Class: 10th

Subject: Physics

Unit 15: ELECTROMAGNETISM

Exercise MCQs:

i. Which statement is true about the magnetic poles?

(a) Unlike poles repel

(b) Like poles attract

(c) Magnetic poles do not affect each other

(**d**) A single magnetic pole does not exist ✅

ii. What is the direction of the magnetic field lines inside a bar magnet?

(a) From north pole to south pole

(**b**) From south pole to north pole ✅

(c) From side to side

(d) There are no magnetic field lines

iii. The presence of a magnetic field can be detected by a:

(a) Small mass

(b) Stationary positive charge

(c) Stationary negative charge

(**d**) Magnetic compass ✅

iv. If the current in a wire which is placed perpendicular to a magnetic field increases, the force on the wire:

(**a**) Increases ✅

(b) Decreases

(c) Remains the same

(d) Will be zero

v. A D.C motor converts:

(a) Mechanical energy into electrical energy

(b) Mechanical energy into chemical energy

(**c**) Electrical energy into mechanical energy ✅

(d) Electrical energy into chemical energy

vi. Which part of a D.C. motor reverses the direction of current through the coil every half-cycle?

(a) The armature

(**b**) The commutator ✅

(c) The brushes

(d) The slip rings

vii. The direction of induced e.m.f. in a circuit is in accordance with conservation of:

(a) Mass

(b) Charge

(c) Momentum

(**d**) Energy ✅

viii. The step-up transformer:

(a) Increases the input current

(**b**) Increases the input voltage ✅

(c) Has more turns in the primary

(d) Has less turns in the secondary coil

ix. The turn ratio of a transformer is 10. It means:

(a) $I_s = 10 I_p$

(b) $N_s = N_p / 10$

(c) $N_s = 10 N_p$ ✅

(d) $V_s = V_p / 10$

Important MCQs:

1. What is produced around a conductor when current passes through it?

(a) Electric charge

(b) Heat energy

(c) Magnetic field ✅

(d) Light waves

2. What is the shape of magnetic field lines around a straight current-carrying conductor?

(a) Parallel lines

(b) Concentric circles ✅

(c) Zigzag lines

(d) Straight lines

3. Which rule is used to find the direction of magnetic field around a straight conductor?

(a) Left hand rule

(b) Fleming's rule

(c) Right hand grip rule ✅

(d) Ohm's law

4. In which direction does a current-carrying conductor experience force when placed in a magnetic field?

(a) Along the conductor

(b) Opposite to current

(c) At right angles to both current and field ✅

(d) In circular motion

5. Which device converts electrical energy into mechanical energy?

(a) Generator

(b) Transformer

(**c**) D.C motor ✅

(d) Relay

6. What is the number of magnetic field lines passing through a surface called?

(a) Electric flux

(**b**) Magnetic field strength ✅

(c) Current

(d) Resistance

7. What happens when the magnetic field strength through a coil changes?

(a) Current stops

(b) Heat is produced

(**c**) An e.m.f. is induced ✅

(d) Resistance increases

8. The e.m.f. induced in a coil is directly proportional to:

(a) Number of turns in coil

(b) Current in coil

(c) Rate of change of magnetic field strength ✅

(d) Voltage of battery

9. Which device converts mechanical energy into electrical energy?

(a) Motor

(b) Battery

(c) A.C Generator ✅

(d) Transformer

10. Which principle does a transformer work on?

(a) Right hand rule

(b) Magnetic rotation

(c) Electromagnetic induction

(d) Mutual induction ✅

11. Who discovered that a current-carrying conductor produces a magnetic field around it?

(a) Faraday

(b) Ampere ✅

(c) Oersted

(d) Henry

12. What is the shape of magnetic field lines around a straight current-carrying wire?

(a) Straight lines

(**b**) Concentric circles ✅

(c) Zigzag lines

(d) Ellipses

13. The direction of magnetic field around a current-carrying conductor can be found by:

(a) Fleming's Left-hand Rule

(b) Right-hand Thumb Rule

(**c**) Right-hand Grip Rule ✅

(d) Ampere's Rule

14. If the direction of current is reversed, what happens to the magnetic field?

(a) It disappears

(b) It becomes stronger

(c) Its direction remains the same

(**d**) Its direction is reversed ✅

15. What happens when iron filings are sprinkled around a current-carrying wire on cardboard?

(a) They form straight lines

(**b**) They form a circular pattern ✅

(c) They remain stationary

(d) They move away

16. The magnetic field around a current-carrying wire is:

(a) Stronger farther from the wire

(b) Equal at all distances

(**c**) Stronger near the wire ✅

(d) Depends on air pressure

17. What is a solenoid?

(a) A single loop of wire

(b) A straight wire

(**c**) A coil with many loops ✅

(d) A magnetic rod

18. The magnetic field of a solenoid is similar to that of a:

(a) Bar magnet ✅

(b) Electric bulb

(c) Charged plate

(d) Straight wire

19. What kind of magnet is produced when current flows through a solenoid?

(a) Natural magnet

(b) Permanent magnet

(c) Electromagnet ✅

(d) Temporary bar magnet

20. In the Right-Hand Grip Rule for a coil, the thumb shows:

(a) Direction of current

(b) Direction of force

(c) Direction of magnetic field lines

(**d**) North pole of the coil ✅

21. What happens when a current-carrying conductor is placed in a magnetic field?

(a) No effect

(b) It heats up

(**c**) It experiences a force ✅

(d) It produces light

22. The direction of force on a current-carrying wire in a magnetic field can be determined by:

(a) Right-hand grip rule

(b) Fleming's right hand rule

(**c**) Fleming's left hand rule ✅

(d) Ampere's law

23. In Fleming's left hand rule, the middle finger represents:

(a) Magnetic field direction

(b) Force

(**c**) Current direction ✅

(d) None of these

24. Force on a wire increases if:

(a) Current is increased

(b) Magnetic field is stronger

(c) Wire length in field is longer

(**d**) All of these ✅

25. The force on a wire is at right angles to:

(a) The magnetic field only

(b) The current only

(**c**) Both current and magnetic field ✅

(d) None of these

26. What is observed when a current-carrying coil is placed in a magnetic field?

(a) It vibrates

(**b**) It rotates ✅

(c) It breaks

(d) Nothing happens

27. The working principle of electric motors is

based on:

(a) Heating effect of current

(b) Electrostatics

(c) Turning effect of current-carrying coil ✅

(d) Ohm's law

28. Which of the following increases the turning effect on the coil?

(a) Decreasing current

(b) Reducing number of loops

(c) Increasing number of loops ✅

(d) Using thinner wire

29. Why do the sides PQ and RS of the coil experience opposite forces?

(a) Different wire material

(b) Magnetic poles attract

(c) Current flows in opposite directions ✅

(d) Temperature difference

30. The force acting on the opposite sides of a coil

forms:

(a) Magnetic poles

(b) Parallel currents

(**c**) A couple ✅

(d) A loop

31. Why does a simple current-carrying coil stop rotating after 90° in a magnetic field?

(a) Coil melts

(**b**) Net force becomes zero ✅

(c) Current stops flowing

(d) Magnetic field disappears

32. What enables continuous rotation of the coil in a D.C. motor?

(a) Constant magnetic field

(b) Permanent magnet

(**c**) Reversing the current at 90° position ✅

(d) Increasing coil size

33. What device is used to reverse the direction of

current in a D.C. motor?

