Magnetic Effects of Electric Current

TOPICS COVERED

Magnetic Field and Field Lines

Multiple Choice Questions **1 Mark**

1. **Magnetic effect of current was discovered by**
   (*a*) Oersted (*b*) Faraday
   (*c*) Bohr (*d*) Ampere
2. **By which instrument, the presence of magnetic field be determined?**
   (*a*) Magnetic Needle
   (*b*) Ammeter
   (*c*) Galvanometer
   (*d*) Voltmeter
3. **The needle of magnetic compass indicates the direction of**
   (*a*) magnetic north at the point of earth surface.
   (*b*) magnetic south at the point of earth surface.
   (*c*) east.
   (*d*) west.
4. **A compass needle is a/an**
   (*a*) iron piece (*b*) small magnet
   (*c*) steel bar (*d*) powerful bar magnet
5. **The behaviour of compass needle in a magnetic field is**
   (*a*) to assure a position of magnetic field line.
   (*b*) to assure the perpendicular magnetic field line.
   (*c*) to rotate and stops in any direction.
   (*d*) both (*b*) and (*c*)

6. **Magnetic field is a quantity that has**
   (*a*) magnitude only
   (*b*) direction only
   (*c*) both direction and magnitude
   (*d*) none of the above

7. **Relative strength of magnetic field at a point in the space surrounding the magnet is shown by the**
   (*a*) length of magnet
   (*b*) thickness of magnet
   (*c*) degree of closeness of the field.
   (*d*) resistance offered by the surroundings

8. **Which of the following statement is not correct about the magnetic field?**
   (*a*) Magnetic field lines form a continuous closed curve.
   (*b*) Magnetic field line do not interest each other.
   (*c*) Direction of tangent drawn at any point on the magnetic field line curve gives the direction of magnetic field at that point.
   (*d*) Outside the magnet, magnetic field lines go from South to North pole of the magnet.

9. **Magnetic needle is/an** [CBSE 2021(C)]
   (*a*) isolated north pole pivoted at its centre of mass.
   (*b*) isolated south pole pivoted at its centre of mass.
   (*c*) ordinary needle made of soft iron and pivoted at its centre of mass.
   (*d*) small bar magnet pivoted at its centre of mass.

10. **A freely suspended magnet always rests in geographically north and south direction because** [CBSE 2021(C)]
   (*a*) the Earth has two poles.
   (*b*) the Earth behaves as a huge magnet.
   (*c*) the magnetic north pole of the Earth magnet is located very close to its south pole.
   (*d*) the magnetic south pole of the Earth magnet is located very close to its south pole.

11. **The crowding of iron fillings at the end of a bar magnet indicates**
   (*a*) strong magnetic field at the ends of magnet.
   (*b*) strong magnetic field at the centre of a magnet.
   (*c*) weak magnetic field around the region of bar magnet.
   (*d*) all of the above.

12. **No two field lines are found to intersect each other. If they intersect, then at the point of intersection, the compass needle would point**
   (*a*) in two different directions which is possible.
   (*b*) in two different directions which is not possible.
   (*c*) in a particular direction.
   (*d*) nowhere

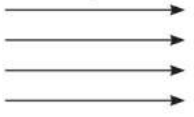
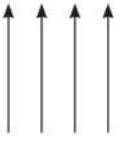
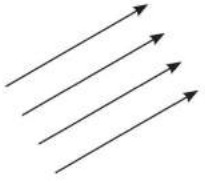
13. **After drawing the magnetic field lines around the bar magnet with the help of a compass needle, a student writes the following statements:**
   I. Symmetrical magnetic field lines pattern is obtained on both the sides of bar magnet.
   II. The field lines around the bar magnet follow the pattern of iron filling around the magnet.
   III. Deflection increases as the needle is moved towards the pole of a bar magnet.
   IV. At the poles of a bar magnet, opposite poles of a compass needle comes to rest.
   Choose which of the following would be correct statement(s).
   (*a*) only III and IV
   (*b*) I, III and IV
   (*c*) I, II and III
   (*d*) All four statements

14. **Equidistance parallel magnetic field lines indicate:**
   (*a*) Uniform magnetic field.
   (*b*) Non-uniform magnetic field.
   (*c*) Both (*a*) and (*b*).
   (*d*) Uniform electric field.

15. **How can you find the direction of magnetic field from a magnetic field line?**
   (*a*) Perpendicular to the tangent drawn at that point.
   (*b*) Along the tangent at any point of the field line.
   (*c*) Along parallel to the field line.
   (*d*) Using Right Hand Thumb rule.

16. **A piece of material that has both attractive and directive properties is called _____.**
   (*a*) magnet (*b*) iron fillings
   (*c*) resistor (*d*) coil (inductor)

17. **A bar magnet is cut into two pieces along its length. Which of the following statement is true?**
   (*a*) Two new bar magnets are created with half of pole strength.
   (*b*) Two new bar magnets are created with double pole strength.
   (*c*) Bar magnet is demagnetized.
   (*d*) The one part created magnetic field while other created electric field.

18. **Which of the following diagram indicating an uniform magnetic field?**
   (*a*) 
   (*b*) 
   (*c*) 
   (*d*) All of the these

19. **Right hand thumb rule is used to determine the**
(*a*) direction of magnetic field.
(*b*) strength of magnetic field.
(*c*) direction of magnetic force.
(*d*) direction of induced current.

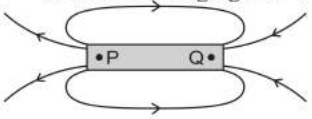
20. **Which of the following process will produce new magnetic poles?**
(*a*) Cutting a bar magnet in two pieces.
(*b*) Current through a solenoid.
(*c*) Placing an iron needle in contact with a magnet.
(*d*) All of the above.

Answers

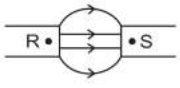
1. (*a*) Oersted showed that electricity and magnetism were related phenomena.
2. (*a*) With the help of magnetic needle, one can find the presence of magnetic field in a region by observing its deflection.
3. (*a*) 4. (*b*) 5. (*a*) 6. (*c*)
7. (*c*) The force acting on the pole of another magnet by the crowded magnetic field lines is greater.
8. (*d*) Outside the magnet, magnetic field line emerges from North-pole and moves towards south-pole.
9. (*d*) 10. (*c*) 11. (*a*) 12. (*b*)
13. (*d*) 14. (*a*) 15. (*b*) 16. (*a*)
17. (*a*) 18. (*d*) 19. (*a*) 20. (*d*)

VSA Very Short Answer Type Questions 2 Marks

21. **(*a*) Name the poles P, Q, R and S of the magnets in the following figures '*a*' and '*b*'.**



'*a*'



'*b*'

(*b*) State the inference drawn about the direction of magnetic field lines on the basis of these diagrams. [CBSE 2022]

Ans. (*a*) In figure '*a*' : P–North pole; Q–South pole
In figure '*b*' : R–North pole; S–South pole
(*b*) The magnetic field lines emerge from the north pole and merge to south pole outside the magnet. (Inside the magnet, the direction is from south pole to north pole).
Alternative answer: Closed curves which emerges from north pole and merge at the south pole.

22. **"Magnetic field is a physical quantity that has both direction and magnitude". How can this statement be proved with the help of a magnetic field lines of a bar magnet?** [CBSE 2022]

Ans. We observe the following two facts about the magnetic field lines of a bar magnet which proves the required statement. These are:
(*i*) Field lines emerge from the north pole and merge at south pole. The deflection in the north pole of compass needle shows that inside the magnet field lines move from south pole to north pole of the bar magnet.
(*ii*) The relative strength of the magnetic field is shown by the degree of closeness of the field lines. Crowded are the field lines, stronger is the field.

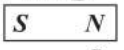
23. **The given magnet is divided into three parts *A*, *B* and *C*.**

A	*B*	*C*

Name the parts where the strength of the magnetic field is : (*i*) maximum, and (*ii*) minimum.
How will density of magnetic field lines differ at these parts?

Ans. Strength of magnetic field is (*i*) maximum at poles of a magnet, i.e. *A* and *C* and (*ii*) minimum at *B*.
The density of field lines will be more i.e., the field lines where they are crowded are *A* and *C* while at *B*, they are spread out away from them.

24. **(*a*) Two magnets are lying side by side as shown below. Draw magnetic field lines between poles *P* and *Q*.**

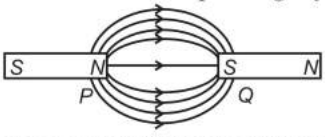


P

Q

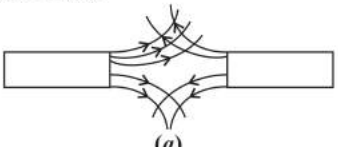
(*b*) What does the degree of closeness of magnetic field lines near the poles signify?

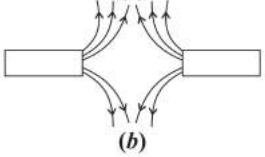
Ans. (*a*)



(*b*) The degree of closeness of magnetic field lines near the poles signify that field is stronger, i.e. the pole of another magnet when placed in the magnetic field experiences a greater force in the region where the field lines are crowded.

25. **Magnetic field lines of two magnets are shown in fig. (*a*) and (*b*).**

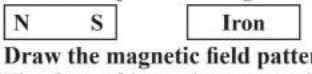

(*a*)


(*b*)

Select the figure that represent the correct pattern of field lines. Give reason for your answer. Also name the poles of the magnet facing each other.

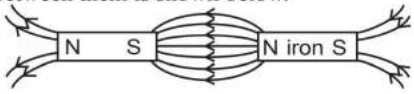
Ans. Figure (*b*) represents the correct pattern of field lines.
In figure (*a*), field lines cross each other which is not possible because at the point of intersection, there will be two directions of field lines.
In figure (*b*), field lines are emerging in nature, so poles of magnet facing each other are north poles while opposite faces will have south polarity.

26. The diagram shows a piece of iron 3 cm long placed near the S-pole of a magnet as shown below.

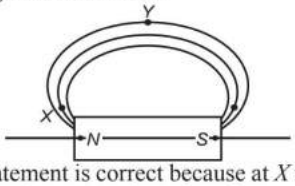


Draw the magnetic field pattern for the same.

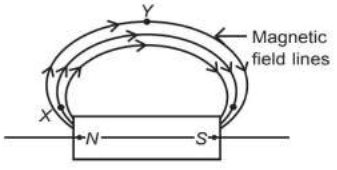
Ans. The face of iron piece towards the S-pole of the magnet will act as a N-pole and its opposite face will act as S-pole. Accordingly magnetic field pattern between them is shown below.



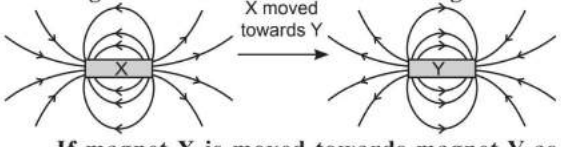
27. Magnetic field lines are shown in the given diagram. A student makes a statement that magnetic field at *X* is stronger than at *Y*. Justify this statement. Also redraw the diagram and mark the direction of magnetic field lines.



Ans. The statement is correct because at *X* magnetic field lines are closer near the poles of a magnet, indicating strong magnetic field. At point *Y*, magnetic field lines are widely separated indicating a weak magnetic field.



28. The figure shows two magnets X and Y kept near each other. Their poles are not marked, but the magnetic field lines are shown in the figure.



If magnet X is moved towards magnet Y as indicated by the arrow, will the two magnets attract or repel each other? Justify your answer by describing how you interpret the field lines. [CFPQ, CBSE]

Ans. They will repel each other.
The right end of magnet X and the left end of magnet Y are both north poles since field lines start from there.

SA Short Answer Type Questions 3 Marks

29. Define magnetic field. What are magnetic field lines? Justify the following statements

(*a*) Two magnetic field lines never intersect each other. [CBSE 2014]

(*b*) Magnetic field lines are closed curves. [CBSE 2015]

Ans. **Magnetic field:** It is the region around a magnetic material such as bar magnet or moving electric charge within which the magnetic force acts.
Magnetic field lines: It is defined as the path along which the unit North pole (imaginary) tends to move in a magnetic field if free to do so.
By drawing a tangent at that point on the magnetic field lines one can find the direction of magnetic field at that point.

(*a*) The magnetic lines of force do not intersect (or cross) one another. If they do so then at the point of intersection, two drawn tangents at that point indicate that there will be two different directions of the same magnetic field, i.e. the compass needle points in two different directions which is not possible.

(*b*) Magnetic field lines are closed continuous curves. They emerge out from the north pole of a bar magnet and go into its south pole. Inside the magnet they move from south pole to north pole.

30. A student dipped a bar magnet in a heap of iron fillings and pulled it out. He found that iron fillings got stuck to the magnet.

(*a*) Which regions of the magnet have more iron fillings sticking to it? What are these regions called?

(*b*) What conclusion would you like to draw from the amount of iron fillings clinging to these regions? [CBSE 2015]

Ans. (*a*) • The ends of the magnet have more amount of iron fillings sticking to it as compared to middle part of the bar magnet. It is because the magnetic strength is maximum at the end and minimum at the middle of the magnet.
• These regions are called pole of the bar magnet.

