13 MAGNETIC EFFECTS OF ELECTRIC CURRENT

BASIC CONCEPTS – A FLOW CHART

MAGNETIC EFFECTS OF ELECTRIC CURRENT

Electric current through a metallic conductor produces a magnetic field around it.

Application → **Electric motor**

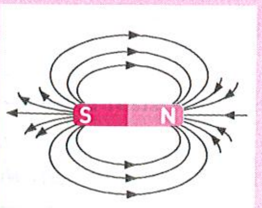
- Electrical energy is converted into mechanical energy.
- Used in electric fans, refrigerators, washing machines, computers, etc.

Magnetic field

- Space surrounding a magnet within which a magnetic force is experienced.
- Has both direction and magnitude.
- SI Unit is tesla

Magnetic field lines

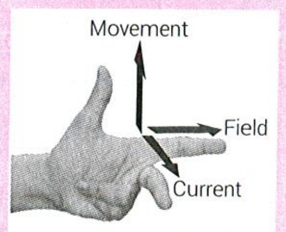
- Continuous curve in a magnetic field such that the tangent at any point on it gives the direction of magnetic field at that point.
- If field lines are close, field is stronger.
- If field lines are far apart, field is weak.
- Field lines around a bar magnet:



Force on a current-carrying conductor

Force acting on the conductor is perpendicular to the direction of magnetic field.

Direction of force → **Fleming's left hand rule**

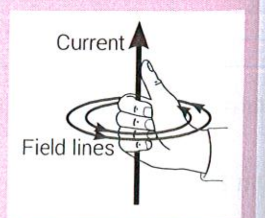


Field patterns produced in different shapes by current carrying conductor

Straight conductor

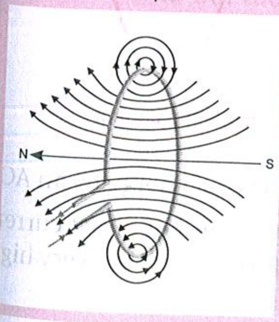
Magnetic field is represented by concentric circles which become larger and larger as the distance increases.

Direction of magnetic field lines → **Right hand thumb rule**



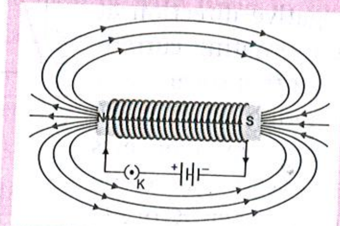
Circular loop

Magnetic field lines are represented by concentric circles near the wire of the loop that flattens as we move towards centre and appear as straight lines at the centre of loop.

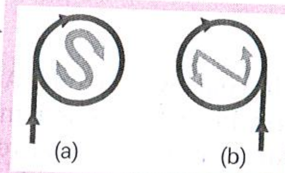


Solenoid

Magnetic field produced is similar to that produced by a bar magnet.



Direction of magnetic field →



(a) Clockwise current shows south polarity

(b) Anti-clockwise current shows north polarity

Electromagnet

- A temporary magnet of soft iron core with a coil wound around it which retains magnetism only when current passes through the coil.
- Used in electric bell, telephone, electric motor, etc.

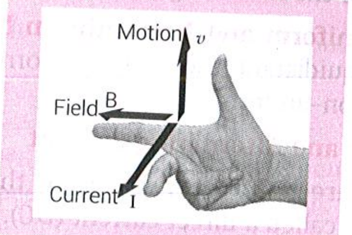
Electromagnetic induction

Phenomenon of induction of emf in a coil when there is a change in magnetic flux linked with the coil.

Application → **Electric generator**

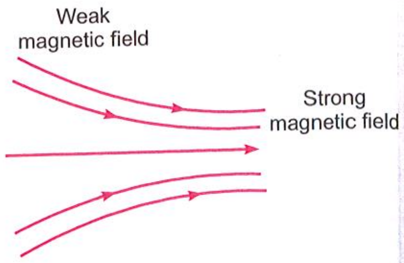
- Mechanical energy is converted into electrical energy.
- An AC generator produces alternating current, which reverses its direction after equal intervals of time. In this case, we use slip rings due to which the direction of current changes.
- DC generator produces direct current *i.e.*, the direction of current remains the same. In this case, we use split rings called commutator, which give current only in one direction.

Direction of induced current → **Fleming's right hand rule**



MORE POINTS TO REMEMBER

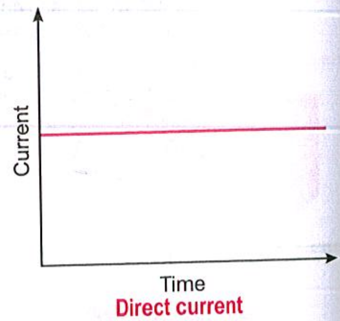
Properties of Magnetic Field Lines



- They travel from north pole to south pole outside the magnet and south pole to north pole inside the magnet.
- They are always in the form of closed and continuous curves.
- The number of field lines per unit area is the measure of the strength of magnetic field. The magnetic field is strong, where the field lines are close together and weak where the lines are far apart.
- Magnetic field lines are closest near the pole of a magnet and become wider as we move away from the pole. This means that the magnetic field is stronger near the poles and it becomes weaker as we move away from the poles.
- The direction of magnetic field at any point is along the tangent on the line of force at that point.
- Two magnetic lines of forces never intersect each other. If the lines intersect, then at the point of intersection there would be two directions (the needle would point towards two directions) for the same magnetic field, which is not possible.
- **Uniform and Non-uniform Magnetic Fields:** If the magnetic field lines are parallel and equidistant, the field is uniform and if they are non parallel and unequally spaced the field is non-uniform.

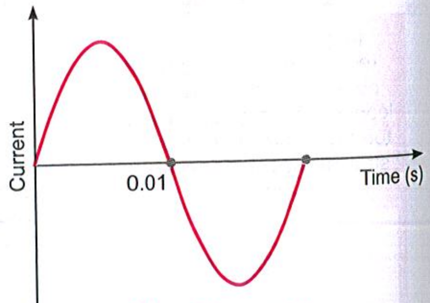
Direct and Alternating Current

- **Direct Current:** A current that always flows in one direction is called a direct current (DC). The current which we get from a battery or a cell is direct current because it always flows in the same direction. It is graphically represented by a straight line parallel to the time axis.



Direct current

- **Alternating Current:** An electric current which flows first in one direction in a circuit, called the positive direction, then in the reverse or negative direction at a regular interval of time is called alternating current (AC). In other words, an electric current that reverses its direction with time is called an alternating current. The symbol for an AC source is ~. The generators (converts mechanical energy into electrical energy based on electromagnetic induction) can produce either DC or AC.



Alternating current

Advantages of AC over DC

(i) Electric power can be transmitted over long distances without much loss of energy by an AC.

(ii) Alternating current can be controlled by a choke coil at small energy losses but direct current can be controlled by ohmic resistances only and energy losses in the form of heat are very high.

(iii) Alternating current equipments are more durable and convenient.

Fuse

Fuse: A fuse in a circuit prevents damage to the appliances and the circuit due to overloading. Overloading can occur when the live wire and the neutral wire come into direct contact.

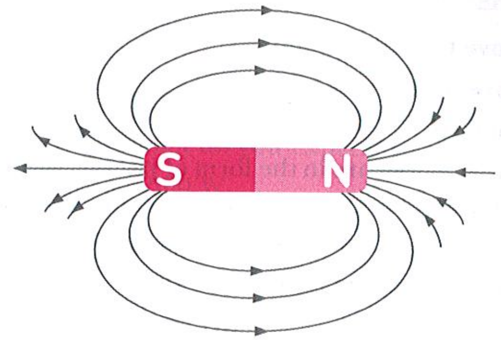
NCERT Intext Questions

Q. 1. Why does a compass needle get deflected when brought near a bar magnet?

Ans. A compass needle gets deflected when brought near a bar magnet because magnetic force is exerted by the bar magnet on the compass needle, which is itself a tiny pivoted magnet.

Q. 2. Draw magnetic field lines around a bar magnet.

Ans.



Q. 3. List the properties of magnetic field lines.

Ans. (i) They travel from north pole to south pole outside the magnet and south pole to north pole inside the magnet.

(ii) They are closed and continuous curves.

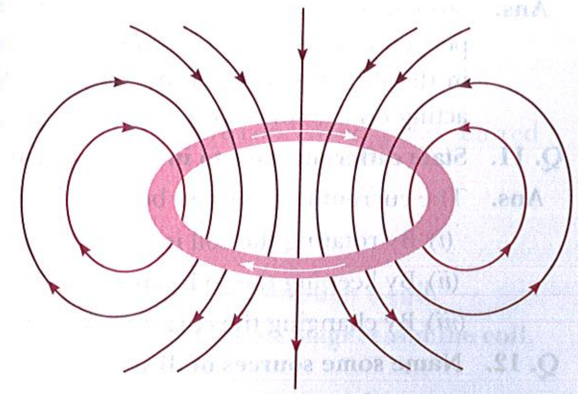
(iii) Two magnetic field lines never intersect each other. If the lines intersect, then at the point of intersection there would be two directions (the needle would point towards two directions) for the same magnetic field, which is not possible.

(iv) The number of field lines per unit area is the measure of the strength of magnetic field, which is maximum at poles. The magnetic field is strong, where the field lines are close together and weak where the lines are far apart.

