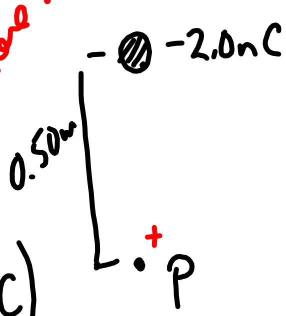
	Gravitational	Electric
Force	$F = \frac{Gm_1m_2}{r^2}$	$F = \frac{kq_1q_2}{r^2}$
constant	$G = 6.67 \times 10^{-11}\ N\,m^2\,kg^{-2}$	$k = 8.99 \times 10^{9}\ N m^2 C^{-2}$
Field Strength	$\vec{g} = \frac{\vec{F}}{m}$	$\vec{E} = \frac{\vec{F}}{q}$
Field Strength (due to a point source)	$g = \frac{GM}{r^2}$	$E = \frac{kQ}{r^2}$
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 q -2.0nC.



the magnitude only →

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

don't put any sign here.

$$E = \frac{(8.99\times10^{9}\,Nm^{2}C^{-2})(2.0\times10^{-9}\,C)}{(0.50\,m)^2}$$

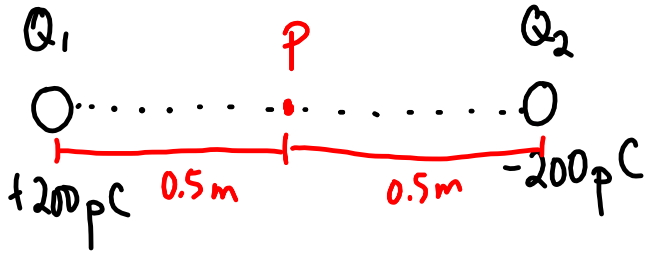
$$E = 72\,NC^{-1}$$

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

↑ 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 +200pC and −200pC which are 1.0m apart.



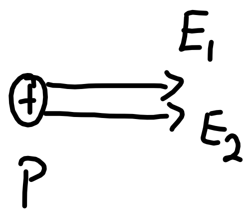
Determine the field strength at P due to Q_1 and then Q_2:

$$E_1 = \frac{kQ_1}{r^2} = \frac{(8.99\times10^9\,Nm^2C^{-2})(200\times10^{-12}C)}{(0.5m)^2}$$

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

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

Draw a FBD for a + test charge at P:

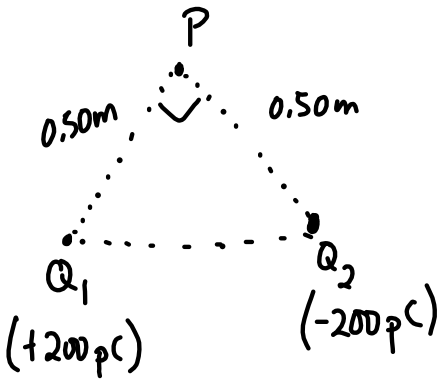


$$\therefore \vec{E}_{net} \text{ at } P = 2(7.192\,NC^{-1}) \text{ [right]}$$

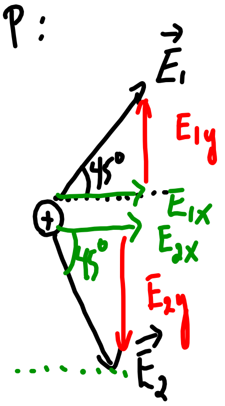
$$\vec{E}_{net} = 14\,NC^{-1} \text{ [right]}$$

Example

Determine the electric field strength at the point P due to the charges Q = +200pC and Q_2 = -200pC as shown in the diagram. The triangle Q_1PQ_2 is right angle at P.



Draw a FBD for a positive test charge at P:



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

$7.192\,NC^{-1}$

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

$$E_{1x} = E_1 \cos 45^\circ = (7.192\,NC^{-1})(\cos 45^\circ$$

$$E_{1x} = 5.1\,NC^{-1}$$

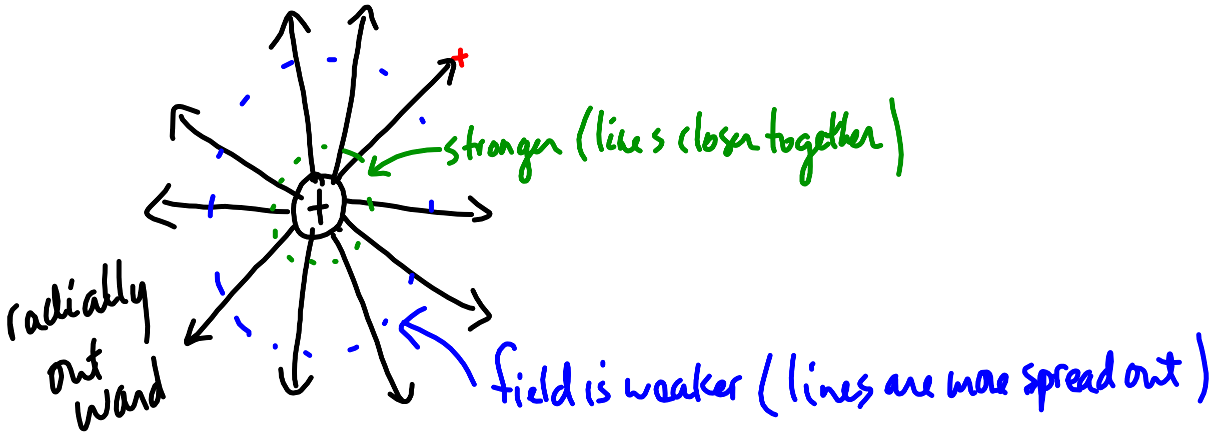
$$E_{2x} = 5.1\,NC^{-1} \text{ (due to symmetry)}$$