(*b*) Equal magnetic strength of each pole is indicated by the equal amount of iron fillings clinging to them.

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

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

(*b*) Which physical quantity is indicated by the pattern of field lines around the bar magnet?

(*c*) State any two properties of magnetic field lines. **[CBSE Sample Paper 2023]**

Ans. (*a*) When iron filings are placed in a magnetic field around a bar magnet, they behave like tiny magnets. The magnetic force experienced by these tiny magnets make them rotate and align themselves along the direction of field lines. **(1 Mark)**

(*b*) The physical property indicated by this arrangement is the magnetic field produced by the bar magnet. **(1 Mark)**

(*c*) Magnetic field lines never intersect, magnetic field lines are closed curves. **(1 Mark)**

[CBSE Marking Scheme]

PRACTICE QUESTIONS

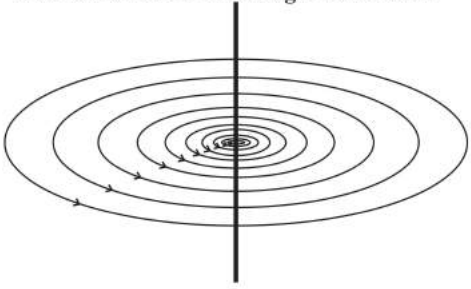
1. Choose the incorrect statement from the following regarding magnetic lines of field
   (*a*) The direction of magnetic field at a point is taken to be the direction in which the north pole of a magnetic compass needle points.
   (*b*) Magnetic field lines are closed curves.
   (*c*) If magnetic field lines are parallel and equidistant, they represent zero field strength.
   (*d*) Relative strength of magnetic field is shown by the degree of closeness of the field lines.
2. The SI unit of magnetic field intensity is
   (*a*) Gauss (*b*) Torr
   (*c*) Tesla (*d*) Newton
3. According to Right-hand thumb rule, the thumb indicates the direction of
   (*a*) magnetic field (*b*) electric current
   (*c*) magnetic force (*d*) motion of the conductor
4. (*a*) In a pattern of magnetic field lines due to a bar magnet, how can the regions of relative strength be identified?
   (*b*) Compare the strength of field near the poles and middle of a bar magnet.
5. "Magnetic field is a physical quantity that has both direction and magnitude." How can this statement be proved with the help of a magnetic field lines of a bar magnet? **[CBSE 2022]**
6. When a compass needle near the north pole of a magnet is placed, how does it behave?
7. Give three uses of magnetic compass needle.

TOPIC COVERED

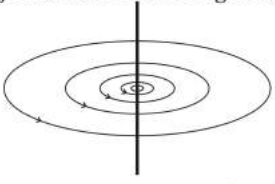
Magnetic Field due to a Current Carrying Conductor

Multiple Choice Questions 1 Mark

1. The diagram below shows the magnetic field lines due to a current in a straight conductor.



Something was done to the current because of which the magnetic field lines changed as shown below.



What was done to the current? **[CFPQ, CBSE]**

(*a*) Its magnitude was increased and its direction reversed.
(*b*) Its magnitude was decreased and its direction reversed.
(*c*) Its magnitude was increased.
(*d*) Its magnitude was decreased.

2. **When a current flows through a straight conductor, a magnetic field is produced around it. Consider the following statements about this field:**
   I. The direction of the magnetic field of a current carrying straight conductor is determined by right-hand thumb rule.
   II. A charged body placed in this field experiences a force whose direction is given by Fleming's left hand rule.
   III. The magnetic field lines around a current carrying straight conductor are in the form of concentric circles with the conductor as the centre.
   The correct statement(s) is/are: [CBSE 2021(C)]
   (*a*) I only (*b*) III only
   (*c*) I and II (*d*) I and III

3. **The strength of magnetic field around a current carrying conductor is**
   (*a*) inversely proportional to the current but directly proportional to the square of the distance from wire.
   (*b*) directly proportional to the current and inversely proportional to the distance from wire.
   (*c*) directly proportional to the distance and inversely proportional to the current.
   (*d*) directly proportional to the current but inversely proportional the square of the distance from wire.

4. **A current through a horizontal power line flows from south to North direction. The direction of magnetic field line 0.5 m above it is towards**
   (*a*) North (*b*) South
   (*c*) West (*d*) East

5. **Who has stated the Right hand Thumb Rule?**
   (*a*) Orsted
   (*b*) Fleming
   (*c*) Einstein
   (*d*) Maxwell

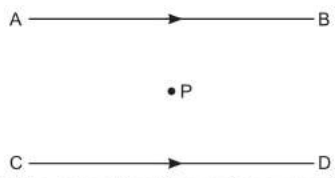
6. **The magnetic field at a point due to current carrying conductor is directly proportional to**
   (*a*) resistance of the conductor.
   (*b*) current flowing through the conductor.
   (*c*) voltage applied across the conductor.
   (*d*) distance of the point from the conductor.

7. **Oersted experiment prove that when an electric current is passed through a conducting wire, a _____ is produced around it.**
   (*a*) Electric field (*b*) Magnetic field
   (*c*) Heat (*d*) Light

8. **Right hand thumb rule is used to determine the**
   (*a*) direction of magnetic field.
   (*b*) strength of magnetic field.
   (*c*) direction of magnetic force.
   (*d*) direction of induced current.

9. **Suppose a horseshoe magnet is held vertically upwards with the North Pole is on left. A wire passing between the poles carries a direct current directed away from you. In what direction is the magnetic force exert on the wire?**
   (*a*) Downward (*b*) Upward
   (*c*) Towards East (*d*) Towards South

10. **The resultant magnetic field at point 'P' situated midway between two parallel wires (placed horizontally) each carrying a steady current *I* is** [CBSE 2023]



   (*a*) in the same direction as the current in the wires.
   (*b*) in the vertically upward direction.
   (*c*) zero
   (*d*) in the vertically downward direction.

Answers

1. (*d*)
2. (*d*)
3. (*b*)
   - magnetic field strength increases on increasing the current through the wire.
   - magnetic field strength decreases as the distance from the wire increases.
4. (*d*) Apply right-hand thumb rule. It is from West to East.
5. (*d*)
6. (*b*)
7. (*b*)
8. (*a*)
9. (*a*)
10. (*c*) Use Right Hand Thumb rule.

VSA Very Short Answer Type Questions 2 Marks

11. **The magnetic field associated with a current carrying straight conductor is in anticlockwise direction.**
    If the conductor was held along the east-west direction, what will be the direction of current through it? Name and state the rule applied to determine the direction of current.

Ans. **Direction of current** – east to west is determined by Right-hand thumb rule.
Right-Hand Thumb Rule : If we hold a current carrying conductor by right hand in such a way that the stretched thumb is along the direction of current,

then the curly fingers around the conductor represents the direction of field lines of magnetic field.

12. A compass needle is placed near a current-carrying wire. State your observation for the following cases, and give reason for the same in each case -
(*a*) Magnitude of electric current in the wire is increased.
(*b*) The compass needle is displaced away from the wire. **[CBSE 2019]**

Ans. (*a*) **Observation:** Deflection of the needle increases
Reason: Magnetic field strength due to current carrying wire increases as current in the wire increases, i.e. $B \propto I$.

(*b*) **Observation:** The deflection in the compass needle decreases as its displacement from the current - carrying wire increases.
Reason: Strength of magnetic field reduces with the increase in distance from the wire as $B \propto \frac{1}{r}$.

13. A student performs an experiment to study the magnetic effect of current around a current carrying straight conductor. He reports that
(*a*) for a given battery, the degree of deflection of a N-pole decreases when the compass is kept at a point farther away from the conductor.
(*b*) the direction of deflection of the north pole of a compass needle kept at a given point near the conductor remains unaffected even when the terminals of the same battery sending current in the wire are interchanged.
Which of the above observations of the student appears to be wrong and why? **[HOTS]**

Ans. (*a*) The first observation is correct because the strength of magnetic field decreases with the increase in distance. As a result, degree of deflection of a N-pole of a compass needle decreases.

(*b*) Second observation is incorrect because if the direction of current is reversed, the direction of field lines will also be reversed. So, north pole of the magnetic compass needle will be directed in the opposite direction.

14. How is the strength of magnetic field near a straight current-conductor
(*a*) related to the strength of current in the conductor? **[CBSE 2014]**
(*b*) is affected by changing the direction of flow of current in the conductor?

Ans. (*a*) The strength of magnetic field around a straight current conductor increases on increasing the strength of current in the conductor or vice versa.

(*b*) The direction of magnetic field around a straight current carrying conductor gets reversed if the direction of current through that conductor is reversed.

15. (*a*) A compass needle gets deflected when brought near a current carrying conductor. Why?
(*b*) What happens to the deflection of the needle when current in the conductor is increased?

Ans. (*a*) The current carrying conductor produces a magnetic field around it. This magnetic field exerts a force on the magnetic needle of compass. As a result, compass needle gets deflected.

(*b*) When the current in the conductor increases, the magnitude of magnetic field produced around it increases and consequently, the deflection in the compass needle increases.

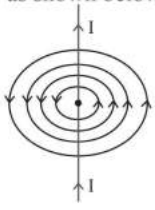
SA Short Answer Type Question 3 Marks

16. (*a*) List two factors on which the magnitude of magnetic field produced by a current carrying straight conductor depends.
(*b*) State the rule which determines the direction of magnetic field in the above case.
(*c*) Draw the pattern of magnetic field lines produced in this case. **[CBSE 2023]**

Ans. (*a*) The factors on which magnitude of magnetic field (B) produced by a current (I) carrying conductor depends
(*i*) **current** flowing in the conductor as $B \propto I$.
(*ii*) **distance (r) from the wire** as $B \propto \frac{1}{r}$

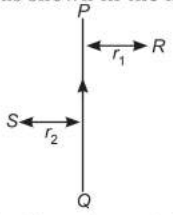
(*b*) **Right hand thumb rule:** It state that it we hold the current carrying conductor in the right hand in such a way that the thumb is stretched along the direction of current, then the curly finger around the conductor represent the direction of magnetic field around the conductor produced by it.

(*c*) **Pattern of magnetic field around current carrying straight conductor** is similar is concentric circles whose centre lie on the conductor as shown below:



Long Answer Type Question 5 Marks

17. PQ is a current carrying conductor in the plane of the paper as shown in the figure below.



(*i*) Find the directions of the magnetic fields produced by it at points R and S.

(*ii*) Given $r_1 > r_2$, where will the strength of the magnetic field be larger? Give reasons.

(*iii*) If the polarity of the battery connected to the wire is reversed, how would the direction of the magnetic field be changed?

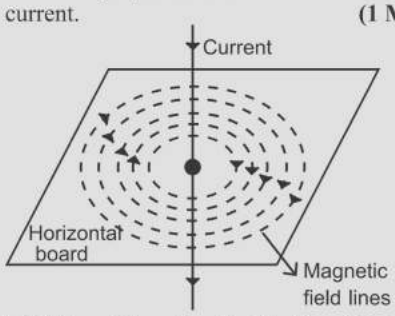
(*iv*) Explain the rule that is used to find the direction of the magnetic field for a straight current carrying conductor.

[CBSE Sample Paper 2021]

Ans. (*i*) The magnetic field lines produced is into the plane of the paper at R and out of it at S. **(1 Mark)**

(*ii*) Field at S > Field at P
Magnetic field strength for a straight current carrying conductor is inversely proportional to the distance from the wire. **(2 Marks)**

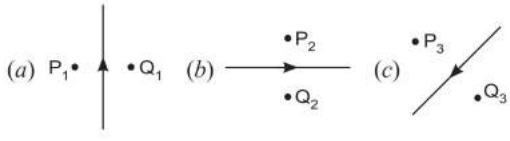
(*iii*) The current will be going from top to bottom in the wire shown and the magnetic field lines are now in the clockwise direction on the plane which is perpendicular to the wire carrying current. **(1 Mark)**



(*iv*) **Right hand thumb rule.** The thumb is aligned to the direction of the current and the direction in which the fingers are wrapped around the wire will give the direction of the magnetic field. **(1 Mark)** [CBSE Marking Scheme]

PRACTICE QUESTIONS

1. According to Right-hand thumb rule, the thumb indicates the direction of
   (*a*) magnetic field
   (*b*) electric current
   (*c*) magnetic force
   (*d*) motion of the conductor
2. The pattern of the magnetic field produced by the straight current carrying conducting wire is
   (*a*) in the direction opposite to the current
   (*b*) in the direction parallel to the wire
   (*c*) circular around the wire
   (*d*) in the same direction of current
3. Draw the magnetic field lines around a straight current carrying conductor. **[CBSE Sample Paper 2021]**
4. How can you show that the magnetic field produced by a given electric current in the wire decreases as the distance from the wire increases?
5. 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 two observations of the student appears to be wrong and why?
6. State and represent the direction of magnetic field produced by the current carrying conductors at point '*P*' and '*Q*' in the following cases.



