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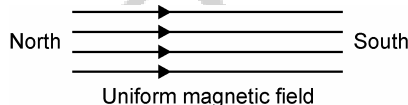
## MAGNETIC EFFECTS OF ELECTRIC CURRENT

### TEXTBOOK QUESTIONS AND THEIR ANSWERS

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

**Ans.** The magnetic field lines of compass needle interact with magnetic field lines of a bar magnet. Thus, a force acts on both of them. However, magnetic needle being free to move, gets deflected.

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

**Ans.** 

**Q.3. Choose the correct option.**

**The magnetic field inside a long straight solenoid-carrying current :**

**(a) 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) is the correct choice.

**Q.4. 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 answers).**

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

**Ans.** The (c) and (d) are correct.

**Q.5. State Fleming's left-hand rule.**

**Ans.** Stretch the thumb, the forefinger and middle finger of your left hand mutually at right angles to each other, such that forefinger points in the direction of the magnetic field and middle finger in the direction of flow of current. Then, the thumb gives the direction of motion of conductor.

**Q.6. What is the principle of an electric motor ?**

**Ans.** It is based on the principle that when a coil carrying current is placed in a magnetic field, it always experiences a couple due to interaction of the magnetic fields.

**Q.7. What is the role of the split ring in an electric motor?**

**Ans.** The split rings help in changing the direction of current in the coil after every  $180^\circ$  of rotation and hence help the coil to move in the same direction.

**Q.8. Choose the correct option**

**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) is the correct option.

**Q.9. List three sources of magnetic fields?**

- Ans.** (i) Earth's magnetism produces magnetic field.
- (ii) Permanent, natural and artificial magnets produce magnetic fields.
- (iii) Conductors carrying current produce magnetic fields.

**Q.10. When is the force experienced by a current-carrying conductor placed in a magnetic field largest?**

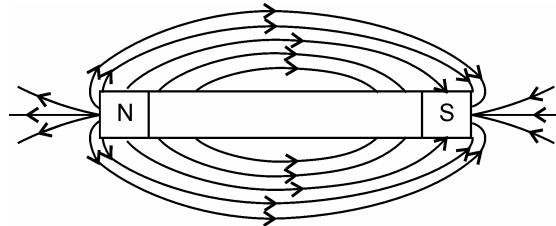
**Ans.** When the conductor is placed parallel to the magnetic field such that magnetic field set up by the current is at right angles to it.

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

**Ans.** (i) Mixer-grinders, (ii) electric fans, (iii) washing machine (iv) electric water pumps.

**Q.12. Draw magnetic field lines around a bar magnet.**

**Ans.**



Field lines due to a bar magnet

**Q.13. List the properties of magnetic lines of force.**

- Ans.**
1. They are closed continuous curves which originate from the north pole and end at the south pole of a bar magnet.
  2. They mutually repel each other.
  3. No two magnetic lines of force cross each other.

**Q.14. Why don't two magnetic lines of force intersect each other?**

**Ans.** If we imagine that two magnetic lines of force cancel each other at some point, then the tracing magnetic compass, when placed at that point will point in two

different directions at the same time, which is impossible. Thus, we can say that magnetic lines of force don't intersect each other.

**Q.15. 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 magnetic field inside and outside the loop.**

**Ans.** The magnetic field lines will move at right angles to the plane of table, such that they move upward inside the loop and downward outside the loop.

**Q.16. 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       |

**Explain your choice.**

**Ans.** (d) is the correct choice.

As the positively charged particle is moving towards west, the conventional current also flows towards west. Now, applying Fleming's left hand rule, when middle finger points to west (current) and thumb points to north (deflection by magnetic field), then forefinger points upward. Thus, magnetic field is directed upward, and hence (d) is correct answer.

**Q.17. Think you are sitting in a chamber with your back to one of the walls. An electron beam, moving horizontally from back wall towards the front wall, is deflected by a strong magnetic field to your right. What is the direction of the magnetic field ?**

**Ans.** As the electron beam is moving horizontally from back wall, towards the front wall, therefore, conventional current is moving horizontally from the front wall, towards the back wall. Applying Fleming's left-hand rule, the forefinger points vertically downward. Thus, the direction of magnetic field is vertically downward at right angles to the direction of the electron beam.

**Q.18. 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 perpendicular to it.**

**Ans. (i) Right-hand thumb rule :** Imagine you are holding the conductor with the palm of your right hand, such that the fingers encircle the conductor and the thumb points in the direction of current. Then the direction of fingers encircling the conductor gives the direction of magnetic lines of force around it.

- (ii) Fleming's left-hand rule :** Stretch the thumb, the middle finger and the forefinger of your left hand mutually at right angles to each other, such that the forefinger points in the direction of magnetic field and middle finger in the direction of flow of current. Then, the thumb gives the direction of motion of conductor.