(a) Diode

(**b**) Split ring commutator ✅

(c) Transformer

(d) Resistor

34. What is the function of brushes in a D.C. motor?

(a) Produce magnetic field

(b) Reduce resistance

(**c**) Allow current flow into the coil ✅

(d) Convert mechanical energy

35. What happens when the coil changes brushes in a D.C. motor?

(a) Field reverses

(b) Current stops

(**c**) Current is reversed ✅

(d) Rotation stops

36. What keeps the coil rotating continuously in a magnetic field?

(a) Increase in temperature

(b) Balanced torque

(c) Reversal of force direction at each half turn ✅

(d) Constant current

37. What is the name of the rotating coil in a practical electric motor?

(a) Transformer

(b) Armature ✅

(c) Commutator

(d) Rotor

38. Which factor does NOT increase the torque of a D.C. motor?

(a) More coil turns

(b) Stronger magnetic field

(c) Lower resistance ✅

(d) Higher current

39. What controls the speed of a D.C. motor?

(a) Size of brushes

(b) Strength of magnet only

(c) Current through the motor ✅

(d) Direction of commutator

40. Who discovered electromagnetic induction?

(a) Ampere

(b) Oersted

(c) Michael Faraday ✅

(d) Fleming

41. What is electromagnetic induction?

(a) Magnetic field due to a magnet

(b) Electric field due to a magnet

(c) Induced current due to changing magnetic field ✅

(d) Movement of electric field

42. What causes an induced e.m.f. in a coil?

(a) Constant current

(b) Heating the wire

(c) Change in magnetic field lines ✅

(d) Length of coil

43. How can e.m.f. be induced in a circuit?

(a) By heating the wire

(b) By moving a wire in a magnetic field ✅

(c) By increasing voltage

(d) By connecting a resistor

44. According to Faraday's law, induced e.m.f. is proportional to:

(a) Coil temperature

(b) Magnetic field strength only

(c) Rate of change of magnetic lines ✅

(d) Resistance of coil

45. Which of the following increases induced e.m.f.?

(a) Slower motion of magnet

(b) Fewer turns in coil

(c) Higher speed of coil-magnet movement ✅

(d) Smaller magnetic field

46. What does Lenz's Law state about the direction

of induced current?

(a) It supports the cause producing it

(b) It flows in the direction of magnetic field

(**c**) It opposes the cause that produces it ✅

(d) It depends on the wire's length

47. What happens when the north pole of a magnet is brought near a solenoid?

(a) Induced current attracts the magnet

(b) No current is induced

(**c**) Induced current repels the magnet ✅

(d) Solenoid becomes a south pole

48. According to the right-hand grip rule, if current in solenoid is clockwise, which pole is formed?

(a) South pole

(**b**) North pole ✅

(c) No pole

(d) Both poles

49. What is the direction of induced current when

the magnet is moved away from the solenoid?

(a) Clockwise

(b) No current

(c) Anticlockwise ✅

(d) Upward

50. Lenz's Law confirms which fundamental law?

(a) Newton's Law

(b) Law of Inertia

(c) Law of Conservation of Energy ✅

(d) Coulomb's Law

51. What causes an e.m.f. in an A.C. generator?

(a) Constant magnetic field

(b) Rotating magnetic poles

(c) Rotation of a coil in a magnetic field ✅

(d) Heating the coil

52. In an A.C. generator, when is the induced current maximum?

(a) When coil is vertical

(b) When coil is perpendicular to field

(**c**) When coil is parallel to magnetic field ✅

(d) When no field is applied

53. What happens when the loop of the generator rotates through 180°?

(a) Current stops

(**b**) Direction of current reverses ✅

(c) Coil stops moving

(d) Resistance increases

54. The strength of induced e.m.f. in a generator depends on:

(a) Size of magnets only

(b) Temperature of the coil

(**c**) Number of magnetic field lines cut per second ✅

(d) Thickness of wire only

55. How can we increase the output of an A.C. generator?

(a) Use thinner wire

(b) Rotate the coil slowly

(c) Reduce magnetic field strength

(d) Increase number of turns in the coil ✅

56. What is mutual induction?

(a) Current production in a coil due to friction

(b) Current production in a coil due to change in temperature

(c) Induced current in one coil due to changing current in a nearby coil ✅

57. Which law explains the mutual induction phenomenon?

(a) Newton's Law

(b) Faraday's Law of Electromagnetic Induction ✅

(c) Ohm's Law

(d) Coulomb's Law

58. What happens in coil B when the switch in coil A is closed?

(a) Galvanometer shows momentary deflection ✅

(b) Galvanometer shows no deflection

(c) Galvanometer shows continuous deflection

(d) Coil B starts glowing

59. Why does the galvanometer needle move when the switch is opened or closed in coil A?

(a) Due to static electricity

(b) Due to change in magnetic field across coil B ✅

(c) Due to resistance

(d) Due to heating effect

60. What type of magnetic field is produced by a current-carrying coil?

(a) Same as a bar magnet

(b) Same as a disk-shaped permanent magnet ✅

(c) Irregular magnetic field

(d) No magnetic field

61. What is the main function of a transformer?

(a) Store current

(b) Convert DC to AC

(c) Increase or decrease AC voltage ✅

(d) Measure resistance

62. What is the name of the coil connected to the AC source in a transformer?

(a) Primary coil ✅

(b) Secondary coil

(c) Neutral coil

(d) Output coil

63. Which coil receives the induced e.m.f. in a transformer?

(a) Primary coil

(b) Secondary coil ✅

(c) Both coils

(d) Iron core

64. What happens in a step-up transformer?

(a) Secondary voltage is greater than primary voltage ✅

(b) Secondary voltage is less than primary voltage

(c) No voltage is induced

(d) Voltage remains constant

65. Which component in the transformer helps in transferring magnetic field from primary to secondary coil?

(a) Air

(b) Plastic core

(c) Iron core ✅

(d) Copper wires

66. Why is electric power transmitted at high voltage over long distances?

(a) To increase current in cables

(b) To reduce cost of cables

(c) To minimize energy loss in the form of heat ✅

(d) To avoid short circuit

67. What component is used to change voltage

levels during power transmission?

(a) Generator

(b) Resistor

(c) Transformer ✅

(d) Inductor

68. Which type of current is used for high-voltage transmission?

(a) Direct Current (DC)

(b) Static Current

(c) Alternating Current (AC) ✅

(d) Pulsed Current

69. What is the function of a relay?

(a) To generate electricity

(b) To convert AC into DC

(c) To control large current using a small current ✅

(d) To store electric charge

70. Which material is commonly used in

electromagnets due to easy magnetization and demagnetization?

(a) Copper

(b) Aluminium

(c) Soft iron ✅

(d) Steel

Important Short Questions:

1. What happens when electric current passes through a conductor?

Answer:

A magnetic field is produced around the conductor.

2. What is the shape of magnetic field lines around a straight current-carrying conductor?

Answer:

They are in the form of concentric circles.

3. What rule is used to find the direction of the

magnetic field around a current-carrying wire?

Answer:

The Right-Hand Rule is used.

4. State the Right-Hand Rule.

Answer:

Grasp the wire with your right hand so that the thumb points in the direction of current; the curling fingers show the direction of the magnetic field.

5. What happens when a current-carrying conductor is placed perpendicularly in a magnetic field?

Answer:

It experiences a force at right angles to both the current and the magnetic field.

6. On which principle does a D.C motor work?

Answer:

It works on the principle that a current-carrying coil placed in a magnetic field experiences a couple.

7. What is magnetic field strength?

Answer:

It is the number of magnetic lines of force passing through a certain surface.

8. When is an e.m.f. induced in a coil?

Answer:

When the magnetic field strength through the coil is changing.

9. What does an A.C. generator do?

Answer:

It converts mechanical energy into electrical energy by electromagnetic induction.

10. What is mutual induction?

Answer:

The phenomenon in which a change of current in one coil induces a current in another nearby coil.

11. What did Ampere discover about current and magnetism?

Answer:

Ampere discovered that an electric current produces a magnetic field around a conductor.

12. In what shape is the magnetic field formed around a straight current-carrying wire?

Answer:

The magnetic field is in the shape of concentric circles around the wire.

13. State the Right Hand Grip Rule.

Answer:

Hold the wire with your right hand such that the thumb points in the direction of current. Then, the curled fingers show the direction of the magnetic field.

14. What happens to the direction of magnetic field if the direction of current is reversed?

Answer:

The direction of the magnetic field also reverses.

15. What does the magnetic field of a current-carrying solenoid resemble?

Answer:

It resembles the magnetic field of a bar magnet.

16. What is an electromagnet?

Answer:

An electromagnet is a temporary magnet formed by passing current through a coil wound on soft iron.

