NCERT SOLUTIONS
CLASS X SCIENCE
CHAPTER 13 - MAGNETIC EFFECTS OF ELECTRIC CURRENT

Question 1:

What is the reason behind the compass needle is deflected when it is brought close to the bar magnet?

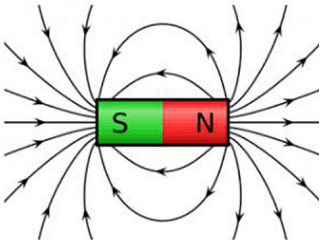
Answer:

Compass needles work as a small bar magnet; when they are brought near to another bar magnet the like poles will end up repelling, as the needle will be deflected.

Question 2:

Around the bar magnet draw its magnetic fields.

Answer:



Question 3:

Write down properties of the magnetic lines of force.

Answer:

The lines of force are parallel to one another in the uniform magnetic field.
Magnetic lines of force do not cross each other.
Magnetic lines of force are always closed curves.
Magnetic lines are always directed from the North Pole towards South Pole.
Magnetic fields get more crowded near the poles other than any region of the field

Question 4:

Why two magnetic lines of force never cross each other?

Answer:

None of the field lines cross each other. This is because if they did, the compass needle will point in two directions, which is not possible in any case.

Question 5:

If a circular loop of wire is lying in the plane of the table and the current is being passed through the loop in a clockwise manner, find out the magnetic field inside and outside the loop by applying the right-hand thumb rule.

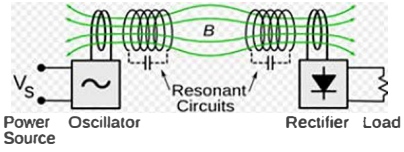
Answer:

The concentric circles representing the magnetic fields around every point of current – carrying loop will become larger and larger as we move away from the wire. The arc of these big circles will appear as straight lines when we reach the center of the circular loop.

Question 6:

Draw a diagram to represent a magnetic field given region is uniform.

Answer:



Question 7:

The magnetic field inside a long straight solenoid carrying current

1. Is high
2. Decreases when moving toward center.
3. Is the same at all points
4. All of the above.

Answer:

3. Is the same at all points.

Question 8:

A proton moves freely in a magnetic field. Which of the following property of a proton changes?

1. Gravity
2. Velocity
3. Momentum
4. Weight

Answer:

2. Velocity

3. Momentum

Question 9:

What happens to the displacement of rod when

1. Current in rod AB is increased.
2. A stronger horseshoe magnet is used.
3. Length of the rod AB is increased.

Answer:

1. The displacement of rod will not be affected.
2. Force is exerted and hence the displacement increases.
3. There is no change in the displacement of the rod AB.

Question 10:

What happens to the direction of the magnetic field when a positively-charged particle projected toward west is deflected toward north by a magnetic field?

1. Towards center
2. Towards east
3. Towards north
4. Towards south

Answer:

2. Towards east

Question 11:

Explain Fleming's left hand rule.

Answer:

Fleming's left-hand rule:-

It states that if we stretch the thumb, fore finger and the middle finger such that they are mutually perpendicular (of the left hand) and if the fore finger and the middle finger points in the direction of magnetic field and direction of current respectively, then the thumb will be in the direction of motion or the force acting on the conductor.

Question 12:

Explain the principle of an electric motor.

Answer:

Mechanical effect of an electric current is responsible for the working of the electric motor. Mechanical force is experienced when a conductor carrying a current is placed in a magnetic field. The coil rotates continuously when a current is passed through a rectangular coil of wire placed in a magnetic field (in a motor).

Question 13:

Explain the role of split ring in an electric motor.

Answer:

A split ring acts just like a commutator in the electric motor. A commutator is a device that reverses the direction of flow of current through a circuit. The reversing of this current also reverses the direction of force acting on the two arms.

Question 14:

What are the different ways to induce current in a coil? Explain it.

Answer:

Either by moving the coil in a magnetic field or by changing the magnetic field around it, current can be induced in a coil. When the direction of motion of the coil is at the right angles to the magnetic field, the induced current is found to be the highest.

The process of changing the magnetic field in a conductor which induces a current in another conductor is known as electromagnetic induction.