Q. 4. Why do two magnetic field lines of force never intersect each other?

Ans. Two magnetic field lines of force never intersect each other. If the lines intersect, then at the point of intersection there would be two directions (the needle would point towards two directions) for the same magnetic field, which is not possible.

Q. 5. Consider a circular loop of wire lying in the plane of the table. Let the current pass through the loop clockwise. Apply the right-hand rule to find out the direction of the magnetic field inside and outside the loop.



Ans. Since the current passes through the loop in clockwise direction, therefore, the front face of the loop will be the south pole and the back face, i.e., the face touching the table will be north pole. According to right-hand rule, the direction of magnetic field inside the loop will be pointing downward. Outside the loop, the direction of the magnetic field will be upward.

Q. 6. The magnetic field in a given region is uniform. Draw a diagram to represent it.

Ans. A uniform magnetic field in a region is represented by drawing parallel and equidistant straight lines, all pointing in the same direction.

Q. 7. Choose the correct option. The magnetic field inside a long straight solenoid carrying current

(*i*) is zero.

(*ii*) decreases as we move towards its ends.

(*iii*) increases as we move towards its ends.

(*iv*) is the same at all points.

Ans. The field lines inside the solenoid are in the form of parallel straight lines. This indicates that the magnetic field is the same at all points inside the solenoid. Thus, answer (*iv*) is correct.

Q. 8. Which of the following property of a proton can change while it moves freely in a magnetic field? (There may be more than one correct answer).

(*i*) mass **(*ii*) speed**

(*iii*) velocity **(*iv*) momentum**

Ans. Whenever a charged particle (in this case a proton) moves in a magnetic field, its velocity and as a result of this its momentum change. Thus, (*iii*) and (*iv*) are the properties which change when a proton moves freely in a magnetic field.

Q. 9. A positively charged particle (alpha-particle) projected towards west is deflected towards north by a magnetic field. The direction of magnetic field is:

(*i*) towards south **(*ii*) towards east**

(*iii*) downward **(*iv*) upward**

Ans. Since the positively charged particle (alpha-particle) projected towards west, so the direction of current is towards west. Now the deflection is towards north, so the force is towards north.

Now hold the forefinger, centre finger and thumb of our left-hand at right angles to one another. Let us adjust the hand in such a way that our centre finger points towards west and thumb points towards north. If we look at our forefinger, it will be pointing, upward. Thus, the magnetic field is in the upward direction. So, the correct answer is (*iv*).

Q. 10. State Fleming's left hand rule.

Ans. Stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular. If the fore finger points in the direction of magnetic field and the middle finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.

Q. 11. State different ways to induce current in a coil.

Ans. The current in a coil can be induced by the following ways:

(*i*) By rotating the coil in the magnetic field between the poles of U-shaped magnet.

(*ii*) By keeping the coil stationary and moving a magnet inside it.

(*iii*) By changing the current continuously in an another coil kept near it.

Q. 12. Name some sources of direct current.

Ans. Some of the sources of direct current are dry cell battery, car battery, and dc generator.

Q. 13. Which sources produce alternating current?

Ans. Some of the sources that produce alternating current are bicycle dynamos, car alternators and power house generators.

Q. 14. Choose the correct option.

A rectangular coil of copper wires is rotated in a magnetic field. The direction of the induced current changes once in each

(*a*) two revolutions **(*b*) one revolution**

(*c*) half revolution **(*d*) one-fourth revolution**

Ans. (c) Half revolution.

Q. 15. Name two safety measures commonly used in electric circuits and appliances.

Ans. (*i*) Electric fuse

(*ii*) Earthing of metal bodies of electrical appliances

Q. 16. An electric oven of 2 kW power rating is operated in a domestic electric circuit (220 V) that has a current rating of 5 A. What result do you expect? Explain.

Ans. Power, P = 2 kW = 2 × 1000 W = 2000 W

Voltage, V = 220 V

Current drawn, I = ?

Power, $P = V \times I$

$$I = \frac{P}{V} = \frac{2000}{220}$$

$$= \mathbf{9\ A} \text{ (approx)}$$

The current drawn by this electric oven is 9 A whereas the fuse in the circuit is only 5 A capacity. When a high current of 9 A flows through the 5 A fuse, the fuse wire will get heated too much, melt and break the circuit. Therefore, when a 2 kW power rating electric oven is operated in a circuit having 5 A fuse, the fuse will blow off cutting off the power supply in this circuit.

Q. 17. What precautions should be taken to avoid the overloading of domestic electric circuits?

Ans. (*i*) Too many electrical appliances should not be operated on a single socket.

(*ii*) Too many high power rating electrical appliances should not be switched on at the same time.

NCERT Exercises

Q. 1. Which of the following correctly describes the magnetic field near a long straight wire?

(*i*) The field consists of straight lines perpendicular to the wire.

(*ii*) The field consists of straight lines parallel to the wire.

(*iii*) The field consists of radial lines originating from the wire.

(*iv*) The field consists of concentric circles centred on the wire.

Ans. The magnetic field lines near a long straight wire carrying current are concentric circles centred on the wire. So, choice (*iv*) is correct.

Q. 2. The phenomenon of electromagnetic induction is:

(*i*) The process of charging a body.

(*ii*) The process of generating magnetic field due to a current passing through a coil.

(*iii*) Producing induced current in a coil due to relative motion between a magnet and the coil.

(*iv*) The process of rotating a coil of an electric motor.

Ans. The phenomenon of electromagnetic induction is producing induced current in a coil due to relative motion between a magnet and the coil. So, choice (*iii*) is correct.

Q. 3. The device used for producing current is called a:

(*i*) Generator **(*ii*) Galvanometer**

(*iii*) Ammeter **(*iv*) Motor**

Ans. Generator is a device for producing electric current. So, choice (*i*) is correct.

Q. 4. The essential difference between an AC generator and a DC generator is that

(*i*) AC generator has an electromagnet while a DC generator has permanent magnet.

(*ii*) DC generator will generate a higher voltage.

(*iii*) AC generator will generate a higher voltage.

(*iv*) AC generator has slip rings while the DC generator has a commutator.

Ans. AC generator has slip rings while DC generator has a commutator. So, choice (*iv*) is correct.

Q. 5. At the time of short circuit, the current in the circuit

(*i*) reduces substantially **(*ii*) does not change**

(*iii*) increases heavily **(*iv*) varies continuously**

Ans. At the time of short circuit, the resistance of circuit becomes nearly zero; so current increases heavily. So, choice (*iii*) is correct.

Q. 6. State whether the following statements are true or false.

(*i*) An electric motor converts mechanical energy into electrical energy.

(*ii*) An electric generator works on the principle of electromagnetic induction.

(*iii*) The field at the centre of a long circular coil carrying current will be parallel straight lines.

(*iv*) A wire with a green insulation is usually the live wire of an electric supply.

Ans. (*i*) False, because an electric motor converts electric energy into mechanical energy.

(*ii*) True (*iii*) True

(*iv*) False, because a live wire has always **red** or **brown** insulation.

Q. 7. List three sources of magnetic field.

Ans. (*i*) Moving charges (*ii*) Electric current

(*iii*) Magnet

Q. 8. How does a solenoid behave like a magnet? Can you determine the north and south poles of a current-carrying solenoid with the help of a bar magnet? Explain.

Ans. A solenoid has a large number of close, insulated circular turns. The magnet at the centre of current carrying circular wire is along the axis; so when current is passed in a solenoid, the magnetic fields due to all circular turns are added and hence the field line becomes just as for a bar magnet.

Yes, we can determine the north and south poles of a current carrying solenoid with the help of a bar magnet. For this we suspend the bar magnet freely and note its ends pointing along north and south directions and mark on these ends N (north pole) and S (south pole).

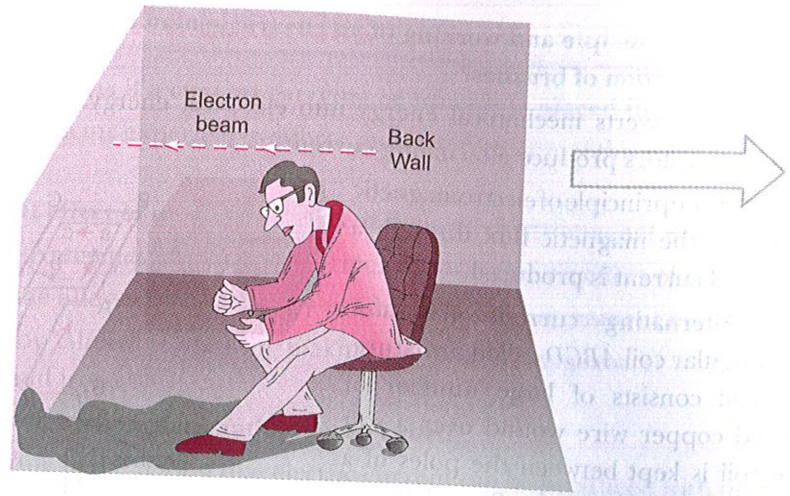
Now we bring N-pole near one end of freely suspended current carrying solenoid; if there is repulsion, then that end of solenoid is N-pole and other S-pole; but if there is attraction, then that end of solenoid is S-pole and the other is N-pole.

