Magnetic Field

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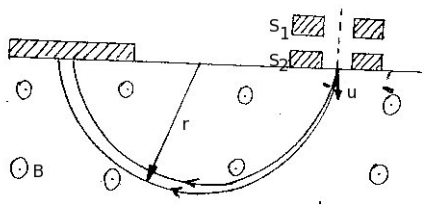
The problem:

Two ions of zinc isotopes ^{70}Zn and ^{68}Zn are accelerated with voltage V from point $(0,0,0)$ in the x direction. The field B is in the z direction and the ions have the same charge q. Find the distance between points of impact of the isotopes on the y-axis.



The solution:

From the energy conservation we get that the potential energy the electron gets, equal to it's kinetic energy

$$\frac{mu^2}{2} = qV \tag{1}$$

$$u = \sqrt{\frac{2qV}{m}} \tag{2}$$

where u is the speed of the ion.
The motion of the particle in magnetic field is circular with radius R.

$$R = \frac{mu}{qB} = \left(\frac{2mV}{qB^2}\right)^{\frac{1}{2}} \tag{3}$$

See the problem "e_45_2_175" for the derivation.
The distance between the points of impact is

$$\delta = D_2 - D_1 = 2\left[R(m+\Delta m) - R(m)\right] \tag{4}$$

where D is a diameter and m is the mass of the lighter ion ($\Delta m \ll m$).
By the definition of a derivative we get

$$\delta = 2\frac{\partial R}{\partial m}\Delta m = \frac{R}{m}\Delta m \tag{5}$$

since

$$\frac{\Delta m}{m} = \frac{2}{68} \approx 0.03 \tag{6}$$

the distance will be

$$\delta \approx 0.03R \tag{7}$$

or

$$\frac{\delta}{R} \approx 0.03 \tag{8}$$