Question 15:

Explain the principle of an electric generator.

Answer:

A generator, also known as a dynamo, is a device used to convert mechanical energy into electrical energy. To produce electricity, the mechanical energy is used to rotate the conductor in a magnetic field. It is an application of electromagnetic induction. An A.C generator generates an alternating current. A D.C generator is used to deliver a current, which flows in the same direction.

Question 16:

What are the sources of direct current?

Answer:

Split-ring type commutator is a source of direct current. In a split-ring type commutator, two brushes are there where first one is always in contact with the arm moving up in the field, while the other one is in contact with the arm moving down. Because of this process, a unidirectional current is produced.

Question 17:

What are the sources to produce alternating current (A.C.)?

Answer:

The sources which produce A.C. is a permanent magnet called the field magnet, armature, slip ring and carbon brushes. The polarity of the current in the respective arms changes after every half rotation. This type of current which changes direction after equal intervals of time is called an alternating current (A.C.).

Question 18:

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

1. Two revolutions
2. One revolution
3. Half revolution
4. One-fourth revolution

Answer:

2. One revolution.

Question 19:

Name any safety measure used in electric circuits and appliances.

Answer:

To prevent electric circuits and appliance from possible damage, by passing the flow of unduly high electric current, we use an electric fuse. In the fuse, Joule heating takes place which melts it to break the electric circuit.

Question 20:

An electric oven of 4 KW power rating is operated in a domestic electric circuit (220V) that has a current rating of 5A. What result do you expect? Explain.

Answer:

V=220 V, I = 5A

Power, P = VI

P = 220 x 5

P = 1100W

Therefore, power P = 1100W = 1.1KW

Therefore, an electric oven of 4 KW power rating cannot be operated in a domestic electric circuit (220V) that has a current rating of 5A because electric oven has higher power than the power of the electric circuit.

Question 21:

To avoid the overloading of domestic electric circuits, what precautions should be taken?

Answer:

To avoid the overloading of domestic electric circuits, fuse should be used. It is the most important safety device.

Too many appliances should not be connected to a single socket.

Question 22:

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

1. The field consists of concentric circles centered on the wire.
2. The field consists of radial lines originating from the wire.
3. The field consists of straight lines parallel to the wire.
4. The field consists of straight lines perpendicular to the wire.

Answer:

1. The field consists of concentric circles centered on the wire.

Question 23:

The phenomenon of electromagnetic induction is

1. producing induced current in a coil due to relative motion between a magnet and the coil.
2. the process of generating magnetic field due to a current passing through a coil.
3. the process of charging a body.
4. the process of rotating a coil of an electric motor

Answer:

1. producing induced current in a coil due to relative motion between a magnet and the coil.

Question 24:

The device used for producing electric current is called a

1. Galvanometer.
2. Generator.
3. Motor.
4. Ammeter .

Answer:

2. Generator.

Question 25:

The essential difference between an AC generator and a DC generator is that:

1. DC generator will generate a higher voltage.
2. AC generator has slip rings while the DC generator has a commutator.
3. AC generator has an electromagnet while a DC generator has permanent magnet.
4. AC generator will generate a higher voltage.

Answer:

2. AC generator has slip rings while the DC generator has a commutator.

Question 26:

At the time of short circuit, the current in the circuit

1. does not change.
2. reduces substantially.
3. vary continuously.
4. increases heavily.

Answer:

4. increases heavily.

Question 27:

State whether the following statements are true or false.

1. An electric generator works on the principle of electromagnetic induction.
2. An electric motor converts mechanical energy into electrical energy.
3. A wire with a green insulation is usually the live wire of an electric supply.
4. The field at the center of a long circular coil carrying current will be parallel straight lines.

Answer:

1. True
2. False
3. True
4. True

Question 28:

List three sources of magnetic fields.

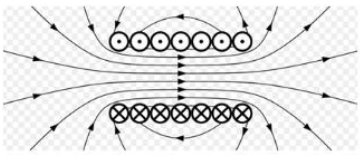
Answer:

1. Magnetic field due to a current in a solenoid.
2. Magnetic field due to a current through a circular loop.
3. Magnetic field due to a current through a straight conductor.

Question 29:

How does a solenoid behave like a magnet? Determine the north and the south poles of a current-carrying solenoid with the help of a bar magnet. Explain.