17. How can we determine the north pole of a solenoid?

Answer:

By using the Right Hand Rule: If the fingers curl in the direction of current, the thumb points to the North Pole.

18. Why does a current-carrying wire experience a force in a magnetic field?

Answer:

Because the magnetic field interacts with the current, producing a force perpendicular to both.

19. State Fleming's Left Hand Rule.

Answer:

If the forefinger, middle finger, and thumb are placed at right angles, then:

Forefinger ⇒ magnetic field

Middle finger ⇒ current

Thumb ⇒ force (motion direction)

20. Name three factors that increase the force on a current-carrying wire in a magnetic field.

Answer:

1. Increase in current
2. Stronger magnetic field
3. Longer length of wire in the field

21. What happens when a current-carrying loop is placed in a magnetic field?

Answer:

The loop rotates due to torque acting on it, which is the principle of electric motors.

22. What causes the turning effect on a current-carrying coil in a magnetic field?

Answer:

A couple of equal and opposite forces act on the sides of the coil due to magnetic field and current, producing torque.

23. How can we increase the turning effect in a current-carrying coil?

Answer:

By increasing:

- The number of turns in the coil
- The strength of the magnetic field
- The current through the coil
- The area of the coil

24. What is the role of the commutator in a D.C. motor?

Answer:

The commutator reverses the direction of current in the coil after every half rotation, allowing continuous rotation.

25. What are brushes in a D.C. motor and what do they do?

Answer:

Brushes are graphite pieces that maintain electrical contact between the external circuit and the rotating commutator.

26. What is the function of an electric motor?

Answer:

An electric motor converts electrical energy into rotational kinetic energy.

27. Define electromagnetic induction.

Answer:

The process of generating current in a circuit by changing the number of magnetic lines of force through it.

28. What did Faraday conclude about electromagnetic induction?

Answer:

An e.m.f. is induced when there is relative motion between a magnet and a coil.

29. What factors affect the magnitude of induced

e.m.f.?

Answer:

Speed of relative motion

Number of turns of the coil

30. State Faraday's Law of Electromagnetic Induction.

Answer:

The induced e.m.f. is directly proportional to the rate of change of magnetic lines of force through the coil.

31. State Lenz's Law.

Answer:

The direction of the induced current is such that it opposes the cause that produces it.

32. How does Lenz's law obey the law of conservation of energy?

Answer:

The mechanical energy used to move a magnet is converted into electrical energy, confirming energy conservation.

33. What is an A.C. generator?

Answer:

A device that converts mechanical energy into electrical energy by electromagnetic induction.

34. On what principle does an A.C. generator work?

Answer:

It works on the principle of electromagnetic induction.

35. Why does the direction of current change in an A.C. generator?

Answer:

Because the coil rotates, causing the magnetic field lines through the coil to reverse every half turn.

36. What is mutual induction?

Answer:

It is the production of induced current in one coil due to the changing current in a nearby coil.

37. What happens when current in the primary coil

of a transformer is changed?

Answer:

A changing magnetic field is produced, which induces an e.m.f. in the secondary coil.

38. Define a transformer.

Answer:

A device used to increase or decrease alternating voltage using mutual induction.

39. What is a step-up transformer?

Answer:

A transformer that increases the voltage from primary to secondary coil.

40. What is a step-down transformer?

Answer:

A transformer that decreases the voltage from primary to secondary coil.

41. What is the role of the iron core in a transformer?

Answer:

It enhances the magnetic linkage between the primary and secondary coils.

42. Why is electricity transmitted at high voltage?

Answer:

To reduce energy loss due to heat in transmission cables.

43. How does high voltage reduce power loss?

Answer:

By reducing current, which decreases heat loss since heat $\propto I^2R$.

34. What is a relay?

Answer:

A device that uses a small current to control a large current in another circuit.

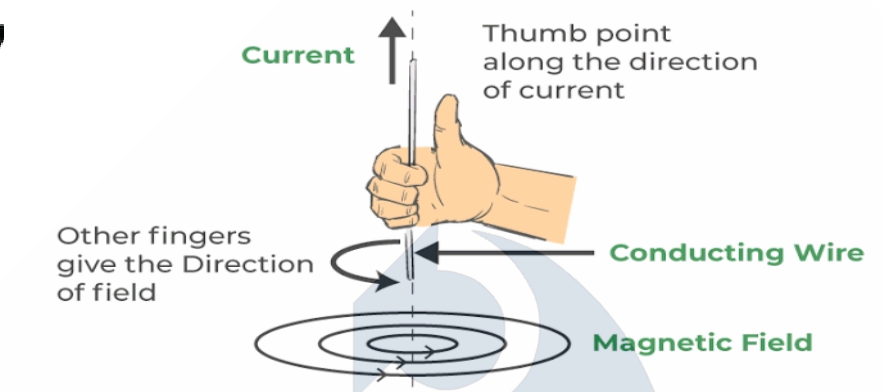
35. Name three devices that use the magnetic effect of current.

Answer:

Electric bell, relay, and circuit breaker.

Important Long Questions:

🌟 **Q1: What is the difference between the magnetic field of a current-carrying loop and a straight wire? Explain with activity.**



❖ **Answer:**

🔹 Magnetic Field of a Straight Conductor:

- When electric current passes through a straight wire, it produces concentric circular magnetic field lines around the wire.
- The strength of the magnetic field is strongest near the wire and decreases with distance.
- The direction of the field can be determined using the Right Hand Rule — if we grip the wire with the right hand such that the thumb shows current, fingers give the direction of magnetic

lines.

◆ Magnetic Field of a Circular Loop:

A wire is bent in a circular loop and passed through a cardboard. When current is passed and iron filings are sprinkled:

- The filings arrange themselves in curved lines, showing a magnetic field similar to that of a bar magnet.
- One face of the loop behaves like a north pole, and the opposite face behaves like a south pole.

◆ Direction and Shape of Field Lines:

- In a straight conductor, the field is circular around the wire.
- In a loop, the field lines pass from one face to another, forming a shape like a magnet's field.
- Inside the loop, the magnetic field is strong and concentrated.

◆ Practical Significance:

- Loops are used to produce strong, focused magnetic fields.

- This principle is used in devices like electromagnets, DC motors, and transformers.

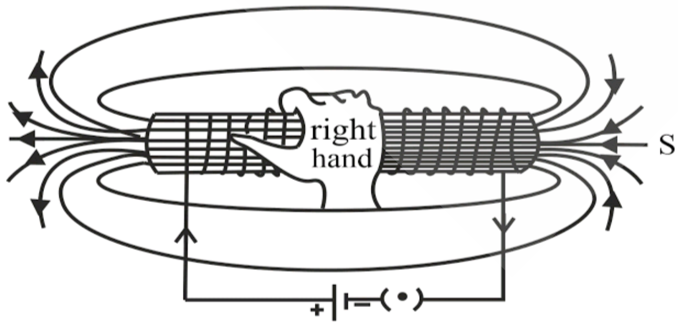
🔍 Summary:

The magnetic field of a loop is stronger and directional compared to a straight wire. A loop behaves like a bar magnet, making it useful in electrical applications, whereas a straight wire only creates circular fields around it.

🌟 Q2: Define a solenoid. Describe the magnetic field produced by a current-carrying solenoid.

❖ Definition of Solenoid:

A solenoid is a long cylindrical coil made by winding insulated wire in multiple turns. When electric current flows through it, it produces a strong magnetic field.



🔹 Magnetic Field of a Solenoid:

- Inside the solenoid, the magnetic field lines are straight, parallel, and close together, showing a strong and uniform field.
- Outside the solenoid, the field lines spread out, becoming weaker and curved.
- This pattern is similar to that of a bar magnet.

🔹 Polarity of Solenoid:

Using the Right Hand N-Grip Rule, we can find the polarity:

- If fingers curl in the direction of current, the thumb points toward the North Pole of the solenoid.
- Thus, one end acts as North Pole, and the other as South Pole.