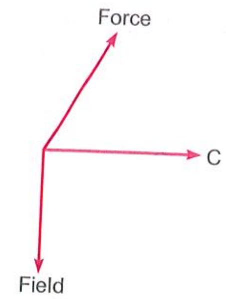
Q. 9. When is the force experienced by a current-carrying conductor placed in a magnetic field largest?

Ans. The force experienced by a current-carrying conductor placed in a magnetic field is largest when the direction of current is at right angles to the direction of the magnetic field.

Q. 10. Imagine that you are sitting in a chamber with your back to one wall. An electron beam, moving horizontally from back wall towards the front wall, is deflected by a strong magnetic field to your right side. What is the direction of magnetic field?

Ans.





The current due to moving electron beam is in a direction opposite to motion. The force on electron is towards right. By Fleming's left hand rule, the direction of magnetic field is vertically downward.

Q. 11. Name some devices in which electric motors are used.

Ans. Electric motors are used in electric fans, refrigerators, mixers, washing machines, etc.

Q. 12. A coil of insulated copper wire is connected to a galvanometer. What will happen if a bar magnet is (*i*) pushed into the coil (*ii*) withdrawn from inside the coil (*iii*) held stationary inside of coil?

Ans. (*i*) When a bar magnet is pushed into the coil, a momentary deflection is observed in the galvanometer. This deflection indicates that a momentary current is produced in the coil.

(*ii*) When a bar magnet is withdrawn from the coil, the deflection of galvanometer is in opposite direction. It indicates that a current of an opposite direction is produced.

(*iii*) When a bar magnet is held stationary inside the coil, there is no deflection in the galvanometer. It indicates that no current is produced in the coil.

Q. 13. Two circular coils A and B are placed close to each other. If the current in the coil A is changed, will some current be induced in the coil B? Give reason.

Ans. Yes, by changing current in coil A, some current will be induced in coil B. The reason is that when current in coil A is changed, the magnetic field around A changes, so magnetic flux linked with nearby coil B changes; this gives rise to induced current in coil B.

Q. 14. State the rule to determine the direction of a (*i*) magnetic field produced around a straight conductor-carrying current (*ii*) force experienced by a current-carrying straight conductor placed in a magnetic field which is perpendicular to it and (*iii*) current induced in a coil due to its rotation in a magnetic field.

Ans. (*i*) The direction of magnetic field produced around a current-carrying conductor is given by **right hand thumb rule.** If the conductor carrying current is held in the right hand in such a way that the thumb points in the direction of current, then direction of curl of fingers gives the direction of the magnetic field.

(*ii*) The direction of force experienced by a straight conductor carrying current placed in a magnetic field, which is perpendicular to it is determined by **Fleming's left hand rule**. Hold the thumb and first two fingers of the left hand at right angles to each other with the first finger pointing in the direction of the Field and the second finger in the direction of the current, then the thumb points in the direction of the motion.

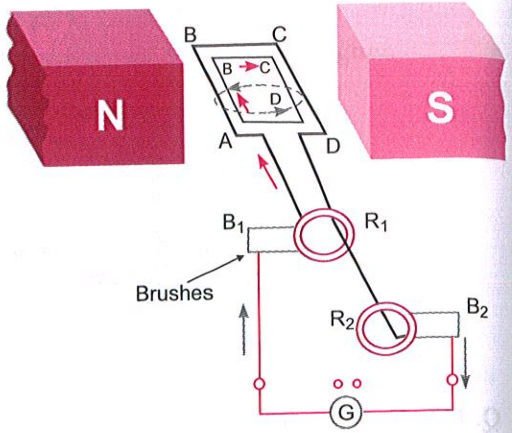
(*iii*) The direction of current induced in a circuit by changing magnetic flux due to motion of a magnet is determined by **Fleming's right hand rule.** If we stretch our right hand in such a way that the thumb, forefinger and central finger remain perpendicular to each other, so that the forefinger indicates the direction of the magnetic field and the thumb in the direction of motion of conductor; then the central finger indicates the direction of induced current.

Q. 15. Explain the underlying principle and working of an electric generator by drawing a labelled diagram. What is the function of brushes?

Ans. An electric generator converts mechanical energy into electrical energy. Alternating current generators or AC generators produce alternating current.

Principle: It works on the principle of electromagnetic induction. Whenever the magnetic flux through a coil changes, induced current is produced.

Construction : Alternating current generator consists of a rectangular coil *ABCD* called armature. The armature coil consists of large number of turns of insulated copper wire wound over a soft iron core. The coil is kept between the poles of a strong magnet. In the figure shown R_1 and R_2 are two slip rings connected to the two ends of the coil and convey the current produced to outside circuit. B_1 and B_2 are two carbon brushes remain in sliding contact with slip rings.



Basic principle of operation of AC generators.

Working : The coil of the generator is rotated with the help of an axel. When coil rotates, it cuts the magnetic lines of force (magnetic field) near the north (N) and south (S) poles of the magnet. By electromagnetic induction, a current is induced in the coil. The direction of this current is given by Fleming's right hand rule.

As this coil turns clockwise, arm AB moves up and arm CD goes down. The direction of current is from A to B in AB and C to D in CD. The induced current is taken out through slip rings and carbon brushes. After half this rotation, AB and CD interchange their position. Now CD moves upward and AB downward.

The direction of induced current is from D to C in CD and B to A in AB, during this half rotation. The slip rings R_1 and R_2 also rotate along with the coil ABCD. Thus, their polarities keep changing after every half rotation. Thus, the current changes its direction twice in one complete revolution of the coil. Such a current which changes its polarity after fixed intervals is called alternating current.

Function of Brushes : The brushes B_1 and B_2 remain fixed in their positions and maintain sliding contacts with the rotatable slip rings R_1 and R_2 respectively. It is through these brushes that the current induced in the armature coil is fed to the external circuit by means of line wires.

Q. 16. When does an electric short circuit occur?

Ans. If the insulation of the live wire and neutral wire gets damaged then the two wires touch each other. This touching of the live wire and neutral wire is known as short circuit. In this situation, resistance of a circuit decreases to a very small value. Due to this, current flowing through the wires becomes very large and heats the wires to a very high temperature, and a fire may be started.

Q. 17. What is the function of an earth wire? Why is it necessary to earth the metallic appliances?

Ans. Sometimes, the insulation of live wire is torn and due to this the live wire touches the metallic body of the appliances. This causes the flow of current in metallic body. This current flows to the Earth through the earth wire and does not harm the user of the appliances.

Therefore, to prevent the user getting an electric shock, due to leakage of current to metallic body, Earth wire must always be used.

VERY SHORT ANSWER QUESTIONS [1 mark]

Q. 1. What happens if a current carrying conductor is placed in the magnetic field?

Ans. The conductor experiences a force and the direction of this force is given by Fleming's left hand rule.

Q. 2. On what effect of an electric current does an electromagnet work?

Ans. An electromagnet works on the principles of magnetic effect of current.

Q. 3. Name the alloy which is mainly used for making permanent magnets.

Ans. The alloy 'Alnico' is used for making permanent magnets. It is an alloy of aluminium, nickel, cobalt and iron.

Q. 4. Why is electromagnetic induction so called?

Ans. This is due to the reason that electric current can be produced with the help of varying magnetic field without any physical contact of the source of magnetic field and the conductor.

Q. 5. Name an instrument in which the directive property of a magnet is used.

Ans. A compass needle.

Q. 6. What is a solenoid?

Ans. Solenoid is a coil of many turns of wire, wrapped in the shape of a cylinder.

Q. 7. Which effect of electric current is utilised in the working of an electric fuse?

Ans. An electric fuse works on the heating effect of current.

Q. 8. What is the frequency of A.C. (alternating current) in India?

Ans. It is 50 Hz.

Q. 9. What will you do if you see a person coming in contact with a live wire?

Ans. Such a person should be provided with an insulated support like wood, plastic or rubber in order to disconnect the person from wire.

Q. 10. How can it be proved that a magnetic field exists around a current carrying metallic wire?

Ans. When a magnetic compass needle is placed close to the current carrying wire, it will get deflected.

Q. 11. How is the strength of the magnetic field at a point near a wire related to the strength of the electric current flowing in the wire?

Ans. The magnitude of magnetic field is directly proportional to the strength of the electric current flowing in the wire.

Q. 12. How is the fuse connected in an electric circuit?

Ans. Fuse is connected in series in the circuit.

Q. 13. Why is a fuse usually made of tin or tin-copper alloy?

Ans. A fuse is usually made of tin or tin-copper alloy because it has a low melting point.

Q. 14. What is the capacity of a fuse commonly used in domestic electrical fittings?

Ans. Fuses of capacity 5 ampere or 15 ampere are commonly used in domestic electrical fittings.

Q. 15. Name the device used to protect the electric circuits from overloading and short circuiting.

Ans. A fuse is used to protect circuits from overloading and short circuiting.

Q. 16. On which effect of electricity does fuse work?

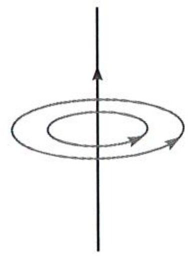
Ans. Heating effect of current.

Q. 17. What kind of magnetic field is produced by a current carrying solenoid?

Ans. The magnetic field produced by a current-carrying solenoid is similar to the magnetic field produced by a bar magnet.