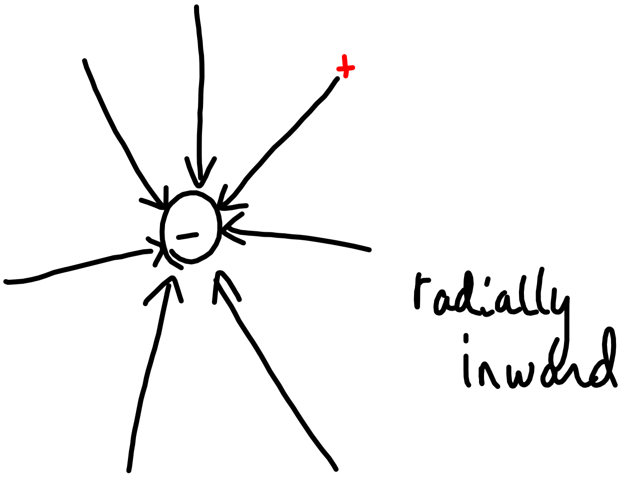
$$E_{net} = 10.2\,NC^{-1} \text{ [right]}$$

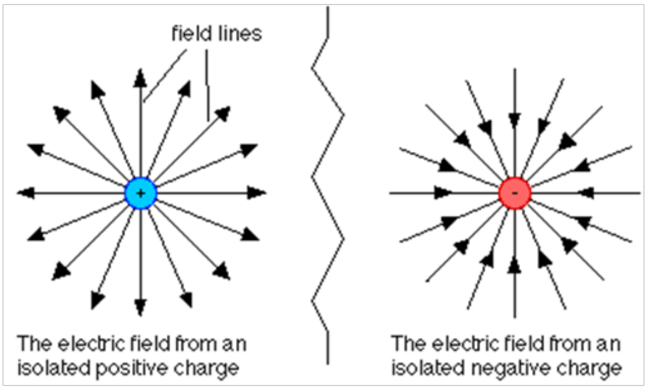
OR vector addition

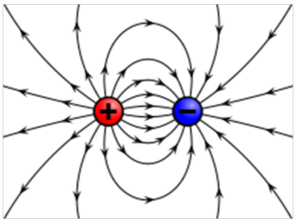
$$c^2 = (7.192)^2 + (7.192)^2$$

Electric Field Line Patterns

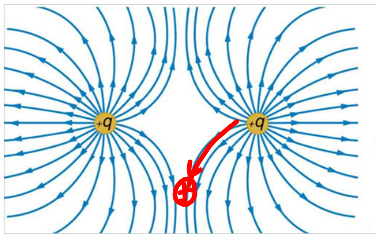




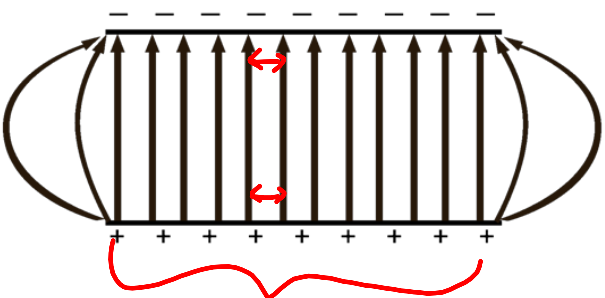




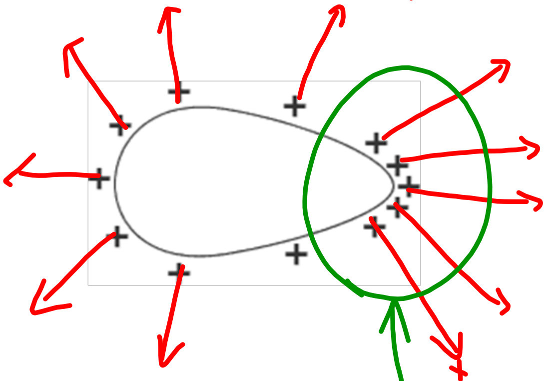
(field lines go from + -> -)



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



uniform field (due to equal spacing)



stronger field at the "pointy" end