Class 10th Science

Chapter - 13

Magnetic Effects of Electric Current

Textual Questions and Answers :

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

Ans :- A compass needle is a small bar magnet. When a magnet brought near the compass the north pole of the compass attracted by the south pole of the magnet and south pole of the compass attracted by the north pole of the magnet. so the compass needle deflected when brought near a bar magnet.

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Q.1. Draw a magnetic field lines around a bar magnet.

Ans :-

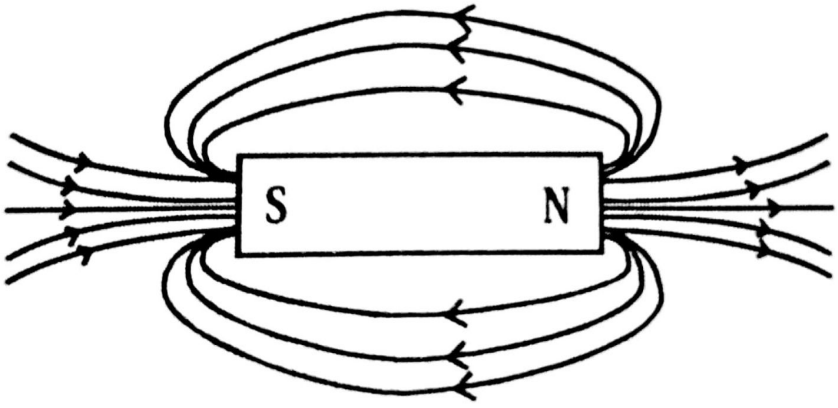

Fig : Field lines around a bar magnet

Q.2. List the properties of magnetic lines of force.

Ans :- (i) They emerge from north pole of the magnet and enter the south pole.

(ii) The two magnetic lines of force never intersect each other.

(iii) Inside the magnet, they are from south to north pole.

Q.3. Why don't two magnetic lines of force intersect each other?

Ans :- If two magnetic lines of force intersect each other it would mean that at the point of intersection, the compass needle would point towards two directions which is not possible.

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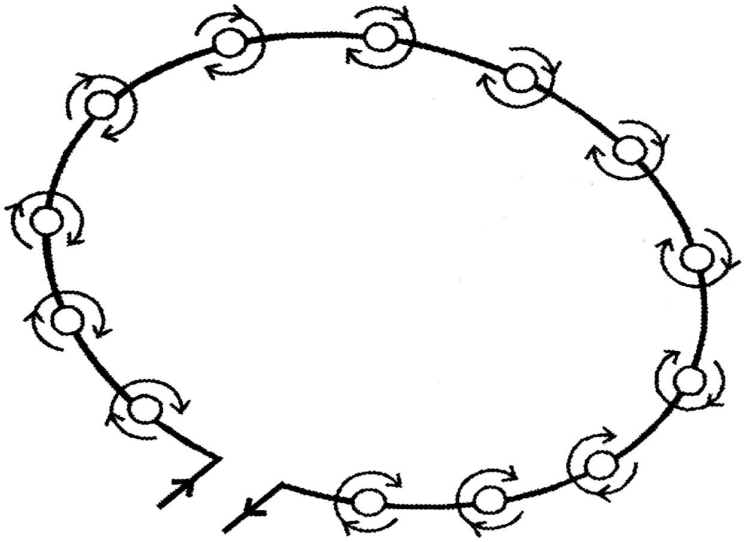
Q.1. Consider a circular loop of wire lying in the plane of the table. Let the current pass through the loop clockwise. Apply the right-hand rule to find out the direction of the magnetic field inside and out side the loop.

Ans :-



As shown if fig. each section of wire produces its concentric set of lines of force. By applying right hand thumb rule, we find that all the section produce magnetic field directed downward at all points inside the loop while at the outside points, the field is directed upwards. Hence the magnetic field acts normally into the place of paper at the points inside the loop and normally out of the plane of paper at points outside the loop.

