

Q (a)- A beta particle (high-speed electron) is traveling at right angles to a 0.5 T magnetic field. It has a speed of $2.5 * 10^7$ m/s. What size force acts on the particle? (b) A magnetic field of 25 T acts in a direction due west. An electron is traveling due south at $7.0 * 10^5$ m/s. What are the magnitude and direction of the force acting on the electron?

(a) The force on a moving charge in a magnetic field is given by Lorentz formula as

$$\vec{F} = -q(\vec{v} \times \vec{B})$$

As the magnetic field and the velocity are right angles to each other, the magnitude of the force will be given by

$$F = qvB = 1.6 * 10^{-19} * 2.5 * 10^7 * 0.5 = 2.0 * 10^{-12} \text{ N}$$

And the direction of the force can be given by right hand rule of the vector product (consider negative sign of the charge afterward), which is perpendicular to both the direction of the magnetic field and the velocity.

(b) The magnitude of the force is given as above by

$$F = qvB = 1.6 * 10^{-19} * 7.0 * 10^5 * 25 = 2.8 * 10^{-12} \text{ N}$$

The direction of the force is given by the right-hand rule of the cross product according to which if the forefinger, middle and the thumb of right hand are kept perpendicular to each other such that the forefinger points in the direction of the first vector and the middle finger towards the second vector then the thumb shows the direction of the cross product. Now as the force is

$$\vec{F} = q(\vec{v} \times \vec{B})$$

Keeping the forefinger to the south and the middle finger to the west, the thumb will point into the page means vertically downwards and hence $(\vec{v} \times \vec{B})$ will be vertically downwards. But due to the negative sign of electronic charge, the direction of F will be opposite to that of $(\vec{v} \times \vec{B})$, hence the direction of the force on electron will be vertically upwards.