Answer:



Solenoid is known as a coil of several circular turns of insulated copper wire which is wrapped closely in the shape of a cylinder. In this figure, the pattern of the magnetic field lines is shown. Two ends of the solenoid behave as a magnetic north pole and south pole respectively. The form of the field lines inside the solenoid are parallel straight lines. The magnetic field inside the solenoid is same at all points, i.e. , the field is uniform inside the solenoid. If we place a piece of magnetic material, like soft iron, inside the coil we can use the strong magnetic field produced inside the solenoid to magnetise it. The piece of magnetic material will now be known as electromagnet.

Question 30:

Force experienced by a current-carrying conductor placed in a magnetic field is largest in which condition?

Answer:

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

Question 31:

You are sitting in a chamber with your back lying on one wall. An electron beam is deflected by a strong magnetic field to your right side which is moving horizontally from back wall towards the front wall. What is the direction of the magnetic field?

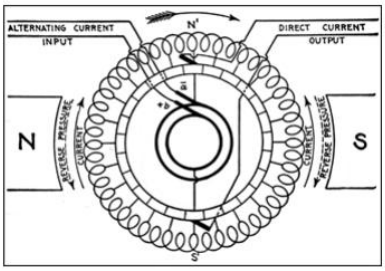
Answer:

The direction of the magnetic field is towards west.

Question 32:

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

Answer:



A device that converts the electrical energy into mechanical energy is known as a motor.

Principle:

An electric motor works on the fact that the conductor experiences a force, given by Fleming's Left Hand Rule, when a current carrying conductor is placed in a magnetic field. For example, when a rectangular coil is placed in the magnetic field and current is passed through it, a torque acts on the coil, which rotates it continuously. When the coil rotates, the shaft attached to it also rotates and thus the electrical energy supplied to the motor is converted into the mechanical energy of rotation.

An electrical motor consists of a rectangular coil ABCD of insulated copper wire which is wounded around on a soft iron core called armature. The coil rotates between the poles N and S as the coil is mounted between the poles of a magnet. The two ends of the coil are joined to the end of a commutator. Its main function is to reverse the direction of the current flowing through the coil every time the coil passes the vertical position during revolution.

Working:

Initially, the coil ABCD is at a horizontal position. The current enters the coil through the carbon brushes and the half ring 'A' of the commutator when the switch is in ON position.

The current flows in the direction DCBA and leaves via the half ring 'B'. In the side PQ of the coil, the direction is from Q to P towards the south and the direction of the magnetic field is from the N to S pole towards the east. By applying Fleming's left hand rule, we find that it will experience a force in upward direction and the side SR of the coil will experience a downward force. Now we have two parallel wires experiencing forces in opposite direction. They form a couple tending to rotate the coil in the anticlockwise direction.

The two commutator half rings automatically change contact from one brush to the other when the coil goes beyond the vertical position. Because of this, the direction of the current through the coil reverses which, in turn, reverses the direction of forces acting on the two sides of the coil. The sides of the coil rotate in the same anticlockwise direction and they are interchanged. As long as the current is passing, this process is repeated again and again and the coil continues to rotate.

Question 33:

Which are the devices where electric motors are used?

Answer:

Electric motors are used in:-

1. Electric fans.
2. Mixers.
3. Computers.
4. Refrigerators.
5. MP3 players etc.

Question 34:

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

1. Pushed into the coil,
2. Withdrawn from inside the coil,
3. Held stationary inside the coil?

Answer:

1. A deflection is observed in the galvanometer due to the induced current because of the increase in magnetic flux through the turns of the coil connected to the galvanometer.
2. A deflection is observed in the galvanometer, as when it is pulled out, the flux linked with the coil due to the bar magnet decreases. Therefore, a current flows in the coil

to reduce the change in flux. The deflection can be observed in the opposite direction (if compared with the previous case).

3. No deflection is observed in the galvanometer. The flux linked with the coil due to the magnetic field is at a constant. Hence no current is induced due to the bar magnet.

Question 35:

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

Answer:

Yes, some current will be induced in the coil Q, if the current in coil P is changed, due to the change in the magnetic field effect around the coils.