Q. 18. Show, with the help of a diagram, the nature of field lines of magnetic field around a current carrying straight conductor.

Ans.



Q. 19. State Faraday's law of electromagnetic induction.

Ans. Whenever the magnetic field lines linked with a coil change due to relative motion of a magnet and the coil, an induced current is produced in the coil. The magnitude of induced current is directly proportional to the rate of change of number of magnetic field lines linked to the coil.

Q. 20. The frequency of alternating current in India is 50 Hz. What does it mean?

Ans. In India, the alternating current changes direction after every $\frac{1}{100}$ second, so the frequency of alternating current is 50 Hz.

Q. 21. Name the scientist who discovered the relationship between electric current and magnetic field.

Ans. Danish physicist, H.C. Oersted established the relation between electricity and magnetism.

Q. 22. What does the closeness of field lines in a magnetic field signify?

Ans. The degree of closeness of the field lines in a magnetic field indicates the strength of magnetic field in the region. The closer the field lines, the stronger is the field.

Q. 23. Name the device which converts mechanical energy into electrical energy.

Ans. Electric generator.

Q. 24. Which type of generator is used at power stations?

Ans. AC generator.

Q. 25. Does the AC generator have any slip ring?

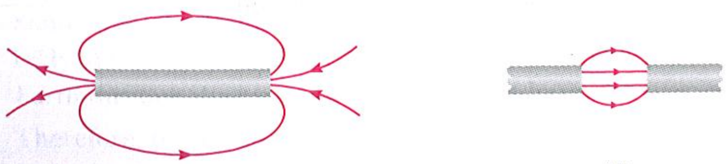
Ans. Yes, the AC generator has two slip rings.

Q. 26. What is the frequency of DC?

Ans. Zero.

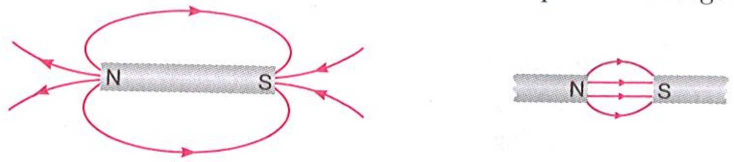
SHORT ANSWER QUESTIONS–I [2 marks]

Q. 1. Identify the poles of the magnet in the figure (a) and (b) shown below.



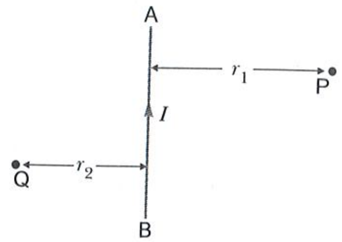
(a) (b)

Ans. The magnetic field lines emerge from north pole and merge at the south pole.



(a) (b)

Q. 2. AB is a current-carrying conductor in the plane of the paper as shown in figure. What are the directions of magnetic fields produced by it at points P and Q? Given $r_1 > r_2$, where will the strength of the magnetic field be larger? *[NCERT Exemplar]*



Ans. Magnetic field at P is into the plane of paper and at Q it is out of the plane of paper. The strength of the magnetic field at Q will be larger as strength of the field $\propto \frac{1}{r}$.

Q. 3. What is electromagnetic induction?

Ans. Whenever the magnetic flux linked with a coil changes, an induced e.m.f. (electromotive force) is produced in the coil. This phenomenon is known as electromagnetic induction and is used to generate electric current in a generator or a dynamo.

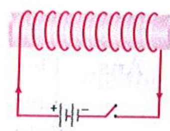
Q. 4. Write SI unit of magnetic field. Under what condition does a moving charge experience (*i*) maximum force (*ii*) minimum force?

Ans. The SI unit of magnetic field is tesla.

(*i*) **Maximum force:** When the velocity of charge and the magnetic field are perpendicular to each other.

(*ii*) **Minimum force:** When this charge is moving in the direction of the magnetic field.

Q. 5. What is an electromagnet? Draw a circuit diagram to show how a soft iron piece can be transformed into an electromagnet.



Ans. The magnetic field produced due to current flowing in a coil or a solenoid can be used to magnetise a material like soft iron temporarily. The insulated copper wire is wrapped on a soft iron piece. When current is passed through the coil using a battery and a key the iron piece behaves like a bar magnet as long as current is being passed. Such a magnet is called an electromagnet.

Q. 6. A magnetic compass shows a deflection when placed near a current-carrying wire. How will the deflection of the compass get affected if the current in the wire is increased? Support your answer with a reason. *[NCERT Exemplar]*

Ans. If the current in the wire is increased, the deflection increases. The strength of magnetic field is directly proportional to the magnitude of current passing through the straight conductor.

Q. 7. What does the divergence of magnetic field lines near the ends of a current-carrying straight solenoid indicate? *[NCERT Exemplar]*

Ans. The divergence, that is, the falling degree of closeness of magnetic field lines indicates the fall in strength of magnetic field near and beyond the ends of the solenoid.

Q. 8. A student performs an experiment to study the magnetic effect of current around a current carrying straight conductor with the help of a magnetic compass. He reports that

(*i*) the degree of deflection of the magnetic compass increases when the compass is moved away from the conductor.

(*ii*) **the degree of deflection of the magnetic compass increases when the current through the conductor is increased.**

Which of the above observations of the student appears to be wrong and why?

Ans. The first observation is wrong. Because as the distance from the conductor increases, the strength of the magnetic field will decrease. So the degree of deflection of the compass should decrease instead of increasing.

Q. 9. How does the strength of the Magnetic field at the centre of a circular coil of a wire depend on: (*a*) radius of the coil (*b*) number of turns in the coil.

Ans. (*a*) More the radius weaker the field.

(*b*) Field strength is directly proportional to the number of turns in the coil.

Q. 10. (*i*) How is the direction of magnetic field at a point determined?

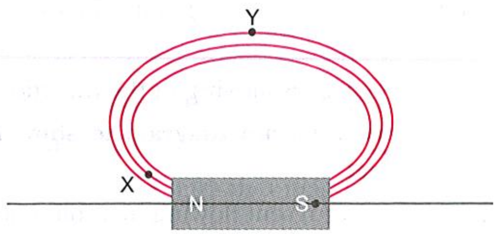
(*ii*) What is the direction of magnetic field at the centre of a current-carrying circular loop?

Ans. (*i*) The direction of the magnetic field at a point can be found by placing a small magnetic compass at that point. The north end of the needle of a compass indicates the direction of magnetic field at a point where it is placed.

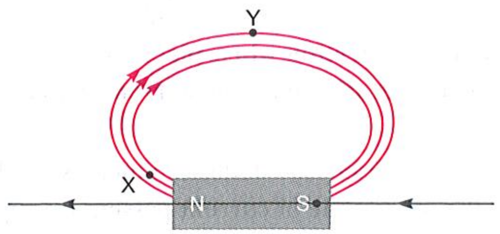
(*ii*) The direction of magnetic field at the centre of a current-carrying circular loop is perpendicular to the plane of the loop.

SHORT ANSWER QUESTIONS–II [3 marks]

Q. 1. Magnetic field lines are shown in the given diagram. A student makes a statement that magnetic field at X is stronger than at Y. Justify this statement. Also redraw the diagram and mark the direction of magnetic field lines.



Ans. The relative strength of the magnetic field is shown by the degree of closeness of the field lines. The degree of closeness is more at X than at Y. Therefore, the field is stronger at X where the field lines are crowded.



Q. 2. What is the difference between a direct current and an alternating current? How many times does AC used in India change direction in one second? [*NCERT Exemplar*]

Ans. Direct current always flows in one direction but the alternating current reverses its direction periodically. Also the magnitude of current in case of DC is same throughout whereas in case of AC, it changes continuously. The frequency of AC in India is 50 Hz and in each cycle it alters direction twice. Therefore, AC changes direction $2 \times 50 = 100$ times in one second.

Q. 3. How can the magnitude of the induced current in a coil be increased?

Ans. The magnitude of the induced current can be increased by:

(*i*) Increasing the number of turns in the coil.

(*ii*) Increasing the strength of the magnetic field used.

(*iii*) Increasing the rate of change of magnetic flux associated with the coil.

Q. 4. What is the role of fuse used in series with any electrical appliance? Why should a fuse with defined rating not be replaced by one with a larger rating? [*NCERT Exemplar*]

Ans. Fuse is used for protecting appliances due to short-circuiting or overloading. The fuse is rated for a certain maximum current and blows off when a current more than the rated value flows through it. If a fuse is replaced by one with larger ratings, the appliances may get damaged while the protecting fuse does not burn off. This practice of using fuse of improper rating should always be avoided.

Q. 5. Answer the following questions:

(*i*) What is the direction of magnetic field lines outside a bar-magnet?

(*ii*) The magnetic field lines in a given region are getting crowded. What does it indicate?

(*iii*) State one advantage of AC over DC.

Ans. (*i*) North pole to south pole.

(*ii*) The strength of magnetic field is higher in this region.

(*iii*) A.C. voltage can be stepped up and transmitted over long distances without much loss of energy.

Q. 6. What are magnetic field lines? How is the direction of a magnetic field at a point determined? Mention two important properties of magnetic field lines.

Ans. The magnetic field lines of force are the lines drawn in a magnetic field along which a hypothetical north magnetic pole would move if it is free to do so.

