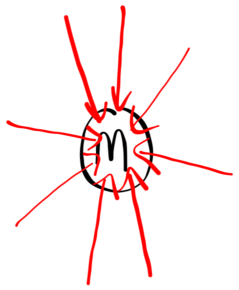
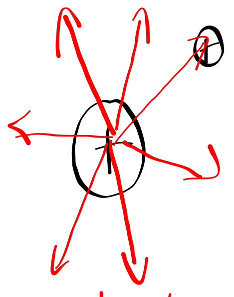
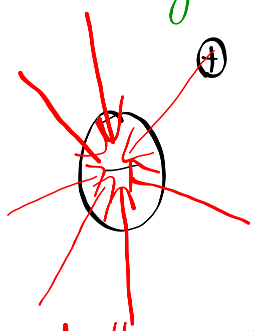
| | Gravitational | Electric |
|---|---|---|
| Force | $F_g = \frac{Gm_1m_2}{r^2}$ (attractive) | $F_Q = \frac{kq_1q_2}{r^2}$ (attractive/repulsive) |
| Field Intensity | $\vec{g} = \frac{\vec{F_g}}{m}$ | $\vec{E} = \frac{\vec{F_Q}}{q}$ (direction is defined by the direction of the force acting on a positive test charge) |



radially inward



radially outward



radially inward

# Fields Near Point Sources

Consider placing a positive test charge $q_t$ near a Source charge $Q$ at a separation distance of $r$:

Coulomb's Law:

$$F_Q = \frac{kQq_t}{r^2}$$

Electric Field Intensity:

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

(consider only the magnitude)

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

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

← only the magnitude

* direction based on the force acting on a + test charge.

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$r = 30.0\,cm$

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

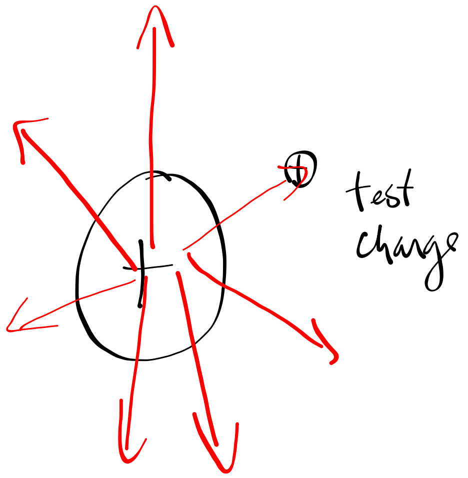
$\vec{E} = ?$

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

$$|\vec{E}| = \frac{\left(9.0 \times 10^{9}\,\frac{N \cdot m^2}{C^2}\right)\left(2.0 \times 10^{-6}\,C\right)}{(0.300\,m)^2}$$

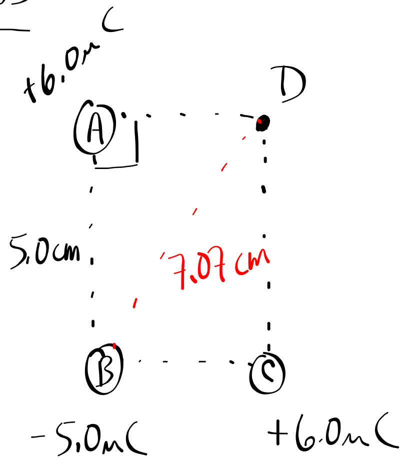
$$|\vec{E}| = 2.0 \times 10^{5}\,N/C$$

only the magnitude

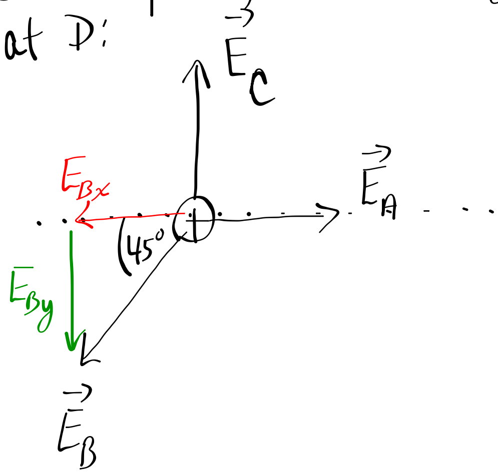



The field intensity is $2.0 \times 10^{5}\,N/C$ radially outward

MP|653




Consider placing a + test charge at D:

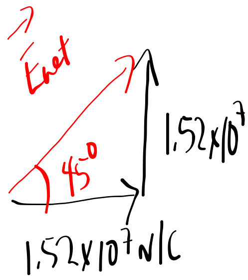



$$|\vec{E}_A| = \frac{kQ_A}{r_A^2} = \frac{k(6.0\times10^{-6}C)}{(0.050m)^2} = 2.16\times10^{7} N/C$$

$$|\vec{E}_C| = 2.16\times10^{7} N/C$$

$$|\vec{E}_B| = \frac{kQ_B}{r_B^2} = \frac{k(5.0\times10^{-6}C)}{(0.0707m)^2} = 9.00\times10^{6} N/C$$

| | x | y |
|---|---|---|
| $\vec{E}_A$ | $+2.16\times10^{7} N/C$ | 0 |
| $\vec{E}_B$ | $-(9.00\times10^{6} N/C)\cos 45°$ $(-6.37\times10^{6} N/C)$ | $-(9.00\times10^{6} N/C)\sin 45°$ |
| $\vec{E}_C$ | 0 | $+2.16\times10^{7} N$ |
| $\vec{E}_{net}$ at D | $1.52\times10^{7} N/C$ | $1.52\times10^{7} N/C$ |




$$\vec{E}_{net} \text{ at } D = 2.15\times10^{7} N/C$$

[45° CCW from + x-axis]

# Gravitational Field Intensity due to a Point Source

Consider a test mass $m$ placed near a source mass $M$ at a separation distance of $r$:

Newton's Law of universal Gravitation:

$$F_g = \frac{GMm}{r^2}$$

Grav Field Intensity:

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

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

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

$\vec{E}$

$$F_Q = \frac{kQq}{r^2}$$

$g$

$$F_g = \frac{GMm}{r^2}$$

TO DO

① PP|655 (electic)

② PP|658 (gravitational)