DAY 11, 12 and 13

Force on charge in magnetic field

Definition of magnetic field

Deflection in magnetic field versus deflection in electrical field

Path of charged particle in magnetic

Behaviour of momentum behaviour of kinetic energy for charge in magnetic field

CYCLOTRON

Biot Savart law its uses in finding magnetic due to long conductor

Biot Savart law its uses in finding magnetic due circular you stop

Force on charged conductor kept in magnetic field

Ampere Circuital Law

B due to SOLENOID and TOROID

Force between 2 parallel conductors

Definition of 1 Ampere

Torque on Coil placed in magnetic Field

Principle of Galvanometer

Conversion of Ammeter and Voltmeter

Current Sensitivity

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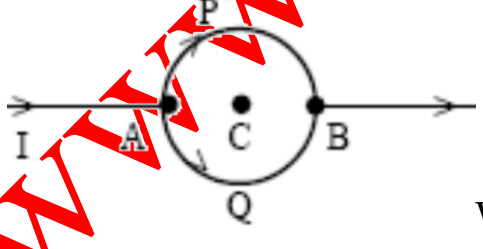
1. State Biot- Savart law and apply it to find the magnetic field due to a circular loop carrying current at a point (a) at its centre (b) on the axis

2. State Ampere's circuital law and apply it to find the magnetic field (a) inside a current carrying solenoid (b) inside a current carrying toroid
3. Apply Ampere's circuital law to determine the magnetic field at a point due to a long straight current carrying conductor.
4. Derive an expression for the force on a current carrying conductor in a uniform magnetic field $F = I L \times B$
5. Derive an expression for the force between long straight conductors carrying current and hence define 1 ampere.
6. Derive an expression for the torque on a current carrying loop in a uniform magnetic field.
7. Describe the principle construction and working of a Moving coil galvanometer.
8. Describe the conversion of a moving coil galvanometer into (a) Ammeter (b) Voltmeter
9. What is radial magnetic field? What is its importance in a moving coil galvanometer? How is a radial magnetic field realized in moving coil galvanometers?
10. Describe the principle construction and working of a cyclotron. Explain why an electron cannot be accelerated using a cyclotron.
11. Describe the motion of a charged particle in a magnetic field when it enters the field (a) perpendicular to the field lines (b) obliquely making and angle Θ with the field lines
12. Derive an expression for the magnetic dipole moment of a revolving electron and hence define Bohr magneton.

QUESTIONS

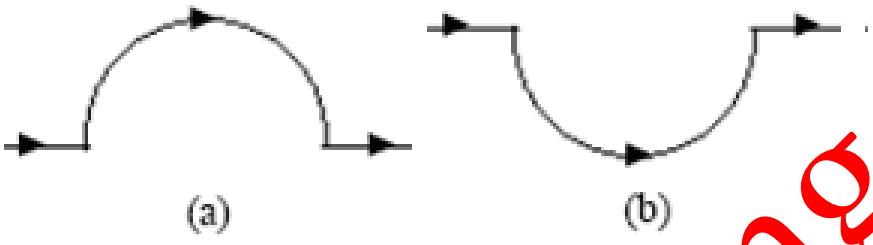
1. Consider the circuit shown here where APB and AQB are semi − circles.



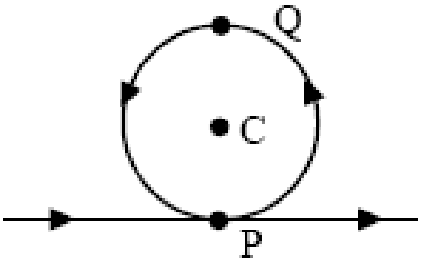
What will be the magnetic field at the centre C of the circular loop?

2. Name the physical quantity whose S.I. unit is Wb/m^2. Is it a scalar or a vector quantity?
3. A 50 cm long solenoid has 200 turns of radius 1 cm each. Find the magnitude of the magnetic field at the centre of the solenoid if a current of 2 A flows through it.