🔹 Magnetic Field Demonstration:

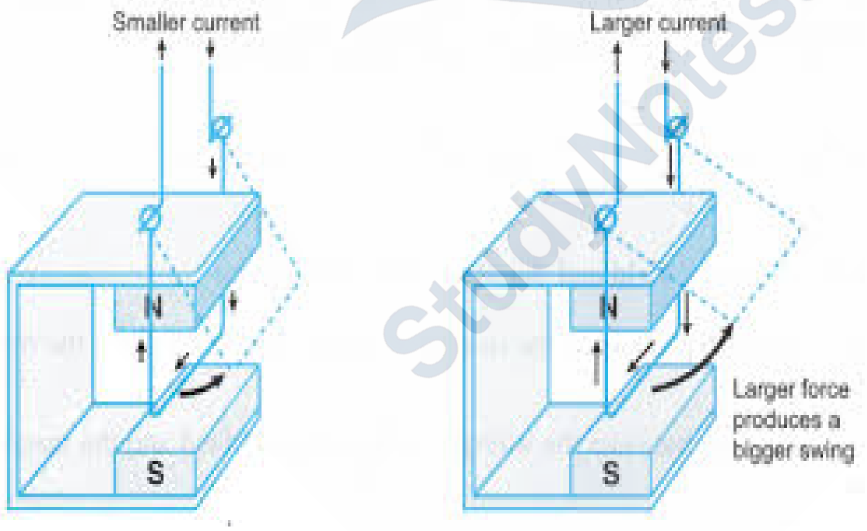
- By sprinkling iron filings around a solenoid, the magnetic field can be made visible.
- A bar magnet reacts with the solenoid similarly

– attraction or repulsion – proving the solenoid acts like a temporary magnet.

🔹 Practical Uses:

- Solenoids are used in electromagnets, electric bells, relays, and other devices requiring temporary magnetism.
- Adding an iron core inside the solenoid further increases its strength.

🌟 Q3: Describe the factors that affect the magnitude of force on a current-carrying conductor placed in a magnetic field.



❖ Introduction:

When an electric current flows through a wire placed in a magnetic field, the wire experiences a force. This force is produced due to the interaction between the magnetic field of the wire and the external magnetic field. The strength of this force depends on three important factors.

🔹 1. Strength of Magnetic Field:

- A stronger magnetic field produces a stronger force on the wire.
- When the magnetic field increases, more magnetic lines of force interact with the wire's magnetic field.
- In simple words: More magnetic field = More force.

Example: Powerful magnets in motors produce stronger force and higher efficiency.

🔹 2. Electric Current in the Wire:

- When more current flows through the wire, the force acting on it increases.
- This is because a stronger current creates a stronger magnetic field around the wire.
- In simple words: More current = More force.

- Example: Increasing current in a motor coil increases its speed.

3. Length of the Wire in the Magnetic Field:

- The longer the wire inside the magnetic field, the stronger the force it experiences.
- More length means a greater part of the wire is interacting with the magnetic field.
- **In simple words**: More length = More force.
- **Example**: Large coils are used in motors to produce more torque.

Working Principle in Electric Motors:

- These three factors are practically used in electric motors.
- Motors work on the principle that a current-carrying conductor in a magnetic field experiences a force.

The speed and power of motors can be increased by increasing:

- The strength of the magnet,

- The current in the wire, and
- The length of the wire or coil used.

🌟 **Q4: Describe the relation between magnetic field lines and induced e.m.f. How does the angle or distance between coil and magnet affect induction?**

❖ **Introduction:**

Electromagnetic induction is the process of generating an electromotive force (e.m.f.) in a conductor due to a change in the number of magnetic field lines (flux) passing through it.

🔹 **Relation Between Magnetic Field Lines and Induced e.m.f.**

- The greater the number of magnetic field lines (flux) passing through a coil, the greater the induced e.m.f.
- If the magnetic flux increases or decreases, it changes the magnetic field through the coil, which induces current.
- A changing magnetic field is necessary for

induction—a stationary field does not induce e.m.f.

◆ Effect of Angle Between Coil and Magnetic Field

- Maximum e.m.f. is induced when the coil is perpendicular to the magnetic field lines.
- Minimum e.m.f. is induced when the coil is parallel to the magnetic field lines.
- This is because the component of magnetic flux through the coil depends on the angle (θ) between the coil and magnetic field:

$$\text{Flux} = B \cdot A \cdot \cos\theta$$

◆ Effect of Distance Between Coil and Magnet

- Closer the coil is to the magnet, the stronger the magnetic field, and hence more magnetic lines of force pass through it.
- Farther the coil, the magnetic field weakens and fewer field lines pass through it, resulting in weaker e.m.f.

- Therefore, moving the coil closer or farther from the magnet changes the induced e.m.f.

🌟 **Q5: State and explain Faraday's law of electromagnetic induction with examples and diagrams.** ✅

❖ **Introduction:**

Michael Faraday discovered the phenomenon of electromagnetic induction in 1831. His experiments showed how motion between a coil and magnet induces an e.m.f.

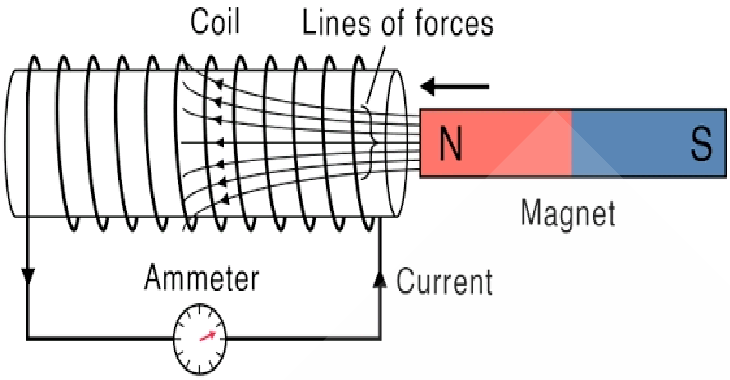
🔹 **Faraday's Law of Electromagnetic Induction:**

"The magnitude of induced e.m.f. in a circuit is directly proportional to the rate of change of magnetic flux through the circuit."

$$\text{e.m.f.} \propto \frac{\Delta\Phi}{\Delta t}$$

Where:

- $\Delta\Phi$ = Change in magnetic flux
- Δt = Time in which the change occurs



◆ Explanation Through Experiment

Faraday performed several experiments using a magnet and coil:

1. When the magnet is stationary near the coil ⇒ No current is induced.

2. When the magnet is moved towards or away from the coil ⇒ Current is induced.

3. Faster the movement of the magnet ⇒ Greater the induced current.

This proves that a changing magnetic field is necessary to induce e.m.f.

◆ Examples of Faraday's Law

- Moving a magnet in and out of a coil.
- Rotating a coil in a magnetic field (used in electric generators).

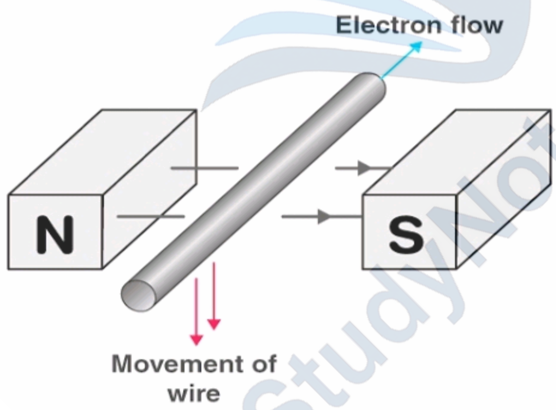
- Transformers work on the principle of electromagnetic induction.

◆ Applications

- **Electric generators**: Convert mechanical energy into electrical energy.
- **Induction cookers and transformers**: Work on Faraday's principle.

🌟 **Q6: Explain Lenz's Law. How does it relate to the Law of Conservation of Energy?**

❖ Definition of Lenz's Law:



Lenz's Law states:

"The direction of the induced current is such that it always opposes the cause that produced it."

In simple words, if a changing magnetic field induces a current in a coil, that current will create its own magnetic field to resist the original change.

