Magnetic Fields & Force

1. A point charge, $q = 5x10^{-6}$ C and $m=1x10^{-3}$kg, travels with a velocity of: $\vec{v} = 30\frac{m}{s}\ \hat{i}$ then enters a magnetic field: $\vec{B} = 1x10^{-6}T\ \hat{j}$.

a. What is the kinetic energy of the point charge?

Ans. $K = \frac{1}{2}mv^2 = 0.45$ J

b. What is the magnitude of the magnetic force that acts on the charge once it has entered the field?

Ans. $\left|\vec{F}_B\right| = qvB = 1.5x10^{-10}$ N

c. What is the magnetic force <u>vector</u> exerted on the charge just as it enters the field?

Ans. $\vec{F}_B = q\vec{v}\times\vec{B} = 1.5x10^{-10}N\ \hat{k}$

d. Why does the magnetic force exerted on the point charge not change its kinetic energy?

Ans. The magnetic force is always to the direction of travel.

2. Initially at rest, a charged particle, $q=+1.6x10^{-19}$ C and $m=1.67x10^{-27}$ kg, is accelerated through a region of constant electric field ($\vec{E} = E_y\hat{j}$), across a potential difference of V = 100V. The charged particle then enters a magnetic field: $\vec{B} = 10^{-3}$ T $\hat{i}$.

a. What is the kinetic energy of the particle just as it enters the magnetic field? *Apply the Conservation of Energy to the particle.*

Ans. $K = \Delta K = \Delta U = q\Delta V = 1.6x10^{-17}$ J

b. Determine the magnetic force vector exerted on the charge, in component form, as it enters the field?

Ans. $v = \sqrt{\frac{2K}{m}} = 1.38x10^5\frac{m}{s} \Rightarrow \vec{F}_B = q\vec{v}\times\vec{B} = -2.21x10^{-17}N\ \hat{k}$

c. In which direction is the particle deflected once it enters the field? Calculate the radius of the particles path.

Ans. Clockwise