Example

Calculate the force of attraction between an electron and a proton in a hydrogen atom.

Solution

A hydrogen atom is just a proton and an electron. The separation distance between them is simply the radius of the hydrogen atom.

$r = 5.29 \times 10^{-11}\ m$

$Q = e = 1.60 \times 10^{-19}\ C$

$q = e^- = -1.60 \times 10^{-19}\ C$

$k = 9.0 \times 10^9\ N m^2 C^{-2}$

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

$$F = \frac{(9 \times 10^9)(1.6 \times 10^{-19})(-1.6 \times 10^{-19})}{(5.29 \times 10^{-11})^2}$$

$$F = -8.23 \times 10^{-8}\ N$$

the negative means the force is repulsive.

Example

How many electrons make up a charge of -30.0 µC?

Solution

$q = -30.0\ \mu C = -30 \times 10^{-6}\ C$

$e^- = -1.60 \times 10^{-19}\ C$

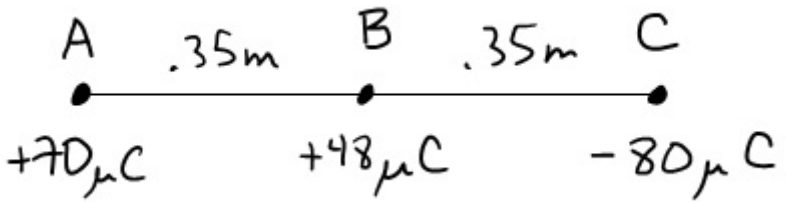
$N = \frac{q}{e}$

$N = \frac{-30 \times 10^{-6}}{-1.6 \times 10^{-19}}$

$N = 1.88 \times 10^{14}$ electrons

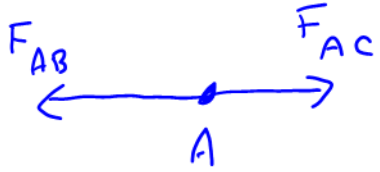
Example

Particles of charge +70, +48, and -80 μC are placed in a line as shown in the figure. The center one is 0.35m from each of the others. Calculate the net force on the leftmost charge due to the other two.



Solution

The net force on A is the sum of the forces F_{AB} and F_{BC}



$q_A = +70\mu C$ $\quad r_{AB} = 0.35m$

$q_B = +48\mu C$ $\quad r_{AC} = 0.70m$

$q_C = -80\mu C$ $\quad k = 9 \times 10^9 \frac{Nm^2}{C^2}$

$$F_{AB} = \frac{k q_A q_B}{(r_{AB})^2} \qquad F_{AC} = \frac{k q_A q_C}{(r_{AC})^2}$$

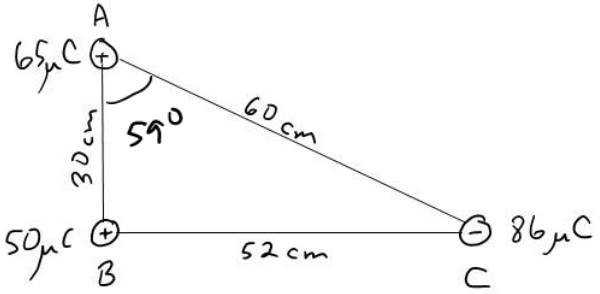
$F_{AB} = 246.9\,N$ to the left

$F_{AC} = 102.9\,N$ to the right

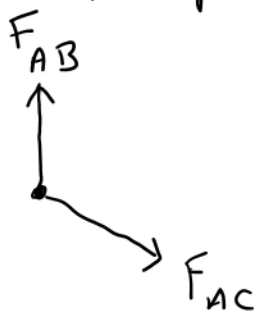
$\Sigma F = F_{AB} - F_{AC} = 144\,N$ to the left

Example

Three charged particles are arranged in a triangle as shown in the figure below. Find the net electric force on particle A.

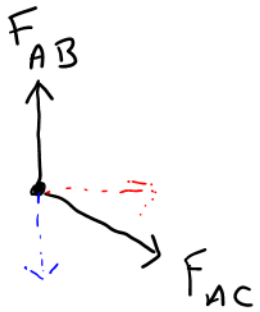


free body diagram

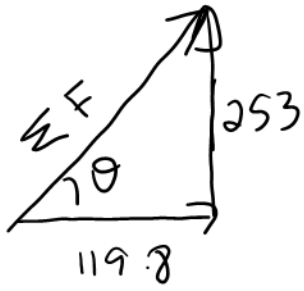


$$F_{AB} = \frac{k q_A q_B}{(r_{AB})^2} = 325\,N$$

$$F_{AC} = \frac{k q_A q_C}{(r_{AC})^2} = 139.75\,N$$



force	θ	x	y
F_{AB}	90°	0	325
F_{AC}	329°	119.8	-72.0
ΣF	65°	119.8	253.0



$\Sigma F = 280\,N \text{ @ } 65^\circ$