- **Activity Example: Solenoid and Magnet**

To understand this law, consider a practical experiment:

- Take a coil (solenoid) connected to a galvanometer.
- Now bring a bar magnet (north pole) closer to the coil.
- The galvanometer needle deflects, indicating that a current is induced in the coil.
- The end of the coil facing the approaching north pole becomes a north pole as well. This happens so that it repels the magnet — this is Lenz's Law in action.
- If you now pull the magnet away, the current reverses direction and the coil end becomes a south pole to attract the magnet back — again, opposing the motion.
- This shows that the induced current always acts in a way to oppose the movement of the

magnet, either by repelling it or attracting it back.

◆ Direction of Induced Current:

- When the magnet moves towards the coil: Induced current creates a repelling field.
- When the magnet moves away from the coil: Induced current creates an attracting field.
- This direction of current can be determined using Lenz's Law and Fleming's Right Hand Rule.

◆ Relation with the Law of Conservation of Energy:

- Lenz's Law supports the Law of Conservation of Energy.
- When you move a magnet towards a coil, you do mechanical work.
- That mechanical work is not wasted — it is converted into electrical energy in the form of current in the coil.
- If the induced current helped the motion

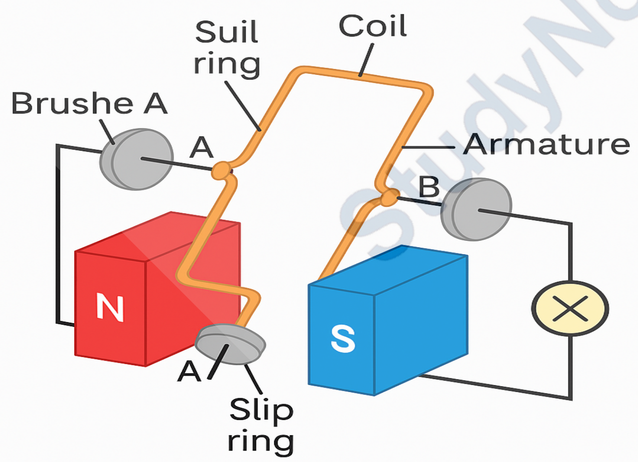
instead of opposing it, we could generate energy without doing work — which is

🌟 Q7: What are the main components of an A.C Generator? Explain their functions with a labeled diagram

❖ Definition of A.C Generator:

An A.C Generator is a device that:

- "Converts mechanical energy into electrical energy using the principle of electromagnetic induction."
- It generates alternating current (A.C), which changes direction after every half rotation.



A.C. Generator

🔹 Main Components and Their Functions:

1. Armature (Coil):

- It is a rectangular coil made of copper wire.
- It is placed between the poles of a strong magnet.
- When it rotates, it cuts through the magnetic field lines, producing an induced current.

2. Magnets:

- These provide a magnetic field.
- The coil rotates inside this magnetic field.
- They can be permanent magnets or electromagnets.

3. Slip Rings:

- Two metal rings connected to the ends of the coil.
- They rotate with the coil and provide a continuous connection between the rotating coil and the external circuit.

4. Brushes:

- These are stationary conductors made of carbon or metal.

- They stay in contact with the slip rings.
- They carry the induced current from the rotating coil to the external load (like a bulb or circuit).

5. Shaft or Handle:

- This is used to rotate the coil manually or with a motor.
- The rotation is the mechanical input that gets converted into electrical output.

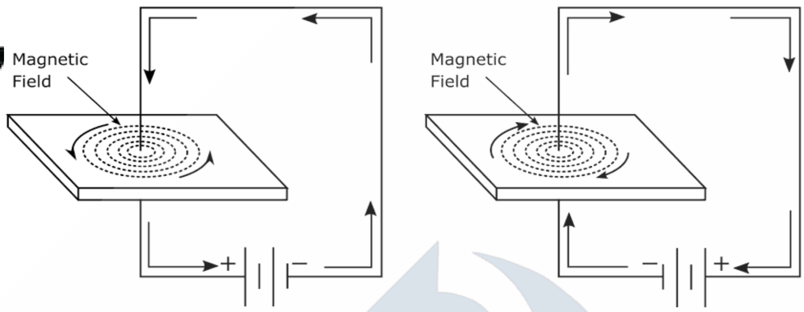
◆ Working Principle:

- When the coil (armature) rotates between the magnetic poles, it cuts through magnetic field lines.
- According to Faraday's Law if Induction, an e.m.f. is induced in the coil.
- As the coil keeps rotating, the direction of this induced current changes every half turn.
- This results in alternating current (A.C) in the

external circuit.

🌟 **Q8: Explain how a magnetic field is produced around a current-carrying conductor.**

❖ **Answer:**



🔸 Magnetic Field Around a Conductor:

When an electric current passes through a straight conductor, it creates a magnetic field in the space surrounding it. This magnetic field is invisible but can be detected using magnetic compass needles or iron filings.

🔸 Nature of Magnetic Field Lines:

The magnetic field lines around a straight conductor form concentric circles. These circles are centered on the wire, and their direction depends on the direction of the current.

🔸 Right-Hand Rule:

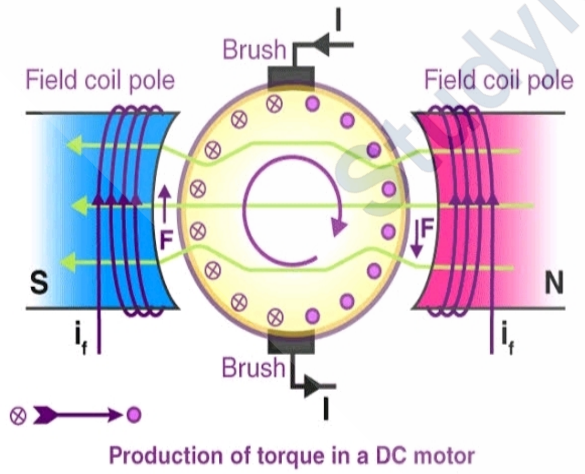
To determine the direction of the magnetic field, we use the Right-Hand Rule. According to this rule:

"Grasp the wire with your right hand so that the thumb points in the direction of the conventional current (positive to negative). The curling of the fingers shows the direction of the magnetic field lines."

- This rule helps visualize how the magnetic field behaves around a wire.

🌟 **Q9: Explain the working principle of a D.C Motor. How does it convert electrical energy into mechanical energy?**

Answer:



🔸 Basic Principle:

A D.C Motor works on the principle that a current-carrying conductor placed in a magnetic field experiences a force. When this conductor is shaped into a coil, it experiences a couple, which causes it to rotate.

◆ Magnetic Force on Coil:

When current flows through the coil placed in a magnetic field, the magnetic force acts in opposite directions on either side of the coil. This results in a rotational movement.

◆ Rotation of Coil Due to Couple:

The opposite forces on the sides of the coil create a couple (a turning effect), making the coil spin continuously as long as current flows. This is how mechanical motion is produced.

◆ Use of D.C Current:

D.C motors require direct current (D.C) to maintain consistent direction of rotation. A commutator is used to reverse the current direction every half rotation to keep the motor running smoothly.

🔸 Applications:

- Electric fans
- Mixers
- Toys
- Drills

🌟 Q10: What is meant by magnetic field strength? How is it related to magnetic lines of force?

❖ Definition:

Magnetic field strength refers to the measure of the intensity of a magnetic field at a given point. It indicates how strong or weak the magnetic influence is in a particular area.

🔸 Relation to Magnetic Lines of Force:

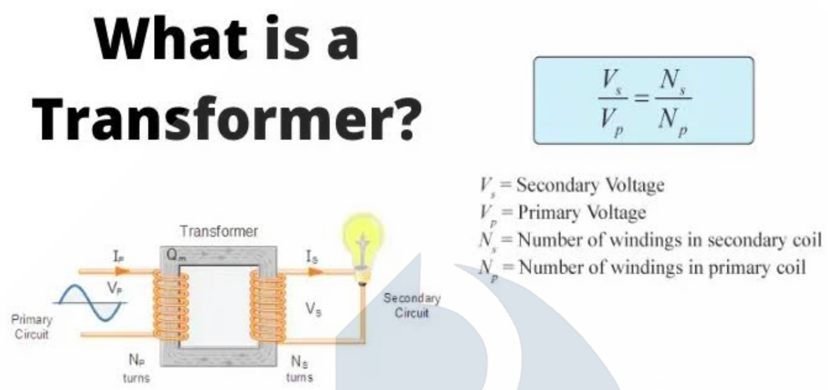
Magnetic field strength is proportional to the number of magnetic field lines passing perpendicularly through a surface. More lines mean a stronger field; fewer lines mean a weaker field.

