Q- A charged particle with initial velocity $v_0 = 3 \times 10^6$ m/s in the positive x-direction enters a region of depth $d_1 = 1.1$ m that has a uniform magnetic field $B = 0.011$ T in the positive z-direction (out of the page). The magnetic field is zero elsewhere. The particle leaves the magnetic field region with a velocity vector at an angle $\theta = 12°$ with respect to the x-axis.

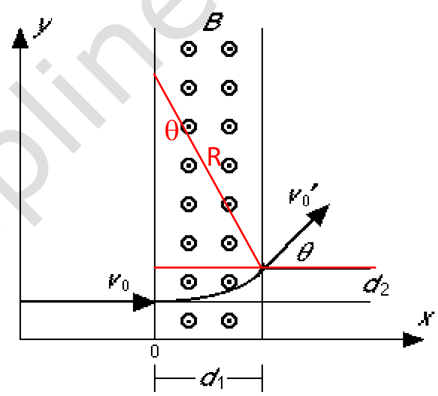
(a) What is the magnitude v_0' of the particle's velocity when it exits the magnetic field region?

As the magnetic force on a moving charge particle is always perpendicular to the direction of motion, the kinetic energy and hence the magnitude of velocity does not change and hence

$$v_0' = v_0 = 3*10^6 \text{ m/s}$$

(b) What is the radius of curvature R of the particle's trajectory when in the region of the magnetic field?

From the geometry of the diagram the radius of curvature of the path R is given by



$$R \sin\theta = d_1$$

Or $$R = d_1/\sin\theta = 1.1/\sin 12^0 = 5.29 \text{ m}$$

$$R = 5.29 \text{ m}$$

(c) Calculate the ratio q/m of the charge to the mass of the particle. Be sure to include the correct algebraic sign in your answer.

The force on a moving charge particle in a magnetic field which behaves as centripetal force is given by

$$B\,q\,v = mv^2/R$$

Gives $$q/m = v/BR = 3*10^6/(0.011*5.29) = 5.16*10^7 \text{ C/Kg}$$

As using Fleming's left hand rule, the direction of the force on a positive charge in above situation should be to the negative y direction but the force here is in positive y direction, hence the charge on the particle must be **negative** and thus

$$q/m = -\,5.16*10^7 \text{ C/kg}$$

(d) Calculate the displacement d_2 in the y-direction of the particle from its original trajectory at the point where the particle exits the magnetic field region.

The displacement d_2 in y direction is given by

$$d_2 = R - R\cos\theta = R(1 - \cos\theta) = 5.29(1 - \cos 12^0) = 0.116 \text{ m}$$

$$d_2 = 0.116 \text{ m}$$