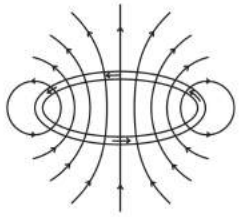
TOPIC COVERED

Magnetic Field due to a Current Carrying Circular Loop

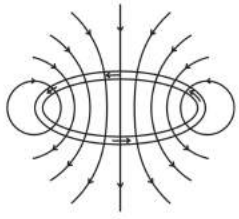
Multiple Choice Questions 1 Mark

1. **The nature of magnetic field line passing through the centre of current carrying circular loop is**
   (*a*) circular (*b*) ellipse
   (*c*) parabolic (*d*) straight line
2. **Every section of the current carrying circular loop contributes to the magnetic field lines within the loop is in the**
   (*a*) same direction
   (*b*) opposite direction
   (*c*) into the page
   (*d*) out of the page
3. **If the radius of a current carrying circular loop is doubled keeping all other factors remain same, then the magnetic field at the centre of the loop becomes**
   (*a*) remains same
   (*b*) twice the original
   (*c*) half the original
   (*d*) thrice the original
4. **Current flows in a circular loop appears to be anticlockwise, the magnetic polarity of that face is**
   (*a*) East (*b*) West
   (*c*) North (*d*) South
5. **Which of the following correctly describes the magnetic field lines within the current carrying circular loop?**
   (*a*) Outwards magnetic field.
   (*b*) Converging magnetic field lines as we move away from the centre of the loop.
   (*c*) Diverging magnetic field lines as we move away from the centre of the loop.
   (*d*) All of the above.
6. **Magnetic field produced by a current carrying circular wire at its centre is**
   (*a*) directly proportional to the current flowing through it.
   (*b*) directly proportional to the number of turns of the coil.
   (*c*) inversely proportional to radius of the coil.
   (*d*) all of the above.
7. **The figure shows the magnetic field caused by a current carrying conductor which is**
   (*a*) straight conductor
   (*b*) a solenoid
   (*c*) a circular coil
   (*d*) all of these
8. **If the current is flowing anti-clockwise in a circular loop then the direction of magnetic field inside the loop is correctly represent by which of the following figure?**

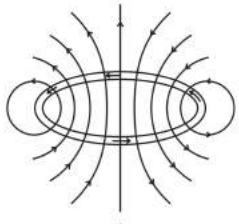
(*a*)



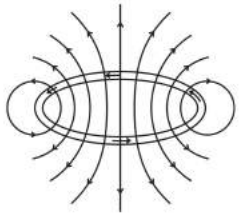
(*b*)



(*c*)



(*d*)

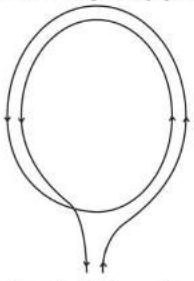


Answers

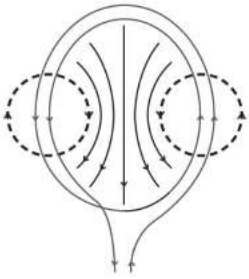
1. (*d*) Magnetic field line at the centre of current carrying loop appears as a straight line.
2. (*a*) 3. (*c*) 4. (*c*) 5. (*c*)
6. (*d*) 7. (*c*) 8. (*a*)

Short Answer Type Questions 3 Marks

9. For the circular coil carrying current shown, draw the magnetic field lines. Decide which of its face behaves as north pole and which face as south pole. Give reason to justify your answer.



Ans. According to the clock face rule, on looking the front face of circular coil, the current flows in the loop in anticlockwise direction. So front face will behave as north pole and back face as south pole because of current in clockwise direction. The magnetic field lines will emerge out from the front face and enter into the coil from the back face as shown below:



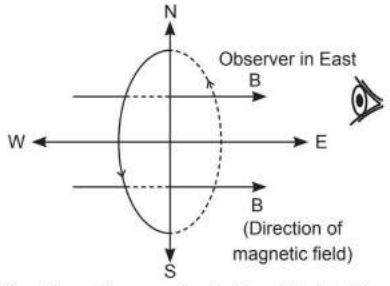
10. How will the magnetic field produced at a point due to a current carrying circular coil change if we:
(*a*) increase the current flowing through the coil?
(*b*) reverse direction of current through the coil?
(*c*) increase the number of turns in the coil?

Ans. Magnetic field (B) at the centre of the circular coil
(*a*) increases if the current is increased as $B \propto I$
(*b*) reverses on reversing the current.
(*c*) increases if the number of turns in the coil increases as field is directly proportional to the number of turns.

11. Find the direction of magnetic field due to current carrying circular coil held:
(*a*) Vertically in North-South plane and an observer looking it from east sees the current to flow in anticlockwise direction.
(*b*) Vertically in East-West plane and an observer looking it from south sees the current to flow in anti-clockwise direction.
(*c*) Horizontally and observer looking at it from below sees current to flow in clockwise direction. [CBSE 2016]

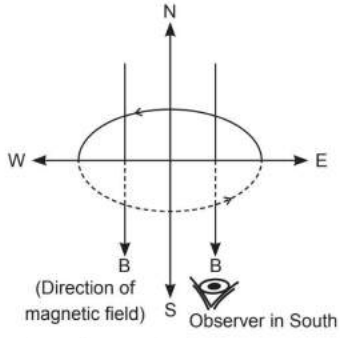
Ans. Direction of magnetic field can be found by using Right hand thumb rule

(*a*)



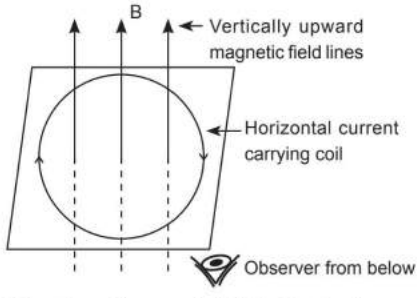
Direction of magnetic field = West to East
(Face of the coil towards observer – North pole)

(*b*)



Direction of magnetic field = North to South
(Face of the coil towards observer – North pole)

(*c*)



Direction of magnetic field = Vertically upwards
(Face of the coil towards observer – South pole)

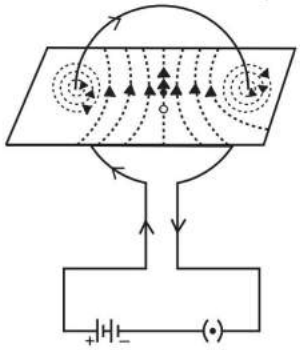
Long Answer Type Question 5 Marks

12. Draw the pattern of magnetic field lines through and around a current carrying loop of wire.
Mark the direction of
(*i*) electric current in the loop
(*ii*) magnetic field lines.
How would the strength of magnetic field due to current, carrying loop be affected if-

(a) radius of the loop is reduced to half its original value?

(b) strength of current through the loop is doubled?

Ans. The direction of electric current in the loop and magnetic field lines is shown in figure given below.



(a) Magnetic field strength (B) produced is inversely proportional to the radius of current carrying loop of wire, i.e.

$$B \propto \frac{1}{r}$$

$$\Rightarrow \quad B_1 = \frac{k}{r_1} \text{ and } B_2 = \frac{k}{r_2}$$

Where k is proportionality constant.

given, $r_2 = \frac{1}{2} r_1$

$$\therefore \quad \frac{B_2}{B_1} = \frac{r_1}{r_2}$$

$$= \frac{r_1}{\frac{1}{2} r_1} = 2$$

$$\Rightarrow \quad B_2 = 2B_1$$

Hence, strength of magnetic field double if the radius of loop is reduced to half its original value.

(b) Strength of magnetic field increases to twice its original value as $B \propto I$.

PRACTICE QUESTIONS

1. There is a current carrying circular coil having n turns. The field produced at its centre is _____ times as that produced by a single turn.
   (a) $n/2$ (b) $2n$ (c) n (d) n^2
2. The ratio of the strength of the magnetic field due to current carrying loop if the magnitude of the current through the loop is doubled is
   (a) 1 : 2 (b) 2 : 1 (c) 4 : 1 (d) 1 : 4
3. Explain with a reason whether the field will be stronger at the centre of current carrying loop or near the circumference of the loop.
4. The flow of current in a circular loop of wire creates a magnetic field at its centre. How may existence of this field be detected? State the rule which helps to predict the direction of this magnetic field.

TOPIC COVERED

Magnetic Field due to a Current in a Solenoid

Multiple Choice Questions 1 Mark

1. **The strength of magnetic field of a current carrying solenoid is** [CBSE 2021C]
   (a) minimum at its ends
   (b) uniform inside it at all points
   (c) maximum at its centre
   (d) zero at its centre
2. **What type of energy conversion is observed in a current carrying linear solenoid?** [CBSE Sample Paper 2021]
   (a) Mechanical to Magnetic
   (b) Electrical to Magnetic
   (c) Electrical to Mechanical
   (d) Magnetic to Mechanical
3. **What will happen if a soft iron bar is placed inside the solenoid?**
   (a) The bar will be electrocuted resulting in short circuit.
   (b) The bar will be magnetised as long as there is current in the circuit.
   (c) The bar will be magnetised permanently.
   (d) The bar will not be affected by any means.
   [CBSE Sample Paper 2021]
4. **The magnetic field lines produced inside the solenoid are similar to that of _____** [CBSE Sample Paper 2021]

(*a*) a bar magnet
(*b*) a straight current carrying conductor
(*c*) a circular current carrying loop
(*d*) electromagnet of any shape

5. **Polarity of a current carrying solenoid can be determined by**
(*a*) use of compass needle
(*b*) Right hand thumb rule
(*c*) Fleming left hand rule
(*d*) either (*a*) or (*b*)

6. **The factors on which one magnetic field strength produced by current carrying solenoids depends are**
(*a*) magnitude of current
(*b*) number of turns
(*c*) nature of core material
(*d*) all of the above

7. **A soft iron bar is introduced inside the current carrying solenoid. The magnetic field inside the solenoid**
(*a*) will decrease (*b*) will remains same
(*c*) will increase (*d*) will become zero

8. **If the direction of current in a solenoid, when viewed from a particular end, is clockwise, then this end of the solenoid will be:**
(*a*) North pole (*b*) East pole
(*c*) West pole (*d*) South pole

9. **The front face towards the observer of a current carrying solenoid behaves like a north pole. The direction of current in this face is**
(*a*) clockwise (*b*) anticlockwise
(*c*) upwards (*d*) downwards

10. **The pattern of magnetic field lines around a current carrying solenoids resemble with the pattern of magnetic field lines**
(*a*) around current carrying straight conductor.
(*b*) around a bar magnet.
(*c*) by a current carrying circular coil.
(*d*) between two magnets facing like poles one-another.

11. **The important features(s) of magnetic field inside the current carrying solenoid is/are**
(*a*) highly uniform.
(*b*) same in strength at all points.
(*c*) in the same direction at all points.
(*d*) all of the above.

Answers

1. (*b*) 2. (*b*) 3. (*b*) 4. (*a*)
5. (*d*) both (*a*) and (*b*) can be use to determine the polarity of solenoid.
6. (*d*) Factors given in (*a*), (*b*) and (*c*).
7. (*c*) Soft iron inside the current carrying solenoid act as an electromagnet.
8. (*d*) 9. (*b*) 10. (*b*) 11. (*d*)

VSA Very Short Answer Type Questions 2 Marks

12. **What does the divergence of magnetic field lines near the ends of a current carrying straight solenoid indicate?**

Ans. The divergence of magnetic field lines near the ends of a current carrying straight solenoid indicate the decrease in strength of magnetic field near and beyond the ends of the solenoid.

13. **What is the purpose of the soft iron core used in making an electromagnet? How is it different from the permanent magnet?**

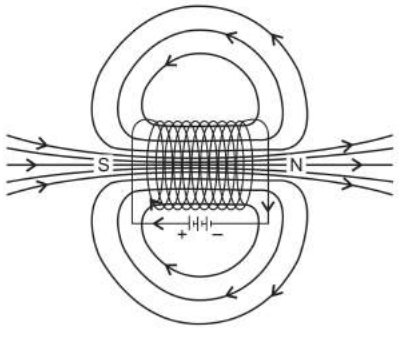
Ans. The purpose of soft iron core used in making an electromagnet that
- It loses all its magnetic property, i.e. magnetism immediately when current in the solenoid is switched off.
- It increases the magnetic field strength of an electromagnet.

It is different from the permanent magnet in the following way:
(*i*) Electromagnet can be demagnetised by stopping the current flowing through the solenoid while permanent magnet cannot be demagnetised easily.
(*ii*) Strength of magnetic field produced by electromagnet can be changed by changing the magnitude of electric current through the solenoid while strength of magnetic field of a permanent magnet cannot be changed.
(*iii*) The polarities of the electromagnet can be interchanged by reversing the direction of current through the solenoid while the polarities of permanent magnet cannot be interchanged.
(*iv*) An electromagnet can easily be made more powerful then the permanent magnet. (*any one*)

14. **(*a*) What is a solenoid?**
(*b*) Draw the pattern of magnetic field lines of the magnetic field produced by a solenoid through which a steady current flows. [CBSE 2022]

Ans. (*a*) **Solenoid:** A coil of many circular turns of copper wire wrapped closely in the shape of cylinder is called a solenoid.

