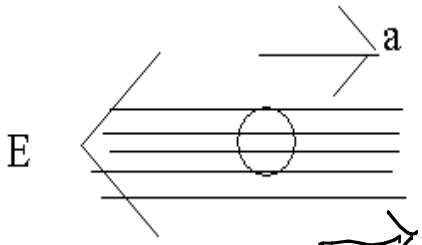
Homework 4

Note Title 9/7/2008

1. An electron moving through an electric field is observed to have an acceleration of $1.0*10^{16}$ m/s^2 in the x direction. What must be the magnitude and direction of the electric field that produces this acceleration?

$$\vec{F} = M\vec{a} = Q\vec{E}$$

From this equation we can deduce that a positive charge will be accelerated in the direction of the electric field, and a negative charge will accelerate in the direction anti-parallel to the field. So we already know that the charge will have positive acceleration in the direction opposite of the field, or negative acceleration in the direction of the field.



$\rightarrow$ +X dir.

$$\vec{E} = \frac{M\vec{a}}{Q} = \frac{M_e(1\cdot10^{16}\ m/s^2)}{-|Q_e|}\frac{\vec{a}}{|\vec{a}|}$$

$$\vec{E} = -56.8\ kN/C\ \hat{a}$$

$M_e = 9.109\cdot10^{-31}$ kg

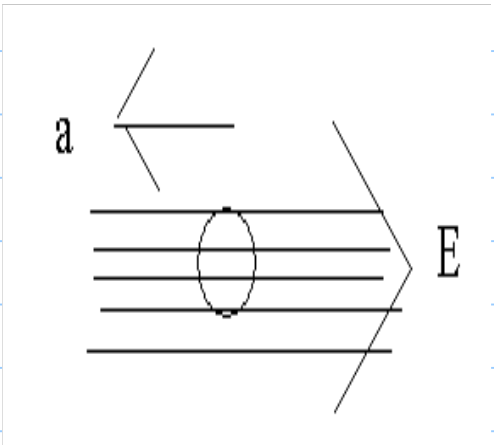
$|Q_e| = 1.602\cdot10^{-19}$ C

Remember, the negative sign means that the electric field is in the opposite direction to the acceleration. Notice the vector a over magnitude a. That is a "unit vector" pointing in the same direction as a. Please let me know if you need further clarification on this point.

$E = 56.8$ kN/C in the -X direction

2. An electron experiences an electric field of 10^{14} N/C. Neglecting other influences, what is the magnitude of the acceleration of the electron?

This problem is just the opposite of the last problem. In that one we had the acceleration and wanted the field, and now we are given the field and want the acceleration. So we use the same equation but solve for a instead of E.



$$m\vec{a} = Q\vec{E}$$

$$\vec{a} = \frac{Q}{m}\vec{E}$$

$$\vec{a} = \frac{-|Q_e|}{m_e}\, 10^{14}\frac{N}{C}\,\hat{E}$$

$$= -1.759\cdot 10^{25}\ m/s^2\,\hat{E}$$

$$= 1.759\cdot 10^{25}\ m/s^2\,(-\hat{E})$$

$$\boxed{|\vec{a}| = 2\cdot 10^{25}\ m/s^2}$$

The problem does not tell us which direction the E field was in, and it does not ask us for the direction of the acceleration. But the above notation would be just fine for this purpose.