

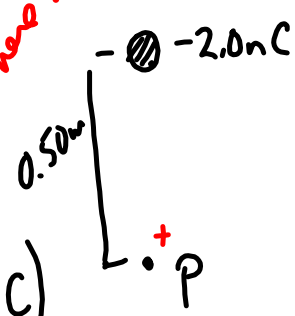
	<u>Gravitational</u>	<u>Electric</u>
Force	$F = G \frac{m_1 m_2}{r^2}$	$F = k \frac{q_1 q_2}{r^2}$
constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$	$k = 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$
Field Strength	$\vec{g} = \frac{\vec{F}}{m}$	$\vec{E} = \frac{\vec{F}}{q}$
Field Strength (due to a point source)	$g = \frac{GM}{r^2}$	$E = \frac{kQ}{r^2}$
types of forces	attractive	attractive / repulsive.

Example

Determine the electric field strength at a point P
 which is 0.50 m immediately below a point charge of -2.0 nC .

the magnitude only → $E = \frac{kQ}{r^2}$

don't put any sign here.



$E = \frac{(8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2})(2.0 \times 10^{-9} \text{ C})}{(0.50 \text{ m})^2}$

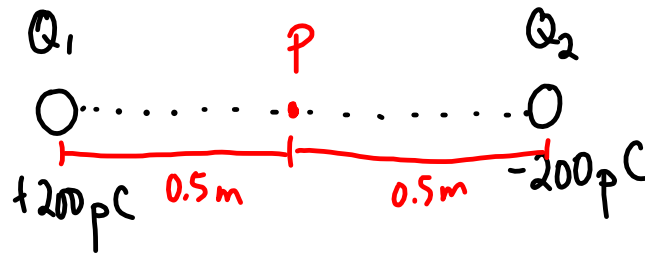
$$E = 72 \text{ N C}^{-1}$$

$$\vec{E} = 72 \text{ N C}^{-1} \text{ [vertically up]}$$

↑
 use a positive test charge at P to figure out direction

Example

Determine the electric field strength at a point mid-way between two point charges $+200\text{pC}$ and -200pC which are 1.0m apart.



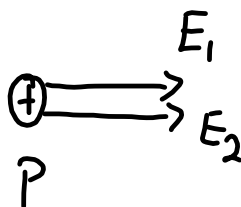
Determine the field strength at P due to Q_1 and then Q_2 :

$$E_1 = \frac{kQ_1}{r^2} = \frac{(8.99 \times 10^9 \text{ Nm}^2 \text{ C}^{-2})(200 \times 10^{-12} \text{ C})}{(0.5\text{m})^2}$$

$$E_1 = 7.192 \text{ NC}^{-1}$$

$$\therefore E_2 = 7.192 \text{ NC}^{-1} \quad (\text{same charge/same distance})$$

Draw a FBD for a $+$ test charge at P :

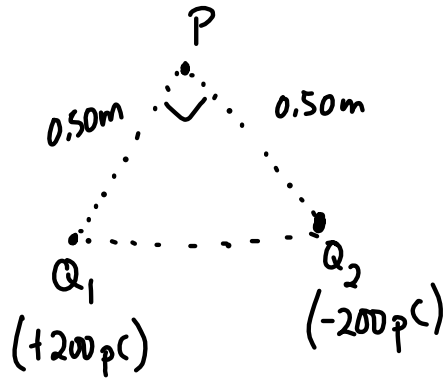


$$\therefore \vec{E}_{\text{net}} \text{ at } P = 2(7.192 \text{ NC}^{-1}) \text{ [right]}$$

$$\vec{E}_{\text{net}} = 14 \text{ NC}^{-1} \text{ [right]}$$

Example

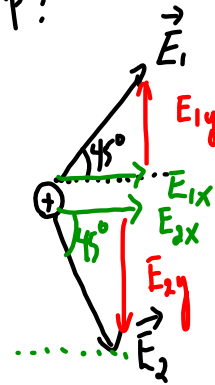
Determine the electric field strength at the point P due to the charges $Q_1 = +200 \mu\text{C}$ and $Q_2 = -200 \mu\text{C}$ as shown in the diagram. The triangle $Q_1 P Q_2$ is right angled at P.



The magnitudes of the field strengths due to Q_1 and Q_2 were previously found to be:

$$7.192 \text{ N C}^{-1}$$

Draw a FBD for a positive test charge at P:



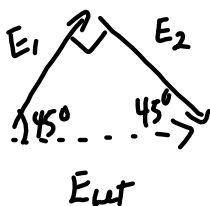
Due to symmetry $E_{1y} = E_{2y}$
so the net field is due to E_{1x} and E_{2x}