(*b*)

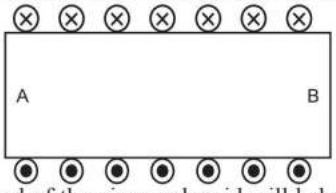


Short Answer Type Questions 3 Marks

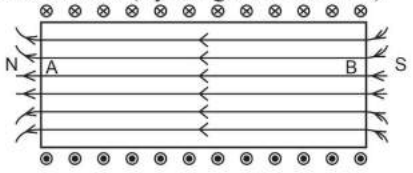
15. How does the strength of the magnetic field produced by a current carrying solenoid increased?

Ans. Strength of the magnetic field can be increased by:
(*i*) increasing the current in the coil
(*ii*) increasing the number of coils in the solenoid; and
(*iii*) using a soft iron core within the solenoid.

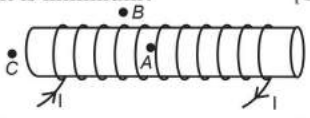
16. Diagram shows the lengthwise section of a current carrying solenoid. ⊗ indicates current entering into the page, ⊙ indicates current emerging out of the page. Decide which end of the solenoid A or B, will behave as north pole. Give reason for your answer. Also draw field lines inside the solenoid.



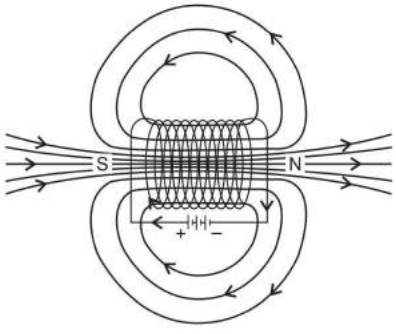
Ans. 'A' end of the given solenoid will behave as north pole because at this end direction of current appears anticlockwise (By using clock face rule)



17. For the current carrying solenoid as shown below, draw magnetic field lines and giving reason explain that out of the three points *A*, *B* and *C* at which point the field strength is maximum and at which point it is minimum? [CBSE 2023, 15]



Ans. Outside the solenoid magnetic field is minimum. At the ends of solenoid, magnetic field strength is half that of inside it. So Minimum – at point *B*; Maximum – at point *A*



18. (*a*) Name the material which can be used to make-
(*i*) Permanent magnet
(*ii*) Temporary magnet
(*b*) State two ways by which the strength of an electromagnet can be increased.

Ans. (*a*) Material which can be used to make
(*i*) Permanent magnet – steel, alloys (Alnico and Nipermag)
(*ii*) Temporary magnet – soft iron
(*b*) Strength of electromagnet can be increased by
(*i*) increasing the number of turns per unit length of the solenoid and
(*ii*) increasing the magnitude of the current through the solenoid.

19. Can a freely suspended current carrying solenoid stay in any direction? Justify your answer. What will happen when the direction of current in the solenoid is reversed?

Ans.
- No, the freely suspended current carrying solenoid always stay only in geographical North and South direction, because it behaves like a bar magnet. The one end of a solenoid behave as a magnetic North pole while the other behave as a South pole.
- If the direction of current in a freely suspended solenoid is reversed, then the polarity of its end will be interchanged and the solenoid will rotate through an angle of 180°.

20. State the various advantages and applications of electromagnet.

Ans. **Advantages of an electromagnet**
1. It produces very strong magnetic field.
2. Its magnetism lasts as long as current flows through it So, it is a temporary magnet.
3. The strength of electromagnet can be controlled by varying either the number of turns or the current flowing through it.
4. Polarity of electromagnet can be interchanged by changing the direction of current flowing through the solenoid.

Applications of electromagnets
1. Electromagnets are used to separate magnetic substances from non-magnetic substances.
2. Electric cranes use the electromagnets to lift and shift heavy iron loads for loading and unloading purpose.
3. They are also used in electric bells, telephones receivers, microphones, loudspeakers, electric relay, television, etc.
4. Hospitals use electromagnets to extract iron or steel bullets from the human body.

Long Answer Type Question 5 Marks

21. (*a*) What is an electromagnet? List any two uses.
(*b*) Draw a labelled diagram to show how an electromagnet is made.
(*c*) State the purpose of soft iron core used in making an electromagnet.
(*d*) List two ways of increasing the strength of an electromagnet if the material of the electromagnet is fixed. **[CBSE 2020]**

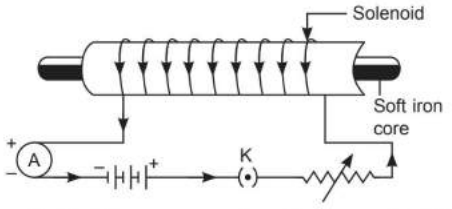
Ans. (*a*) **Electromagnet:** It is a device consisting of an iron or steel core that is magnetised by the strong magnetic field produced by electric current passing through the coil that surrounds it i.e. solenoid.

Uses of electromagnet:

(*i*) It is used to separate magnetic substance from non-magnetic substance.

(*ii*) It is used in electric bells, telephone receivers, microphones, loudspeakers, television etc.

(*b*)



(*c*) (*i*) Soft iron core makes the magnetic field stronger because it becomes a magnet itself.

(*ii*) Soft iron loses its magnetism as soon as the current stops flowing. So, it is a temporary magnet.

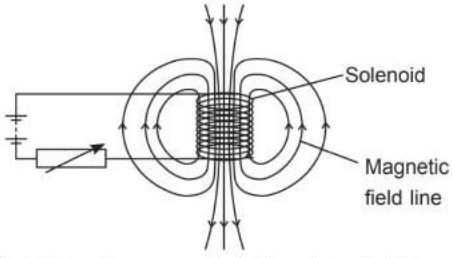
(*d*) Two ways of increasing the strength of an electromagnet:

(*i*) By increasing the current magnitude passing through the solenoid.

(*ii*) By increasing the number of turns in solenoid.

PRACTICE QUESTIONS

1. The magnetic field lines inside a current carrying solenoid is:
   (*a*) along the axis and parallel to each other
   (*b*) perpendicular to the axis of a solenoid
   (*c*) non-uniform
   (*d*) circular and do not intersect each other
2. A soft iron core is inserted inside a current-carrying solenoid. The magnetic field inside the solenoid will
   (*a*) increase
   (*b*) decrease
   (*c*) remain same
   (*d*) becomes zero
3. A long solenoid carrying a current produces a magnetic field B along its axis. If the number of turns per cm is halved, then new value of the magnetic field is
   (*a*) B (*b*) 2B
   (*c*) $\frac{B}{2}$ (*d*) 4B
4. **Give reason:** There is either a convergence or a divergence of magnetic field lines near the ends of a current carrying straight solenoid.
5. A circuit contains a battery, a variable resistor and a solenoid. The figure below shows the magnetic field pattern produced by the current in the solenoid.



   (*a*) State how the magnetic field pattern indicates regions where the magnetic field is stronger.
   (*b*) What happens to the magnetic field when the current in the circuit is reversed?
   [CBSE Sample Question Paper 2022]
6. What is meant by solenoid? How does a current carrying solenoid behave? Give its main use.
   [CBSE 2015]
7. (*a*) Draw circuit diagram of solenoid to prepare an electromagnet.
   (*b*) Can we control the strength of electromagnet? If yes, then how?
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 magnetic compass needle or a bar magnet?

TOPIC COVERED

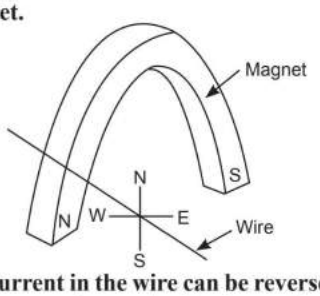
Force on a Current-Carrying Conductor in a Magnetic Field

Multiple Choice Questions 1 Mark

1. **Which one of the following would not experience a force while moving perpendicular to a uniform magnetic field?**
   (*a*) A neutron (*b*) An alpha particle
   (*c*) An electron (*d*) A proton

2. **The direction of force acting on current carrying conductor in external magnetic field is given by**
   (*a*) right hand thumb rule
   (*b*) Fleming's left hand rule
   (*c*) Fleming's right hand rule
   (*d*) Maxwell's cork screw rule

3. **A copper wire is held between the poles of a magnet.**



The current in the wire can be reversed. The pole of the magnet can also be changed over. In how many of the four directions shown can the force act on the wire? [CBSE Sample Paper 2023]
(*a*) 1 (*b*) 2 (*c*) 3 (*d*) 4

4. **When current is parallel to magnetic field, then force experience by the current carrying conductor placed in uniform magnetic field is**
   (*a*) twice to that when angle is 60°
   (*b*) thrice to that when angle is 60°
   (*c*) zero
   (*d*) infinite

5. **Which of the following factors affect the strength of force experience by a current carrying conduct in a uniform magnetic field?**
   (*a*) Magnetic field strength
   (*b*) Magnitude of current in a conductor
   (*c*) Length of the conductor within magnetic field
   (*d*) All of above.

6. **A positive charge is moving upwards in a magnetic field directed towards north. The particle will be deflected towards**
   (*a*) west (*b*) north
   (*c*) south (*d*) east

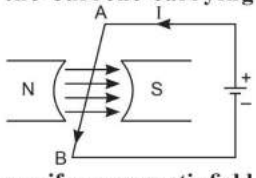
7. **The force acting on conductor is directly proportional to**
   (*a*) strength of external field
   (*b*) strength of electric current
   (*c*) length of conductor
   (*d*) all of these

8. **The maximum force is exerted on the conductor when angle between its direction and that of magnetic field is**
   (*a*) 0° (*b*) 45° (*c*) 90° (*d*) 180°

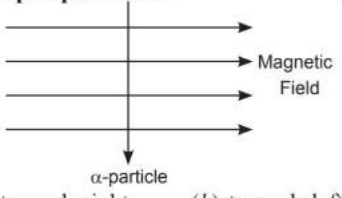
9. **A device based on principle of force acting on a current carrying conductor in external magnetic field is**
   (*a*) electric motor (*b*) electric generator
   (*c*) fuse wire (*d*) earth wire

10. **A current carrying wire has no tendency to rotate in a magnetic field what does it mean?**
    (*a*) wire is parallel to direction of magnetic field.
    (*b*) wire is perpendicular to direction of magnetic field.
    (*c*) wire is having very strong current flowing through it.
    (*d*) magnetic field is very strong.

11. **Based on the diagram, choose the direction of force that act on the current carrying conductor AB:**
    (*a*) upwards
    (*b*) downwards
    (*c*) towards east
    (*d*) towards south

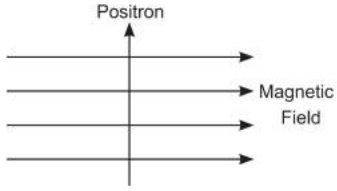


12. **An alpha particle enters a uniform magnetic field as shown. The direction of force experienced by the alpha particle is:** [CBSE 2023]



(*a*) towards right (*b*) towards left
(*c*) into the page (*d*) out of the page

13. **A positron enters a uniform magnetic field at right angles to it as shown. The direction of force experienced by the positron will be**



(*a*) to the right (*b*) to the left
(*c*) into the page (*d*) out of the page

Answers

1. (*a*) 2. (*b*)
3. (*b*) 2 (Either North or South)
4. (*c*) If the current direction is parallel to the magnetic field, then there will no force on the conductor exerted by the magnetic field.
5. (*d*) All the factors affect the strength of magnetic force.
6. (*a*) Apply Fleming's left hand rule
7. (*d*) 8. (*a*) 9. (*a*) 10. (*a*)
11. (*a*) 12. (*d*) out of the page
13. (*c*) into the page

VSA Very Short Answer Type Questions 2 Marks

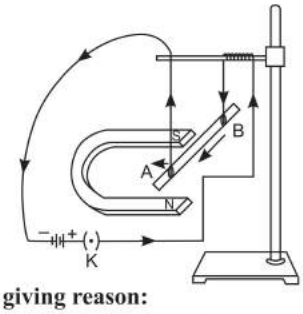
14. (*a*) An alpha particle while passing through a magnetic field gets projected towards north. In which direction will an electron project when it passes through the same magnetic field?
(*b*) Name the rule to determine the direction of magnetic field and direction of motion of electron.

Ans. (*a*) South
(*b*) In both cases it is Fleming's Left Hand rule.

15. When is the force experienced by a current-carrying straight conductor placed in uniform magnetic field
(*a*) Maximum; (*b*) Minimum **[CBSE 2022]**

Ans. (*a*) **Maximum:** When the direction of current in a current carrying conductor is perpendicular to the direction of magnetic field.
(*b*) **Minimum:** (Zero) When the direction of current in a current carrying conductor is parallel/anti-parallel/along the direction of magnetic field.

16. As shown in the diagram an aluminium rod 'AB' is suspended horizontally between the two poles of a strong horse shoe magnet in such a way that the axis of rod is horizontal and the direction of the magnetic field is vertically upward. The rod is connected in series with a battery and a key.