**Q.19. A metallic conductor is suspended freely between the poles of horse-shoe magnet and current is passed.**

**How do you think the displacement of conductor will be affected, if :**

- (i) current in the conductor is increased?**
- (ii) a stronger horse-shoe magnet is used ?**
- (iii) length of the conductor is increased?**

**Ans.** (i) The displacement of conductor will increase with the increase in current.

(ii) The displacement of conductor will increase with the increase in magnetic strength.

(iii) The displacement of conductor will increase with the increase in the length of conductor.

**Q.20. How does a solenoid behaves 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.** When the current flows through a solenoid, each turn of it sets up a magnetic field which is at right angles to the plane of the coil. Thus, each turn in its own right behaves like a magnet, such that its one face is north pole, and the other face is south pole. As these tiny magnets in the form of turns are arranged along the same axis, therefore, solenoid on the whole behaves like a magnet.

In order to find the polarity of the solenoid suspend it free so that it is pointing in north-south direction. Now bring the north pole of a permanent bar magnet near one end of the solenoid. If this end get repelled then this is north pole of solenoid.

**Q.21. Draw a labelled diagram of a D.C. electric motor. Explain its principle and working. What is the function of split ring in an electric motor?**

**Ans. Principle of Electric Motor**

When a rectangular coil of very many turns and carrying a current is placed in a strong magnetic

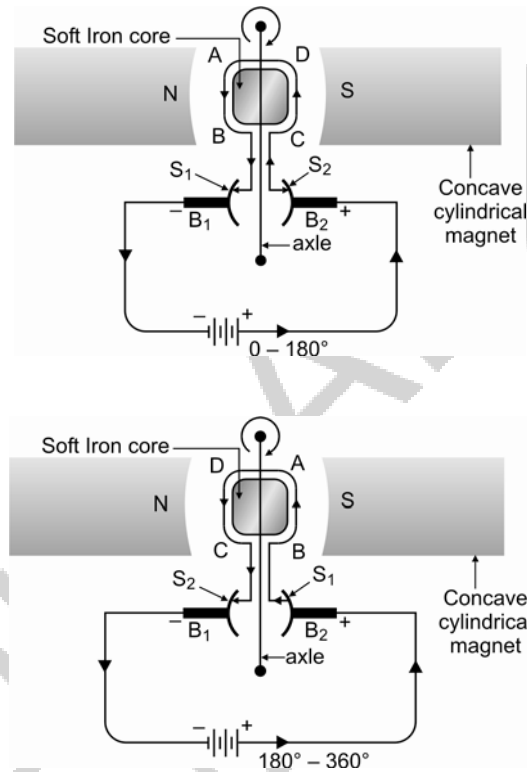
field, it experiences a torque (couple) and rotates continuously.

### **Construction of a D.C. Motor**

Following are the parts of a D.C motor :

- 1. Core :** It is *soft iron laminated cylinder* through which passes an axle. The axle is mounted on two ball bearings and on one side is connected to a shaft. Its function is to provide strong magnetic field when the current flows through the coil wound around it.
- 2. Coil :** An insulated copper wire of many turns is wound on the soft iron core. For the sake of simplicity, a single coil ABCD is shown in the figure. *The function of a coil is to set up magnetic field, when the current flows through it.*
- 3. Commutator :**  $S_1$  and  $S_2$  represent two split rings or the commutator. The ends of the coil are welded to the split rings. The axle passes from the middle of the commutator. *The function of the*

*commutator is to alter the direction of current in the coil after every half rotation, i.e., after  $180^\circ$ .*



**4. Brushes :** B<sub>1</sub> and B<sub>2</sub> are the carbon or gun metal brushes, which press tightly against the split rings S<sub>1</sub> and S<sub>2</sub> of the commutator. *The function of the brushes is to supply a continuous current to the rotating coil through the commutator.*

**5. Concave cylindrical magnet :** The coil is placed in between the concave ended cylindrical magnet. Its function is to provide strong uniform radial

magnetic field which interacts with the magnetic field of the coil to produce mechanical energy.

- 6. Battery :** It consists of a number of cells or some D.C. power sources. *Its function is to provide current to the coil, which in turn changes the electric energy into the mechanical energy.*

### **Working of a D.C. Motor**

**Fig. :** Imagine coil ABCD in a horizontal plane, such that the magnetic field of the concave cylindrical magnet is parallel to the plane of the coil. When electric current is passed through the coil, it sets up a magnetic field which is at right angles to the plane of the coil, and hence, at right angles to the magnetic field of the concave cylindrical magnet. Thus, a magnetic couple acts on the coil, and hence, it turns. The direction in which the coil turns can be found out by Fleming's left-hand rule and is discussed as under :

- (i) In the segment AB of the coil, the current flows from A to B and the magnetic field from north to south. Applying Fleming's left-hand rule, the direction of the thumb points upward, and hence, *segment AB will tend to*