Question 36:

State the rule to determine the direction of a:

1. Magnetic field produced around a straight conductor-carrying current

2. Force experienced by a current-carrying straight conductor placed in a magnetic field which is perpendicular to it.

3. Current induced in a coil due to its rotation in a magnetic field.

Answer:

1. Right-hand thumb rule:

We are holding a current carrying straight conductor in the right hand such that the thumb points towards the direction of current. Our fingers will wrap around the conductor in the direction of the field lines of the magnetic field. This is known as Right hand thumb rule.

2. Fleming's left-hand rule:

Fleming's left hand rule states that, when we stretch the thumb, fore finger and middle finger of the left hand such that they are mutually perpendicular and if the fore finger and middle finger points in the direction of the magnetic field and the direction of current respectively, then the thumb will point in the direction of motion or the force acting on the conductor.

3. Fleming's Right hand rule:

If the thumb and the first two fingers of right hand are held at right angles to each other, with the forefinger held in the direction of the field, and the thumb in the direction of motion, the induced current I flows in the direction of the middle finger.

Question 37:

Draw a labeled diagram of an electric generator and explain its principle and working. What is the function of brushes?

Answer:

AC generators:

A.C. is an abbreviation for Alternating Current. An A.C. generator produces alternating current and alternates in polarity continuously.

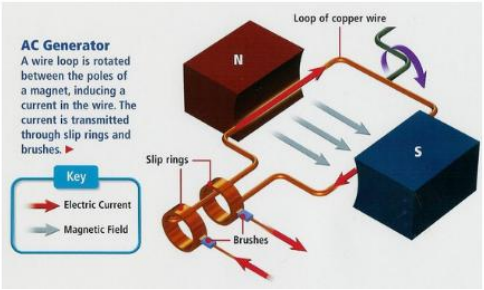
Construction of an A.C. generator:

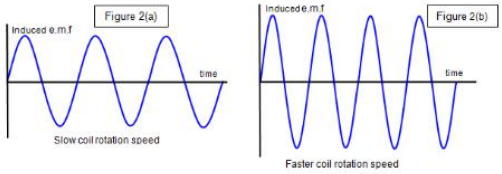
A simple A.C. generator consists of a rectangular coil ABCD that can be rotated rapidly between the poled N and S of a strong horseshoe type magnet M. The coil is made of a large number of turns of insulated copper wire. The ends A and D of the rectangular coil are connected to two circular pieces of copper metal called slip rings R_1 and R_2. As the slip rings R_1 and R_2 rotate with the coil, the two pieces of carbon called brushes; B_1 and B_2 keep contact with them. The current produced in the rotating coil can be tapped out through slip rings into the carbon brushes. From the carbon brushes B_1 and B_2 we take the current into various electrical appliances like TV, bulbs, etc. In this figure, we have shown only a galvanometer G connected the two carbon brushes.

Working of an AC generator:

Initially, the generator coil ABCD is in the horizontal position. The coil ABCD is being rotated in the anticlockwise direction between the poles N and S of a horseshoe type magnet.

i) As the coil rotates in the anticlockwise direction, the side AB and side CD of the coil moves down cutting the magnetic lines of force near the N-Pole of the magnet and moves up cutting the line of force near S-pole of the magnet respectively. Due to this, induced current is produced in the sides AB and DC of the coil. On applying Fleming's right hand rule to the side AB and DC of the coil, we find that the currents are in the direction B to A and D to C respectively. The induced currents in the two sides of the coil are in the same direction, and we get an effective induced current in the direction BADC.





ii) After half revolution, the side AB will come on the right hand side and DC will come on the left side. So, after half revolution, side AB starts moving up and side DC starts coming down. As a result of this, the direction of induced current in each side of the coil is reversed after half a revolution. Since the direction of induced current in the coil is reversed after half revolution so the polarity (positively and negative) of the two ends of the coil also changes after half revolution. The end of the coil which was positive in the first half of rotation becomes negative in the second half and vice versa. Thus, in one revolution of the coil, the current changes its direction 2 times.