State giving reason:
(*a*) What is observed when a current is passed through the aluminium rod from end B to end A?
(*b*) What change is observed in a situation in which the axis of the rod 'AB' is moved and aligned parallel to the magnetic field and current is passed in the rod in the same direction? **[CBSE 2022]**

Ans. (*a*) Rod AB get displaced **(½ Marks)**
Reason: When a current carrying conductor is placed in an external magnetic field perpendicularly, it experiences a maximum force. **(½ Mark)**
(*b*) As current and magnetic field are parallel, there will be no force experienced by the conductor. Hence, no displacement in rod. **(1 Mark)**
[CBSE Marking Scheme]

17. What are the factors which govern the force experienced by a current carrying conductor placed in a uniform magnetic field depends?

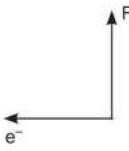
Ans. The factors which govern the force experienced by conductor which is placed in a uniform magnetic field are:
(*a*) strength of the magnetic field in which conductor is placed.
(*b*) strength of current flowing through the conductor.
(*c*) length of conductor.

18. Why and when does a current carrying conductor kept in a magnetic field experience force? List the factors on which direction of this force depends? **[CBSE 2014]**

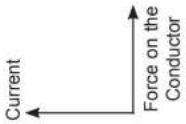
Ans. The drifting of free electrons of a conductor in a definite direction causes the current to flow through it. When such conductor is placed in a uniform magnetic field, each drifted electron of a conductor experience a magnetic force. This force is collectively experience by a conductor as a whole. Hence a current carrying conductor kept in a magnetic field experience a force.
The direction of magnetic force depends on
(*i*) direction of current through the conductor, and
(*ii*) direction of magnetic field.

19. State the direction of magnetic field in the case as shown.

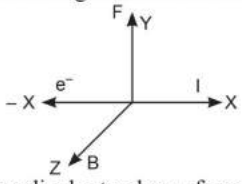
(*i*)



(*ii*)



Ans. (*i*) In given situation, according to Fleming's Left-Hand Rule, Force is along *y*-axis.
Current is along *x*-axis.
Then magnetic field is along *z*-axis.



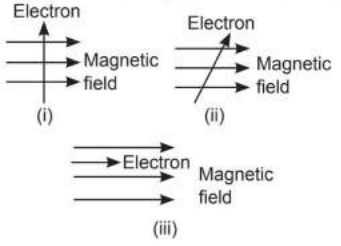
(*ii*) Perpendicular to plane of paper in the outward direction by using Fleming's Left-Hand Rule.

SA Short Answer Type Questions 3 Marks

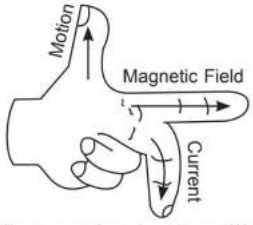
20. What happens to the force acting on current carrying conductor placed in magnetic field when:
(*a*) Direction of magnetic field is reversed without changing the direction of current.
(*b*) Direction of the current is reversed without changing the direction of magnetic field.
(*c*) Direction of both the current and the magnetic field is reversed.

Ans. Force acting on a current carrying conductor placed in a magnetic field will
(*a*) act in opposite direction to that of previous direction.
(*b*) act in opposite direction to that of previous direction.
(*c*) remain in the same direction.

21. (*a*) State the rule used to find the force acting on a current carrying conductor placed in a magnetic field.
(*b*) Given below are three diagrams showing entry of an electron in a magnetic field. Identify the case in which the force will be
(1) maximum and (2) minimum respectively. Give reason for your answer. **[CBSE 2023]**



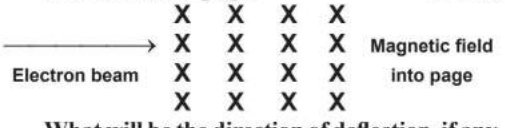
Ans. (*a*) **Fleming's Left-Hand Rule:** Stretch the thumb, forefinger and middle finger of the left hand mutually perpendicular to each other such that the forefinger point towards the direction of magnetic field, the middle finger points in the direction of current, then the thumb will indicate the direction of motion or force experienced by the conductor. It is to be applied only when the current and magnetic fields both are perpendicular to each other.



(*b*) (1) Force on the electron will be **maximum** in the case of figure (*i*) because the direction of motion of electron and magnetic field both are perpendicular to each other.
(2) Force on the electron will be **minimum** in the case of figure (*iii*) because the electron is moving along the direction of magnetic field.

LA Long Answer Type Questions 5 Marks

22. (*a*) Mention the factors on which the direction of force experienced by a current carrying conductor placed in a magnetic field depend.
(*b*) A proton beam is moving along the direction of magnetic field. What force acting on proton beam?
(*c*) The diagram shows a beam of electrons about to enter a magnetic field. The direction of the field is into the page. **[HOTS]**



What will be the direction of deflection, if any, as the beam passes through the field?

Ans. (*a*) The direction of force experienced by a current carrying conductor placed in a magnetic field depends on
(*i*) direction of current in a conductor, and
(*ii*) direction of magnetic field.
(*iii*) angle between the direction of current and direction of magnetic field and
(*iv*) length of the conductor which is placed in magnetic field.

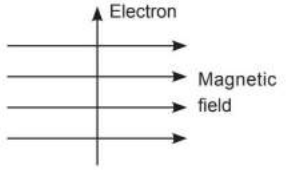
(*b*) The parallel or anti-parallel magnetic field does not exert any force on the charge particle which

moves along the direction of magnetic field. Hence, the proton beam does not experience any force.

(*c*) Direction of current is from right to left as electron beam enters from left to right and magnetic field is into the page. So, according to Fleming's left hand rule, force is perpendicular to the flow of current and in its left side. So, electron beam deflects towards bottom of the page.

PRACTICE QUESTIONS

1. Magnitude of the magnetic force experienced by a current carrying conductor in a uniform magnetic field is maximum when the magnetic field and current direction are
   (*a*) mutually perpendicular to each other
   (*b*) at angle of 60°
   (*c*) at angle of 120°
   (*d*) at angle of 180°
2. The current in the wire is directed towards east and wire is placed in a magnetic field towards north, the force on the wire is
   (*a*) due east
   (*b*) due west
   (*c*) vertically downwards
   (*d*) vertically upwards
3. Name two devices that uses the current carrying conductors and magnetic field.
4. (*a*) State one application of Fleming's left hand rule.
   (*b*) An electron enters a magnetic field at right angles to it, as shown in figure. What will be the direction of force acting on the electron?



5. State whether an alpha particle will experience any force in a magnetic field if (alpha particles are positively charged particles)
   (*a*) it is placed in the field at rest.
   (*b*) it moves in the magnetic field parallel to field lines.
   (*c*) it moves in a magnetic field perpendicular to field lines.

   Justify your answer in each case. **[CBSE 2016]**

TOPIC COVERED

Domestic Electric Circuits

Multiple Choice Questions 1 Mark

1. **At the time of short circuit, the electric current in the circuit** **[CBSE 2020]**
   (*a*) vary continuously
   (*b*) does not change
   (*c*) reduces substantially
   (*d*) increases heavily
2. **The most important safety method used for protecting home appliances from short circuiting or overloading is**
   (*a*) earthing (*b*) use of fuse **[KVS]**
   (*c*) use of stabilizers (*d*) use of electric meter
3. **Earth wire carries**
   (*a*) current (*b*) voltage
   (*c*) no current (*d*) heat
4. **Which among of these are the main characteristics of fuse element?**
   (*a*) High conductivity
   (*b*) Low melting point
   (*c*) Do not burn due to oxidation
   (*d*) All of the above
5. **Overloading is due to**
   (*a*) Insulation of wire is damaged
   (*b*) Fault in the appliances
   (*c*) Accidental hike in supply voltage
   (*d*) All of the above
6. **The metallic body of electrical appliances are connected to the earth wire. For the current, this will provide**
   (*a*) a low-resistance conducting path.
   (*b*) a high-resistance insulating path.
   (*c*) a medium resistance conducting path.
   (*d*) a closed zero resistance insulating path.
7. **The potential difference between the live wire and neutral wire in our country is**
   (*a*) 110 V (*b*) 220 V
   (*c*) 300 V (*d*) 50 V

8. **The user of electrical appliances may not get a severe electric shock due to**
   (*a*) touching the appliances with bare foot
   (*b*) absence of fuse wire
   (*c*) earthing of appliances
   (*d*) short circuit

9. **Which type of current rating supply is required in our country for the electrical devices such as geysers, air conditioners, room heaters etc?**
   (*a*) 220 V, 5 A (*b*) 110 V, 5 A
   (*c*) 220 V, 15 A (*d*) 110 V, 15 A

10. **In domestic electric circuits the wiring with 15 A current rating is for the electric devices which have** [CBSE 2023]
   (*a*) higher power ratings such as geyser.
   (*b*) lower power ratings such as fan.
   (*c*) metallic bodies and low power ratings.
   (*d*) non-metallic bodies and low power ratings.

Answers

1. (*d*)
2. (*b*) It is most important method for protecting the electrical devices from short circuiting or overloading by stopping the flow of any large electric current exceeds from its rating.
3. (*c*) Earth wire carries no current.
4. (*d*) Fuse wire must have all the characteristic to prevent from a possible damage.
5. (*d*) All are the causes to occur overloading
6. (*a*) 7. (*b*) 8. (*c*) 9. (*c*)
10. (*a*)

VSA Very Short Answer Type Questions 2 Marks

11. **Give scientific reasons.**
   (*a*) Wires carrying electricity should not be touched when bare-footed.
   (*b*) We must not use many electrical appliances simultaneously.

Ans. (*a*) When we touch the live wire bare-footed, our body is directly in contact with the earth. So, current passes through the body to the earth. As our body is good conductor of electricity, we get a severe shock. Hence, we should not handle live wires bare footed.
(*b*) When many high power rating appliances are switched on simultaneously, a large amount of current flows through the main circuit and current may exceed the bearing capacity of the connecting wires. This causes overloading, which may cause fire. Hence, we must not use many electrical simultaneously.

12. **Explain, why fuse wire is made of a tin-lead alloy and not copper?**

Ans. Tin-lead alloy has a low melting point so wire made of this alloy melt easily whereas copper has a high melting point due to which fuse made of copper wire will not melt easily when a short circuit takes place.

13. **Explain any two situations that can cause electrical hazards in domestic circuits.** [CBSE 2013]

Ans. (*i*) Connecting too many electrical devices to a single socket or in the extension cord for any length of time draws high current from the mains that will exceed the current rating of connecting wires. The wires cannot withstand such a high current and melt and may cause fire.
(*ii*) Most electrical hazards in domestic circuits are caused by the faulty electrical outlets, old and out-dated appliances. The chances of short circuit, i.e. contact of live wire and neutral wires with each other due to damage in their insulation or some fault in the appliances are very high. It may result spark at the contact point which may even cause fire.

14. **(*a*) Electrical switches should not be operated with wet hand.**
   (*b*) In domestic electric circuit, with which wire we connect a fuse?

Ans. (*a*) Switches should not be operated with wet hand: Water is a good conductor of electricity as it contains salt and impurities. When we touch the switch with wet hand, it is possible that electric current will pass through our body and we get a severe shock.
(*b*) Fuse is always connected in series with live wire.

15. **Earth wire has zero voltage just like the neutral wire, then what is the difference between these two wires?**

Ans. Earth wire provides a good grounding connection between the metallic case of an electrical appliance and the ground, which helps to save the user from getting a severe electric shock in case of any leakage of current, while neutral wire provides a return path for the current.

16. **Cable of a microwave oven has three wires inside it which have insulation of different colours black, green and red. Mention the significance of the three colours and potential difference between red and black one.** [DoE]

Ans. **Significance of insulation colour:**
(*i*) Red colour insulation wire – Live wire
(*ii*) Black colour insulation wire – Neutral wire
(*iii*) Green colour insulation wire – Earth wire
Live wire is at higher potential of 220 V while neutral wire is at zero potential. So, potential

difference between red and black insulation wire is 220 V.

17. **(*a*) Why switches are connected in live wire not in neutral wire?**
(*b*) Can we use the same kind of fuse for both power and lightning circuits?

Ans. (*a*) Switch is always connected in the live wire because
(*i*) the appliances must be put to the high potential terminal.
(*ii*) in OFF position, circuit is incomplete, i.e. the circuit will becomes an open circuit. Therefore, no current reaches to appliances.
But if we connect the switch in neutral wire, the appliance remain connected with live wire which is dangerous for the user.
(*b*) No, for power circuit, the fuse rating is 15 A while for lightning circuit, fuse rating is 5 A.

Short Answer Type Questions 3 Marks

18. **(*i*) Why is an alternating current (A.C.) considered to be advantageous over direct current (D.C.) for the long distance transmission of electric power?**
(*ii*) How is the type of current used in household supply different from the one given by a battery of dry cells?
(*iii*) How does an electric fuse prevent the electric circuit and the appliances from a possible damage due to short circuiting or overloading? [CBSE 2023]

Ans. (*i*) AC is preferred over DC because it can be transmitted over long distance without much loss of energy.
(*ii*) • In household supply, alternating current (AC) is used. The source of AC is AC generator.
• The current given by a battery of dry cell is direct current (DC).
• (*a*) The alternating current (AC) reverses its direction periodically whereas the direct current (DC) always flow in one direction.
(*b*) The frequency of AC is 50 Hz while that for DC is zero.
(*iii*) Fuse wire, an alloy of copper, aluminium, tin, lead, etc. having low melting point. When excessive amount of current larger than the specified value due to short circuiting or overloading flows through the circuit, the temperature of fuse wire increases. The heating effect of current causes the fuse wire to melt and breaks the circuit there by stopping the flow of current in the circuit.
Thus, electric fuse prevent the electric circuit and appliances from a possible damage due to short circuiting or overloading.