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

Ans :-

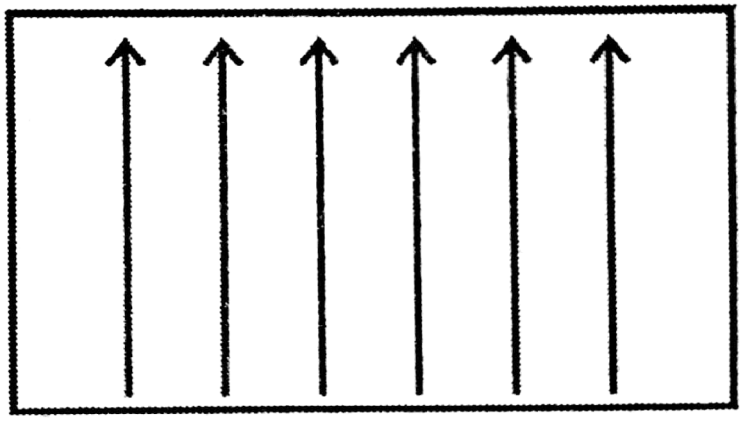


Fig: uniform field

Uniform magnetic field is represented by equidistant and parallel lines as shown. The parallel lines are close to each other, if the field is strong. Stronger the field, closer are the lines.

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Choose the correct option.

Q.1. The magnetic field inside a long straight solenoid carrying current.

(a) Is zero.

(b) Decreases as we move to wards end.

(c) Increases as we move towards end.

(d) Is same at all the points.

Ans :- (d) Is same at all the points.

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Q.1. Which of the following property of porton can change which 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)

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Q.1. In activity 13.7, 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) Lengths of the rod AB is increased?

Ans :- (i) When the current in the rod AB is increased, force exerted on the conductor increases, so the displacement of the rod increases.

(ii) When a stronger horse shoe magnet is used, the magnitude of the magnetic field increases. This increases the force exerted on the rod and the displacement of the rod.s

(iii) Force is also directly proportional to the length of the ord. Hence rod will be displaced more if the length is increased.

Q.2. A positively charged particle (a particle) emitted from a nucleus and projected towards west is deflected

towards north by a magnetic field. The direction of the magnetic field is

(a) Towards south.

(b) Towards east.

(c) Down ward.

(d) Upward.

Ans :- (d) Upward.

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Q.1. State Fleming's left hand rule.

Ans :- According to this rule, stretch the thumb, forefinger and middle finger of our left hand such that they are mutually perpendicular. If the first finger points in the direction of magnetic field and the second finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.

Q.2. What is the principle of an electric motor?

Ans :- Electric motor is based upon Fleming's left hand rule.

Q.3. What is the role of the split ring in an electric motor?

Ans :- In electric motors, the split ring acts as a commutator. i.e. it is a device that reverses the direction of flow of current through a circuit.

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Q.1. Explain different ways to induce current in a coil.

Ans :- A current can be induced in a coil by

(i) moving a magnet towards or away from the coil or vice versa.

(ii) Changing current in the neighbouring coil.

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Q.1. State the principle of an electric generator.

Ans :- An electric generator works on the principle of electromagnetic induction. When a closed coil is rotated in a uniform magnetic field with its axis perpendicular to the direction of the field, the magnetic field lines passing through the coil change and an induced potential difference and hence a current is set up in it.

Q.2. Name some source of direct current.

Ans :- Dry cell, button cell etc.

Q.3. Which sources produce Alternating current?

Ans :- Alternating current is produce by A.C generator. There are hydro-generator and thermal generators. Hydro generators convert P.E. of water to electricity whereas thermal generators convert heat energy of steam to electric energy.

Choose the correct option :

Q.1. A rectangular coil of copper wires is rotated in magnetic field. The direction of induced current changes once in each :

(a) Two revolutions.

(b) One revolutions.

(c) Half revolution.

(d) One forth revolution.

Ans :- (c) Half revolution.

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

Ans :- (i) Electric fuse.

(ii) Earthing.

Q.2. An electric oven of 2kw power rating is operated in a domestic electric circuit (220v) that has a current ratting of 5A. What result do you except? Explain.

Ans :- Here, $P = 2kw$

$= 2000w$

$v = 220$ volt

$I = ?$

$P = VI$

$$\text{Or } I = \frac{P}{v}$$

$$= \frac{2000}{220}$$

$= 9.09$ A

A current of 9.09A will flow in the circuit. Since the current rating of circuit is 5A, the fuse rating if inserted in circuit will burn up. If no fuse has been put in the circuit, there may be a fire.

