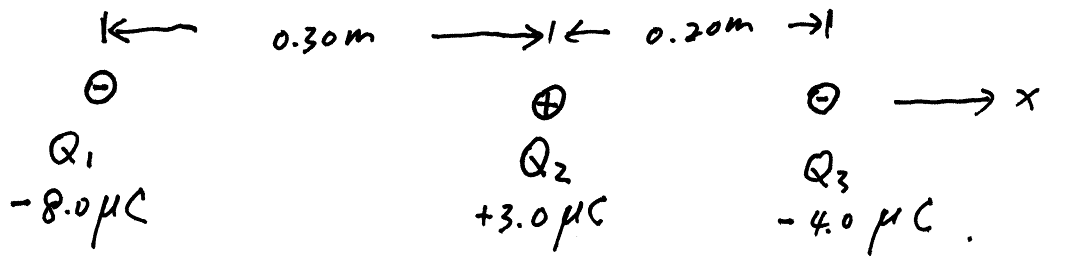
e.g. 21-2. Three charges in a line. (p.566)



$$1\,\mu C = 10^{-6}\,C$$

Calculate the net force acting on Q_3.

Q_1 exerts a force on Q_3: $\vec{F}_{31}$: Direction: $\hat{x}$ $\xrightarrow{\vec{F}_{31}}$ (repulsive)

$$\left[\begin{array}{l} \varepsilon_0 = 8.85 \times 10^{-12}\, C^2/N\cdot m^2 \\ \text{(permittivity of free space)} \end{array}\right]$$

magnitude: $F_{31} = \dfrac{|Q_1 Q_3|}{4\pi\varepsilon_0 (0.5)^2} = 1.2N$.

Q_2 exerts a force on Q_3: $\vec{F}_{32}$: Direction: $-\hat{x}$ $\xleftarrow{\vec{F}_{32}}$ (attractive).

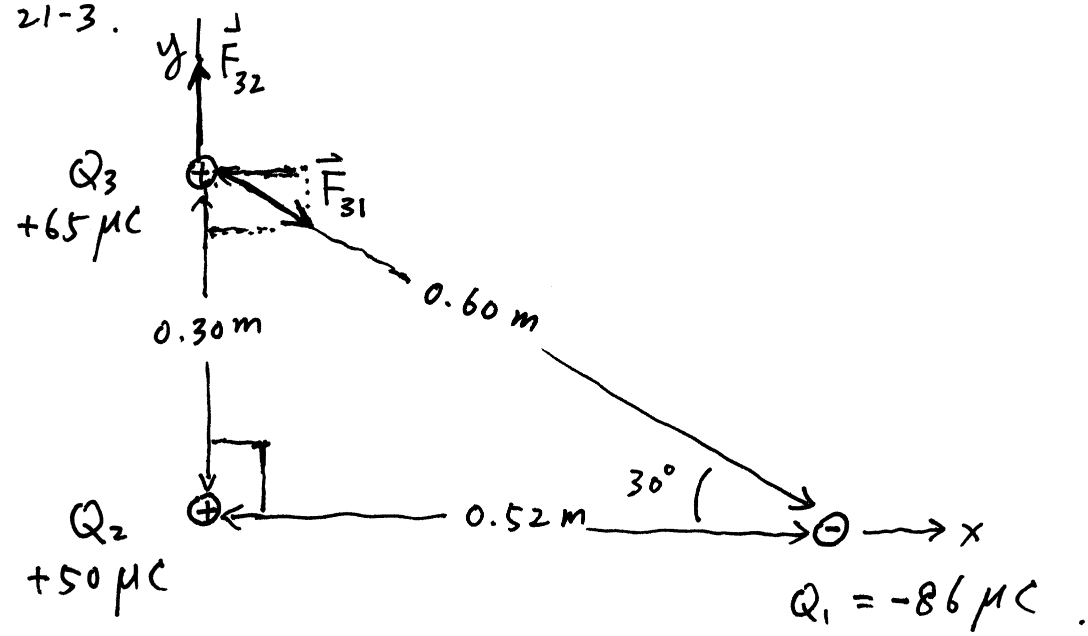
magnitude: $F_{32} = \dfrac{|Q_2 Q_3|}{4\pi\varepsilon_0 (0.2)^2} = 2.7N$.