19. **State the consequences that can lead to a short circuit.**

Or

One of the major cause of fire in office building is short circuiting. List three factors which may lead to the short circuit. [CBSE 2014]

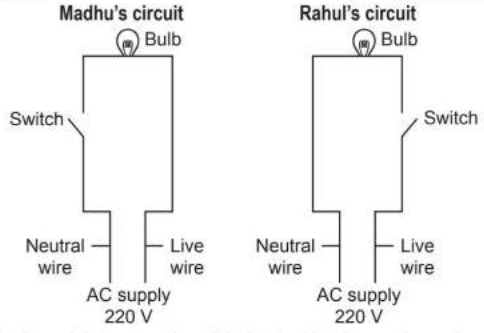
Ans. It occurs as a consequence of
- failure of electrical insulations due to which live wire comes in direct contact with neutral or earth wire.
- presence of external conducting material (such as water) that is introduced accidently into the circuit.
- electrical appliances are forced to operate when its moving parts are jammed.
- connection of current carrying parts of electrical equipment's to one another due to human or natural cause or
- use of less rating wires.

When this happens, there is a flow of an excessive electric current which can damage the circuit and may also cause electrical fires.

20. **Explain the meaning of overloading of an electrical circuit. List two possible causes due to which overloading may occur in household circuits.**
Write one preventive measure that should be taken to avoid overloading of domestic circuits. [CBSE 2023]

Ans. • **Overloading:** If the current drawn by the many electrical appliances connected to a single socket exceeds the current rating of the wire, the entire circuit or part of circuit gets heated and can even cause fire. This is known as overloading.
• It might be due to
(*i*) accidental hike in supplied voltage or
(*ii*) connecting too many appliances to a single socket or
(*iii*) damage in the insulation of wires or
(*iv*) some fault in the appliances or
(*v*) direct contact between a live wire and a neutral wire.
• **Preventive measure to avoid overloading are:**
(*i*) An excess number of electrical device should not be connected to the same single socket.
(*ii*) One should not use too many appliances having high power device at the same time.
(*any one*)

21. Observe Madhu's and Rahul's circuits shown below. [CFPQ, CBSE]



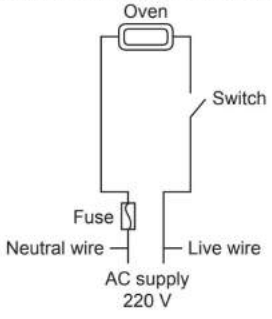
(*a*) In which circuit will the bulb glow when the switch is closed? Explain why.

(*b*) Both Madhu and Rahul open the switches in their circuits to change the bulbs. For whom will changing the bulb be safe and for whom will it be dangerous? Explain why.

Ans. (*a*)
- The bulb will glow in both the circuits.
- The circuits will be closed/complete.

(*b*)
- Changing the bulb will be dangerous for Madhu.
- Changing the bulb will be safe for Rahul.
- In Madhu's circuit, the bulb point is still connected to the live wire and can give an electric shock even when the switch is in the open position.
- In Rahul's circuit, the bulb point is no longer connected to the live wire when the switch is in the open position.

22. (*a*) In the circuit below, in case of an overload, will the fuse protect the electric oven from damage? Justify your answer.



(*b*) If the oven has a rating of 13 A, what should be the minimum rating of the fuse? [CFPQ, CBSE]

Ans. (*a*)
- No
- The fuse will blow only after current has passed through the oven and damaged it.

(*b*) A little above 13 A, i.e., 14 A, 15 A.

23. (*a*) An electric fuse of rating 3 A is connected in a circuit in which an electric iron of power 1.5 kW is connected which operates at 220 V. What would happen? Explain. [CBSE 2015]

(*b*) Which effect of electric current is utilised in the working of an electrical fuse?

(*c*) Name two safety measures taken in domestic circuits.

Ans. (*a*) Power, $P = VI$

$$\Rightarrow \quad I = \frac{P}{V} = \frac{1.5\text{ kW}}{220\text{ V}}$$

$$= \frac{1500\text{ W}}{220\text{ V}} = 6.8\text{ A}$$

Thus, current drawn by the electric iron is much more greater than the fuse rating 3 A. So, fuse will be blown.

(*b*) Heating effect of electric current.

(*c*) Earthing and fuse.

24. (*a*) State two point difference between short circuit and overloading.

(*b*) An electric sandwich maker of 1.0 kW is operated in a domestic circuit (220 V) that has a current rating of 5 A. What result do you expect in this case? Explain.

Ans. (*a*)

Short circuit	Overloading
1. It occurs when live wire comes in direct contact with neutral wire.	1. It occurs by connecting too many appliances to a single socket and turned on simultaneously.
2. Current in the circuit abruptly increases.	2. Less amount of current flows as compared to short circuit.
3. Voltage drops to zero.	3. Voltage becomes low but cannot be zero.

(*b*) Current drawn by electric oven,

$$I = \frac{P}{V} = \frac{1.0\text{ kW}}{220\text{ V}} = \frac{1000\text{ W}}{220\text{ V}} = 4.54\text{ A}$$

which is less than the current rating 5 A. So fuse will not blow off and oven will work continuously.

25. (*a*) Why the current abruptly increases during short circuit? Explain.

(*b*) When you connect the live wire to the neutral wire through an electric bulb a short circuit does not occur. Why?

Ans. (*a*) During the short circuit, at the point of contact, the resistance becomes zero. So as per Ohm's law,

$$I = \frac{V}{R} = \frac{V}{0} = \text{(infinite)}$$

Hence, infinite or maximum current will flow from that path which is called short circuit.

(*b*) The filament of an electric bulb has some resistance. When a current passes through it, there is some potential drop across the resistance. This will limit the flow of current and ensure that a short circuit does not occur.

Long Answer Type Questions 5 Marks

26. (*a*) Explain why there are two separate circuits one for high power rating appliances and other for low power rating appliances.

(*b*) A domestic circuit has 5 A fuse. How many bulbs of rating 100 W, 220 V can be safely used in this circuit? Justify your answer.

[CBSE 2014]

Ans. (*a*) Two separate circuits are formed in the domestic wiring, one for high power rating appliances called power circuit and other for low power rating called lightning circuit.

Power circuit: The circuit which draw heavy current (15 A) from mains and used for high power rating devices such as microwave, oven, air conditioners, geysers, washing machine, etc. is known as power circuit.

Lightning circuit: The circuit which draw small amount of current from the mains and used for low power rating devices such as bulb, tube light, fans, T.V., Computer, etc. having a current rating of 5A is known as lightning circuit.

(*b*) Power rating of bulb = 100 W, 220 V

Electric current flowing in the circuit is given by

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

Hence, $I = 5$ A, $V = 220$ V and $P = n \times 100$ W

Where, n = number of bulbs

$$\therefore \quad 5 = \frac{n \times 100}{220}$$

$$\therefore \quad n = \frac{5 \times 220}{100} = \frac{1100}{100} = 11$$

So, 11 bulbs of 100 W can be used in the domestic circuit having potential difference of 220 V.

27. State the various advantages and disadvantages of AC over DC.

Ans. Advantages of AC over DC.

(*i*) The generation of AC is cheaper than that of DC.

(*ii*) AC voltage can be stepped up or stepped down with the help of transformers.

(*iii*) The magnitude of AC can be controlled by using inductor (coil) without any appreciable loss of energy.

(*iv*) AC can easily be converted into DC with the help of rectifiers.

(*v*) AC can be transmitted over a long distance without much loss of energy as compared to a DC transmission.

(*vi*) AC devices are highly efficient, more durable, less expensive and are simple in their functions.

Disadvantages of AC.

(*i*) It is dangerous to use due to its high peak value. Therefore, good insulation of wire is required.

(*ii*) As AC is transmitted near the surface of a conductor, it needs several strands of thin wire insulated from each other.

(*iii*) Any electrical equipment which need DC cannot run on AC.

(*iv*) At higher voltage of AC, more safety measures are required.

(*v*) AC attracts a person who touches it unlike DC which gives a repelling shock.

28. Although electric kettle and electric toaster were used simultaneously in the kitchen to prepare breakfast for the family, yet the two devices could work efficiently due to 'fuse' used in the electric circuit.

(*i*) What is a fuse? Write the material used in fuse wires. How is a fuse connected in an electric circuit?

(*ii*) State the ratings of fuse used in electric circuits.

(*iii*) What is the function of a fuse? How does it perform its function?

(*iv*) A device uses 1 kW electric power when operated at 220 V. Calculate the rating of the fuse to be used. **[CBSE 2021(C)]**

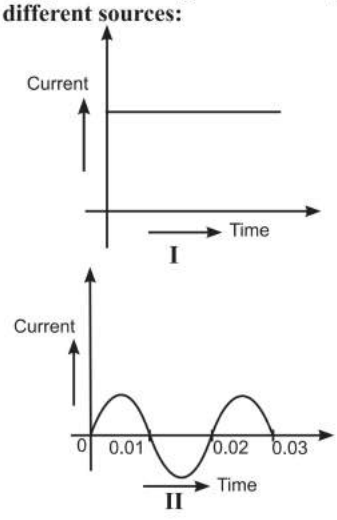
Ans. (*i*)
- A fuse is a safety device / used in domestic electric circuits to prevent damages from short circuiting or overloading. **(½ Mark)**
- An alloy / metal of appropriate (lower) melting point / aluminium / copper / iron / lead etc. **(½ Mark)**
- In series **(½ Mark)**

(*ii*) 1A, 2A, 3A, 5A, 10A (any other appropriate value) **(½ Mark)**

(*iii*)
- To protect the circuits and appliances by stopping the flow of unduly high electric current. **(½ Mark)**
- If current larger than the specified / rated value flows through the circuit, the temperature of the fuse wire increases, this melts the fuse wire and breaks the circuit. **(½ Mark)**

(*iv*) Power = 1 kW; V = 220 V; I = ?
Formula used
• $P = VI$ **(½ Mark)**
$\Rightarrow$ $I = \frac{P}{V} = \frac{1000}{220}$ **(½ Mark)**
$= 4.54$ A **(½ Mark)**
Rating of fuse will be 5A and above **(½ Mark)**
[CBSE Marking Scheme]

29. You are given following current-time graphs from two different sources:

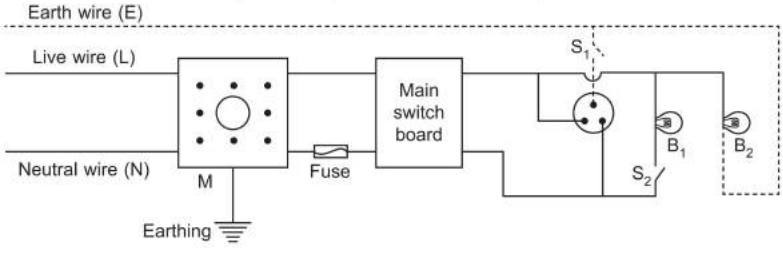


(*a*) Name the type of current in two cases.
(*b*) Identify any one source for each type of these currents.
(*c*) What is the frequency of current in case II in India?
(*d*) Use above graphs to write two differences between the current in two cases.
(*e*) After what interval of time current in the case II changes its direction?

Ans. (*a*) DC in case I and AC in the case II.
(*b*) Cell or a battery – Source of DC.
Generator – Source of AC.
(*c*) Frequency of AC is 50 Hz in India while DC has zero frequency.
(*d*) In case I, current remains constant and frequency is zero whereas in case II, current varies periodically with a frequency of $\frac{1}{0.02 \text{ sec}}$ = 50 Hz. in India.
(*e*) From graph, the time interval after which AC current changes its direction is 0.01 second.

PRACTICE QUESTIONS

1. Overloading is due to
(*a*) direct contact between live wire and neutral wire.
(*b*) accidental hike in supply voltage.
(*c*) connecting too any appliances to a single socket.
(*d*) all of the above.
2. A fuse is normally a
(*a*) current rating device
(*b*) voltage rating device
(*c*) power rating device
(*d*) all of the above
3. (*a*) Give one difference between the wires used in the element of an electric heater and in a fuse.
(*b*) A domestic circuit is shown in figure. Analyse it and find out any four mistakes and their corrections.



INTEGRATED (MIXED) QUESTIONS

1. The instrument that use to detect electric current in the circuit is known as **(1 Mark)**
   (*a*) electric motor
   (*b*) A.C generator
   (*c*) galvanometer
   (*d*) none of these

2. State and explain the rule to determine the direction of a
   (*a*) magnetic field produced around a straight conductor-carrying current.
   (*b*) force experienced by a current-carrying straight conductor placed in a magnetic field that is perpendicular to it. **[DoE 2023] (3 Marks)**

ASSERTION AND REASON QUESTIONS

In the following Questions, the Assertion and Reason have been put forward. Read the statements carefully and choose the correct alternative from the following:

(*a*) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.
(*b*) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.
(*c*) Assertion is true but the Reason is false.
(*d*) The statement of the Assertion is false but the Reason is true.