The direction of a magnetic field at a point is in the direction of the resultant force acting on a hypothetical north pole placed at that point.The tangent at any point on the magnetic field line gives the direction of magnetic field at that point. The direction of the magnetic field at a point can be found by placing a small magnetic compass at that point. The north end of the needle indicates the direction of the field.

Two important properties of the magnetic lines of force are:

(*i*) The magnetic lines of force start from north pole and terminate at south pole. Inside the magnet they travel from south pole to north pole. Thus, they are closed curves.

(*ii*) They do not intersect each other because at the point of intersection there will be two directions of same magnetic field which is impossible.

Q. 7. A copper coil is connected to a galvanometer. What would happen if a bar magnet is

(*i*) pushed into the coil with its north pole entering first

(*ii*) held at rest inside the coil

(*iii*) pulled out again?

Ans. (*i*) When north pole is pushed into the coil, a momentary deflection is observed in the galvanometer. This deflection indicates that a momentary current is produced in the coil. The direction of current in the coil is anticlockwise. When seen from the end from where the magnet was pushed in.

(*ii*) When the magnet is held at rest, there is no deflection in the galvanometer. It indicates that no current is produced in the coil in this case.

(*iii*) In pulling the magnet out of the coil, a deflection in opposite direction is observed. It indicates that the current produced in the coil is in opposite direction.

Q. 8. Explain what is short circuiting and overloading in an electric supply.

Ans. **Short circuiting:** Whenever live and neutral wires come in contact with each other, the incident is called short circuiting. In this case, resistance of a circuit decreases to a very small value. The decreasing of resistance increases the current. Due to this increased current, the wires get heated. This extreme heat may cause fire in the building.

Overloading: Every supply has a capacity to bear a maximum load, *i.e.*, the power that can be supplied has a limit. Sometimes, the number of appliances which are switched on at the same time have power more than the capacity of the line. This is called overloading. In this situation, wires of the supply get heated due to extremely large current flowing through them and the circuit may catch fire. To avoid this fire, we use an electric fuse in the circuit.

Q. 9. What change in the deflection of the compass needle placed at a point near current carrying straight conductor shall be observed if the (*a*) current through the conductor is increased? (*b*) direction of current in the conductor is reversed? (*c*) compass is moved away from the conductor?

Ans. (*a*) Deflection increases.

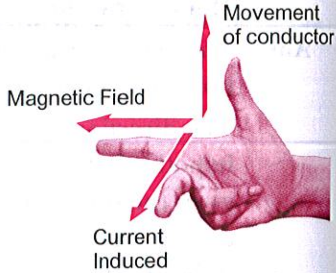
(*b*) Direction of deflection is reversed.

(*c*) Deflection decreases.

Q. 10. Name and state the rule used for determination of direction of induced current produced in a conductor due to a changing magnetic field and give one practical application of this phenomenon in everyday life.

Ans. **Rule:** Fleming's right-hand rule.

It states that if we stretch the thumb, forefinger and middle finger of our right hand such that they are mutually perpendicular to each other. If forefinger indicates direction of magnetic field and the thumb shows the direction of motion of conductor, then middle finger will show direction of induced current.



Fleming's righ-hand rule

Application: Electrical generator.

Q. 11. A coil made of insulated copper wire is connected to a galvanometer. What will happen to the deflection of the galvanometer if this coil is moved towards a stationary bar magnet and then moved away from it? Give reason for your answer and name the phenomenon involved.

Ans. When coil is moved towards a stationary magnet, the magnetic field associated with the coil will change and so current will be induced in the coil. This causes galvanometer to show deflection in one direction. Now when coil is moved away, the magnetic field will decrease and so current induces in the opposite direction causing galvanometer to show deflection in opposite direction. The phenomenon is electromagnetic induction.

Q. 12. In what respect does the construction of an AC generator differ from that of a DC generator?

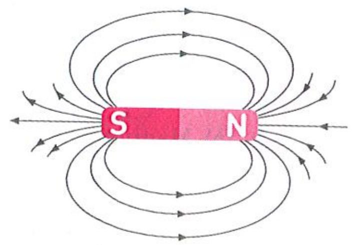
Ans. The only difference between a DC generator and an AC generator is in the way the two ends of the generator coil are connected to the outer circuit. In a DC generator, the two ends of the generator coil are connected to a split ring type commutator consisting of two half rings of copper. In an AC generator, the ends of the coil are connected to two full rings of copper called slip rings. There is no commutator in an AC generator.

LONG ANSWER QUESTIONS [5 marks]

Q. 1. Briefly explain an activity to plot the magnetic field lines around a bar magnet. Sketch the field pattern for the same specifying field directions.

A region A has magnetic field lines relatively closer than another region B. Which region has stronger magnetic field. Give reason to support your answer.

Ans.
1. Take a drawing sheet and fix it on a smooth table with adhesive tape.
2. Place a bar magnet in the middle of the drawing sheet and draw its boundary with a sharp pencil.
3. Place a magnetic compass near one end of the magnet (N-pole) and mark the positions of the two ends (N and S-poles) of the compass needle using a sharp pencil.
4. Shift the compass from this position and place it in such a way that S-pole of its needle is on the point you marked in previous step for N-pole.
5. Again mark the position of the other end (N-pole) of the compass needle.
6. Repeat the steps 4 and 5, till you reach the other end (S-pole) of the bar magnet.
7. Join all the points with a sharp pencil to get a smooth curve.
8. Put the compass at some other points near the N-pole of the magnet and draw another magnetic field lines. Similarly, draw many field lines on both the sides of the bar magnet as shown in figure.
9. Observe the pattern of the magnetic field lines.



Result: Magnetic field lines can be drawn around a bar magnet using a magnetic compass. The field lines do not cross each other.

Region A has stronger magnetic field. This is due to the strength of the field is proportional to the relative closeness of field lines.

Q. 2. Briefly explain an activity to plot the magnetic field lines around a straight current carrying conductor. Sketch the field pattern for the same, specifying current and field directions. What happens to the field,

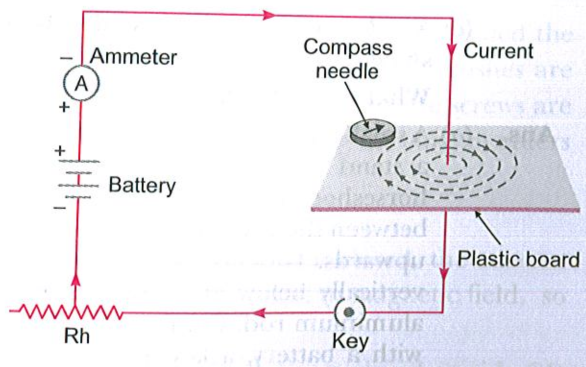
(*a*) if the strength of the current is decreased?

(*b*) if the direction of the current is reversed?

Ans. The pattern of magnetic field lines around a straight conductor carrying current can be described by the following activity.

(*i*) Insert vertically a long straight wire carrying an electric current so that it passes through the centre of a horizontal piece of plastic board as shown in figure.

(*ii*) Take care that the plastic board is fixed and does not move up and down. Now, sprinkle some iron filings onto the plastic board to show the shape of the field.



(*iii*) You will notice that the iron filings get arranged round the wires in the shape of circles. This is due to the reason that the magnetic field lines around the current carrying straight conductor are circular. The iron filings align along these field lines.

(*iv*) On reversing the direction of flow of current, we observe that the iron filings arrange themselves in circles around the wire showing that the magnetic field lines are still circular in nature.

The direction of the magnetic field can be obtained by using a compass. If the current direction is reversed, the direction of the magnetic field is also reversed.

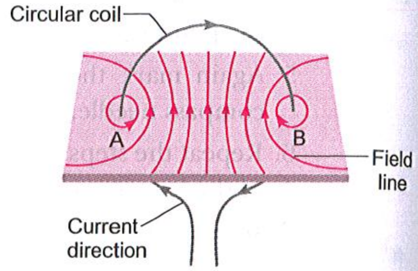
(*a*) When current through the wire is decreased, field also gets reduced.

(*b*) When the current is reversed, field also gets reversed in direction.

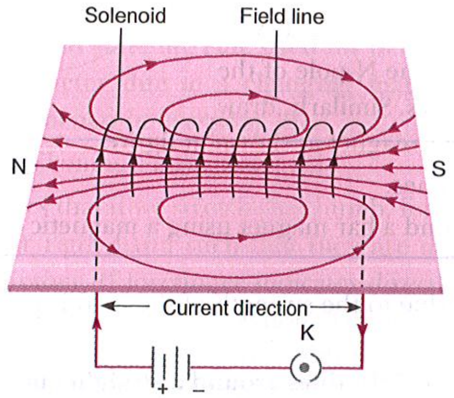
Q. 3. **(*a*) With the help of a labelled diagram, explain the distribution of magnetic field due to a current through a circular loop. Why is it that if a current carrying coil has n turns the field produced at any point is n times as large as that produced by a single turn?**

(*b*) Draw a pattern of magnetic field formed around a current carrying solenoid. What happens to the magnetic field when the current through the solenoid is reversed?

Ans. (*a*) The pattern of the magnetic field lines near the wires of the coil are concentric circles. The curvature of these curves goes on increasing as we move away from the wire. At the centre of the circular loop, the field lines are nearly straight and parallel.



