Chapter - 13
Magnetic Effects of Electric Current

Q: 1 **Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements A and R.**

Assertion (A): In an AC electric generator, a current is induced in the coil as the coil rotates between the poles of a permanent magnet.

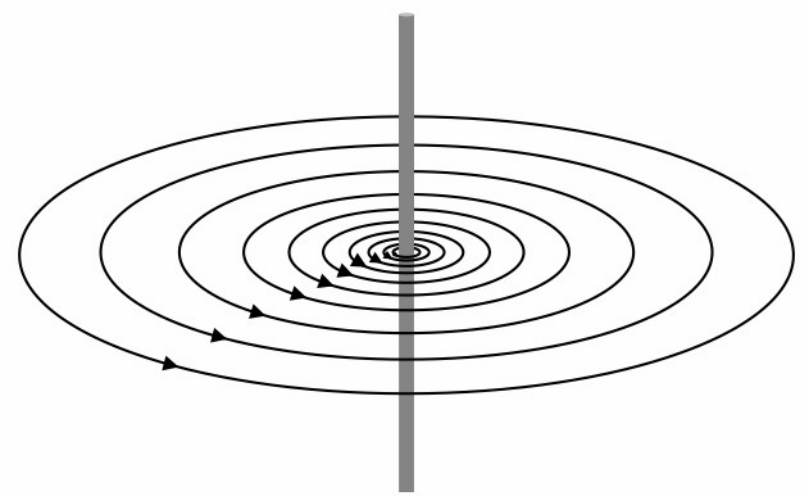
Reason (R): The force due to the magnetic field makes the coil rotate in an AC electric generator.

Which of the following is correct?

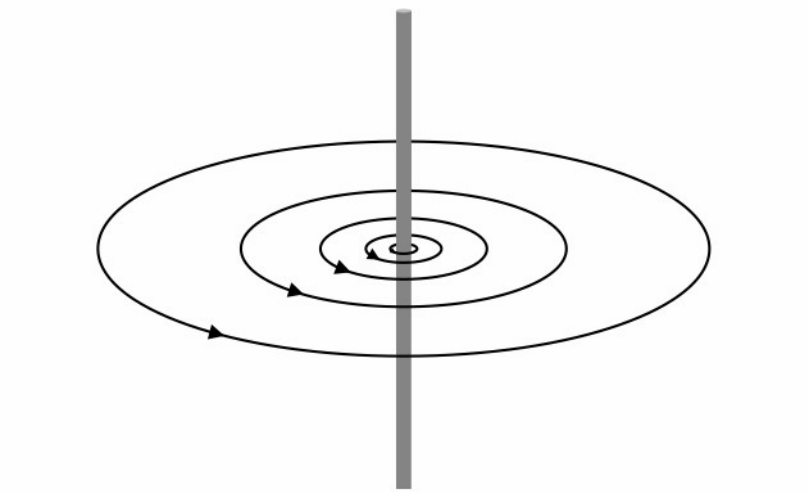
1 Both A and R are true, and R is the correct explanation of A.
2 Both A and R are true, but R is not the correct explanation of A.

3 A is true, but R is false.
4 A is false, but R is true.

Q: 2 **The diagram below shows the magnetic field lines due to a current in a straight conductor.**



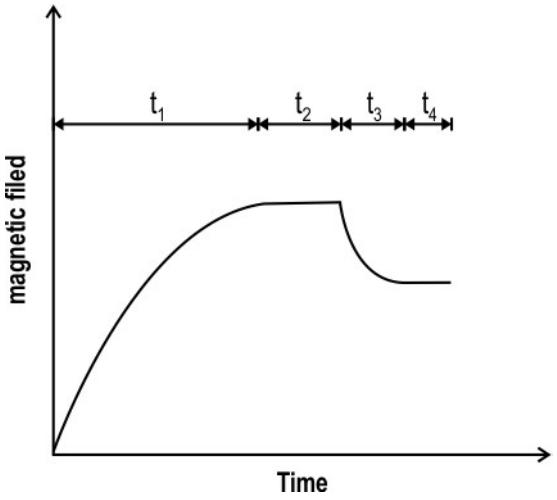
Something was done to the current because of which the magnetic field lines changed as shown below.



