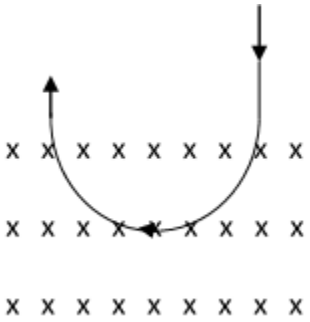
Q- In an experiment with cosmic rays, a vertical beam of particle that have charge of magnitude 3e and mass 12 times the proton mass enters a uniform horizontal magnetic field at 0.250 T and is bent in a semicircle of diameter 95.0 cm as shown in the diagram.

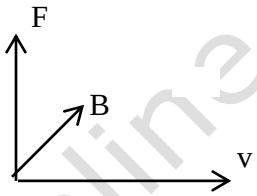


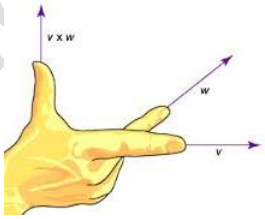
a) Find the speed of the particles and the sign of their charge.

b) Is it reasonable to ignore the gravity force on the particles?

c) How does the speed of the particles as they enter the field compare to their speed as they exit the field.

As the force acting on a moving charged particle is given by $\vec{F} = q(\vec{v} \times \vec{B})$ the direction of force is given by the direction of cross product of v, the velocity of the particle and B, the magnetic field. If the direction of the velocity of the particle is perpendicular to that of magnetic field, this can be done in an easy way using right hand rule of the vector product.





Initially the direction of velocity is downwards and if the magnetic field is into the page, the direction of the force will be to the right. As the particle is bending to the left, the charge of the particle must be negative.

The magnitude of force acting on a moving charged particle is given by q*v*B (B and v are perpendicular) and providing the necessary centripetal force hence,

$B*v*q = m*v^2/R$

Here R is the radius of the path.

a) The speed of the particles is given using above equation as

$v = BqR/m = B*3e*(d/2)/(12m_p)$

$= 0.250*3*1.6*10^{-19}*(0.95/2)/(12*1.67*10^{-27})$

$=2.844*10^6$ m.

b) the force magnetic $Bqv = 0.250*3*1.6*10^{-19}*2.844*10^6 = 3.41*10^{-13}$ N

the gravitational force $mg = 12*1.67*10^{-27}*9.8 = 2.045*10^{-27}$ N

Clearly the gravitational force is negligible as compared to the magnetic force.

c) As the force is always perpendicular to the direction of motion, no change in the speed of the particles.