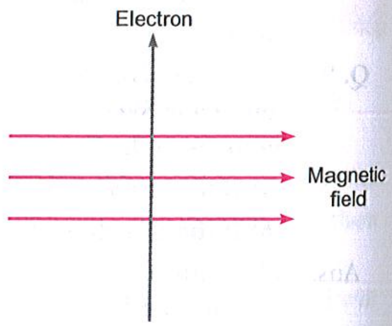
(*b*) Magnetic field also gets reversed.



Q. 4. **(*a*) Explain an activity to show that a current-carrying conductor experiences a force when placed in a magnetic field.**

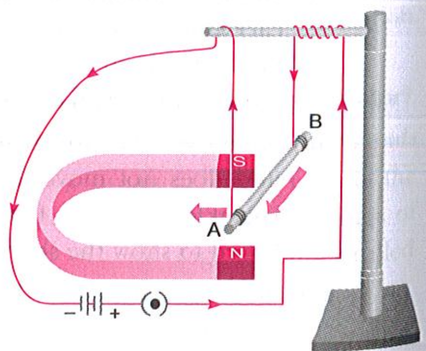
(*b*) State the rule which gives the direction of force acting on the conductor.

(*c*) An electron moves perpendicular to a magnetic field as shown in the figure.



What would be the direction of force experienced by the electron?

Ans. (*a*) A small aluminium rod is suspended horizontally from a stand using two connecting wires. Place a strong horseshoe magnet in such a way that the rod lies between the two poles with the magnetic field directed upwards. For this, put the north pole of the magnet vertically below and south pole vertically above the aluminium rod. Connect the aluminium rod in series with a battery, a key and a rheostat. Pass a current through the aluminium rod from one end to other (B to A). The rod is displaced towards left. When the direction of current flowing through the rod is reversed, the displacement of rod across towards right.



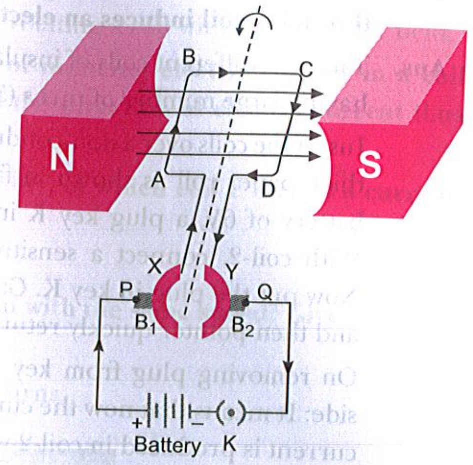
(*b*) **Fleming's left-hand rule.**

Stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular to one another. If the forefinger points in the direction of magnetic field and the middle finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.

(*c*) According to Fleming's left hand rule, the direction of force is perpendicular to the direction of magnetic field and current. We know that the direction of current is taken opposite to the direction of motion of electrons. Therefore, the force is directed upwards from the plane of the paper.

Q. 6. **Draw a labelled circuit diagram of a simple electric motor and explain its working. In what way these simple electric motor are different from commercial motors?**

Ans. An electric motor is a device which converts electrical energy into mechanical energy.



Principle

The electric motor works on the magnetic effect of current. Its principle is when a rectangular coil is placed in a magnetic field and current is passed through it, a force acts on the coil, due to which the coil rotates. When the coil rotates the shaft attached to it also rotates. The rotating shaft has mechanical energy. In this way electric energy supplied to motor is converted into mechanical energy.

Construction: An electric motor has the following parts:

1. **Field Magnet:** It is a permanent U-shaped magnet NS; whose north and south poles are N and S respectively.
2. **Armature:** It is a rectangular coil ABCD which contains a large number of turns of insulated copper wire wound on a soft iron core. This coil is free to rotate between the pole pieces of the magnet.
3. **Split Rings and Brushes:** Split rings (X and Y) are simply a brass (or copper) ring which is divided into two parts. These both parts are separated from each other and are soldered to the two ends of the coil. These split rings are mounted on the shaft of the motor and can rotate with the shaft.

The split rings touch the two strips of graphite B1, B2; these strips of graphite are called the brushes. These brushes are connected to two connecting screws P and Q. These brushes are fixed to the base of the motor and they keep contact with the half rings lightly. The screws are connected to terminals of battery. When current is passed by means of battery, the current enters the coil from one brush and leaves through the other.

Working

Let initially coil ABCD be horizontal as shown in Fig. 2.35. When key is closed, the current begins to flow in the coil. Initially the sides AD and BC of coil are parallel to magnetic field, so no magnetic force acts on them.

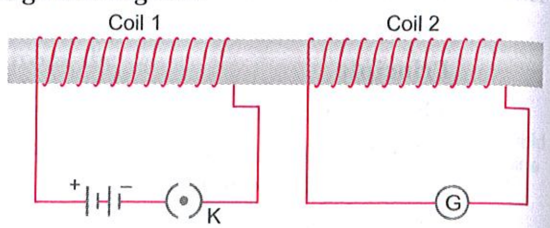
By Fleming's left hand rule, the force on arm AB of coil is vertically downward and on side CD of coil, it is vertically upward. These two forces are equal and opposite and hence form a couple. This tends to rotate the coil in anticlockwise direction. When rotating coil becomes perpendicular to its initial position, then couple becomes zero. But due to inertia the coil continues to rotate along the same direction. As the split rings also rotate with the coil, therefore, the split rings come in contact with other brushes. [That is initially B1 had contact with X and B2 had contact with Y; now B1 has contact with has contact with X.] When this happens the direction of current in the coil is reversed.

This in turn reverses the direction of forces in AB and CD. The side of the coil will be on left hand side with a downward force on it and the side AB of coil will be on right hand side with an upward force on it. Thus a couple acts on the coil which rotates the coil in the same direction (anti-clockwise). This process is repeated again and again and the coil rotates continuously.

Due to rotation of coil, its shaft gains kinetic energy; which may be used to run electric fan, water pump, washing machine, mixer and grinder etc.

Q. 5. With the help of a diagram, describe an experiment to show that a change in current flowing through a coil induces an electric current in a neighbouring coil.

Ans. Take two different coils of insulated copper wire having large number of turns (50 or even more) Insert the coils over a non-conducting cylindrical thick paper roll as shown in figure. Connect a battery of 6V, a plug key K in series of coil-1. With coil-2, connect a sensitive galvanometer.

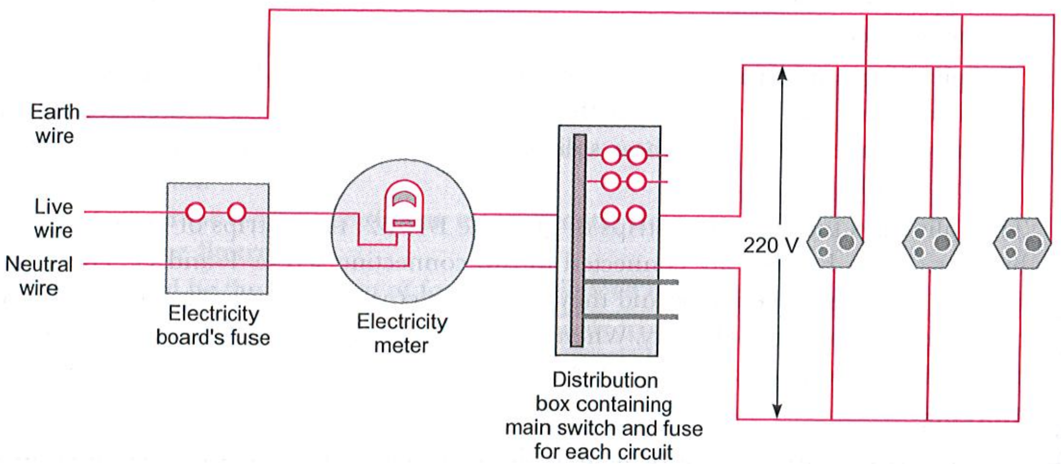


Now put the plug in key K. Galvanometer joined with coil-2 also gives a momentary deflection and then pointer quickly returns to its mean position.

On removing plug from key K in coil-1 the needle momentarily moves, but to the opposite side. It means that now the current flows in the opposite direction in coil 2. So we conclude that current is produced in coil-2 whenever the current flowing in the neighbouring coil is changing.

Q. 6. Draw an appropriate schematic diagram showing common domestic circuits and discuss the importance of fuse. Why is it that a burnt out fuse should be replaced by another fuse of identical rating? *[NCERT Exemplar]*

Ans.



A fuse in a circuit prevents damage to the appliances and the circuit due to overloading. Otherwise, the appliances or the circuit may be damaged.

When current in the circuit exceeds the value of fuse rating, the fuse wire burns due to overloading. This causes a gap in the circuit and the current stops flowing in the circuit.

This is done due to the reason so that the circuit or the appliances to be connected in the circuit continue functioning without any damage in future.

Q. 7. (i) Two circular coils P and Q are kept close to each other, of which coil P carries a current. If coil P is moved towards Q, will some current be induced in coil Q? Give reason for your answer and name the phenomenon involved.

(ii) What happens if coil P is moved away from Q?

(iii) State any two methods of inducing current in a coil.