What was done to the current?

1 Its magnitude was increased and its direction reversed.
2 Its magnitude was decreased and its direction reversed.
3 Its magnitude was increased.
4 Its magnitude was decreased.

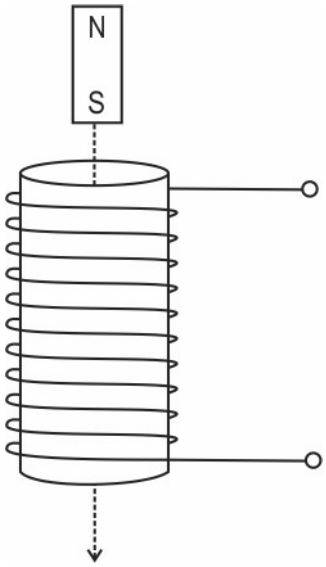
Q: 3 **A stationary metal coil is placed in a magnetic field. The strength of the magnetic field varies with time as shown in the graph below.**



In which of the time intervals(s) is a current induced in the coil?

1. only t_1
2. only t_1 and t_3
3. only t_2 and t_4
4. all - t_1 ,t_2 ,t_3 ,t_4

Q: 4 **A small bar magnet is dropped vertically from rest into a long coil of wire, and it leaves from the other end as shown in the diagram below.** **[1]**



Compare the magnitude and direction of
- the induced current in the coil when the magnet enters the coil, with
- the induced current in the coil when it leaves the coil.

Q: 5 **In a DC motor with a commutator, how many times does** **[1]**
(i) the current in the armature coil change its direction during one rotation of the coil,
(ii) the current stop flowing in the armature coil during one rotation of the coil?

Q: 6 **Arun built a DC electric motor using whatever scrap material he had. Since he did not have a split ring, he used a full ring in contact with the brushes.** **[2]**

Diagram of DC motor using a split ring

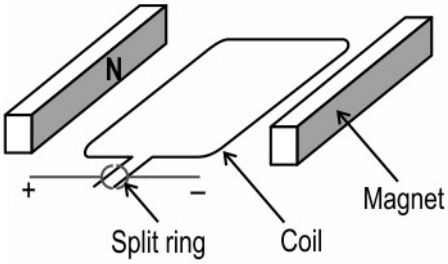
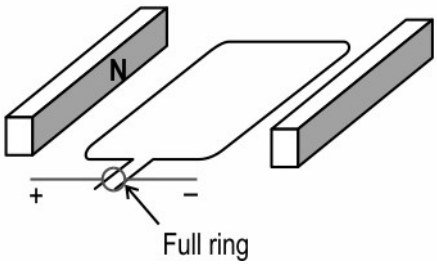