Net force on Q_3: $\vec{F}_3 = \vec{F}_{31} + \vec{F}_{32}$

x-component: $F_{3x} = 1.2 - 2.7 = -1.5N$.

$\therefore \quad \vec{F}_3 = -\hat{x}\, 1.5\, N$.

e.g. 21-3.



Magnitudes: F_{31}, F_{32}

$$F_{31} = \frac{|Q_3 Q_1|}{4\pi\varepsilon_0 (0.6)^2} = 140\,N.$$

$$F_{32} = \frac{|Q_3 Q_2|}{4\pi\varepsilon_0 (0.3)^2} = 330\,N.$$

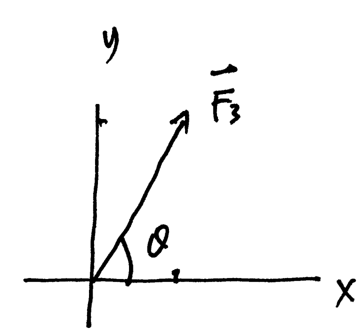
Net force on Q_3: $\vec{F}_3 = \vec{F}_{31} + \vec{F}_{32}$ (but $F_3 \neq F_{31} + F_{32}$)

use components: x: $F_{3x} = 140 \cdot \cos 30^\circ = 120\,N$

y: $F_{3y} = F_{31y} + F_{32y}$

$= 330 - 140 \sin 30^\circ$

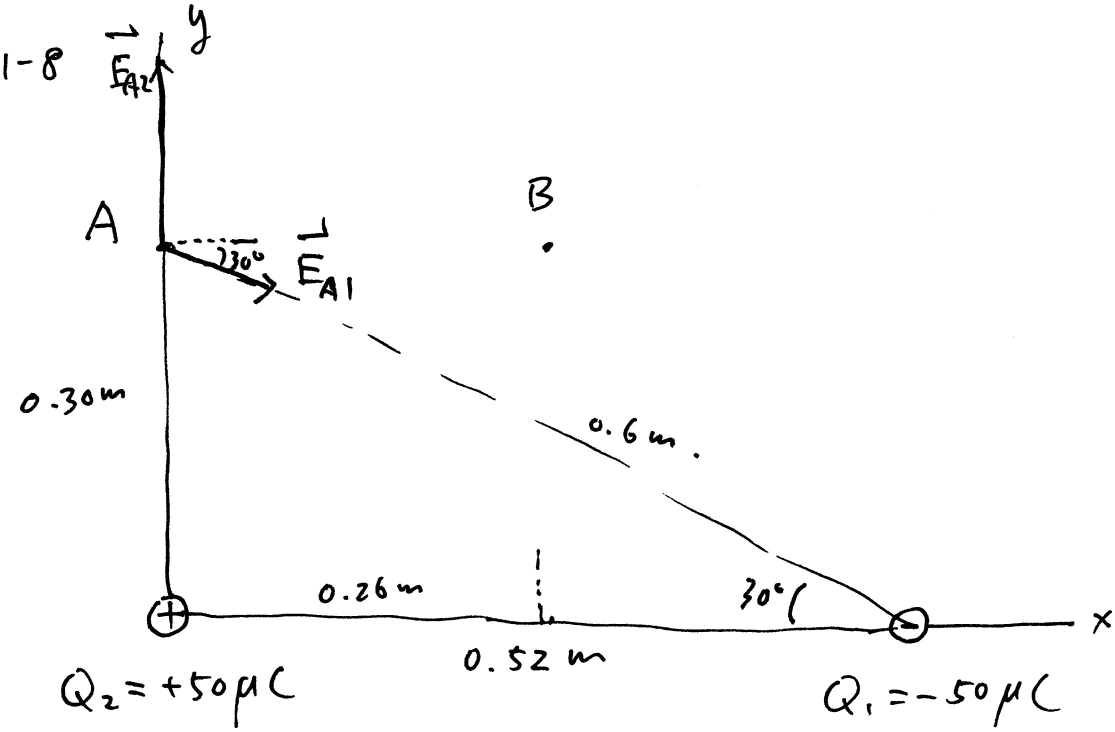
$= 260\,N$.