Q.3. What precaution should be taken to avoid the nozoverloading of domestic electric circuits?

Ans :- (i) The wires used in the circuit must be coated with good insulating materials like pvc etc.

(ii) Separate circuit should be there for heating appliance.

(ii) High power appliances like air-conditioner, refrigerator, water heater etc, should not be used simultaneously.

EXERCISES

Q.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) The field consists of concentric circles centred on the wire.

Q.2. The phenomenon of electromagnetic induction is

(a) The process of charging a body.

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

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

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

Ans :- (c) Producing induced current in a coil due to relative motion between a magnet and the coil.

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

(a) Generator.

(b) Galvanometer.

(c) Ammeter.

(d) Motor.

Ans :- (a) Generator.

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

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

(b) DC generator will generate a higher voltage .

(c) AC generator will generate a higher voltage.

(d) AC generator has slip rings while the DC generator has a connector.

Ans :- (d) AC generator has slip rings while the DC generator has a connector.

Q.5. 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.

Q.6. State whether the following statement are true or false-

(a) An electric motor converts mechanical energy into electrical energy.

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

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

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

Ans :- (a) False.

(b) True.

(c) True.

(d) False.

Q.7. List two methods of producing magnetic fields.

Ans :- (i) Magnetic field around current carrying conductor.

(ii) Magnetic field around a current carrying solenoid.

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

Ans :- The pattern of the field of a solenoid is same with the magnetic field around a bar magnet. One end of the solenoid behaves as a magnetic north pole, while the other behaves as the south pole. The field lines inside the solenoid are in the form of parallel straight lines. This indicates that the magnetic field is the same at all

points inside the solenoid, That is, the field is uniform inside the solenoid.

A strong magnetic field produced inside a solenoid can be used to magnetise a piece of magnetic material, like soft iron, when place inside the coil.

We bring the N-pole of the bar magnet near one end of the solenoid :- If there is an attraction, then that end of the solenoid has south polarity and the other has north polarity. If there is a repulsion, then that end of the solenoid has north polarity and the other end has south polarity.

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

Ans :- When the conductor carries current in a direction perpendicular to the direction of the magnetic field, the force experienced by the conductor is largest.

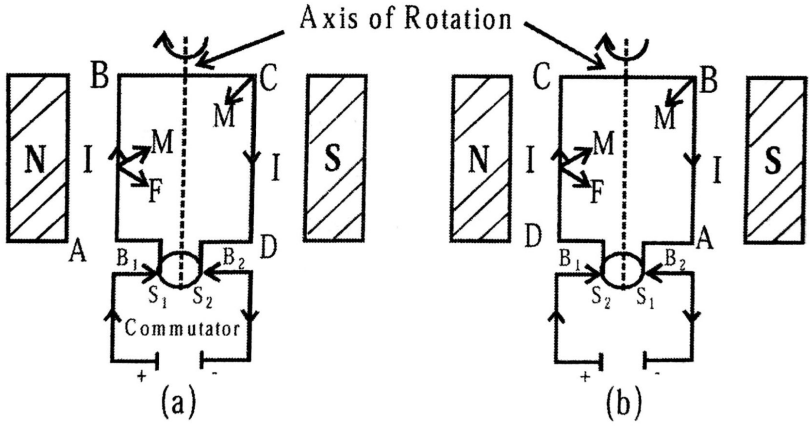
Q.10. Imagine that you are sitting in a chamber with your back to one wall. An electron beam moving horizontally with back towards the front wall is defected by a strong magnetic field to your right side. what is the direction of the magnetic field?

Ans :- The magnetic field will be acting in vertically downward direction in accordance with Fleming's left hand rule.

Q.11. Draw a labelled diagram of an electric motor. Explain its principle and working. What is the function of a split ring in electric motor?

Ans :- Principle :- Electric motor is based upon Flemings left hand rule. When a current carrying conductor capable of free movement Is placed in a magnetic field, it experiences a mechanical force and begin to move in a direction given by Fleming's left hand rule.

Construction :- A DC motor consists of single coil ABCD called armature between the pole pieces of a magnet as shown in fig. Armature consists of a coil of a large number of turns of insulated wire wrapped on a soft iron core. The two ends of the armature are connected to segments S_1 and S_2 of a commutator. The brushes B_1 and B_2 keep their contact with the commutator as it rotates.