$$E_{1x} = E_1 \cos 45^\circ = (7.192 \text{ N C}^{-1}) (\cos 45^\circ)$$

(OR) vector addition

$$E_{1x} = 5.1 \text{ N C}^{-1}$$

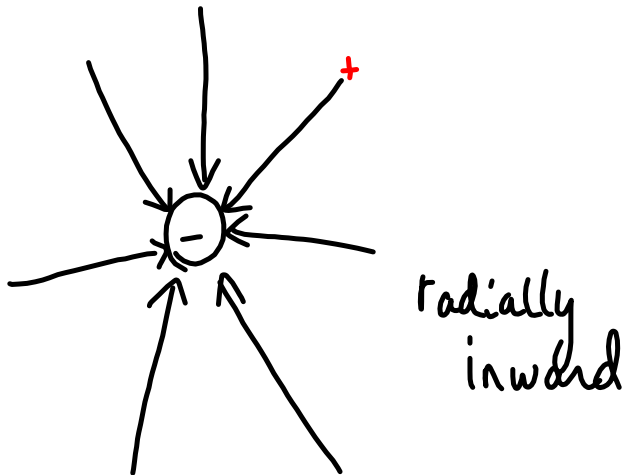
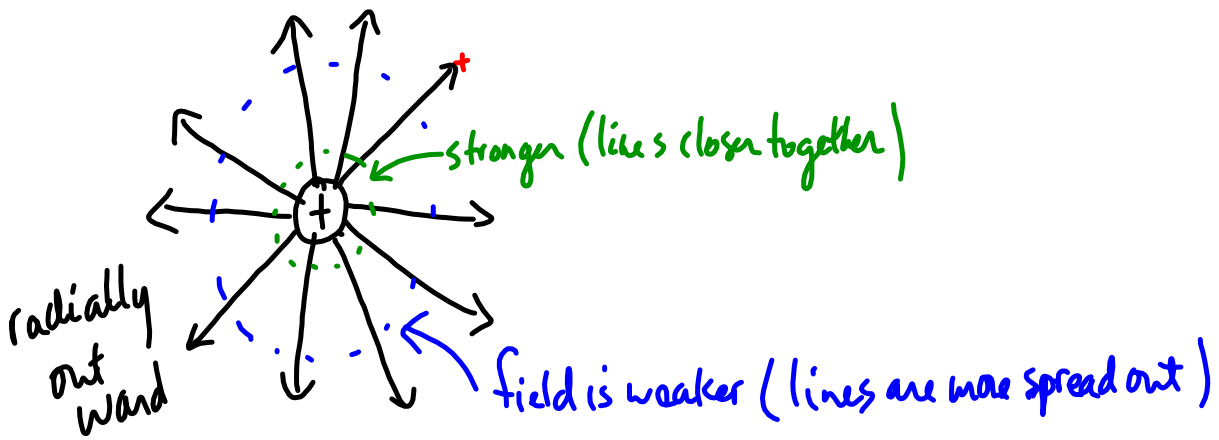
$$E_{2x} = 5.1 \text{ N C}^{-1} \text{ (due to symmetry)}$$

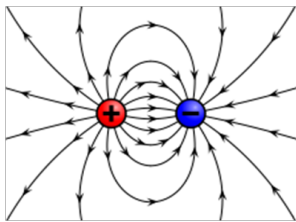
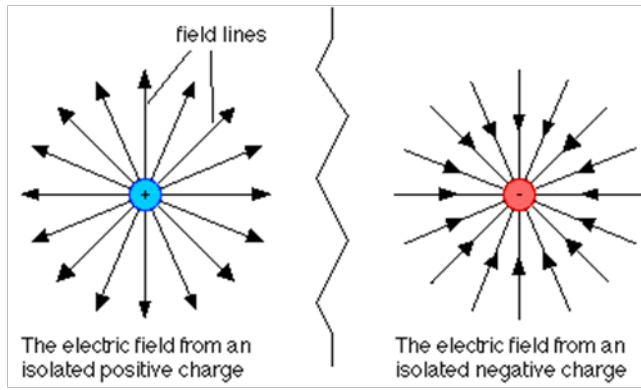


$$E_{\text{net}} = 10.2 \text{ N C}^{-1} \text{ [right]}$$

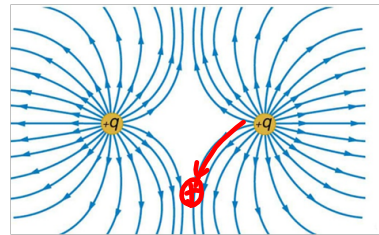
$$c^2 = (7.192)^2 + (7.192)^2$$

Electric Field Line Patterns

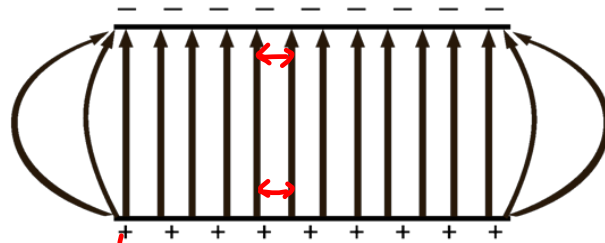




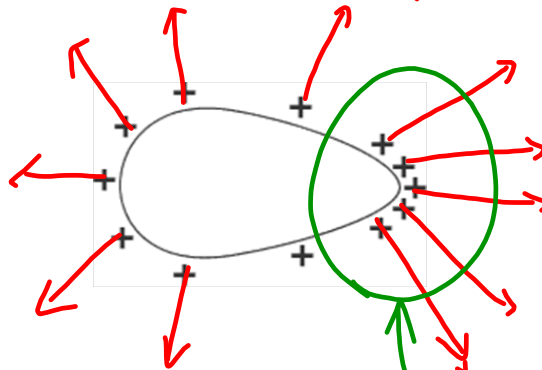
(field lines go from + → -)



(same pattern for 2 neg. charges, but opp direction)



uniform field (due to equal spacing)



stronger field at the "pointy" end