Diagram of DC motor using a full ring

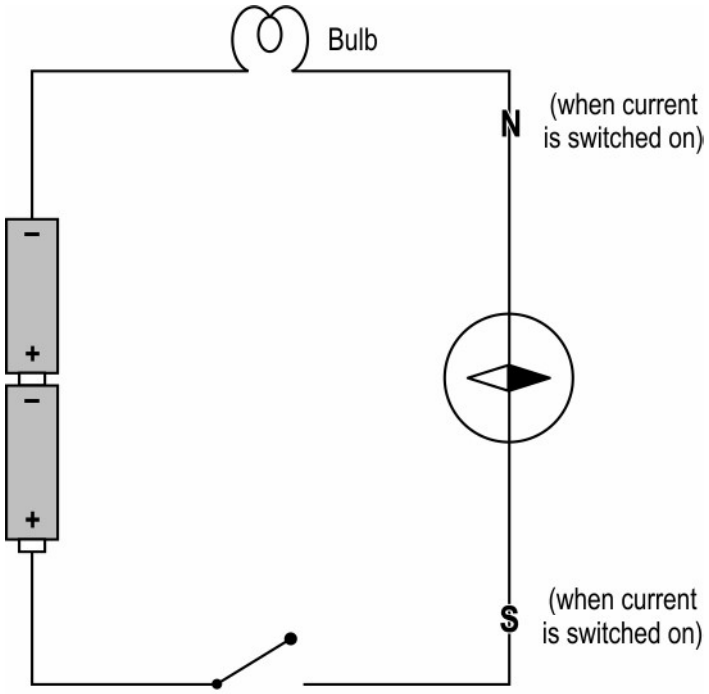


State what will be the effect of using a full ring on the movement of the axle in Arun's motor. Give a reason for your answer.

Q: 7 **In 1820, Hans Christian Oersted discovered that a magnetic needle is deflected by a current-carrying wire. For many years, he had expected to find a connection between electricity and magnetism.** **[3]**

Before his discovery, Oersted had imagined the magnetic field to be a straight line along the direction of the wire - with the north pole at one end and the south pole at the other. This was a major reason why he took so long to discover electromagnetism.

The figure below shows how Oersted would have arranged his wire and magnetic needle in his early experiments.

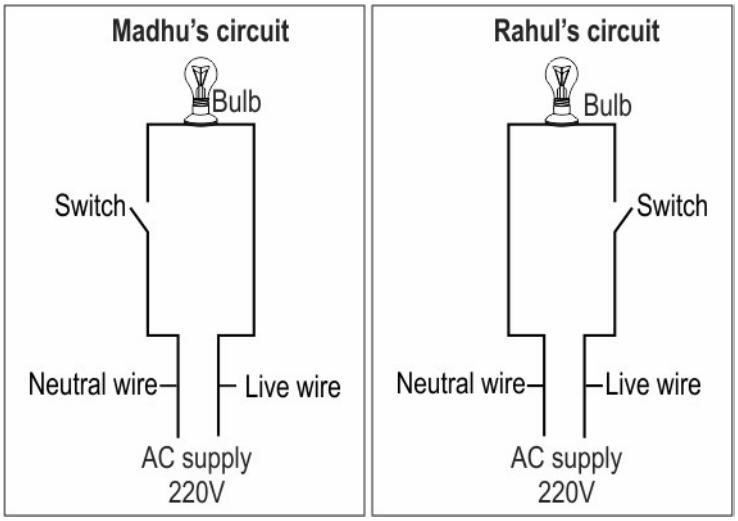


How Oersted imagined the magnetic field

(a) Draw a diagram to show the observation that Oersted would have expected when switching on the current, if his hypothesis had been correct.

(b) Based on our current knowledge of the magnetic field around a wire, explain why his experiment failed.

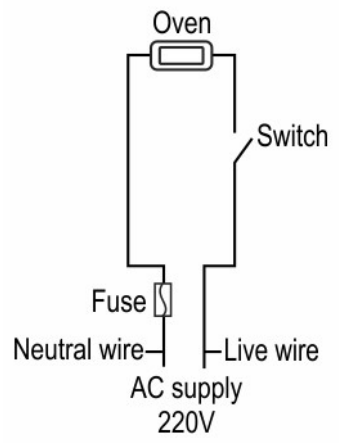
Q: 8 **Observe Madhu's and Rahul's circuits shown below.** **[3]**