Working :- A direct current from a battery is passed through armature. The current flows in the coil along ABCD as shown in fig (a). The limb AB of the coil experience downwards and CD of the coil experience

upward force in accordance with Fleming's left hand rule. These two equal and apposite forces constitute a couple tending to rotate the coil in clockwise direction. After half the rotation, brush B_1 has contact with S_2 and brush B_2 with S_1. The direction of the current gets reversed. The current now flows along DCBA instead of along ABCD. Limb DC experiences downward and BA experiences an upward force in accordance with Fleming's left hand rule.

The process repeats itself and motion of armature becomes continuous after some time.

Split rings help in reversing the current in the coil after every half rotation.

Q.12. Name some devices in which electric motors are used.

Ans :- Electric fans, washing machines, mixers, computers etc.

Q.13. A coil of insulated copper wire is connected to galvanometer. What will happen if a bar magnet is

(a) Pushed into the coil.

(b) With drawn from inside the coil.

(c) Held stationary inside the coil?

Ans :- (i) An electric current is induced in the coil and the galvanometer shows a deflection.

(ii) When the bar is with drawn, there will again be momentarily a deflection but in a direction opposite to that when magnet was pushed.

(iii) When the magnet is held stationary in the coi, there will be no deflection in galvanometer.

Q.14. Two circular coils A and B are placed closed to each other. If the current in the coil A is changed will some current be induced coil B? Give reason.

Ans :- When the current in coil A is changed, some current is induced in the coil B. Due to the change in current in coil A, the magnetic field lines linked with coil A and with coil B get changed. This sets up induced current in coil B.

Q.15. 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 will determine the direction of a magnetic field around a straight conductor carrying current.

(ii) Fleming's left hand rule will determine the direction of a force experienced by a current carrying straight conductor placed in a magnetic field which is perpendicular to it.

(iii) Fleming's right hand rule will determine the direction of current induced in a coil due to its rotation in a magnetic field.

Q.16. Explain the underlying principle and working of an electric generator by drawing a labelled diagram. What is the function of brushes?

Ans :- In an electric generator, mechanical energy is used to rotate a conductor in a magnetic field to produce electricity.

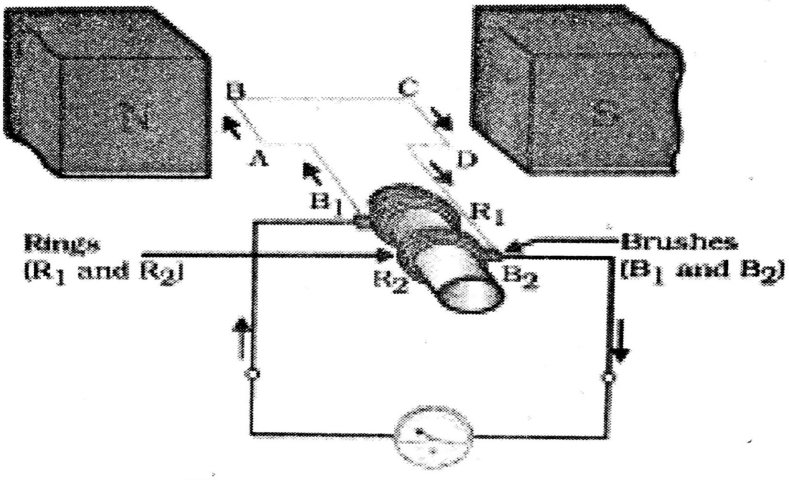


Illustration of the principle of electric generator

An electric generator, as shown in fig consists of a rotating rectangular coil ABCD placed between the two poles of a permanent magnet. The two ends of this coil are connected to the two rings R_1 and R_2. The inner side of these rings are made insulated. The two conducting stationary brushes B_1 and B_2 are kept pressed separately on the rings R_1 and R_2 respectively. The two rings R_1 and R_2 are internally attached to an axle. The axle may be mechanically rotated from outside to rotate the coil inside the magnetic field. Outer ends of the two brushes are connected to the galvanometer to show the flow of current in the given external circuit.