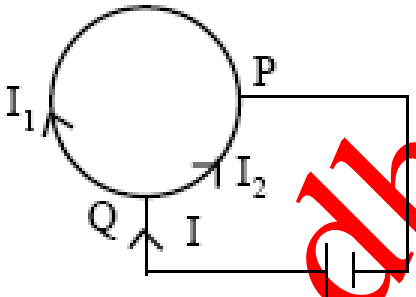
4. A straight wire carrying a current of 12 A is bent into a semi circular arc of radius 2.0 cm as shown in figure (a). What is the direction and magnitude of B at the centre of the arc? Would your answer be different if the wire were bent into a semi − circular arc of the same radius but in the opposite way as shown in figure (b).



5. A long wire is bent into the shape as shown here with out cross contact at P. A current is passed through it as shown. Calculate the magnetic field at the centre C.

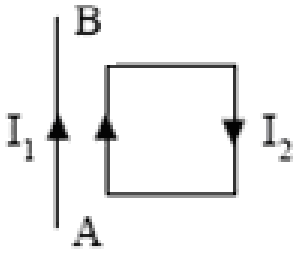


6. Show that no magnetic field is there at centre of circular coil as shown.

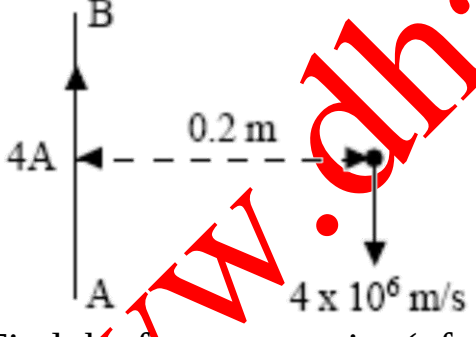


7. Why is cyclotron not suitable for accelerating electrons?
8. Why do parallel current carrying conductors attract each other?
9. Deduce an expression for the force per unit length, experienced by each conductor.
10. The force F experienced by a particle of charge q moving with velocity v in a magnetic field B is given by $F = q (v \times B)$. Which pair of vectors is always at right angles to each other?
11. Under what condition, an electron moving through a magnetic field experiences maximum force?
12. In the figure, the straight wire AB is fixed while the loop is free to move under the influence of the electric currents flowing in them. In which

direction does the loop begin to move? Give reason for your answer.



13. Describe the motion of a charged particle in a uniform magnetic field. Obtain an expression for the radius of the path of the charged particle moving perpendicular to uniform magnetic field. Show that the time taken to complete one revolution by the particle is independent of its speed.
14. A particle with charge '*q*' moving with a velocity '*v*', moving in the plane of the paper enters a uniform magnetic field 'B', acting perpendicular to the plane of the paper. Deduce an expression for the time period of the charge, as it moves in a circular path in the field. Why does the kinetic energy of the charge not change, while moving in the magnetic field?
15. A chamber is maintained at 5×10^{-3} T. An electron enters it with a speed of 5×10^{-7} m/s perpendicular to field. Calculate (i) radius of path, (ii) frequency of revolution of electron.
16. A long straight wire AB carries a current of 4 A. A proton P travels at 4×10^6 m/s, parallel to the wire, 0.2 m from it and in a direction opposite to the current as shown in the figure. Calculate the force which the magnetic field of current exerts on the proton. Also specify the direction of the force.



17. Find the force on a wire (of negligible mass) of length 4.0 cm placed inside a solenoid near its centre, making an angle of 60° with its axis. The wire carries a current 12 A and magnetic field due to solenoid has a magnitude of 0.25 T. Find also the direction of the force experienced by the wire.

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1 MARKER CONCEPTUALS and ANSWER

Q.1 The North pole of a magnet is brought near a negatively charged conductor. Will the pole experience any force?

A.1 The pole experiences force only if it is placed in some external magnetic field. As the stationary charge doesn't produce any magnetic field, the force acting on the pole will be zero.

