Answer on Question #79246- Physics- Electric Circuits

Question: *a positive charge q is located at p a distance A from a very long line of positive charge find the force on the charge*

Answer:

The force acting on the positive charge q can be obtained by means of the following expression:

$$\vec{F} = q\vec{E}, \tag{1}$$

where $\vec{E}$ is the electric field created by the long line at the point where the charge q is located. It can be shown (see [1] for details) that direction of this field is perpendicular to the line (going outwards because the line is positively charged) and its magnitude can be calculated as follows:

$$E = \frac{\lambda}{2\pi r\varepsilon_0}, \tag{2}$$

where λ is linear charge density of the line (= charge per unit length), r is the length of a perpendicular from the point of observation to the line (= radius of a cylinder if one uses the Gauss' law in order to obtain expression(2)).

Hence, the long positively charged line is repulsing the positive charge along the perpendicular direction (in respect of the line) with the Coulomb force which magnitude is equal to:

$$F = \frac{\lambda q}{2\pi\varepsilon_0 A}. \tag{3}$$

One should stress that this force depends on the linear charge density of the line (here it is assumed to be uniform), and in order to make numerical estimation of (3) one needs this quantity as well.

[1] (Electronic resource) http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elecyl.html