When the axle attached to the two rings is rotated such that the arm AB moves up in the magnetic field produced by the permanent magnet.

Let us say the coil ABCD is rotated clockwise in the arrangement shown in fig. By applying Fleming's right hand rule, the induced currents are set up in these arms along the directions AB and CD. Thus an induced current flows in the direction ABC.. If there are larger numbers of turns in the coil, the current generated in each tarns adds up to give a large current through the coil. This means that the current in the external circuit flows from B_2 to B_1.

After half a rotation, arm CD starts moving up an AB moving down. As a result, the direction of the induced currents in both the arms change, giving rise to the net induced current in the direction DCBA. The current in the external circuit now flows from B_1 to B_2 Thus after

every half rotation the polarity of the current in the respective arms changes. Such a current, which changes direction after equal intervals of time is called direction after equal intervals of time is called an alternating current. This device is called an AC generator.

To get a direct current, a split ring type commutator must be used. With this arrangement one brush is at all times in contact with the arm moving up in the field, while the other is in contact with the arm moving down. We have seen the working of a split ring commutator in the case of an electric motor. Thus a unidirectional current is produced. The generator is thus called a DC generator.

Q.17. When does an electric short circuit occur?

Ans :- Overloading can occur when then live wire and the neutral wire come into direct contact. This occurs when the insulation of wires is damaged or there is a fault in the appliance. In such situation the current in the circuit abruptly increases. This is called short- circuiting.

Q.18. What is the function of an earth wire? Why is it necessary to earth metallic appliances?

Ans :- The earth wire connects the metallic body of the high powered appliance to the earth. It is a safety measure which ensures any leakage of current of the metallic body of the appliance keeps its potential equal to that of the earth and the user may not get a sever electric shock.

Additional Questions and Answers:

Q.1. Define magnet and magnetism.

Ans :- The substances which have the property of attracting small pieces of iron, nickle, cobalt etc are called magnets and this property of attraction is called magnetism.

Q.2. What is magnetic poles?

Ans :- The regions of concentrated magnetic strength inside the magnet just near its ends are called magnetic poles. The pole of freely suspended magnet which points towards north is called north pole and that points towards south is called south pole.

Q.3. What is the basis law of magnetic poles?

Ans :- It stalis that like pdes repel while unlike poles of 3. magnets attract each other.

Q.4. What are the basic properties of magnets?

Ans :- (i) Magnets attract small pieces of iron, nickes cobalt etc.

(ii) When freely suspended, they come to rest in north-south direction.

(iii) Like magnetic poles repel each other and unlike magnetic poles attract each other.

(iv) The magnetic poles always exist in pairs.

Q.5. What is artificial magnet ?

Ans :- Pieces of iron and other magnetic materials which can be made to acquire the properties of natural magnets are called artificial magnets.

Q.6. What is magnetic field?

Ans :- It is the region around a magnet within which its influence can be experienced.

Q.7. Define magnetic line of force.

Ans :- It may be defined as the path in a magnetic field in which a unit north pole tends to move when allowed to do so. It may also be defined as a curve, the tangent to which at any point gives the direction of the magnetic field at that point.

Q.8. What is solenoid?

Ans :- Along cylindrical coil of insulated copper wire of large number of circular turns is called a solenoid.

Q.9. What ir direct current?

Ans :- It is thawt current which flows in a circuit with a constant magnitude in the same direction.

Q.10. What is alternating current?

Ans :- It is that current whose magnitude and direction change alternately and regularly with the passage of time.

Q.11. Name an instrument used determine the direction.

Ans :- Magnetic compass needle.

Q.12. What is an electric motor?

Ans :- It is a device to convert electric energy into mechanical energy.

Q.13. What is function of electric fuse?

Ans :- It is a safety device to save the houses from fire due to overloading or short circuit.

Q.14. What is colour code for different wires used in household?

Ans :- Live wires red, neutral is black and earth wire is green.

Q.15. What is frequency of A.C. supplied in India?

Ans :- 50HZ.

Q.16. Compare the permanent magnet and an electromagnet.

Ans :-

Permanent Magnet	Electromagnet
1. Its strength is fixed.	1. Strength can be changed by changing the current through coil.
2. Polarities are fixed.	2. Polarities can be reversed by changing the direction of the current. ous
3. Cannot be immediately demagnetised.	3. Can be demagnetised immediately by stopping the current in the coil.

