Q1- A proton is released from rest where an electric field of 640 N/C exists. (a) what is the acceleration of proton? (b) how long does it take to reach a speed of 1.2*106 m/s (c) How much distance does it travel durion this time.

(a) The force experiendec be a charge q in the field E is given in magnitude by

F = q*E

Hence the force experienced by the Proton of charge q = +e = $1.6*10^{-19}$ C will be

F = q*E = $1.6*10^{-19}*640 = 1.024*10^{-16}$ N.

If m is the mass of the proton its acceleration is given by the second law of motion as

$$a = F/m = \frac{1.024*10^{-16}\,N}{1.67*10^{-27}\,kg} = 6.13*10^{10}\ \text{m/s}^2.$$

(b) The time taken t to reach the velocity v = $1.2*10^6$ m/s is given by first equation of motion

v = u + a*t

where u is the initial velocity (=0) and a is the acceleration. Hence

$1.2*10^6 = 0 + 6.13*10^{10}*t$

Gives $$t = \frac{1.2*10^6}{6.13*10^{10}} = 1.96*10^{-5}\,s = 19.6\mu s$$

(c) The distance travelled is given by the second equation of motion as

s = u*t + ½ a*$t^2$

or $$s = 0*1.96*10^{-5} + 0.5*6.13*10^{10}*\left(1.96*10^{-5}\right)^2 = 11.77\ \text{m}$$

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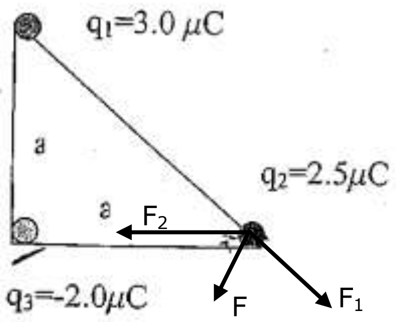
4. Consider the following arrangement of charges. Find the total force on the charge $q_2$, where a = 1.0m.

The two sides of the traingle are equal, each a and it is aright angled one hence the third side will be √2*a according to Pythagauras theorem and the qwo equal angles will be $45^0$ each.




The force of attraction of repulsion between two point charges $q_1$ and $q_2$ placed at distance 'r' is given by Coulomb's law and its magnitude is given by

$$F = \frac{1}{4\pi \in_0}\frac{q_1 * q_2}{r^2}$$

Hence the magnitude of the force between charges $q_1$ and $q_2$ will be

$$F_1 = \frac{1}{4\pi \in_0}\frac{q_1 * q_2}{r^2} = 9*10^9 * \frac{\left(3.0*10^{-6}\right)*\left(2.5*10^{-6}\right)}{\left(\sqrt{2}*1.0\right)^2} = 3.375*10^{-2}\,N$$

As the two charges are positive both, the force is repulsive as shown in the figure.

Similarly force on charge $q_2$ due to charge $q_3$ will be

$$F_2 = \frac{1}{4\pi \in_0} \frac{q_3 * q_2}{r^2} = 9*10^9 * \frac{\left(-2.0*10^{-6}\right)*\left(2.5*10^{-6}\right)}{\left(1.0\right)^2} = -4.5*10^{-2} N$$

Negative sign shows that it is attractive force.

Hence total force on charge $q_2$ will be the resultant of $F_1$ and $F_2$ and its magnitude is given by

$$F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2 \cos 135^O}$$

Or $$F = \sqrt{\left(3.375*10^{-2}\right)^2 + \left(4.5*10^{-2}\right)^2 + 2*\left(3.375*10^{-2}\right)*\left(4.5*10^{-2}\right)\left(-1/\sqrt{2}\right)}$$

Or $$F = \sqrt{11.4*10^{-4} + 20.25*10^{-4} - 21.48*10^{-4}} = 3.19*10^{-2} \text{ N}$$

And the direction it makes with $F_2$ is given by

$$\tan\theta = \frac{F_1 \sin 135}{F_2 + F_1 \cos 135} = 1.129$$

Or $\theta = 48.5^0$.