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

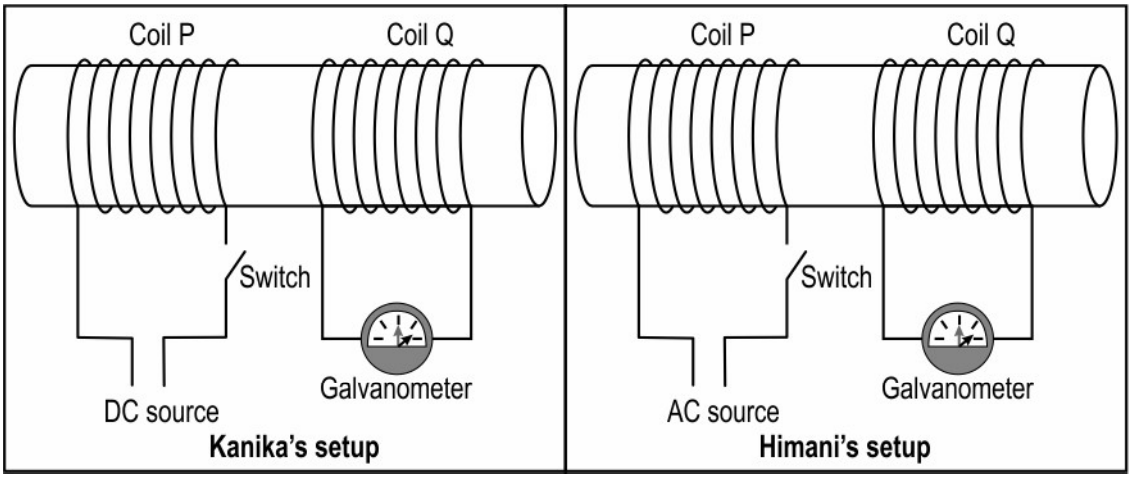
(b) Both Madhu and Rahul open the switches in their circuits to change the bulbs. For whom will changing the bulb be safe and for whom will it be dangerous? Explain why.

Q: 9 **(a) In the circuit below, in case of an overload, will the fuse protect the electric oven from damage? Justify your answer.** **[3]**



(b) If the oven has a rating of 13 A, what should be the minimum rating of the fuse?

Q: 10 **Kanika and Himani have set up two coils P and Q as shown below. The only difference between the two set-ups is the source of electricity.** **[2]**



State what will the galvanometer indicate when the switch is closed in both the set-ups.

Q: 11 **An induction cooktop works on the principle of electromagnetic induction. Inside the cooktop there is a tightly wound metal coil. An alternating current flows through the coil and produces an invisible, high-frequency, alternating magnetic field all around it.** **[3]**

When a vessel made of magnetic material is placed on the cooktop, the magnetic field produced by the coil penetrates the iron of the vessel and induces whirling electrical (eddy) currents inside the pan and makes it hot.

There is no open flame used. Heat from the pan flows directly into the food or water inside it (by conduction) without heating up the area surrounding the cooktop. Unless there is a pan on the cooktop, no heat is produced.

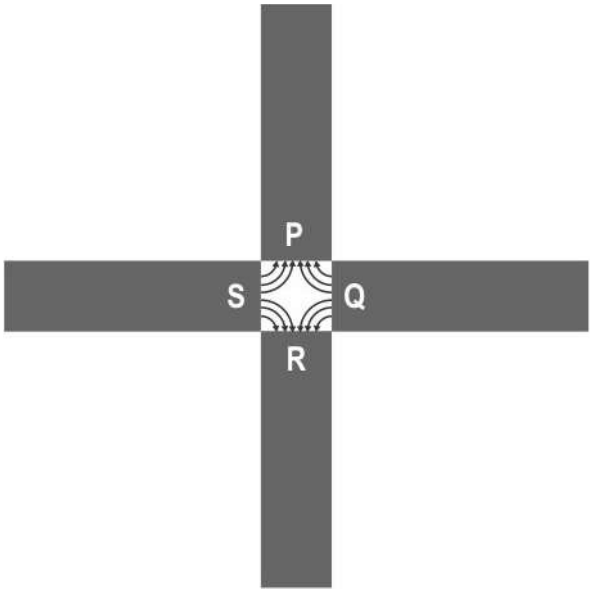
Cooking on a gas stove

Cooking on an induction cooktop

List any two advantages, with reasons, of cooking using an induction cooktop instead of a gas stove.