Q.17. What is the role of two conducting stationary brushes in sa a simple electric motor?

Ans :- Brushes touch the other side of two halves of the split ring and connect this to the battery. It maintains contact of rings with the battery.

Q.18. What is SI unit of magnetic flux?

Ans :- Webber (Wb)

Q.19. What should be the properties of a fuse wire?

Ans :- (i) It should be made of a material of low melting point.

(ii) Specific resistance of material should be high.

Q.20. What is the principle of electric generator?

Ans :- Fleming's right hand rule.

Q.21. What is compass needle?

Ans :- It is a small magnetic needle pivoted at the centre of a small circular brass case provided with a glass top. It is used to find the direction of magnetic field.

Q.22. How does the strength of the magnetic field at the centre of a circular coil of wire depend on

(i) The radius of the coil.

(ii) The number of turns of wire in the coil.

(iii) The strength of current flowing in the coil?

Ans :- The magnetic field produced at the centre of circular coil carrying coil depends on following factors:-

(i) It is inversely proportional to the radius of the coil. That is

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

(ii) It is directly proportional to the number of turns n of the coil. As the direction of current in each circular turn is same, the fields due to the various turns get added up. That is

$$B \propto n$$

(iii) It is directly proportional to the strength of current passing the coil. That is

$$B \propto I$$

Q.23. Give some uses of permanent magnets.

Ans :- (i) In microphones, loudspeakers and electric clocks.

(ii) In devices like ammeters, voltmeters and speedometers.

(iii) In electric generators and motors.

(iv) On video and audio cassette tapes.

Q.24. What is the meaning of the term 'frequency' of an alternating current? What is its value in India?

Ans :- The frequency of an alternating current is the number of times the direction of electric current change in one second. In India, the frequency of a.c. is 50 Hz.

Q.25. How can it be shown that a magnetic field exists around a wire through which a direct electric current is passing?

Ans :- A magnetic needle brought close to a straight current carrying wire aligns itself perpendicular to the wire, reversing the direction of current reverses the direction of deflection. This shows that the current carrying wire is associated with a magnetic field.

Q.26 How is an electromagnet different from a permanent magnet?

Ans :- An electromagnet loses its magnetism when the current through its solenoid is switched off. A permanent magnet retains magnetism for a long time.

Q.27. Why is essential to earth electrical appliances having metallic body?

Ans :- Earth wire is used as a safety measure to ensure that any leakage of current to the metallic body of an appliance does not give any severe shock to the user.

Q.28. Fill in the blanks :

(i) A generator converts ---------- into ---------- energy.

(ii) Electric switch is connected to ---------- wire.

(iii) At time of short circuit current in the circuit ----------.

(iv) Commercial unit of electric energy is ----------.

(v) A long wound cylindrical coil of insulated wire is called ---------- .

Ans :- (i) Mechanical; electric.

(ii) Live.

(iii) Increases heavily.

(iv) kwh.

(v) Solenoid.

Q.29. What is transformer?

Ans :- It is a device which converts low voltage at high current in to high voltage at low current and vice versa.

Q.30. What is Ampere's swimming rule?

Ans :- Imagine a person swimming along the direction of the current,current entering the foot and leaving the head, the face turned towards the compass with hands spread normal to the body then the north pole will be deflected towards his left hand.

Multiples choice questions :

Q.1. The magnetic lines of force

(a) Always intersect each other.

(b) Never intersect each other.

(c) Sometimes intersect and sometimes do not intersect.

(d) Are always parallel to each other.

Ans :- (b) Never intersect each other.

Q.2. The magnetic effect of current was discovered by

(a) Faraday.

(b) Henry.

(c) Oersted.

(d) Maxwell.

Ans :- (c) Oersted.

Q.3. When soft iron bar is introduced inside a current carrying solenoid, the magnetic field inside the solenoid coil.

(a) Increase.

(b) Decrease.

(c) be zero.

(d) Remain unaffected.

Ans :- (a) Increase.

Q.4. An electric motor transfers :

(a) Electric energy into mechanical energy.

(b) Mechanical energy into electric energy.

