma = 7.9 \times 10^{-3}\ C/m^2$

(a) $x = 5\ cm = 0.05\ m$

(b) $x = 10\ cm = 0.1\ m$

(c) $x = 0.5\ m$

(d) $x = 2\ m$

(e) $x = 0\ m$.

$$E = 2\pi K\sigma \left[1 - \frac{x}{(R^2+x^2)^{1/2}}\right]$$

708 ص ملخص
23.9

(a) $x = 0.05\ m$

$$E = 2 \times 3.14 \times 9 \times 10^9 \times 7.9 \times 10^{-3} \left[1 - \frac{0.05}{\left((0.35)^2 + (0.05)^2\right)^{1/2}}\right]$$

$= 44650800 \times 0.86$

$= 384 \times 10^6\ N/C$

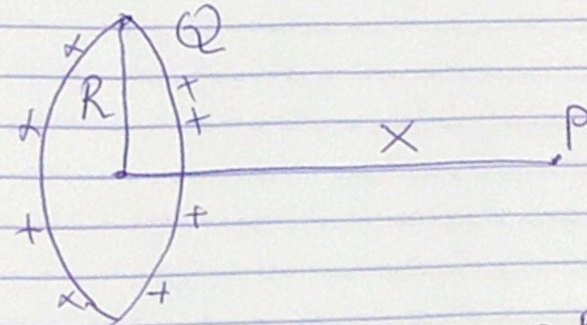
(b)(c)(d) نفس الطريقة

(e) $x = 0 \longrightarrow E = 2\pi K\sigma$

$= 2 \times 3.14 \times 9 \times 10^9 \times 7.9 \times 10^{-3}$

$= 447 \times 10^6\ N/C$

(39 / 779) A uniformly charged ring of radius 10.0 cm has a total charge of 75.0 μC. Find the electric field on the axis of the ring at (a) 1.00 cm, (b) 5.00 cm, (c) 30.0 cm, and (d) 100 cm from the center of the ring



$$E_p = \frac{K \times Q x}{(a^2 + x^2)^{3/2}}$$

a = 0.1 m
Q = 75 μC

(a) x = 0.09 m
(b) x = 0.05 m
(c) x = 0.3 m
(d) x = 1 m
(e) x = 0 m

(a) $x = 0.09$ m

$$E_p = \frac{9\times10^9 \times 0.09 \times 75\times10^{-6}}{\left((0.1)^2 + (0.09)^2\right)^{3/2}}$$

$$= \frac{60750}{(0.0181)^{3/2}} = 24.9\times10^6$$

~~[illegible]~~

(d) $$E_p = \frac{9\times10^9 \times 1 \times 75\times10^{-6}}{\left((0.1)^2 + (1)^2\right)^{3/2}} = \frac{675000}{1.015} = 665\times10^3 \text{ N/C}$$

(e) $x = 0$ $E = 0$