1. **Assertion:** At high temperature, metal wires have a greater chance of short circuiting.
   Reason: Both resistance and resistivity of material vary with temperature.

2. **Assertion:** A stationary charged particle placed in a magnetic field experiences a force.
   Reason: A stationary charged particle does not produce a magnetic field.

3. **Assertion:** It is easier to bring North pole of a magnet to South pole of other magnet.
   Reason: There is a force of attraction between unlike poles of magnet.

4. **Assertion:** A compass needle gets deflected when electric current is passed through the metallic conductor.
   Reason: Current carrying conductor produces magnetic field which exerts the force on the compass needle.

5. **Assertion:** The magnetic field inside a solenoid is uniform.
   Reason: The magnetic field lines inside a solenoid are parallel. **[KVS]**

6. **Assertion:** The magnitude of the magnetic field at a point on the axis of a current carrying solenoid is inversely proportional to the current through the solenoid.
   Reason: The magnitude of the magnetic field at a point on the axis of a current carrying solenoid is directly proportional to the number of turns per unit length of a solenoid. **[DoE 2023]**

7. **Assertion:** On freely suspending a current – carrying solenoid, it comes to rest in Geographical N-S direction.
   Reason: One end of current carrying straight solenoid behaves as a North pole and the other end as a South pole, just like a bar magnet.

8. **Assertion:** A current carrying straight conductor experience a force when placed perpendicular to the direction of magnetic field.
   Reason: The net charge on a current carrying conductor is always zero. **[CBSE 2023]**

9. **Assertion:** When the direction of velocity of moving charge is perpendicular to the magnetic field, it experience a maximum force.
   Reason: Force on the moving charge does not depends on the direction magnetic field in which it moves.

10. **Assertion:** It is fatal to touch a live electric wire as the person gets a severe electric shock. In some cases, electric shock can even kill a person.
    Reason: The electric current passes through the body to the earth forming a circuit and burns the blood.

11. **Assertion:** Fuse is a safety device which is installed to prevent electrical circuits and possible fires.
    Reason: Fuse consist of tin-plated copper wire having low melting point, which melts and breaks the circuit if the current exceeds a safe value.

12. **Assertion:** When a battery is short circuited, the terminal voltage is zero.
Reason: In short circuit, the current is zero.

13. **Assertion:** Magnetic field lines do not intersect each other.
Reason: Magnetic field lines are imaginary lines, the tangent to which any point gives the direction of the field at that point. **[CBSE 2023]**

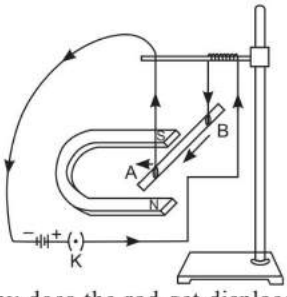
14. **Assertion:** The strength of the magnetic field produced at the centre of a current carrying circular coil increases on increasing the number of turns in it.
Reason: The current in each circular turn has the same direction and the magnetic field due to each turn then just adds up. **[CBSE 2023]**

CASE-BASED QUESTIONS

The following questions are source-based/case-based questions. Read the case carefully and answer the questions that follow.

1. A student fixes a sheet of white paper on a drawing board using some adhesive materials. She places a bar magnet in the centre of it and sprinkles some iron filings uniformly around the bar magnet using a salt-sprinkler. On tapping the board gently, she observes that the iron filings have arranged themselves in a particular pattern. **[CBSE 2022]**
   (*a*) Draw a diagram to show this pattern of iron filings.
   (*b*) Draw the magnetic field lines of a bar magnet showing the poles of the bar magnet as well as the direction of the magnetic field lines.
   (*c*) (*i*) How is the direction of magnetic field at a point determined using the field lines ? Why do two magnetic field lines not cross each other ?
   Or
   (*ii*) How are the magnetic field lines of a bar magnet drawn using a small compass needle ? Draw one magnetic field line each on both sides of the magnet.
   [CBSE 2022]

2. A student was asked to perform an experiment to study the force on a current carrying conductor in a magnetic field. He took a small aluminum rod AB, a strong horse shoe magnet, some connecting wires, a battery and a switch and connected them as shown. He observed that on passing current, the rod gets displaced. On reversing the direction of current, the direction of displacement also gets reversed. On the basis of your understanding of this phenomenon, answer the following questions : **[CBSE 2022]**



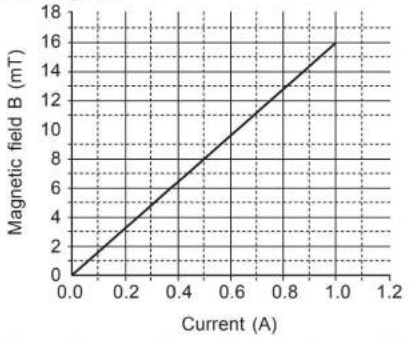
   (*a*) Why does the rod get displaced on passing current through it ?
   (*b*) State the rule that determines the direction of the force on the conductor AB.
   (*c*) (*i*) In the above experimented set up, when current is passed through the rod, it gets displaced towards the left. What will happen to the displacement if the polarity of the magnet and the direction of current both are reversed ?
   (*ii*) Name any two devices that use current carrying conductors and magnetic field.
   Or
   (*c*) Draw the patten of magnetic field lines produced around a current carrying straight conductor held vertically on a horizontal cardboard.
   Indicate the direction of the field lines as well as the direction of current flowing through the conductor.

3. A solenoid is a long helical coil of wire through which a current is run in order to create a magnetic field. The magnetic field of the solenoid is the superposition of the fields due to the current through each coil. It is nearly uniform inside the solenoid and close to zero outside and is similar to the field of a bar magnet having a north pole at one end and a south pole at the other depending upon the direction of current

flow. The magnetic field produced in the solenoid is dependent on a few factors such as, the current in the coil, number of turns per unit length etc.

The following graph is obtained by a researcher while doing an experiment to see the variation of the magnetic field with respect to the current in the solenoid.

The unit of magnetic field as given in the graph attached is in milli-Tesla (mT) and the current is given in Ampere.



(*a*) What will happen if a soft iron bar is placed inside the solenoid?

(*b*) What conclusion would you like to draw after analysing the graph?

(*c*) (*i*) From the graph deduce the magnitude of magnetic field inside the solenoid if it carries a current of 0.8 A.

Or

(*ii*) List the two distinguishing features between the magnetic field of a current carrying solenoid and a bar magnet.

4. Shivani had to replace the electric plug of her clothes iron. She bought a three-pin plug as shown below:

When she removed the old plug, she saw that there were three wires coloured red, black and green.

(*a*) To which pin of the plug should she connect the green wire? To which part of the clothes iron is the green wire connected?

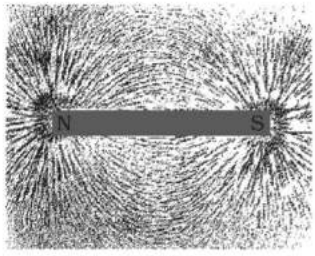
(*b*) State one function of the green wire.

(*c*) (*i*) Direct contact between which of the three coloured wires will result in a short circuit?

Or

(*ii*) State what happens to the current in the circuit in the case of a short circuit. Give a reason for your answer.

5. Michael Faraday was an experimental physicist. He introduces the concept of the magnetic line of force to represent a magnetic field visually. According to his experiment, when bar magnet is surrounded by little bits of iron filings, each a little magnet of its own. By tapping the surface, the iron filings arrange themselves in a particular pattern. They respond to an unseen presence—what Faraday called it "lines of force." The following sketch shows the lines of force due to a bar magnet on the accumulated action on little iron filings.



(*a*) What do the lines along which the iron fillings align themselves represents?

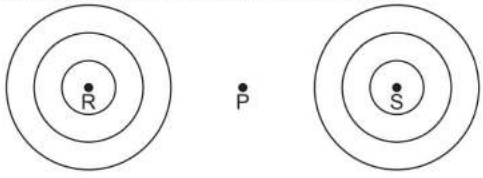
(*b*) Why do iron fillings arrange themselves in a particular pattern?

(*c*) (*i*) What changes in the deflection of the compass needle would you observe as it moves along the field lines?

Or

(*ii*) State your observation about the sticking of iron fillings at the middle and end of a bar magnet. What does this observation represent?

6. Hans Christian Oersted (1777–1851) observed that a compass needle suffers a deflection when placed near a current carrying metallic conductor. Consider two straight current carrying conductors R and S carrying equal amount of current (*I*) in a direction perpendicular to the plane of paper outwards. Let P be the mid point of the line joining R and S. The following figure shows the magnetic field lines around the wires without their directions.



(*a*) Redraw the figure and mark the direction of magnetic field lines for both the wires.

(*b*) If the current in the wire is increased, how will the strength of magnetic field around both the wires change? Represent this change by drawing the magnetic field lines around both the wires.

(*c*) (*i*) What will be the strength of magnetic field at the midpoint P due to both the wires R and S respectively? Give a reason for your answer. Name the rule that helped you to draw this conclusion.

Or

(*ii*) Suppose *B* is the magnetic field at the mid point P due to the current carrying conductor R and let the direction of current in wire S is reversed, what will be the magnetic field at point P now? Give reason for your answer.

7. A coil of many circular turns of insulated copper wire wound on a cylindrical insulating body (i.e. cardboard etc.) such that its length is greater than its diameter is called solenoid. When current is flowing through the solenoid, the magnetic field is present inside the solenoid. These current carrying solenoids are used in electronic circuit and to form an electromagnet. By inserting the magnetic field sensor between the coils of a solenoid, one can measure the magnetic field inside the solenoid and determine the relationship between the (*i*) magnetic field and current, and (*ii*) magnetic field and number of turns per metre in a solenoid. On performing the experiment with the help of suitable apparatus, the following observations were noted.

Table A

Sr. No.	Current in solenoid (A)	Magnetic Field (x 10^{-4} T)
1	0.5	2.51
2	1.0	3.14
3	1.5	3.77
4	2.0	4.39

Table B

Sr. No.	Length of solenoid (m)	No. of turns per metre (m^{-1})	Magnetic Field (x 10^{-4} T)
1	0.5	200	2.51
2	1.0	250	3.14
3	1.5	300	3.77
4	2.0	350	4.39

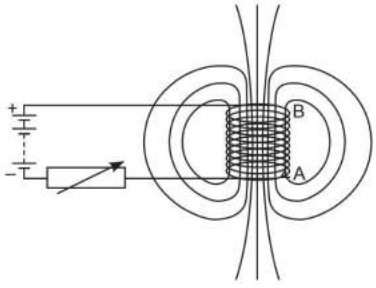
(*a*) From the table, what relationship would you observe between the (*i*) magnetic field and current, and (*ii*) magnetic field and number of turns per metre of a solenoid?

(*b*) Why magnetic field inside the solenoid is uniform?

(*c*) (*i*) For same current flowing through a solenoid and a straight conductor, the magnetic field produced by a solenoid is much stronger than the magnetic field produced by a straight current carrying conductor. State one reason to justify this statement.

Or

(*ii*) State the direction of magnetic field lines for the following magnetic field pattern produced by the current in the solenoid at its end A and B. Give reason.



NCERT ZONE

NCERT INTEXT QUESTIONS

Page 196

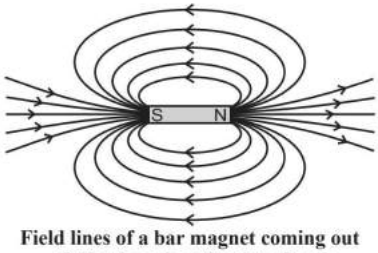
1. Why does a compass needle get deflected when brought near a bar magnet?

Ans. Compass needle is also a tiny pivoted magnet and experience a force exerted by a magnetic field set up due to a bar magnet. Due to this magnetic force, compass needle gets deflected when brought near a bar magnet.

Page 200

1. Draw magnetic field lines around a bar magnet.

Ans. Magnetic lines of force can be drawn by placing a compass needle near the north pole of the magnet and marking the position of north and south pole of the compass needle. Repeat this process till we reach near the south pole of the magnet. In this way, we find the magnetic lines of force around a bar magnet as shown below.



Field lines of a bar magnet coming out of North and getting into South

2. List the properties of magnetic field lines.

Ans. (*i*) Magnetic field lines have both direction and magnitude. The direction of the magnetic field is indicated by the tangent drawn at any point on the curve.

(*ii*) The field lines emerge from the North pole and merge at the South pole while inside the magnet, they move from south to north. So they from a continuous closed curve or loop.

(*iii*) The strength of magnetic field is indicated by the closeness of the field lines. Closer the lines, more will be the strength and farther the lines, lesser will be the field strength.

(*iv*) No two field lines intersect each other.

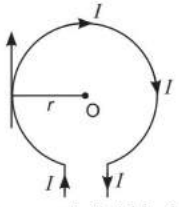
3. Why don't two magnetic field lines intersect each other?

