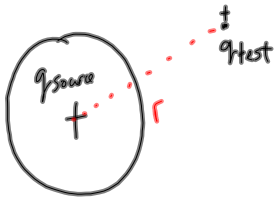
Fields near Point Sources

Recall that the electric field intensity is:

$$\vec{E} = \frac{\vec{F_Q}}{q} \quad \text{and} \quad F_Q = \frac{kq_1q_2}{r^2}$$

Consider the field intensity at a certain location from the point charge.

$$\vec{E} = \frac{\vec{F_Q}}{q}$$



Consider only the magnitude.

$$|\vec{E}| = \frac{|\vec{F_Q}|}{q}$$

$$|\vec{E}| = \frac{\frac{kq_{source}\cancel{q_{test}}}{r^2}}{\cancel{q_{test}}}$$

$$\text{so } |\vec{E}| = \frac{kq_{source}}{r^2}$$

The magnitude of the field intensity at a certain location ONLY depends on the source charge and the distance from the source charge. In order to find the direction of the field, consider the direction of the force acting on a positive test charge at that location

MP|652

$q = +2.0 \times 10^{-6}$ C

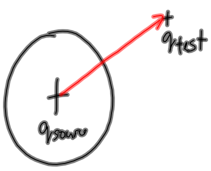
$r = 30.0$ cm

$\vec{E} = ?$

$$|\vec{E}| = \frac{kq}{r^2}$$ do not use the signs on q.

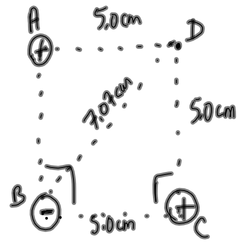
$$|\vec{E}| = \frac{\left(9.0\times10^9 \frac{N\cdot m^2}{C^2}\right)\left(2.0\times10^{-6} C\right)}{(0.300 m)^2}$$

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



$$\vec{E} = 2.0\times10^5 \frac{N}{C} \text{ [away from the source]}$$

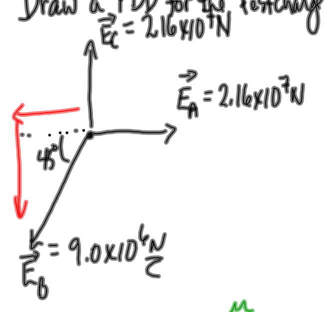
mp|653



$q_A = +6.0\,\mu C$
$q_B = -5.0\,\mu C$
$q_C = +6.0\,\mu C$

Consider placing a positive test charge at D:

Draw a FBD for the testcharge:



$$|\vec{E}_A| = \frac{kq_A}{r_A^2} = \frac{\left(9.0\times10^9 \frac{N m^2}{C^2}\right)(6.0\times10^{-6} C)}{(0.050 m)^2}$$

μ

$$\boxed{|\vec{E}_A| = 2.16\times10^7 \frac{N}{C}}$$ A and C

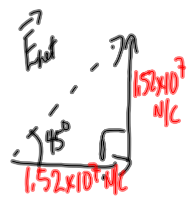
$|\vec{E}_A| = |\vec{E}_C|$ (they have the same charge and D is the same distance away)

$$|\vec{E}_B| = \frac{\left(9.0\times10^9 \frac{N\cdot m^2}{C^2}\right)(5.0\times10^{-6} C)}{(0.0707 m)^2}$$

$$\boxed{|\vec{E}_B| = 9.0\times10^6 \frac{N}{C}}$$

Use the x-y chart to find the net field at D.

	x	y
E_A	$+2.16\times10^7 \frac{N}{C}$	0
E_B	$-9.0\times10^6 N/C(\cos 45°)$ $= 6.37\times10^6 N/C$	$-9.0\times10^6 \frac{N}{C}(\sin 45°)$ $= 6.37\times10^6 N/C$
E_C	0	$+2.16\times10^7 N/C$
E_{net}	$1.52\times10^7 \frac{N}{C}$	$1.52\times10^7 N/C$



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

$\boxed{c = 2.2\times10^7 N/C}$

The net field at D is:

$22\times10^7 \frac{N}{C}$ [45° CCW from +x-axis]

If you were to a charge to put at D, it would experience a force:

$\vec{F}_Q = q\vec{E}$

Gravitational Field Intensity:

$$\vec{g} = \frac{\vec{F_g}}{m} \qquad F_g = \frac{Gm_1m_2}{r^2}$$

Consider the field acting on a test mass (m_{test}) at a distance of r from the source mass (m_{source})

$$|\vec{g}| = \frac{\frac{Gm_{source}\cancel{m_{test}}}{r^2}}{\cancel{m_{test}}}$$

$$\vec{g} \qquad F_g = \frac{Gm_1m_2}{r^2}$$

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

① PP|655

② Look over MP|657 and PP|658