Ans. (*i*) When coil P is moved towards Q, current will be induced in coil Q. This is because on moving P the magnetic field associated with Q increases and so a current is induced. The phenomenon is electromagnetic induction.

(*ii*) If P is moved away from Q, the field associated with Q will decrease and a current will be induced but in the opposite direction.

(*iii*) Current can be induced in a coil by (*a*) moving a magnet towards or away from the coil (*b*) moving a coil towards or away from a magnet (*c*) rotating a coil within a magnetic field.

Q. 8. (i) With the help of an activity, explain the method of inducing electric current in a coil with a moving magnet. State the rule used to find the direction of electric current thus generated in the coil.

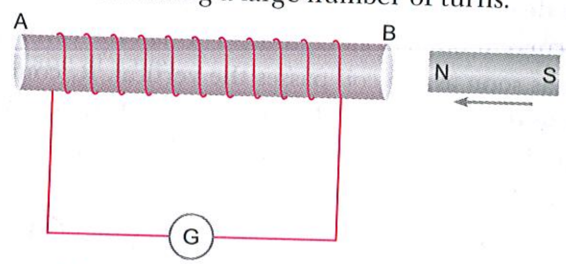
(ii) Two circular coils P and Q are kept close to each other, of which coil P carries a current. What will you observe in Q?

(a) If current in the coil P is changed?

(b) If both the coils are moved in the same direction with the same speed? Give reason.

Ans. (i) Activity:

(*a*) Take a coil of wire AB having a large number of turns.



Moving a magnet towards a coil sets up a current in the coil circuit, as indicated by deflection in the galvanometer needle.

(*b*) Connect the ends of the coil to a galvanometer.

(*c*) Take a strong bar magnet and move its north pole towards the end B of the coil.

(*d*) There is a momentary deflection in the needle of the galvanometer, say to the right. This indicates the presence of a current in the coil AB. The deflection becomes zero the moment the motion of the magnet stops.

(*e*) Now withdraw the north pole of the magnet from the coil. Now the galvanometer is deflected toward the left, showing that the current is now set up in the direction opposite to the previous direction.

(*f*) Place the magnet stationary at a point near to the coil, keeping its north pole towards the end B of the coil. We see that the galvanometer needle deflects toward the right when the coil is moved towards the north pole of the magnet. Similarly, the needle moves toward left when the coil is moved away.

When the coil is kept stationary with respect to the magnet, the deflection of the galvanometer drops to zero.

To find the direction of electric current Fleming's right hand rule is applied. According to it, if we stretch the forefinger, middle finger and thumb of our right hand mutually perpendicular in such a way that thumb points along the direction of motion of conductor, forefinger along the direction of magnetic field; then the middle finger points along the direction of induced current.

(*ii*) (*a*) When current in P is changed, the field associated with Q will vary causing an induced current in Q.

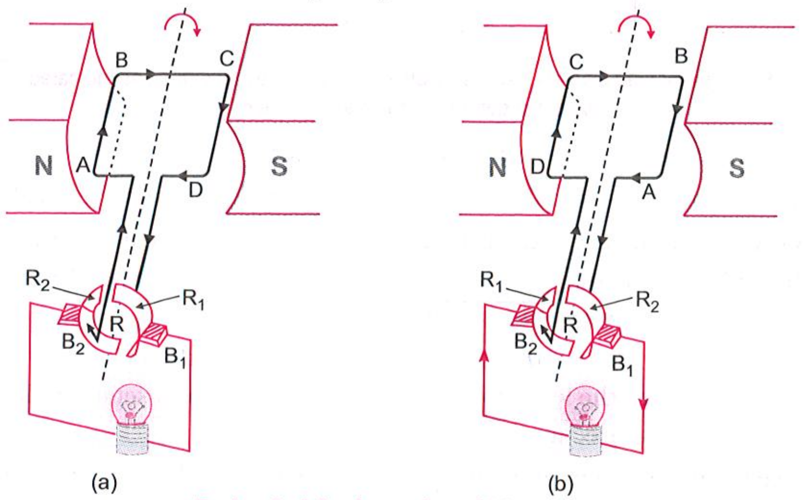
(*b*) If both the coils are moved in the same direction with same speed, there will not be any change in the field associated with Q. Hence no current will be induced in Q.

Q. 9. Explain the underlying principle and working of direct current generator (or DC dynamo) by drawing a labelled diagram.

Ans. A device used to convert mechanical energy into electrical energy is called an electric generator. An armature-coil rotating in a magnetic field develops an alternating emf and sends alternating current in an external circuit. If, however, the connections of the ends of the coil to the external circuit are interchanged every time the emf in the coil reverses, the current in the external circuit flows always in the same direction. This is the principle of a DC dynamo.

The working of a single-coil DC dynamo is shown in the figure. The ends of the armature-coil ABCD are connected to the two separated segments R_1 of a *single* copper ring R, which is called the 'split-ring commutator'. R_1 and R_2 rotate along with the armature between two brushes B_1 and B_2 to which the external circuit is connected.

When the armature-coil ABCD is rotated clockwise (say), an emf is induced in the coil and a current flows in the direction *ABCD* (Fleming's right-hand rule), as shown in Fig (*a*). In the external circuit, the current flows from B_1 to B_2. For half the revolution, R_1 is in contact with B_1 and R_2 with B_2. But as soon as the coil passes the vertical, R_1 comes in contact with B_2 and R_2 with B_1 and remain so during the next half revolution [Fig. (*b*)]. Although the induced emf in the coil is reversed and the current in the coil flows in the direction DCBA, but in the external circuit the current still flows from B_1 to B_2.



Basic principle of operation of DC dynamo

The current generated by such a simple dynamo is uni-directional. As long as the coil is rotating, the direct current flows through the device connected to the terminals of the generator.

HOTS (Higher Order Thinking Skills)

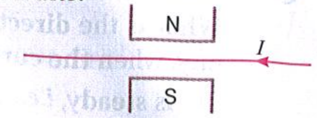
Q. 1. Meena draws magnetic field lines of field close to the axis of a current-carrying circular loop. As she moves away from the centre of the circular loop she observes that the lines keep on diverging. How will you explain her observation? *[NCERT Exemplar]*

Ans. Strength of the magnetic field falls as distance increases. This is indicated by the decrease in degree of closeness of the lines of field.

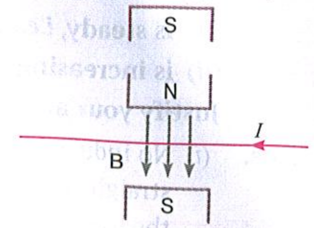
Q. 2. Why does a magnetic compass needle pointing North and South in the absence of a nearby magnet get deflected when a bar magnet or a current carrying loop is brought near it?

Ans. Current-carrying loops behave like bar magnets and both have their associated field lines. This modifies the already existing earth's magnetic field and a deflection results.

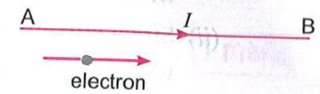
Q. 3. A wire is placed between N and S poles of a magnet as shown in figure. If current flows in the wire as shown, in which direction does the wire tend to move?



Ans. The direction of magnetic field is from N-pole to S-pole; on applying Fleming's left-hand rule, the wire tends to move perpendicular to plane of paper in the upward directions.



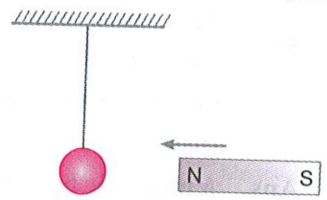
Q. 4. A fixed wire AB carries current *I*. An electron is moving parallel to the wire, in which direction does the electron tend to move?



Ans. By right-hand thumb rule, the magnetic field in the vicinity of wire is downward perpendicular to plane of paper. The conventional direction of electric current is opposite to the direction of motion of electron. By Fleming's left-hand rule, the force on electron is away from wire into the plane of paper; therefore, the electron will be deflected downward (away from wire) into the plane of paper.

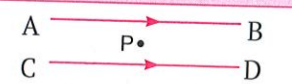
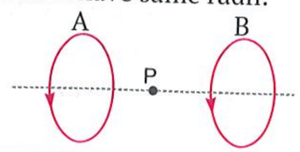
Q. 5. A metallic wire loop is suspended freely and a bar magnet is brought near it as shown in the diagram.

What will be the direction of induced current in the wire loop when the magnet is moved towards it.



Ans. Anticlockwise from the side of a magnet.

Q. 6. Two wires each carrying a steady current i are shown in two different configurations in column I. The magnetic field produced due to current in the wires is described in column II. Match the situations A and B in column I with all the correct statements in column II.

Column I	Column II
 A. Point P is situated midway between the wires above.	(i) The magnetic fields B at P due to the current in the wires are in the same direction.
B. Point P is situated at the mid point of the line joining the centres of the circular wires, which have same radii. 	(ii) The magnetic fields B at P due to the current in the wires are in the opposite directions. (iii) Magnetic field at P is zero.

Ans. (i) A matches with (ii) and (iii).

Applying Right Hand Thumb rule, the magnetic field at P due to current flowing in AB is perpendicular to the plane of paper pointing vertically downwards. The magnetic field at P due to current flowing in CD is perpendicular to the plane of paper pointing vertically upwards.

As P is the mid point, the two magnetic fields, cancel out each other. Therefore, magnetic field at P is zero.

