Conceptual Questions on the Experiment:

Magnetic Field Due to a Bar Magnet

Q. Define a magnetic field.

Answer:
A magnetic field is the region around a magnet or a current-carrying conductor where a magnetic force can be experienced by another magnet, magnetic material, or moving electric charge. It is represented by the symbol **B**, and its SI unit is the **tesla (T)**.

Q. What is a magnetic field line?

Answer:
A magnetic field line is an imaginary line drawn such that the tangent at any point gives the direction of the magnetic field. The closer the field lines, the stronger the magnetic field.

Q. What is the SI unit of magnetic field?

Answer:
The SI unit of magnetic field is the **tesla (T)**. 1 Tesla $= 1 \, \frac{\text{Newton}}{\text{Ampere} \times \text{metre}}$

Q. Why is the magnetic field strongest at the poles of a bar magnet?

Answer:
The magnetic field lines are most concentrated near the north and south poles. A higher density of field lines indicates a stronger magnetic field.

Q. What is magnetic induction?

Answer:
Magnetic induction is the process by which a magnetic material becomes magnetized when placed in an external magnetic field.

Q. What happens if the bar magnet is turned around?

Answer:
The north and south poles exchange positions. Consequently, the direction of the magnetic field lines also reverses, and the compass needle points in the opposite direction.

Q. Why should nearby magnetic materials be avoided during the experiment?

Answer:
Iron objects or other magnets distort the magnetic field around the bar magnet. This causes incorrect compass readings and inaccurate field-line mapping.

Q. How does the magnetic field change with distance from the magnet?

Answer:
The magnetic field strength decreases rapidly as the distance from the magnet increases. Therefore, the field lines become more widely spaced farther from the magnet.

Q. Why do magnetic field lines never intersect?

Answer:
At every point in space the magnetic field has only one direction. If field lines intersected, it would imply two directions for the field at one point, which is impossible.

Q. Why are magnetic field lines continuous closed loops?

Answer:
Outside the magnet they emerge from the north pole and enter the south pole, while inside the magnet they travel from south to north, forming continuous loops.

Q. Why is a compass needle used in this experiment?

Answer:
A compass needle aligns itself with the local magnetic field and therefore indicates the direction of the magnetic field at a particular point.

Conceptual Questions on the Experiment

Determination of Galvanometer Resistance by Half-Deflection Method

Q. What is the principle of the half-deflection method for determining the resistance of a galvanometer?

Answer:
The method is based on the fact that when a suitable shunt resistance is connected in parallel with the galvanometer and the deflection becomes half of its initial value, the shunt resistance is equal to the galvanometer resistance under ideal conditions.

Q. Why is a high resistance connected in series with the galvanometer during the experiment?

Answer:
A high series resistance limits the current through the galvanometer, protects it from damage, and ensures that the total current in the circuit remains nearly constant when the shunt is connected.

Q. Why is the shunt resistance connected in parallel rather than in series with the galvanometer?

Answer:
A parallel connection provides an alternative path for current. This diverts part of the current away from the galvanometer, reducing its deflection without interrupting the circuit.

Q. Why is the galvanometer deflection reduced to exactly half during the experiment?

Answer:
Half deflection simplifies the analysis because the current through the galvanometer becomes half of its original value. Under ideal conditions, this allows the galvanometer resistance to be determined directly from the shunt resistance.

Q. State the assumptions made in the half-deflection method.

Answer:

- The battery emf remains constant.
- The external series resistance is much larger than the galvanometer resistance.
- The galvanometer obeys Ohm's law.
- The galvanometer deflection is directly proportional to the current.

Q. What are the major sources of error in this experiment?

Answer:

- Variation in battery voltage
- Contact resistance
- Loose electrical connections
- Parallax error while reading the galvanometer
- Non-uniform scale of the galvanometer
- Temperature variation affecting resistance

Q. Why should the initial galvanometer deflection be kept within the linear portion of the scale?

Answer:
Within the linear range, the deflection is directly proportional to the current. Outside this range, the proportionality may not hold, leading to inaccurate results.

Q. How would the result be affected if the series resistance were too small?

Answer:
A small series resistance allows a large change in circuit current when the shunt is connected. This violates the assumptions of the half-deflection method and produces an incorrect value of the galvanometer resistance.

Q. Explain why the galvanometer can later be converted into an ammeter or a voltmeter after determining its resistance.

Answer:
Once the galvanometer resistance is known, an appropriate low shunt resistance can be connected to convert it into an ammeter, or a high series resistance can be connected to convert it into a voltmeter.

Q. Suggest two methods to improve the accuracy of the half-deflection experiment.

Answer:

1. Use a fresh battery and a large series resistance to maintain nearly constant current.
2. Take multiple observations, avoid parallax error, and ensure all electrical connections are clean and tight.