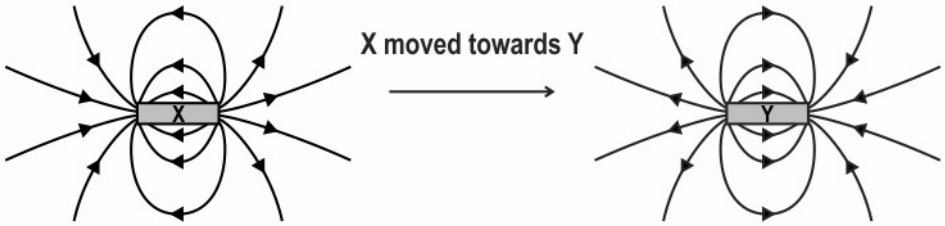
Q: 12 **Quadrupole magnets consist of groups of four magnets and are used in particle accelerators.** **[1]**

The image below shows four bar magnets configured to produce a quadrupole. The magnetic field lines between the magnets is marked.



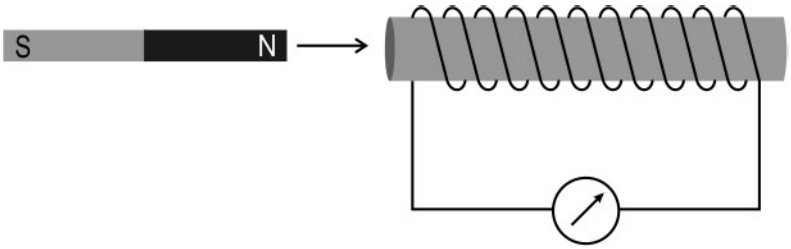
What are the poles of the magnets at P, Q, R and S?

Q: 13 **The figure shows two magnets X and Y kept near each other. Their poles are not marked, but the magnetic field lines are shown in the figure.** **[2]**



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

Q: 14 **A coil is connected to a galvanometer as shown in the image below. The galvanometer shows a deflection to the right when the north pole of a magnet is moved towards the coil.** **[1]**



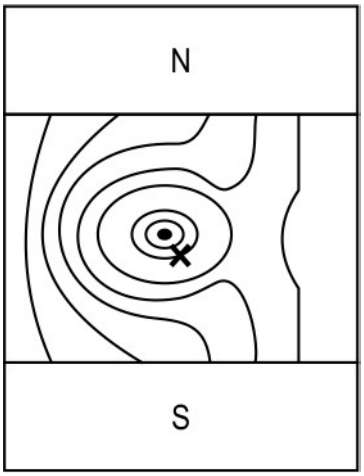
State the deflection in the galvanometer when both the coil and the magnet are moved towards the right at the same speed. Give a reason for your answer.

Q: 15 **A current clamp is an electrical device used to measure current in a conductor without making any physical contact with the conducting part of the conductor. The current clamp has jaws that clamp around the conductor as shown below.** **[2]**

Some current clamps work on the principle of electromagnetic induction and hence can measure only alternating current.

Give a reason why direct current cannot be measured by these current clamps.

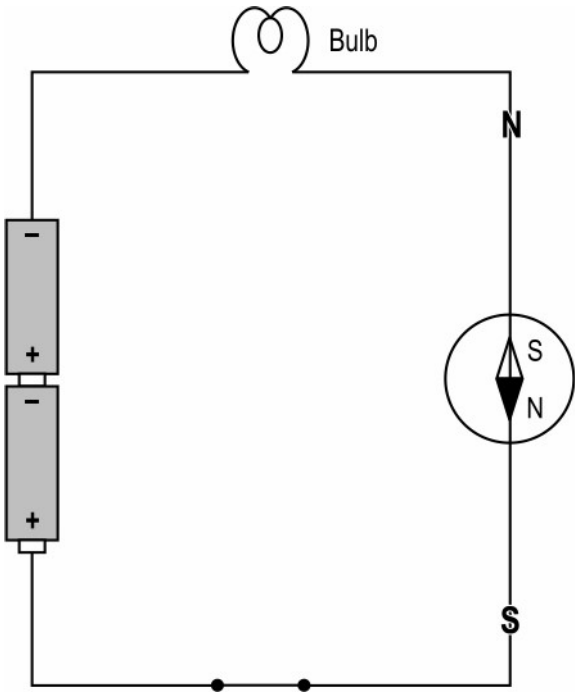
Q: 16 **The image below shows the cross-section of a wire placed between the poles of a magnet. The wire carries an electric current out of the plane of the page. Both the current carrying wire and the magnet generate a magnetic field. The resulting shape of the magnetic field is as shown.** **[3]**