*move upward, i.e., out of the plane of paper with a certain force.*

- (ii) In the segment CD of the coil the current flows from C to D and the magnetic field from north to south. Applying Fleming's left-hand rule, the thumb points downward, and hence, *segment CD will tend to move downward, i.e., into the plane of paper with a certain force.*

Thus, on the whole two equal and opposite forces act on the coil, and hence, turns the coil in a clockwise direction. However, as the coil turns through  $90^\circ$ , its magnetic field becomes parallel to the magnetic field of the concave cylindrical magnet. Thus, *no magnetic couple acts on the coil, and hence, it tends to stop. However, due to the momentum picked up by the coil during its rotation, it continues rotating till it covers  $180^\circ$ .*

After  $180^\circ$  the split ring  $B_1$  of the commutator connects with brush  $B_2$  and split ring  $S_2$  with brush  $B_1$ . *This alters the direction of current in the coil from CDAB to BADC. Thus, another magnetic couple acts on the coil, such that CD tends*

*to move upward i.e., out of the plane of the paper and AB downward i.e., into the plane of the paper.*

Thus, on the whole, the coil continues moving in the clockwise direction. However, one point should be very clear that the coil experiences *maximum force at  $0^\circ$  and  $180^\circ$  and no force at  $90^\circ$  and  $270^\circ$* . Thus, the motion of the coil is *jerky*.

In order to have smooth circular motion, *a number of coils of many turns are wound on the same soft iron core at an angle of a few degrees to each other*. Thus, when the magnetic couple tends to weaken in one coil, it becomes maximum in the other coil. This on the whole transforms the jerky motion to a smooth circular motion.

The commutator alters in direction of current in the coil, after every half rotation and helps the coil to move in the same direction.

**Q.22. State the principle of an electric generator.**

**Ans.** It is based on the phenomenon of electromagnetic induction i.e., when a closed coil is moved in a

magnetic field or vice-versa, an induced current is produced in the coil.

**Q.23. Name some sources of direct electric current.**

**Ans.** Dry cell, lead acid accumulators, NiFe cells, solar cells and d.c. dynamo are the sources of direct electric current.

**Q.24. Which sources produce alternating current?**

**Ans.** An a.c. dynamo produces alternating current.

**Q.25. Choose the correct option :**

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

- (a) two revolutions,**
- (b) one revolution,**
- (c) half revolution,**
- (d) one-fourth revolution.**

**Ans.** (c) is the correct option.

**Q.26. Name two safety measures commonly used in electric circuits and appliances.**

**Ans.** (i) An appropriate fuse is put in each circuit.

(ii) All appliances which are movable or have metal body are earthed.

**Q.27. What precaution should be taken to avoid overloading of domestic circuits?**

**Ans.** An appropriate fuse should be placed in each of the domestic circuits. This will ensure that fuse melts, when circuit is overloaded.

**Q.28. Make the correct choice :**

**A device used for producing electric current, is called :**

**(a) generator, (b) galvanometer, (c) ammeter, (d) motor.**

**Ans.** (a) is the correct choice.

**Q.29. Make the correct choice.**

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

- (a) AC generator has an electromagnet, where 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 commutator.**

**Ans.** (d) is the correct choice.

**Q.30. Make the correct choice.**

**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) is the correct choice.

**Q.31. State whether the following statements are true or false.**

- (a) An electric motor converts mechanical energy into electric energy.**
- (b) An electric generator works on the principle of electromagnetic induction.**
- (c) The field at the centre of 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) Statement is false as the electric energy is converted into mechanical energy.

(b) Statement is true.

(c) Statement is true.

(d) Statement is false as green insulation is used for earth wire.

**Q.32. The phenomenon of electromagnetic induction is:**

- (a) the process of charging a body.
- (b) the process of generating magnetic field due to the passage of electricity.
- (c) producing induced current in a coil due to relative motion between the magnet and the coil.
- (d) the process of rotating a coil of an electric motor.

**Ans.** (c) is the correct choice.

**Q.33. An electric oven of 2kW power rating is operated in a domestic electric circuit (220 V) that has a current rating of 5A. What result do you expect? Explain.**

**Ans.** The fuse of domestic circuit will melt.

The current rating of 2kW heater is  $2000 \text{ W} \div 220 \text{ V} = 9.01 \text{ A}$ . Thus, when placed in 5A circuit; it will overload the circuit and hence the fuse melts.

**Q.34. A coil of insulated copper wire is connected to a galvanometer. What will happen, if a bar magnet is (i) pushed into the coil, (ii) withdrawn from inside the coil, (iii) held stationary inside the coil.**

**Ans.** (i) Needle of the galvanometer shows a momentary deflection, say towards left.

(ii) Needle of the galvanometer shows a momentary deflection, say towards right.

