Chapter 34 Magnetic Field

1. Suppose a charged particle moves with a velocity *v* near a wire carrying an electric current. A magnetic force, therefore, acts on it. If the same particle is seen from a frame moving with velocity *v* in the same direction, the charge will be found at rest. Will the magnetic force become zero in this frame? Will the magnetic field become zero in this frame?

[Sol.
   a) Current doesn't depend on reference frame as if electron comes to rest, protons moves in oppositive direction ; therefore the magnetic field will not become zero.
   b) Since, the charged particle appears to be at rest; therefore the force due to magnetic field becomes zero.]

2. Can a charged particle be accelerated by a magnetic field? Can its speed be increased?

[Sol. Yes (in circular path), No since magnetic field does no work.]

3. Will a current loop placed in a magnetic field always experience a zero force?

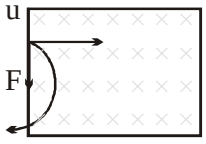
[Sol. If the magnetic field is uniform in space. If it is non-uniform net force will not be always zero.]

4. The free electrons in a conducting wire are in constant thermal motion. If such a wire, carrying no current, is placed in a magnetic field, is there a magnetic force on each free electron? On the wire?

[Sol. Yes, each electron experiences a force. But since the motion is random, the net force on collective electrons is zero.]

5. Assume that the magnetic field is uniform in a cubical region and is zero outside. Can you project a charged particle from outside into the field so that the particle describes a complete circle in the field?

[Sol. No



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6. An electron beam projected along the positive X-axis deflects along the positive Y-axis. If this deflection is caused by a magnetic field, what is the direction of the field? Can we conclude that the field is parallel to the Z-axis?

[Sol. There must exist a component of magnetic field in +Z direction. There can be magnetic field in +X direction also because of which there will be no initial deflection.]

7. Is it possible for a current loop to stay without rotating in a uniform magnetic field? If yes, what should be the orientation of the loop?

[Sol. Angle must be $\theta = 0^o$ or 180^o between magnetic field and magnetic moment.]

8. The net charge in a current-carrying wire is zero. Then, why does a magnetic field exert a force on it?

[Sol. The positive charge at nucleus do not actually move while the negative charges in the conductor moves. So, force is on moving electron and not on proton as they are at rest.]

9. The torque on a current loop is zero if the angle between the positive normal and the magnetic field is either $\theta = 0^o$ or $\theta = 180°$. In which of the two orientations, the equilibrium is stable?

[Sol. As we know the potential energy.

$U = -\vec{m} \cdot \vec{B}$

In the case of stable equilibrium potential energy is minimum.

So, far $\theta = 0°$. Potential Energy is –ve and minimum.]

10. Verify that the units weber and volt-second are the same.

[Sol. $v = \frac{d\phi}{dt} \Rightarrow d\phi = dt$

Charge in flux has unit weber and potential difference as volt.]