Ans. The two magnetic field lines do not intersect each other. If they intersect at the point of intersection, then there will be two different directions of magnetic field, which is impossible.

Page 201

1. 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. Consider a circular loop of wire of radius *r* with centre *O* lying in the plane of the paper. Let the current *I* pass through the loop clockwise. According to right hand thumb rule, direction of magnetic field due to any portion of small current-carrying length of the coil is:



Direction of magnetic field inside the loop

— Perpendicular to the plane of paper inwards and

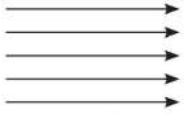
Direction of magnetic field outside the loop

— Perpendicular to the plane of paper outwards.

So, the direction of magnetic field can be considered as the direction of total magnetic field due to circular coil as current through all the elements will contribute to the magnetic field in the same direction.

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

Ans. The uniform magnetic field is represented by equidistant parallel lines. It is shown below.



3. Choose the correct option.
The magnetic field inside a long straight solenoid-carrying current

(*a*) is zero.
(*b*) decreases as we move towards its end.
(*c*) increases as we move towards its end.
(*d*) is the same at all points.

Ans. (*d*) It is the same at all points.

Page 203

1. 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).

(*a*) mass (*b*) speed
(*c*) velocity (*d*) momentum

Ans. (*c*) and (*d*) because when charged particle enter in the magnetic field, then it moves in a circular path so velocity is changing at every point due to change in its direction and hence momentum is also changed.

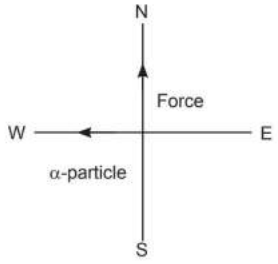
2. In Activity 12.7, how do we think the displacement of rod AB will be affected if (*i*) current in rod AB is increased; (*ii*) a stronger horse-shoe magnet is used; and (*iii*) length of the rod AB is increased?

Ans. In this case, the displacement is directly proportional to the strength of current, strength of magnetic field and length of the conductor. Hence, the displacement of conductor will increase in all the three cases.

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

(*a*) towards south
(*b*) towards east
(*c*) downward
(*d*) upward

Ans. (*d*) According to the Fleming's left-hand rule, the thumb is in the direction of force,middle finger is in the direction of current (direction of motion of positively charged particle) then forefinger indicates the direction of magnetic field that is perpendicularly upwards to the plane of paper.



Page 205

1. **Name two safety measures commonly used in electric circuits and appliances.**

Ans. **Fuse:** For protecting circuits due to short circuit or overloading of the circuit.
Earthing: For protecting us from a severe electric shock if there is any leakage of current in metallic body appliance.

2. **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. $P = 2\text{ kW} = 2000\text{ W}, V = 220\text{ V}$

$$I = \frac{P}{V} = \frac{2000}{220} \simeq 9\text{ A}$$

The current rating of the circuit is 5 A and the current flowing is 9 A so the fuse melts. The circuit is broken and the electric oven is saved from damaging.

3. **What precaution should be taken to avoid the overloading of domestic electric currents?**

Ans. We should not connect the number of appliances with a single socket to avoid overloading.

NCERT EXERCISES

1. **Which of the following correctly describes the magnetic field near a long straight wire?**
   (*a*) The field consists of straight lines perpendicular to the wire.
   (*b*) The field consists of straight lines parallel to the wire.
   (*c*) The field consists of radial lines originating from the wire.
   (*d*) The field consists of concentric circles centred on the wire.

Ans. (*d*) Right-hand thumb rule confirms the presence of this type of field.

2. **At the time of short circuit, the current in the circuit**
   (*a*) reduces substantially.
   (*b*) does not change.
   (*c*) increases heavily.
   (*d*) vary continuously.

Ans. (*c*) Increases heavily as the resistance becomes almost zero at the time of short circuit.

3. **State whether the following statements are true or false.**
   (*a*) The field at the centre of a long circular coil carrying current will be parallel straight lines.
   (*b*) A wire with a green insulation is usually the live wire of an electric supply.

Ans. (*a*) True: The magnetic field at the centre of the coil can be taken to be uniform.
(*b*) False: Green wire is used as earth wire.

4. **List two methods of producing magnetic fields.**

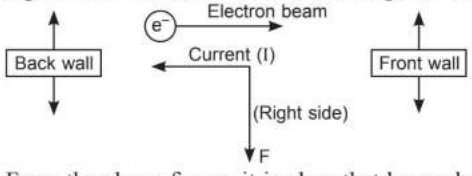
Ans. Bar Magnet, straight wire carrying current and circular coil carrying current. (*any two*)

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

Ans. When the length of the conductor and magnetic field are perpendicular to each other, the force experienced is maximum.

6. **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?**

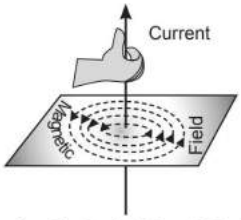
Ans.



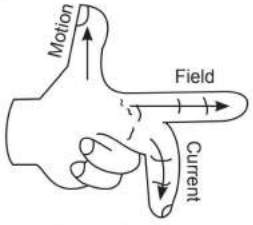
From the above figure, it is clear that by applying Fleming's left hand rule, the direction of magnetic field inside the chamber is in downward direction.

7. **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.

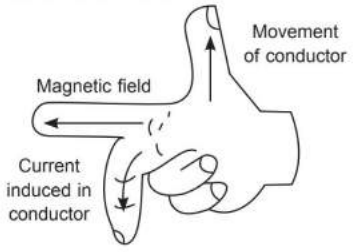
Ans. (*i*) **Right-Hand Thumb Rule:** Hold the wire carrying current in your right hand, such that the thumb indicates the direction of current, then the folded fingers will indicate the presence of magnetic field (lines) surrounding the wire.



(*ii*) **Fleming's Left-Hand Rule:** Stretch the thumb, forfinger and middle finger of the left hand mutually perpendicular to each other such that the forefinger point towards the direction of magnetic field, the middle finger points in the direction of current, then the thumb will indicate the direction of force experienced by the conductor. It is to be applied only when the current and magnetic fields both are perpendicular to each other.



(*iii*) **Fleming's Right-Hand Rule:** Stretch the thumb, forefinger and middle finger of the right hand mutually perpendicular to each other such that the forefinger gives the direction of magnetic field and the thumb points in the direction of the motion of a conductor then, the middle finger will give the direction of the induced current.



[Fleming's Right-Hand rule is not in syllabus for 2023-24]

8. **When does an electric short circuit occur?**

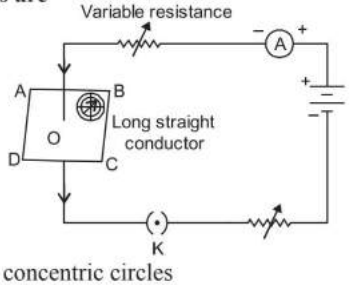
Ans. When live wire touches the neutral wire, circuit offers very low resistance to the flow of current due to which current increases heavily in the circuit, electric short circuit occurs.

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

Ans. Earth wire offers low resistance path to the current and ensure that the body of the electrical appliance is at the same potential (electric) as that of earth (zero). Any leakage of current in an electrical appliances to their metallic body is immediately transferred to the earth through the earth wire and user gets protected from possible and dangerous electrical shock. Hence, it is necessary to ground the metallic appliances through the earth wire which acts as a safety measure.

SELECT NCERT EXEMPLAR PROBLEMS

1. **If the key in the given arrangement is taken out (the circuit is made open) and magnetic field lines are drawn over the horizontal plane ABCD, the lines are**



(*a*) concentric circles
(*b*) elliptical in shape
(*c*) straight lines parallel to each other
(*d*) concentric circles near the point O but of elliptical shapes as we go away from it.

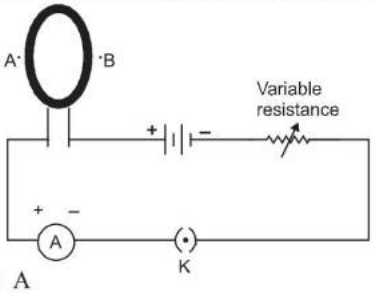
Ans. (*c*) If key is taken out, current will not flow through the conductor and no magnetic field exist. Therefore, at point O, due to presence of earth's magnetic field, the magnetic field lines will be straight and parallel to each other.

2. **For a current in a long straight solenoid N-pole and S-pole are created at the two ends. Among the following statements, the incorrect statement is**

(*a*) The field lines inside the solenoid are in the form of straight lines which indicates that the magnetic field is the same at all points inside the solenoid.
(*b*) The strong magnetic field produced inside the solenoid can be used to magnetise a piece of magnetic material like soft iron, when placed inside the coil.
(*c*) The pattern of the magnetic field associated with the solenoid is different from the pattern of the magnetic field around a bar magnet.
(*d*) The N-pole and S-pole exchange position when the direction of current through the solenoid is reversed.

Ans. (*c*) A solenoid behaves like a bar magnet. Hence the pattern of magnetic field associated with solenoid and around the bar magnet is same.

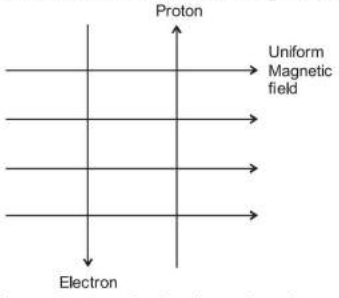
3. A circular loop placed in a plane perpendicular to the plane of paper carries a current when the key is on. The current as seen from points A and B (in the plane of paper and on the axis of the coil) is anticlockwise and clockwise respectively. The magnetic field lines point from B to A. The N-pole of the resultant magnet is on the face close to



(*a*) A
(*b*) B
(*c*) A if the current is small, and B if the current is large
(*d*) B if current is small and A if the current is large

Ans. (*a*)

4. A uniform magnetic field exists in the plane of paper pointing from left to right as shown in figure. In the field an electron and a proton move as shown. The electron and the proton experience



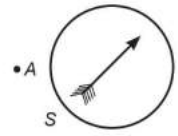
(*a*) forces both pointing into the plane of paper
(*b*) forces both pointing out the plane of paper
(*c*) forces pointing into the plane of paper and out of the plane of paper, respectively
(*d*) forces pointing opposite and along the direction of the uniform magnetic field respectively

Ans. (*a*)

5. What is the role of the two conducting stationary brushes in a simple electric motor?

Ans. The two stationary conducting brushes make the contact in between the two halves of the split rings and the source battery. Current in the coil enters from the source battery through one conducting brush and flows back to the battery through another brush.

6. A magnetic compass needle is placed in the plane of paper near point *A* as shown in figure. In which plane should a straight current carrying conductor be placed so that it passes through *A* and there is no change in the deflection of the compass? Under what condition is the deflection maximum and why? [HOTS]



Ans. In the given situation, a straight current carrying conductor should be placed in the plane of paper. The field produced by it is perpendicular to the plane of paper and parallel to the vertical axis of compass needle. As a result there will be no change in the deflection of compass needle.
The deflection is maximum when the conductor through the point A is perpendicular to the plane of paper so that field due to it is parallel to the plane of paper.

7. 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. [HOTS]

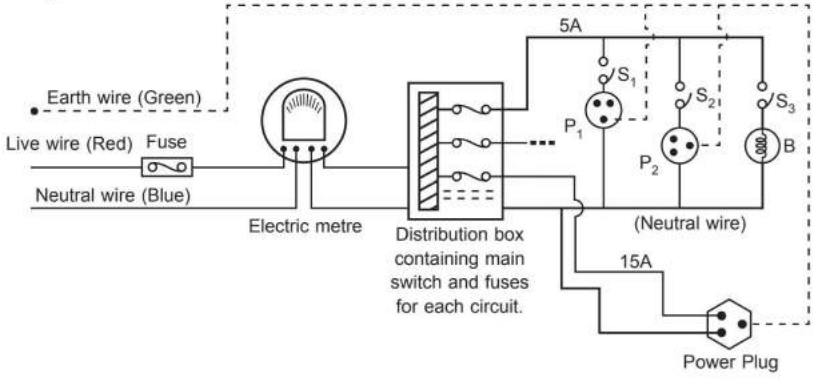
Ans. (*i*) Yes, similar magnetic field produced around a thin beam of moving alpha-particle, α-particle being positively charged constitutes a current in the direction of beam motion.
(*ii*) No, as neutron being electrically neutral and does not constitute a current.

8. 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?

Ans. Strength of magnetic field at a point decreases as the distance increases $\left(B \propto \frac{1}{r}\right)$ Therefore as she moves away from the centre of circular coil, magnetic field decreases. This is indicated by the decrease in degree of closeness of the field lines and appears diverging in nature.

9. 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?

Ans. A schematic diagram for common domestic circuit.



Importance of fuse : It is the most important safety device, used for protecting the circuit from short circuiting or overloading.

- Burnt fuse in the live wire acts as an open circuit. So, to maintain the flow of current in the circuit and to prevent the circuit from damage due to some fault, burn-out fuse should be replaced by another fuse of identical rating.