🔸 Unit of Magnetic Field Strength:

The SI unit of magnetic field strength is the Tesla

(T). Another related unit is Weber per square meter (Wb/m²).

🌟 Q11: What is a transformer? Explain its working and principle.



❖ Definition:

A transformer is an electrical device that is used to increase or decrease the voltage of an alternating current (A.C) without changing its frequency.

🔸 Working Principle – Mutual Induction:

A transformer works on the principle of mutual induction. When the current in the primary coil changes, it produces a changing magnetic field. This changing field induces an e.m.f. in the secondary coil.

🔸 Types of Transformer:

1. Step-up Transformer – Increases voltage and decreases current.

2. Step-down Transformer – Decreases voltage and increases current.

🔸 Importance in Transmission:

Transformers are essential for the transmission of electricity over long distances. They:

- Step up voltage at the power station for efficient transmission.
- Step down voltage before distribution to homes and industries.

🔍 Summary:

A transformer uses mutual induction to change the voltage of A.C electricity. Step-up and step-down transformers play a vital role in power distribution by adjusting voltage levels efficiently.

Exercise Questions:

REVIEW QUESTIONS

🌟 **15.1 Demonstrate by an experiment that a magnetic field is produced around a straight current-carrying conductor.**

❖ **Answer:**

🔸 Aim of the Experiment:

To show that a magnetic field is produced around a conductor when electric current flows through it.

🔸 Apparatus Required:

- A thick straight copper wire
- A battery or power supply
- A switch
- A magnetic compass
- A cardboard sheet
- Iron filings (optional)

🔸 Experimental Procedure:

1. Set up the apparatus by placing the straight

copper wire vertically through a hole in the center of the cardboard sheet.

2. Connect the ends of the wire to a battery and switch to allow current to pass through.

3. Place a magnetic compass on the cardboard near the wire.

4. Close the switch to allow current to flow through the wire.

5. Observe the deflection of the compass needle.

6. If available, sprinkle iron filings on the cardboard to observe the pattern of magnetic field lines.

Observation:

- The compass needle deflects when the current flows through the wire.
- This deflection indicates the presence of a magnetic field.
- The filings form concentric circular patterns around the wire, showing the shape of the field lines.

- **Explanation:**

When electric current flows through the wire, it produces a circular magnetic field around it. The direction of this field can be observed using the compass.

🌟 **15.2 State and explain the rule by which the direction of the lines of force of the magnetic field around a current-carrying conductor can be determined.**

❖ **Answer:**

- **Name of the Rule:**

The rule used to determine the direction of the magnetic field around a current-carrying conductor is called the Right-Hand Rule (also known as Maxwell's Right-Hand Grip Rule).

- **Statement of the Rule:**

"If you hold a straight conductor in your right hand such that your thumb points in the direction of conventional current (from positive to negative), then the curled fingers show the direction of the magnetic field lines."

🔸 **Explanation:**

- This rule is useful to find the circular direction of the magnetic field lines around a wire.
- If the current is flowing upward, the magnetic field circles anticlockwise.
- If the current is flowing downward, the magnetic field circles clockwise.

🔸 **Practical Use:**

This rule is widely used in electromagnetism to:

- Predict magnetic field direction in coils and wires.
- Understand the behavior of electric motors and generators.

🌟 **15.3. You are given an unmarked magnetized steel bar and a bar magnet (with N and S marked). How would you determine the polarity at each end of the unmarked bar?**

❖ **Answer:**

Concept:

A magnet has two poles: North (N) and South (S). To determine the unknown polarity of a bar, we rely on the fundamental law of magnetism:

"Like poles repel, and unlike poles attract."

🔹 **Step-by-step Procedure:**

1. Take the bar magnet with clearly marked North (N) and South (S) poles.

2. Hold the unmarked magnetized steel bar in front of you.

3. Bring the North (N) pole of the marked magnet close to one end of the unmarked bar.

4. Carefully observe the interaction:

- If the end of the unmarked bar repels the North pole, it must also be a North pole.
- If it attracts, it could be a South pole — but attraction alone is not a confirmation.

5. Now, repeat the process with the other end of the unmarked bar.

6. If this second end repels the N pole of the bar magnet, then it is also a North pole, which means the first end was South.

7. Only repulsion gives certainty because attraction can occur even with non-magnetized or weakly magnetic materials (like iron).

🔶 **Scientific Reasoning:**

- Repulsion happens only between two poles of the same type.
- Therefore, observing repulsion confirms the polarity with certainty.

🌟 15.4. When a straight current-carrying conductor is placed in a magnetic field, it experiences a force. State the rule by which the direction of this force can be found out.

❖ Answer:

✅ **Name of the Rule:**

➡ Fleming's Left-Hand Rule

🔹 **Concept:**

- When a wire carrying electric current is placed perpendicularly in a magnetic field, it experiences a mechanical force that acts at right angles to both the current and the magnetic field.
- To find the direction of this force, we apply Fleming's Left-Hand Rule.

◆ Statement of Fleming's Left-Hand Rule:

"If you hold your left hand such that:

- the First finger (F) points in the direction of the magnetic field (from North to South),
- the Second finger (S) points in the direction of the current (from Positive to Negative),
- then the Thumb (T) will point in the direction of the force (motion of the conductor)."

Explanation of the Rule:

Finger	Represents
First finger	Magnetic Field
Second finger	Electric Current

Thumb	Force (Motion)

Example:

- Suppose a wire is placed horizontally in a magnetic field.
- The magnetic field is directed downward.
- Current is flowing forward through the wire.
- Apply the left-hand rule:
- Point first finger downward (field),
- Second finger forward (current),
- Your thumb will point sideways — this is the direction of force.

🌟 **15.5: State that a current-carrying coil in a magnetic field experiences a torque.**

❖ **Answer:**

🔸 **Statement:**

When a current-carrying coil is placed in a magnetic field, it experiences a torque (twisting force) that causes it to rotate.

🔸 **Explanation:**

- A coil has multiple turns of wire.
- When electric current flows through the coil, each side of the coil experiences a magnetic force.
- According to Fleming's left-hand rule, the two sides of the coil experience forces in opposite directions.
- These forces create a couple or torque, which rotates the coil.
- This rotation continues as long as the current is supplied and proper commutator action is maintained.
- This principle is the working basis of electric motors.

🌟 **15.6: What is an electric motor? Explain the working principle of a D.C Motor**

❖ **Definition of Electric Motor:**

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

🔸 **Working Principle of D.C Motor:**

A D.C motor works on the principle that:

A current-carrying coil placed in a magnetic field experiences a force, and this force causes rotation due to torque.

Construction and Working:

- A rectangular coil (armature) is placed between the poles of a permanent magnet.
- The coil is connected to a D.C power supply through split ring commutators and carbon brushes.

When current flows through the coil:

- The magnetic field from the magnets interacts with the electric current in the coil.
- One side of the coil is pushed upward, the other side downward.
- This creates a rotational force (torque) on the coil.
- The split rings reverse the current direction after half rotation to keep the coil rotating in the same direction.

🔸 Application:

D.C motors are used in:

- Electric fans
- Toys
- Washing machines
- Hair dryers

🌟 15.7: Describe a simple experiment to demonstrate that a changing magnetic field can induce e.m.f. in a circuit

❖ **Answer:**

🔸 Aim:

To demonstrate that a changing magnetic field induces electromotive force (e.m.f.) in a coil.

