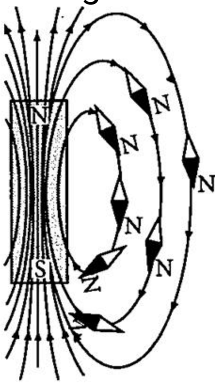
CLASS X CASE STUDY BASED QUESTIONS

Case Study Questions

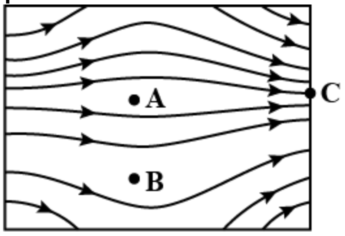
Magnetic Effects of Electric Current - 01

A magnetic field is described by drawing the magnetic field lines. When a small north magnetic pole is placed in the magnetic field created by a magnet, it will experience a force. And if the north pole is free, it will move under the influence of the magnetic field. The path traced by a north magnetic pole free to move under the influence of a magnetic field is called a magnetic field line.



Since the direction of the magnetic field line is the direction of the force on a north pole, so the magnetic field lines always begin from the N-pole of a magnet and end on the S-pole of the magnet. Inside the magnet, however, the direction of magnetic field lines is from the S-pole of the magnet to the N-pole of the magnet. Thus, the magnetic field lines are closed curves. When a small compass is moved along a magnetic field line, the compass needle always sets itself along the line tangential to it. So, a line drawn from the south pole of the compass needle to its north pole indicates the direction of the magnetic field at that point.

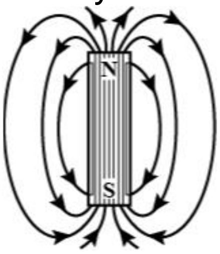
i. Do the magnetic field lines intersect? if not why?
ii. A strong bar magnet is placed vertically above a horizontal wooden board. What would be the magnetic lines of force?
iii. The figure shows the magnetic field lines in a magnetic field. A, B., and C are three points in this field. At what point is the magnetic field strength?



iv. Draw the pattern of magnetic field lines for a bar magnet.

Answer Key:

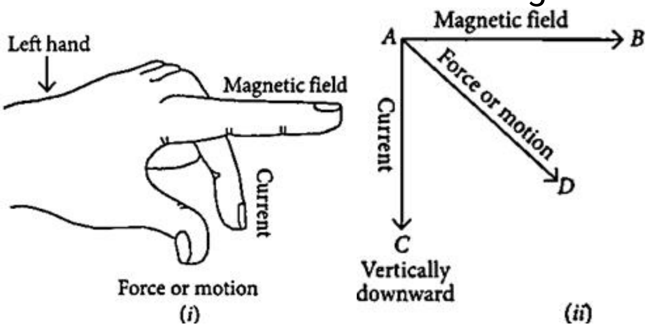
i. No two magnetic field lines are found to cross each other. If two field lines crossed each other, it would mean that at the point of intersection, the compass needle would point in two directions at the same time, which is not possible.

ii. The magnetic field and hence the magnetic line of force exist in all the planes all around the magnet.
iii. The magnetic lines of force are uniform and strong at point C and they diverge as they move towards points A and B and the distance between the lines increases. Eventually, the strength of the magnetic field is strong where the lines are closer and they weaken as the closeness decreases i.e., at point C.
iv. 

Case Study Questions

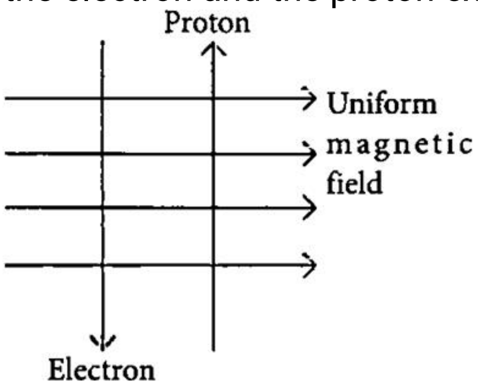
Magnetic Effects of Electric Current - 02

Andre Marie Ampere suggested that a magnet must exert an equal and opposite force on a current-carrying conductor, which was experimentally found to be true. But we know that current is due to charges in motion. Thus, it is clear that a charge moving in a magnetic field experience a force, except when it is moving in a direction parallel to it. If the direction of motion is perpendicular to the direction of magnetic field, the magnitude of force experienced depends on the charge, velocity (v), strength of magnetic field (B), and sine of the angle between v and B. Direction of magnetic force is given by Fleming's left-hand rule.