The alternating current produced in India has a frequency of 50 Hz, i.e., the coil is rotated at the rate of 50 revolutions per second. Since in one revolution of coil, the current changes its direction 2 times, so in 50 revolutions of coil, the current changes its direction 2 x 50 = 100 times. Thus, the A.C. supply in India changes its direction 100 times in 1 second. Another way of saying this is that the alternating current produced in India changes its direction every 1/100 second, i.e., each terminal of the coil is positive (+) for 1/100 seconds and negative (-) for the next 1/100 of a second. This process is repeated again and again with the result that there is actually no positive and negative in an AC generator. We will now describe why the direction of induced current in the coil of an AC generator changes after every half revolution of the coil.

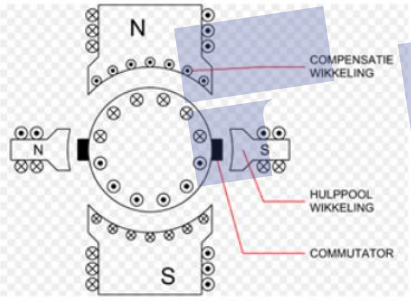
After every half revolution, each side of the generator coil starts moving in the opposite direction in the magnetic field. The side of the coil which was initially moving downwards in a magnetic field, after half revolution, it starts moving in opposite direction – upwards. Similarly the side of the coil which was initially moving upwards, after half revolution, it starts downwards. Due to the change in the direction of the motion of the two sides of the coil in the magnetic field after every half revolution, the direction of current produced in them also changes after every half revolution.

D.C. generator:

D.C. generator refers to the direct current generator which produces direct current.

Construction of a DC generator:

A simple DC generator consists of a rectangular coil ABCD which can be rotated rapidly between the poled N and S of a strong horseshoe type magnet M. The generator coil is made of a large number of turns of insulated copper wire. The two ends of the coil are connected to the two copper half rings or also known as split rings R_1 and R_2 of a commutator. There are two carbon brushes B_1 and B_2, we can take the current into the various electrical appliances like radio, TV, electric iron, bulbs, etc. but in this figure, we have shown only a galvanometer G connected between the two carbon brushes. The galvanometer is a current detecting and current measuring instrument.



Working of a DC Generator:

Suppose that the generator coil ABCD is initially in the horizontal position. Again suppose that the coil ABCD is being rotated in the anticlockwise direction between the poles N and S of a horseshoe type magnet.

1. As the coil rotates in the anticlockwise direction, the side AB of the coil moves down cutting the magnetic lines of force near the N-pole of the magnet, and side DC moves up, cutting the lines of force near the S-pole of the magnet. Due to this the induced current is produced in the sides AB and DC of the coil. On applying Fleming's right hand rule to the side AB and DC of the coil we find that the currents in them are in the direction B to A and D to C respectively. Thus, the induced currents in the two sides of the coil are in the same direction, and we get an effective induced current in the direction BADC. Due to this the brush B_1 becomes a positive (+) pole and brush B_2 becomes negative (-) pole of the generator.
2. After half revolution, the sides AB and DC of the coil will interchange their positions. The side AB will come in the right hand side and start moving up whereas side DC will come on then the two commutator half rings R_1 and R_2 automatically change their contacts from one carbon brush to the other. Dues to this change, the current keeps flowing in the same direction in the other circuits. The brush B_1 always remaining positive terminal and brush B_2 always remaining negative terminal of the generator. Thus, a DC generator supplies a current in one direction by the use of a commutator consisting of two, half rings of copper. In the above discussion we have used the word DC generator everywhere. Please note that we can also write DC dynamo in place of DC generator.

Question 38:

When does an electric short circuit occur?

Answer:

When the live wire and neutral wire touch each other as they get torn, the direct touching is known as short circuiting. The current passing through the circuit formed by these wires is very large and consequently a high heating effect is created which may lead to fire.

Question 39:

Explain the function of an earth wire. Why is it necessary to earth metallic appliances?

Answer:

To avoid electric shocks, the metal body of an electrical device is earthed. To connect the metal body of the electrical device to the earth, an earth wire is used, which is at zero potential. In household circuits, there are three wires, the live wire, the neutral wire and the earth wire. One end of the earth wire is connected to the device and the other end of the wire is connected to the earth. We now say that the device is grounded or earthed. Usually the three wires are connected to a three pin plug. The neutral wire or the earth connection carries the high current to the earth from the device and prevents an electric shock.