(ii) B matches with only (i) in column II.

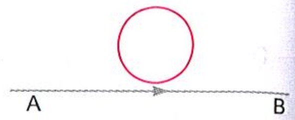
Applying Right Hand Thumb rule, the magnetic field at P due to current in loop A is along the axial line towards right. The magnetic field at P due to current in loop B is also along the axial line towards right.

Q. 7. A circular metallic loop is kept above the wire AB as shown here. What is the direction of induced current produced in the loop, if any, when the current flowing in the straight wire

(*i*) is steady, *i.e.*, does not vary.

(*ii*) is increasing in magnitude.

Justify your answer in each case.



Ans. (*i*) No induced current will be produced in the loop since the constant current flowing in the straight wire produces a constant magnetic field. Hence no induced current is produced in the loop.

(*ii*) Since current in the straight wire is changing, the magnetic flux associated with the loop will change and hence induced current will be produced in it.

Applying Lenz' law, the current flowing in the loop will be in clockwise direction.

Q. 8. An electron and a proton, moving parallel to each other, enter a uniform magnetic field with same velocity. The direction of magnetic field and their motion coincides (is same). How will the direction of their paths be affected when they are travelling in

(*a*) same direction **(*b*) opposite direction.**

Justify your answer.

Ans. A magnetic field does not exert any force on a charge moving parallel or antiparallel to the field direction. Since they are travelling in the direction of the magnetic field, there will be no force acting on them. Hence their paths will remain the same after entering the magnetic field.

Q. 9. You are given a galvanometer, an electroplating equipment, a key and two sources of electricity. Give two different experimental set ups to find whether any of the given sources is AC or DC source.

Ans. (*a*) We can connect the galvanometer to any one of the sources using a key in the circuit. If the galvanometer shows definite deflection in a given direction, the source taken is d.c. source. If the given source is a.c. source, the average deflection shown by the galvanometer will be zero.

(*b*) We can also connect the electroplating equipment to any one of the source using a key in the circuit. If electroplating takes place, the source used is d.c. source. In case of AC source, since the direction of current changes periodically and alternatively, there is no definite shifting of the ions of the electrolyte and hence no electroplating takes place.

Q. 10. A circuit has a fuse of 5 A. What is the maximum number of 100 watt (220 V) bulbs which can be safely used in the circuit?

Ans. Suppose x number of such bulbs can be used.

Power of one bulb = 100 watt

Power of x bulbs $(P) = 100x$ watts

Potential difference $(V) = 220$ volts

$I = 5$ ampere

We know $P = VI$

$\Rightarrow$ $100x = 220 \times 5$

$\therefore$ $x = \frac{220 \times 5}{100}$ **11 bulbs**

Q. 11. It is established that an electric current through a metallic conductor produces a magnetic field around it. Is there a similar magnetic field produced around a thin beam of moving (*i*) alpha particles, (*ii*) neutrons? Justify your answer. *[NCERT Exemplar]*

Ans. (*i*) Yes, Alpha particles being positively charged constitute a current in the direction of motion.

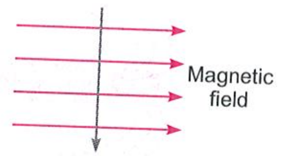
(*ii*) No. The neutrons being electrically neutral constitute no current.

Proficiency Exercise

Very Short Answer Questions

[1 mark]

1. State the rule which gives the direction of force acting on a current-carrying conductor kept in a magnetic field.
2. What does the degree of closeness of the field lines represent?
3. What is the safety method used for protecting home appliances from short circuiting or overloading in domestic electric fittings?
4. A charged particle enters at right angles into a uniform magnetic field as shown. What should be the nature of charge on the particle if it begins to move in a direction pointing vertically out of the page due to its interaction with the magnetic field?



5. Why cannot two magnetic field lines cross each other?
6. Name the phenomenon which is made use of in an electric generator.
7. What change should be made in an AC generator so that it may become a DC generator?

Short Answer Questions–I

[2 marks]

8. Why is it necessary to connect an earth wire to electric appliances having metallic bodies?
9. A student while studying the force experienced by a current-carrying conductor kept in a magnetic field records the following observations:
   (*i*) The force experienced by the conductor increases as the current is increased.
   (*ii*) The force experienced by the conductor decreases as the strength of the magnetic field is increased.
   Which of the two observations is correct and why?
10. Copy and complete the diagrams to show the shape and direction of the magnetic field between the magnetic poles.

(*a*) (*b*) (*c*)

11. Why are the magnetic field lines closed curves?

12. If instead of electron a neutron enters a field, what will be its direction of motion? Give reasons for your answer.

13. What is the principle of an electric generator?

14. Two fuse wires of same length are rated 5 A and 20 A. Which of the two fuse wires is thicker and why?

Short Answer Questions–II [3 marks]

15. (*a*) On what principle does an electric fuse work?

(*b*) What is the frequency of A.C. in India? State one advantage of A.C. over D.C.

16. Two coils 1 and 2 of insulated copper wire having large but different number of turns are wound over a cardboard cylinder. Coil 1 is connected to battery and a plug key. Coil 2 is connected to a galvanometer. How will the galvanometer reading change when (*i*) key is plugged in and (*ii*) key is taken out?

Give reason for your answer in each case.

17. Under what conditions permanent electromagnet is obtained if a current carrying solenoid is used? Support your answer with the help of a labelled circuit diagram. *[NCERT Exemplar]*

18. What is solenoid? What does the divergence of magnetic field lines near the ends of a current-carrying straight solenoid indicate?

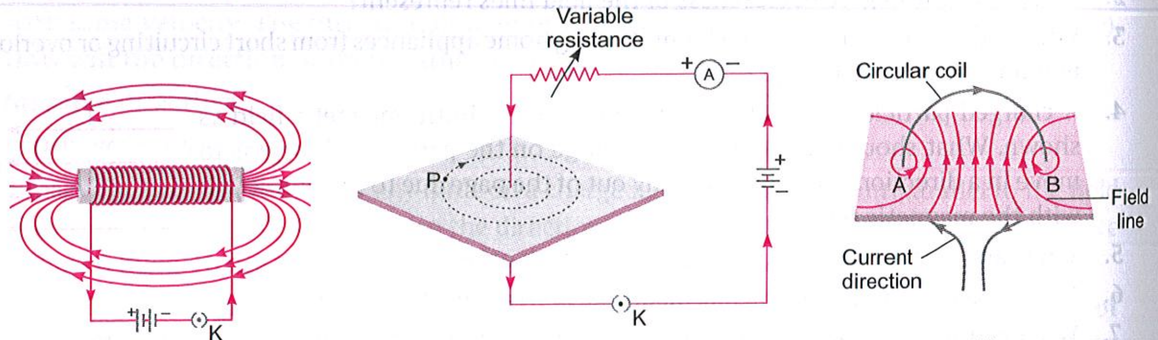
19. How will the magnetic field produced at a point P by a current carrying-circular coil change if we increase the

(*i*) value of current flowing through the coil,

(*ii*) distance of the point P from the coil,

(*iii*) number of turns of the coil?

20. Shown in the given diagrams (*a*), (*b*) and (*c*) are the magnetic fields around different systems. Identify them. Compare the pattern of the field lines in all the three systems.



(a) (b) (c)

21. Explain why the direction of the induced current in the coil of an AC generator changes after every half revolution of the coil.

Long Answer Questions [5 marks]

22. A student fixes a sheet of white paper on a drawing board. He places a bar magnet in the centre of it. He sprinkles some iron filings uniformly around the bar magnet. Then he taps the board gently and observes that the iron filings arrange themselves in a particular pattern.

(*a*) Why do the iron filings arrange in a pattern?

(*b*) What does the crowding of iron filings at the end of the magnet indicate?

(*c*) What does the lines along which the iron filings align represent?

(*d*) Draw a neat diagram to show the magnetic field lines around a bar magnet.

(*e*) Write any two properties of magnetic field lines.

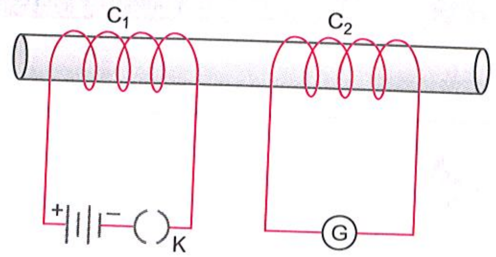
23. (*a*) A stationary charge is placed in a magnetic field. Will it experience a force? Give reason to justify your answer.

(*b*) On what factors does the direction of force experienced by a conductor when placed in a magnetic field depend?

(*c*) Under what conditions is the force experienced by a current carrying conductor placed in a uniform magnetic field maximum?

(*d*) Name and state the rule which gives the direction of force experienced by a current carrying conductor placed in a magnetic field.

24. Two coils C_1 and C_2 are wrapped around a non conducting cylinder. Coil C_1 is connected to a battery and key and C_2 with galvanometer G. On pressing the key (K), current starts flowing in the coil C_1. State your observation in the galvanometer:



(*i*) When key K is pressed on.

(*ii*) When current in the coil C_1 is switched off.

(*iii*) When the current is passed continuously through coil C_1.

(*iv*) Name and state the phenomenon responsible for the above observation. Write the name of the rule that is used to determine the direction of current produced in the phenomena.