🔸 Apparatus:

- A coil of copper wire
- A galvanometer (to detect current)
- A bar magnet

🔸 Procedure:

1. Connect the two ends of the coil to a sensitive galvanometer.

2. Quickly insert the north pole of a bar magnet into the coil.

- The needle of the galvanometer deflects, indicating that current is induced.

3. Hold the magnet still inside the coil.

- The galvanometer shows no deflection — meaning no current is induced if the field is not changing.

4. Pull the magnet out of the coil.

- Again, the needle deflects in the opposite direction.

🌟 **15.8: What are the factors which affect the magnitude of the e.m.f. induced in a circuit by a changing magnetic field?**

❖ **Answer:**

🔸 **The magnitude of the induced e.m.f. depends on the following factors:**

- 1. Speed of change in magnetic field:

- Faster movement of the magnet or coil produces more e.m.f.
- Slower movement produces less e.m.f.

- 2. Number of turns in the coil:

- More turns = greater induced e.m.f.
- Fewer turns = less e.m.f.

- 3. Strength of the magnetic field:

- Stronger magnets induce more e.m.f.
- Weaker magnets induce less e.m.f.

- 4. Relative angle between coil and magnetic field:

- Maximum e.m.f. is induced when the magnet moves perpendicularly to the plane of the coil.
- Lesser angle = less effective induction

🌟 **15.9: Describe the direction of an induced e.m.f. in a circuit? How does this phenomenon relate to conservation of energy?**

❖ **Answer:**

🔸 Direction of Induced e.m.f. – Lenz's Law:

The direction of the induced e.m.f. (and current) in a coil is such that:

"It always opposes the change in magnetic field that produced it."

This is known as Lenz's Law.

🔸 Example:

- When north pole of a magnet is moved towards a coil, the coil produces a north pole at its nearest face to oppose the approaching magnet.
- Similarly, when the magnet is moved away, the coil produces a south pole to oppose the motion.

🔸 How It Relates to the Law of Conservation of Energy:

According to the Law of Conservation of Energy:

"Energy cannot be created or destroyed, it can only be converted from one form to another."

- Lenz's law ensures that mechanical energy used to move the magnet is converted into electrical energy in the coil.
- If the induced current did not oppose the motion, energy would be created from nothing, which violates the law.
- So, the opposing force caused by induced current maintains energy balance.

🌟 **15.10: Draw a labelled diagram to illustrate the structure and working of A.C. Generator**

❖ **Definition:**

An A.C. Generator is a device that converts mechanical energy into electrical energy in the form of alternating current (A.C) using electromagnetic induction.

🔸 **Construction:**

It consists of:

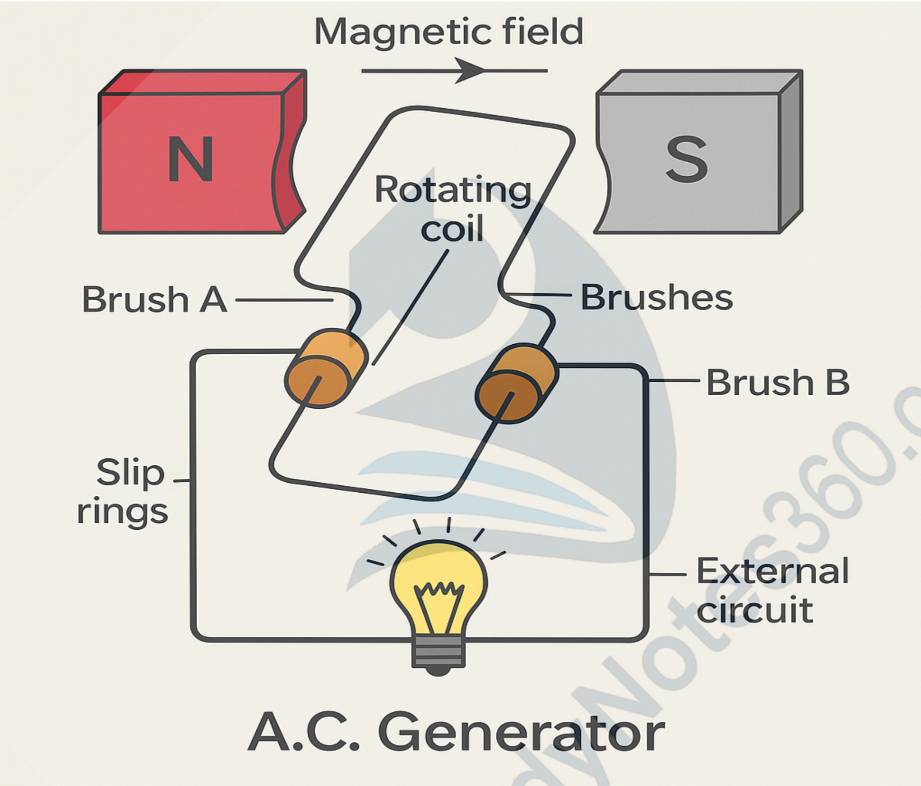
1. **Coil (Armature):** A rectangular wire loop that rotates in magnetic field.

2. **Magnets (Poles):** Provide strong magnetic field.

(One North, one South)

3. Slip Rings: Two metallic rings attached to the ends of the coil. They rotate with the coil.

4. Brushes: Carbon strips that touch the slip rings and connect the coil to the external circuit.



🔸 **Working Principle:**

- As the coil rotates in the magnetic field, the magnetic flux through the coil changes continuously.
- According to Faraday's Law, this change induces an e.m.f.

- Since the coil keeps rotating, the direction of current changes after every half turn, producing alternating current (A.C.).

🌟 **15.11: What do you understand by the term mutual induction?**

❖ **Definition:**

Mutual Induction is the phenomenon in which a changing current in one coil induces an e.m.f. (electromotive force) in another nearby coil without direct contact, due to the changing magnetic field.

🔸 **Explanation:**

- When current flows through a coil, it produces a magnetic field.
- If this current is increased or decreased, the magnetic field around it also changes.
- If another coil is placed close to the first one, this changing magnetic field will cut through the second coil, inducing a current or e.m.f. in it.
- This process is called mutual induction because the effect is mutually generated

between the two coils.

◆ Example:

If two coils are wound around the same iron core:

- The first coil is connected to a battery (called primary coil).
- The second coil is connected to a galvanometer (called secondary coil).
- When the switch of the battery is turned on or off, the galvanometer needle in the second coil deflects, showing that e.m.f. is induced due to mutual induction.

🌟 **15.12: What is a transformer? Explain the working of a transformer in connection with mutual induction.**

❖ **Definition of Transformer:**

A transformer is a device that changes the voltage of alternating current (A.C) using the principle of mutual induction.

It can be:

- Step-up Transformer: Increases voltage.
- Step-down Transformer: Decreases voltage.

🔸 Construction:

A transformer consists of:

1. Primary Coil – Connected to input A.C voltage.
2. Secondary Coil – Connected to output circuit.
3. Soft Iron Core – Enhances magnetic coupling between coils.

🔸 Working Principle (Based on Mutual Induction):

- When A.C. flows through the primary coil, it produces a changing magnetic field.
- This changing magnetic field passes through the iron core and cuts the secondary coil.
- According to Faraday's Law, this change in magnetic field induces an e.m.f. in the secondary coil.
- The amount of voltage in the secondary depends on the number of turns in both coils.

🔸 Transformer Formula:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

Where:

- V_s = Voltage in secondary coil
- V_p = Voltage in primary coil
- N_s = Number of turns in secondary
- N_p = Number of turns in primary

◆ Types of Transformer:

1. **Step-Up Transformer**
   - $N_s > N_p$
   - Increases voltage
   - Used in **power stations**
2. **Step-Down Transformer**
   - $N_s < N_p$
   - Decreases voltage
   - Used in **homes, industries**

◆ Importance:

Transformers are essential in the transmission of electricity over long distances with minimum energy loss.

🌟 **15.13: Why is electrical power transmitted at high voltage over long distances? Give two reasons.**

❖ **Answer:**

Electrical power is transmitted over large distances at high voltage because of the following two main reasons:

✅ 1. To Reduce Power Loss:

When electric current flows through transmission wires, some energy is lost as heat due to resistance.