Q.2 Under what condition the force acting on the charge particle moving in the magnetic field maximum?

A.2 The force will have a magnitude $F = qvB \sin\theta$, thus it will be maximum if $\sin\theta$ is maximum. Thus angle between velocity and magnetic field should be 90 or the charge particle moves perpendicular to the velocity vector.

Q.3 Under what condition the force acting on charge particle moving in the magnetic field minimum?

A.3 Minimum force or no force acts on the charge particle if it is either moving parallel or antiparallel to the magnetic field intensity. $F= q v B \sin\theta$, which implies angle should be either zero[parallel] or 180 [antiparallel]

Q.4 What is the work done by the magnetic field on the moving charge and why?

A.4 No work is done by the magnetic field on the moving charge. The magnetic force acts in such a way that the direction of the magnetic force and velocity are always perpendicular to each other. If force and velocity are perpendicular force and displacement are also perpendicular, thus $W= FS \cos\theta$, if $\theta = 90$, work done will be zero.

Q.5 A proton enters in a straight line in a uniform magnetic field along the field direction. How will its path and velocity change?

A.5 As the proton is moving along the field direction, thus no force acts on it and the velocity and the path will not change. It will keep on moving with the same speed along the field direction.

Q.6 A charge particle enters a uniform magnetic field perpendicular to the direction of magnetic field. How will its kinetic energy and momentum change?

A.6 As the charge particle enters perpendicular to the magnetic field, the force will act perpendicular to the velocity. Thus the particle starts moving in the circular path. As force and displacement are perpendicular the work done will be zero and kinetic energy will not change. But as it moves in circular path direction of momentum will change but magnitude is unchanged.

Q.7 A positive charge is moving vertically upwards in magnetic field towards south. In which direction will it be deflected?

A.7 If positive charge is moving upwards the corresponding current is also upwards, the magnetic field is towards south. Using Fleming's left hand rule force is towards east and deflection towards east.

Q.8 If electron is not deflected in passing through a certain region of space, can we be sure that there is no magnetic field?

A.8 No, the electron will not deflect if it is moving parallel or antiparallel to the direction of magnetic field or if magnetic force acting on the electron is balanced by some other force.

Q.9 Does magnetic field exert force on a static charge? Explain

A.9 No, if a charge particle is placed in steady magnetic field it will not experience any force.

Q.10 Free electrons always keep on moving in the conductor. Even then no magnetic force acts on them in a magnetic field. Why?

A.10 In the absence of external potential difference the motion of the electrons inside the conductor is totally random. Thus although the electrons are moving their velocity comes out to be zero. Thus, magnetic force which acts on them will always be zero.

Q.11 What is the nature of the magnetic field generated by a current carrying straight conductor?

A.11 The magnetic field of long straight conductor is in the circular magnetic lines of force. The center of these imaginary lines lies on the wire. The plane of magnetic lines of force is perpendicular to the length of the conductor and is given by right hand thumb rule.

Q.12 What can be the various sources for generation of the magnetic field?

A.12 the magnetic field is generated by the [a] current carrying wire [b] charge particle in motion [c] magnets [d] time varying electric field

Q.13 The net charge on the conductor placed in magnetic field is zero, but still it experiences force in the magnetic field. Why?

A.13 The net charge is zero because of equal positive and negative charges. But the positive changes being stationary don't experience any force whereas the free electrons are moving in the current carrying conductor experiences force.

Q.14 How will you identify if the magnetic field at a given location is due to earth or some other conductor?

A.14 The magnetic field of earth at all places is always in north south direction. Thus if a magnet suspended at a place always align in north south direction it is the magnetic field of earth whereas if the magnetic field is due to some conductor, its magnitude ad direction changes with the change in position.

Q.15 Does magnetic field exert force on the charge particle in the direction of magnetic field intensity?

A.15 The moving charge particle experience force in external magnetic field and its direction is always perpendicular to the direction of external magnetic field.