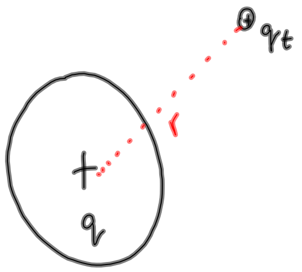
Fields near point sources



Consider placing a + test charge (q_t) near a source charge (q) at a distance r

Recall: $|\vec{E}| = \frac{|\vec{F}_a|}{q_t}$

$$|\vec{E}| = \frac{\frac{kqq_t}{r^2}}{q_t}$$

- The magnitude of the electric field intensity → $|\vec{E}| = \frac{kq}{r^2}$
- do not use the sign on q!
- figure out the direction of the field by using a positive test charge

If q (the source charge) is positive → radially outward
q (the source charge) is negative → radially inward

MP/652

r = 30.0 cm
q = 2.0×10⁻⁶ C (the source of the field)
$\vec{E}$ = ?

$$|\vec{E}| = \frac{kq}{r^2}$$

$$|\vec{E}| = \frac{\left(9.0\times10^9 \frac{N\cdot m^2}{C^2}\right)\left(2.0\times10^{-6}C\right)}{(0.300m)^2}$$

$$|\vec{E}| = 2.0\times10^5 \frac{N}{C}$$

$\vec{E}$ is $2.0\times10^5 \frac{N}{C}$ [radially outward] at 30.0 cm.

What force (magnitude) would a charge of 5.0 μC experience at 30.0 cm from this source charge?

$$|\vec{E}| = \frac{|\vec{F}_a|}{q}$$

$$|\vec{F}_a| = q|\vec{E}|$$

$$|\vec{F}_a| = (5.0\times10^{-6}C)\left(2.0\times10^5 \frac{N}{C}\right) \quad 10\times10^{-1}$$

$$|\vec{F}_a| = 1.0N$$

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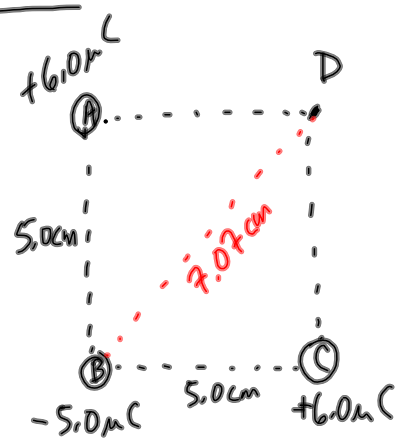
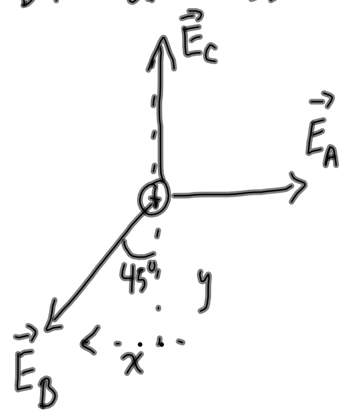


Consider placing a positive test charge at D.... draw FBD.

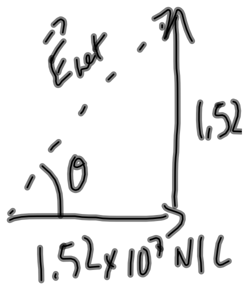


$$|\vec{E}_A| = \frac{kq_A}{r_A^2} = \frac{k(6.0\times10^{-6}C)}{(0.050\,m)^2} = 2.16\times10^7\,\frac{N}{C}$$

$$|\vec{E}_C| = |\vec{E}_A|$$

$$|\vec{E}_B| = \frac{kq_B}{r_B^2} = \frac{k(5.0\times10^{-6}C)}{(0.0707\,m)^2} = 9.0\times10^6\,\frac{N}{C}$$

	x	y
E_A	$+2.16\times10^7$ N/C	0
E_B	$-(9.0\times10^6\,\frac{N}{C})(\sin45°)$ -6.37×10^6 N/C	$-(9.0\times10^6\,\frac{N}{C})(\cos45°)$ -6.37×10^6 N/C
E_C	0	$+2.16\times10^7$ N/C
E_{net}	1.52×10^7 N/C	1.52×10^7 N/C



$\theta = 45°$

$c^2 = (1.52\times10^7)^2 + (1.52\times10^7)^2$

$c = 2.15\times10^7\,\frac{N}{C}$

The net field at D:

$2.15\times10^7\,\frac{N}{C}$ [away from B)

or

Gravitational Field Intensity Near a Point Mass

Consider placing a test mass (m_t) near a point source of mass (m) at a distance r.

$$|\vec{g}| = \frac{|\vec{F_g}|}{m_t}$$

$$|\vec{g}| = \frac{\frac{Gm\cancel{m_t}}{r^2}}{\cancel{m_t}}$$

- magnitude only
- direction is always inwards. (towards the source mass)

$$|\vec{g}| = \frac{Gm}{r^2}$$

$$F_g = \frac{Gm_1m_2}{r^2} \qquad \left(|\vec{g}| \leftarrow \frac{Gm_1}{r^2}\right)$$

$$F_Q = \frac{kq_1q_2}{r^2} \qquad \left(|\vec{E}| \leftarrow \frac{kq_1}{r^2}\right)$$

TODO: PP/655
MP/657 + PP/658