$$F_3 = \sqrt{F_{3x}^2 + F_{3y}^2} = \sqrt{120^2 + 260^2} = 290\,N.$$

$$\theta = \tan^{-1}\frac{F_{3y}}{F_{3x}} = 65^\circ$$

e.g. 21-8



a) Find $\vec{E}$-field at A due to Q_1 and Q_2.

$$E_{A1} = \frac{|Q_1|}{4\pi\varepsilon_0 (0.60)^2} = 1.25\times10^6 \ N/C.$$

$$E_{A2} = \frac{|Q_2|}{4\pi\varepsilon_0 (0.3)^2} = 5.0\times10^6 \ N/C.$$

$$\vec{E}_A = \vec{E}_{A1} + \vec{E}_{A2} \quad (\text{But } E_A \neq E_{A1} + E_{A2})\ !$$

$$E_{Ax} = E_{A1x} + E_{A2x}$$
$$= 1.25\times10^6 \cdot \cos 30^\circ + 0$$
$$= 1.1\times10^6 \ N/C.$$

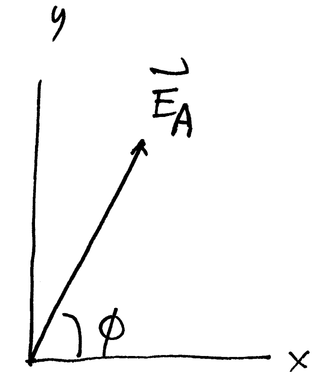
$$E_{Ay} = E_{A1y} + E_{A2y}$$
$$= -1.25\times10^6 \sin 30^\circ + 5.0\times10^6$$
$$= 4.4\times10^6 \ N/C.$$

$$E_A = \sqrt{E_{Ax}^2 + E_{Ay}^2}$$

$$= \sqrt{(1.1\times10^6)^2 + (4.4\times10^6)^2}$$

$$= 4.5\times10^6 \ N/C .$$

$$\phi = \tan^{-1}\frac{E_{Ay}}{E_{Ax}} = 76^\circ .$$

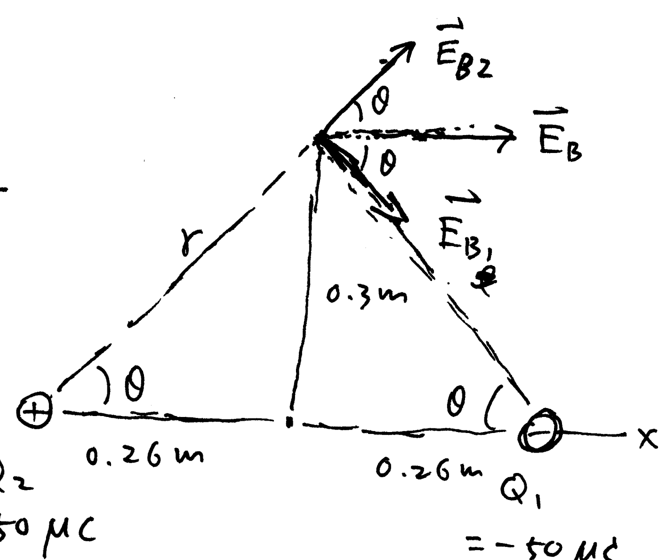


b). Find the field at B.

$$E_{B1} = E_{B2} = \frac{Q_1}{4\pi\varepsilon_0 r^2} = \frac{Q_1}{4\pi\varepsilon_0 r^2}$$

$$= \frac{5\times10^{-6}}{4\pi\times8.85\times10^{-12}\times(0.26^2+0.3^2)}$$

$$= 2.8\times10^6 \ N/C .$$



by symmetry: $E_{By} = 0$. $\vec{E_B} = \hat{x} E_{Bx}$.