This heat loss is given by the formula:

$$\text{Power loss} = I^2R$$

By increasing voltage and reducing current, we can greatly minimize heat loss during transmission.

✅ 2. To Improve Efficiency of Transmission:

- High-voltage transmission allows more electrical energy to reach consumers with less energy wasted.

- It makes long-distance transmission more efficient and economical.

🌟 **15.14: Why is the voltage used for domestic supply much lower than the voltage at which the power is transmitted?**

❖ **Answer:**

The voltage for domestic supply is kept much lower (e.g., 220V) than the transmission voltage (which can be tens of thousands of volts) for the following reasons:

✅ **1. Safety of Humans and Appliances:**

- High voltage is dangerous and can cause serious electric shocks or fires.
- Household devices are designed to operate at safe voltage levels (typically 110–240V).

✅ **2. Compatibility with Electrical Devices:**

- Most electrical appliances like fans, lights, refrigerators, etc., are built for low-voltage operation.

- High voltage would damage these devices and make them unsafe for home use.

CONCEPTUAL QUESTIONS

🌟 **15.1: Suppose someone handed you three similar iron bars and told you one was not a magnet, but the other two were. How would you find the iron bar that was not a magnet?**

❖ **Answer:**

To find the iron bar that is not magnetized, we can use a simple interaction test:

✅ **Step-by-step method:**

1. Pick any two iron bars and bring them close to each other.

2. If they attract at both ends, then:

Either both are magnets, Or one is a magnet, and the other is not.

3. Now, take the third bar and bring it close to the other two, one at a time.

4. If one of the bars does not attract the other two, or it is attracted from all sides, it is most likely the non-magnet.

🔹 **Key point to observe:**

- A magnet has polarity — it attracts only the opposite poles strongly.
- An unmagnetized iron bar is attracted by either pole of a magnet without polarity, but does not attract other objects on its own.

🌟 **15.2: Suppose you haove a coil of wire and a bar magnet. Describe how you could use them to generate an electric current.**

❖ **Answer:**

You can generate electric current using the principle of electromagnetic induction.

✅ **Steps to generate current:**

1. Take a coil of wire connected to a galvanometer (current detector).

2. Move the bar magnet quickly into the coil or out of the coil.

3. The galvanometer needle will deflect, indicating that a current is induced.

✅ **How does it work?**

- When the magnet moves, the magnetic field through the coil changes.
- This change induces e.m.f. (electromotive force) in the coil.
- As a result, an electric current flows.

🔸 **Important Note:**

- The faster the motion, the greater the induced current.
- Reversing the direction of the magnet's motion will reverse the direction of the induced current.

🌟 **15.3. Which device is used for converting electrical energy into mechanical energy?**

❖ **Answer:**

The device used for converting electrical energy into mechanical energy is called a D.C. Motor (Direct Current Motor).

✅ Explanation:

- A D.C. motor works on the principle that a current-carrying conductor placed in a magnetic field experiences a force.
- When electric current flows through the coil of the motor, it interacts with the magnetic field, producing a rotational force (torque).
- This force causes the coil to rotate continuously, converting electrical energy into mechanical (rotational) energy.

🔸 Applications of D.C. Motor:

- Electric fans
- Washing machines
- Toys
- Electric cars

🌟 **15.4. Suppose we hang a loop of wire so that it can swing easily. If we now put a magnet into the coil, the coil will start swinging. Which way will it swing relative to the magnet, and why?**

❖ Answer:

When a magnet is pushed into the coil, the coil will swing away from the magnet.

✅ **Explanation:**

This phenomenon occurs due to Lenz's Law, which states:

"The direction of the induced current is such that it opposes the cause which produces it."

🔸 **In this case:**

- Inserting the magnet into the coil changes the magnetic field, which induces current in the coil.
- The induced current in the coil generates its own magnetic field.
- According to Lenz's Law, this magnetic field opposes the magnet's field.
- As a result, the coil experiences a repelling force and swings away from the approaching magnet.

🌟 **15.5. A conductor wire generates a voltage while moving through a magnetic field. In what direction should the wire be moved, relative to the field, to generate the maximum voltage?**

❖ Answer:

To generate the maximum voltage, the conductor wire should be moved perpendicular (at right angles) to the direction of the magnetic field lines.

🧲 Explanation:

- When a wire moves through a magnetic field, an electromotive force (e.m.f.) or voltage is induced in it due to electromagnetic induction.
- The maximum e.m.f. is produced when the motion of the wire cuts across the magnetic field lines at 90°.
- If the wire moves parallel to the magnetic field, no field lines are cut, and no voltage is generated.
- This principle is based on Faraday's Law of Electromagnetic Induction, which states that

the induced e.m.f. is proportional to the rate at which the magnetic flux is cut by the conductor.

🌟 **15.6. What is the difference between a generator and a motor?**

❖ **Answer:**

A generator and a motor are both electromagnetic devices, but they perform opposite functions.

Motor:

- A motor converts electrical energy into mechanical energy.
- It works on the principle that a current-carrying coil placed in a magnetic field experiences a force which causes it to rotate.
- Example: Used in electric fans, washing machines, and toys.

⚡ **Generator:**

- A generator converts mechanical energy into electrical energy.
- It works on the principle of electromagnetic

induction: when a coil rotates in a magnetic field, a changing magnetic flux induces a voltage in the coil.

- **Example**: Used in power stations to produce electricity.

🔁 **Summary of the Difference:**

- **Motor**: Electricity ⇒ Motion
- **Generator**: Motion ⇒ Electricity

🌟 **15.7. What reverses the direction of electric current in the armature coil of a D.C motor?**

❖ **Answer:**

The commutator (also called a split ring) is the part that reverses the direction of electric current in the armature coil of a D.C motor.

🧲 **Explanation:**

- As the armature coil rotates within the magnetic field, the direction of the current in each side of the coil must reverse every half turn to maintain continuous rotation in the same direction.

- The split ring commutator is connected to the rotating coil and reverses the current direction in the coil after every half rotation.
- It does this by swapping the contacts with the carbon brushes, which are stationary but supply current from an external source.

🔁 **Result**: This reversal ensures that the forces acting on the coil sides remain in the same direction, keeping the coil rotating continuously.

🌟 **15.8. A wire lying perpendicular to an external magnetic field carries a current in the direction shown in the diagram below. In what direction will the wire move due to the resulting magnetic force?**

❖ **Answer:**

The wire will move in a direction perpendicular to both the current and the magnetic field, as determined by Fleming's Left-Hand Rule.

🧲 **Explanation using Fleming's Left-Hand Rule:**

- Stretch your left hand such that the thumb, forefinger, and middle finger are all at right angles to each other.

- Forefinger = Magnetic field (from North to South)
- Middle finger = Current (from positive to negative)
- Thumb = Force/motion (direction in which the wire will move)

💡 Since the current is perpendicular to the field, applying the rule will show that the wire will move vertically upward or downward, depending on the specific directions of current and magnetic field in the diagram.

🔹 **Note**: The exact direction (up or down) depends on:

- Direction of magnetic field lines (left to right or right to left)
- Direction of current in the wire (into or out of the page)

🌟 **15.9. Can a transformer operate on direct current (D.C)?**

❖ Answer:

No, a transformer cannot operate on direct current (D.C). It only works with alternating current (A.C).

🔹 **Explanation:**

A transformer works on the principle of mutual electromagnetic induction, which requires a changing magnetic field to induce voltage in the secondary coil.

🔁 **In case of A.C:**

- Alternating current constantly changes direction.
- This changing current produces a changing magnetic field in the primary coil.
- The changing magnetic field induces an alternating voltage in the secondary coil.

🔋 **In case of D.C:**

- Direct current flows in one fixed direction.
- It produces a constant magnetic field, not a changing one.

- A constant magnetic field cannot induce voltage in the secondary coil.
- So, no output voltage is generated, and the transformer becomes useless with D.C.

⚠ **Additional Note:**

Using D.C in a transformer can also overheat the coils and damage the transformer because D.C causes continuous current flow without the self-regulating effect that A.C provides.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

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Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

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