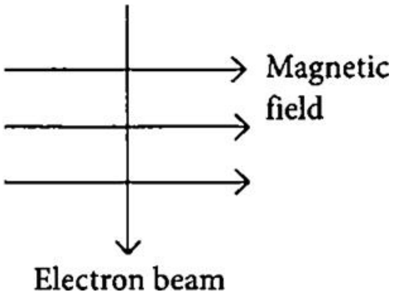


i. If an electron is travelling horizontally towards east. A magnetic field in vertically downward direction exerts a force on the electron along which direction?
ii. A charged particle is moving with velocity v in a magnetic field of induction B. The force on the particle will be maximum when
iii. A uniform magnetic field exists in the plane of paper pointing from left to right as shown in figure. In the field, an electron and a proton move as shown. Where do

the electron and the proton experience the force?



iv. An electron beam enters a magnetic field at right angles to it as shown in the figure. What would be the direction of force acting on the electron beam?



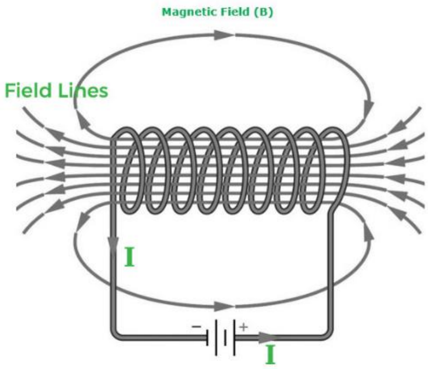
Answer Key:

i. Fleming's left-hand rule is used to determine the direction of force on electron i.e., in south direction.
ii. Force = q (V × B) = qVB sin0
Where, 0 is angle between velocity and magnetic field.
So, sin0 is maximum when 0 is 90^0
or velocity is perpendicular to magnetic field.
iii. As the direction of current is taken opposite to the direction of motion of electrons, therefore, current from the motion of electron and proton is in the same direction, i.e., from bottom to top. Now, according to Fleming's left-hand rule, the electron and the proton experience forces both pointing into the plane of paper.
iv. We know that both the directions are perpendicular, thus for force direction = ?
Using Fleming's left-hand rule,
Direction of force is perpendicular to the direction of magnetic field and current.
Thus direction of force is opposite to electron motion into the page at 90°

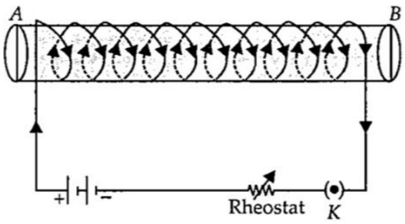
Case Study Questions

Magnetic Effects of Electric Current - 03

An insulated copper wire wound on a cylindrical cardboard tube such that its length is greater than its diameter is called a solenoid. When an electric current is passed through the solenoid, it produces a magnetic field around it. The magnetic field produced by a current-carrying solenoid is similar to the magnetic field produced by a bar magnet. The field lines inside the solenoid are in the form of parallel straight lines. The strong magnetic field produced inside a current-carrying solenoid can be used to magnetize a piece of a magnetic material like soft iron when placed inside the solenoid. The strength of the magnetic field produced by a current-carrying solenoid is directly proportional to the number of turns and strength of the current in the solenoid.



i. What would be the strength of the magnetic field inside a long current-carrying straight solenoid?
ii. Which end is north and which end is south pole when current flows through a solenoid?
iii. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is double and the number of turns per cm is halved, then what will be the new value of the magnetic field?
iv. A soft iron bar is enclosed by a coil of insulated copper wire as shown in the figure. When the plug of the key is closed, then where would the face B of the iron bar be marked?



Answer Key:

i. Magnetic field inside the infinite solenoid is uniform. Hence it is the same at all points.
ii. The end of the current carrying solenoid at which the current flows anti-clockwise behaves as a north pole while that end at which the direction of current clockwise behaves as a south pole and this is according to clock wise.
iii. For a long solenoid, magnetic field $B \propto In$; where I is the flowing current and n is number of turns per unit length in the solenoid. Therefore, in the given case magnetic field will remain unchanged.
iv. For a solenoid, if we imagine gripping the solenoid with your right hand so that your curl fingers follow the direction of the current then your thumb will point towards the north end of the electromagnet.