$$E_{Bx} = 2 \cdot E_{B2} \cdot \cos\theta .$$

$$= 2 \times 2.8\times10^6 \cdot \frac{0.26}{\sqrt{0.26^2+0.3^2}}$$

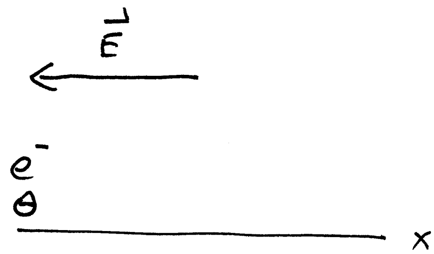
$$= 3.6\times10^6 \ N/C .$$

$$= E_B .$$

$$r = \sqrt{(0.26)^2+(0.3)^2} = 0.4\ m .$$

e.g. 21-15 · (p.578)

(a)



$$\vec{F} = q\vec{E}$$
$$= \hat{x} \cdot |e| \cdot E$$

$$F_x = 1.6 \times 10^{-19} \times 2.0 \times 10^{4}$$
$$= 3.2 \times 10^{-15}\ N$$

$$a_x = \frac{F_x}{m} = \frac{3.2 \times 10^{-15}}{9.11 \times 10^{-31}} = 3.5 \times 10^{15}\ m/s^2$$

$$v^2 = v_0^2 + 2ax \qquad x = 1.5\ cm = 0.015\ m$$

$$v = \sqrt{2ax}$$
$$= \sqrt{2 \times 3.5 \times 10^{15} \times 0.015}$$
$$= 1.0 \times 10^{7}\ m/s$$

OR: $v_0 = 0$. $x_0 = 0$

$$v = at, \quad x = \frac{1}{2} a t^2$$
$$t = \sqrt{\frac{2x}{a}}$$
$$v = a\sqrt{\frac{2x}{a}} = \sqrt{2ax}$$
$$= 1.0 \times 10^{7}\ m/s$$

(b) $mg = 9.1 \times 10^{-31} \times 9.8 = 8.9 \times 10^{-31}\ N \ll |eE|$

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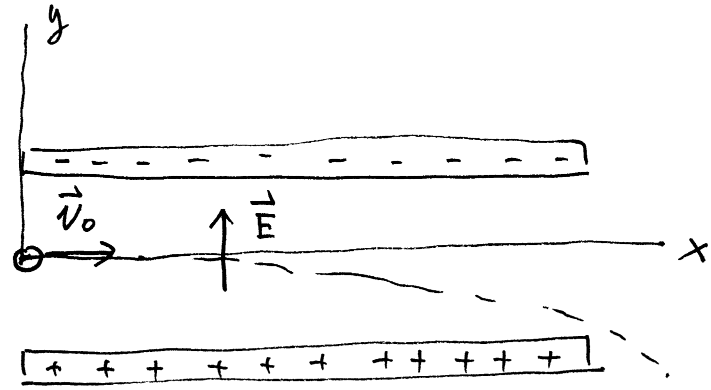
e.g. 21-16.

Find the path of the electron.



$$\vec{F} = q\vec{E} = -e\vec{E}$$
$$= \hat{y}\,-eE$$
$$= -\hat{y}\,eE$$

$a_x = 0$, $\quad a_y = -\dfrac{eE}{m} = a$.

x: $\quad x = v_0 t$. $\quad (x_0 = 0)$

y: $\quad y = \frac{1}{2} a t^2 = -\frac{1}{2} \frac{eE}{m} t^2$.

$t = \dfrac{x}{v_0}$ sub into y:

$$y = -\frac{eE}{2m}\left(\frac{x}{v_0}\right)^2.$$

$$\therefore \quad y = f(x) = -\frac{eE}{2mv_0^2}\,x^2.$$

It's a parabola.