(c) Chemical energy to electric energy.

(d) Electric energy to sound energy.

Ans :- (a) Electric energy into mechanical energy.

Q.5. Material of the core of strong electromagnet is :

(a) Soft iron.

(b) Stell.

(d) Laminated steel strips.

Ans :- (d) Laminated steel strips.

Q.6. The direction of induced current is given by

(a) Ampere's swimming rule.

(b) Fleming's left hand rule.

(c) Fleming's right hand rule.

(d) Maxwell's cork screw rule.

Ans :- (c) Fleming's right-hand rule.

Q.7. An electric generator actually acts as

(a) A source of electric charge.

(b) A source of heat energy.

(c) An electromagnet.

(d) A converter of energy.

Ans :- (d) A converter of energy.

Q.8. The electric fuse and switches should be connected to

(a) Live wire.

(b) Neutral wire.

(c) Earth wire.

(d) None of these.

Ans :- (a) Live wire.

Q.9. The frequency of A.C. mains used in India is

(a) 30 cpsu.

(b) 50 cps.

(c) 60 cps.

(d) 120 cps.

Ans :- (b) 50 cps.

Q.10. The device based on the principle of electromagnetic induction is

(a) Electric generator.

(b) Electric motor.

(c) Voltmeter.

(d) Ammeter.

Ans :- (a) Electric generator.

Q.11. A positive charge projected toward east is deflected towards north by a magnetic field. The magnetic field is directed.

(a) Towards west.

(b) Towards south.

(c) Upward.

(d) Downward.

Ans :- (d) Downward.

Q.12. A bar magnet falls vertically through a magnet. Its acceleration is

(a) Less thang g.

(b) More than g.

(c) Equal to g.

(d) Zero.

Ans :- (a) Less thang g.

Q.13. The force on a charged particle is moving in a magnetic field is maximum when the angle between direction of motion and field is

(a) Zero.

(b) 90°

(c) 180°

(d) 45°

Ans :- (b) 90°

Q.14. Commercial electric motors do not use :

(a) An electromagnet to rotate the armature.

(b) Effectively large number of turns of conducting wire in the current carrying coil.

(c) A permanent magnet to rotate the armature.

(d) A soft iron core on which the coil is wound.

Ans :- (c) A permanent magnet to rotate the armature.

Q.15. The most important safely method used for protecting home appliances from short circuiting or overloading is :

(a) Earthing.

(b) Use of fuse.

(c) Use of stabilizers.

(d) Use of electric meter.

Ans :- (b) Use of fuse.

Q.16. What is electromagnet? How strength of an electromagnet can be increase?

Ans :- It is a solenoid with a soft iron core placed inside it. When current is passed through the solenoid the soft iron core becomes a temporary magnet. The strength of an electromagnet can be increased by

(i) Increasing the number of turns per unit length of the coil.

(ii) Increasing the strength of current and

(iii) Winding the coil over a soft iron core.

Q.17. What do you mean by Earthing?

Ans :- Earthing of an electrical appliance means connecting the metallic body of the powered appliance to the earth through the earth wire. It is a safety measure which ensure any leakage of current to the metallic body of the appliance keeps its potential equal to that of the earth and the user may not get a severe electric shock.

Q.18. What is magnetic effect of current?

Ans :- A current carrying conductor produces a magnetic field around it. This effect is called magnetic effect of current.

Q.19. Write the importance of magnetism in medicine.

Ans :- An electric current always produces a magnetic field. Even weak ion currents that travel along the nerve cells in our body produce magnetic fields. When we touch something, our nerves carry an electric impulse to the muscles we need to use. This impulse produces a temporary magnetic field. These fields are very weak and are about one billion of the earth's magnetic field.

Two main organs in the human body where the magnetic field produced is significant are the heart and the brain.

The magnetic field inside the body forms the basis of obtaining the images of different body parts. This is done using a technique called Magnetic resonance Imaging. Analysis of these images helps in medical diagnosis. Magnetism has, thus, got important uses in medicine.

Q.20. What is galvanometer?

Ans :- A galvanometer is an instrument that can detect the presence of a current in a circuit. The pointer remains at zero for zero current flowing through it. It can deflect either to the left or the right of the zero mark depending on the direction of current.