(iii) Needle of galvanometer shows no deflection.

**Q.35. 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 in the coil B? Give reason.**

**Ans.** Yes, induced current is produced in coil B. It is because, when we change current in coil A, it changes magnetic flux. This changing magnetic flux induces current in coil B.

**Q.36. State the rule to determine direction of a current induced in a coil to its rotation in a magnetic field.**

**Ans. Fleming's right-hand Rule :** Stretch the palm of your right hand such that the thumb, the middle finger and the forefinger are mutually at right angles to each other. Now, if the thumb points in the direction of motion of conductor, the forefinger in the direction of magnetic field then middle finger points in the direction of induced current.

**Q.37. What is the function of an earth wire? Why is it necessary to earth metallic appliances?**

**Ans.** The earth wire transmits the current to the earth, if the metallic body of a given appliance touches the live wire. If the metallic body of a given electrical appliance is not earthed, there is possibility of user getting a nasty electric shock or even electrocution, in case of short circuit due to any reason.

**Q.38. Draw a labelled diagram to explain the principle underlying the working of an electric generator.**

**Ans. A.C. Generator :** It is a device which converts mechanical energy into alternative form of electrical energy.

**Principle** : It works on the principle of electromagnetic induction. When a closed coil is rotated in a uniform magnetic field with its axis perpendicular to the magnetic field, the magnetic field lines passing through the coil change and an induced emf and hence a current is set up in it.

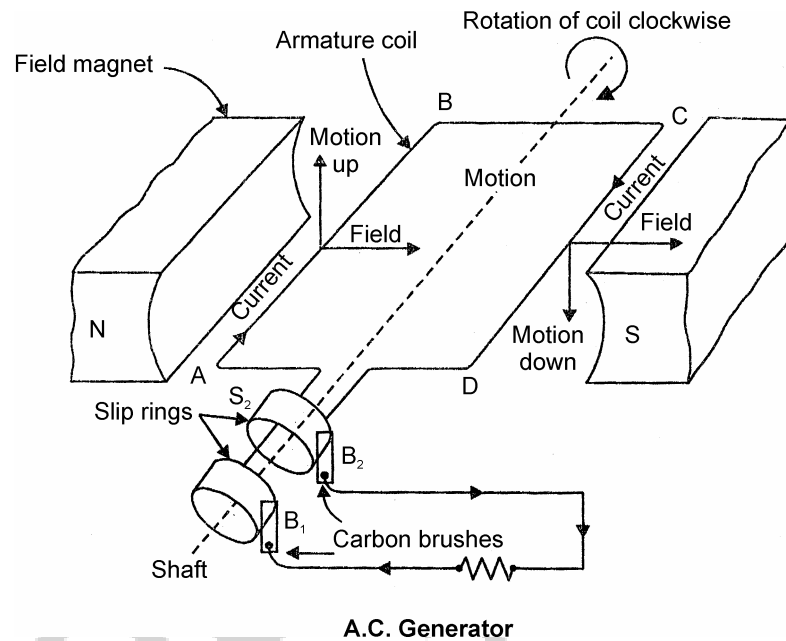
**construction.** It consists of the following main parts:

- 1. Field magnet** : It is a strong horse shoe-type permanent magnet with concave poles.
- 2. Armature** : ABCD is a rectangular armature coil. It consists of a large number of turns of insulated copper wire wound on a soft iron cylindrical core. It can be rotated about an-axis perpendicular to the magnetic field of the field magnet.
- 3. Slip rings** : These are two brass rings  $S_1$  and  $S_2$  rigidly connected to the two ends of the armature coil. As the coil rotated, slip rings also rotate about the same axis of rotation.

**4. Brushes :** These are two graphite rods  $B_1$  and  $B_2$  which are kept pressed against the slip rings  $S_1$  and  $S_2$ . Through these brushes, the current induced in the armature coil is sent to the external circuit.

**Working :** Suppose the armature coil ABCD is in the horizontal position. Now the coil is rotated clockwise. The coil cuts the magnetic lines of force. The arm AB moves upward while the arm CD moves downwards. According to Fleming's right hand rule, the induced current flows from A to B in the AB and C to D in arm CD i.e., the induced current flows in the circuit through brush  $B_2$  to  $B_1$ . After half the rotation of the armature, the arm CD moves upwards and AB moves downwards. The induced current now flows in the reverse direction i.e., along DCBA. The current flows from  $B_1$  to  $B_2$ . Thus, the direction of current in the external circuit changes after every half rotation. Such a current which changes its direction after equal intervals of time is called

alternating current. This device is called A.C. generator.



**Q.39. 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.

**Q.40. When does an electric short circuit occur?**

**Ans.** When the live wire touches the neutral wire on the earth such that the current does not flow through the given appliance, the short circuiting occurs.

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