(a) Draw arrows on the magnetic field lines to mark the direction of the magnetic field.
(b) In the image above, the left side of point X indicates a stronger magnetic field compared to the right side. What feature in the image indicates this?
(c) What is the direction of the force acting on the current carrying wire?
(d) Name and state the rule you used to determine the direction of force in (c).

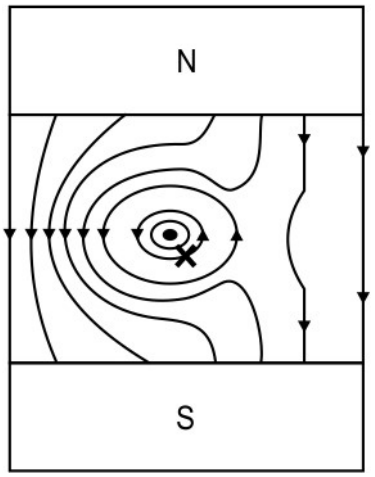
The table below gives the correct answer for each multiple-choice question in this test.

Q.No	Correct Answers
1	3
2	4
3	2

Q.No	Teacher should award marks if students have done the following:	Marks
4	**Magnitude of the induced current will be more when the magnet leaves the coil. [0.5 marks]** **Direction of the induced current will be reversed when the magnet leaves the coil. [0.5 marks]**	**1**
5	**(i) twice [0.5 marks]** **(ii) twice [0.5 marks]**	**1**
6	**The motor will not work.**	**1**
	1 mark for any of the following: **- Electric current will not flow through the coil.** **- There would be a short circuit.**	**1**
7	**(a) 1 mark for showing the magnetic needle aligned with the wire.** 	**1**

Q.No	Teacher should award marks if students have done the following:	Marks
	(b) 1 mark for each point: **- The magnetic field due to the current is perpendicular to the wire.** **- Since the needle is already pointing in a direction perpendicular to the wire, it will not get deflected.**	**2**
8	**(a) 0.5 marks each for the following:** **- The bulb will glow in both the circuits.** **- The circuits will be closed / complete.**	**1**
	(b) 0.5 marks for each of the following: **- Changing the bulb will be dangerous for Madhu.** **- Changing the bulb will be safe for Rahul.** **- In Madhu's circuit, the bulb point is still connected to the live wire and can give an electric shock even when the switch is in the open position.** **- In Rahul's circuit, the bulb point is no longer connected to the live wire when the switch is in the open position.**	**2**
9	**(a) 1 mark for each of the following:** **- No** **- The fuse will blow only after current has passed through the oven and damaged it.**	**2**
	(b) 1 mark for any one of the following: **- a little above 13 A** **- 14 A** **- 15 A**	**1**
10	**1 mark each for the following:** **- In Kanika's set-up the galvanometer will show a deflection when the switch is closed and will then go back to zero.** **- In Himani's set-up the galvanometer will continuously show a deflection from one side to the other.**	**2**

Q.No	Teacher should award marks if students have done the following:	Marks
11	0.5 marks each for any two advantages and 1 mark for the reason such as: - Less wastage of energy as heat: Heat is produced in the vessel, so much less is lost to the surroundings. - Greater safety as less chance of fire: There is no open flame on an induction cooktop. - Less air pollution in the kitchen: As no fuel is used, no carbon dioxide is produced due to combustion of fuel. - Less danger from burns:As the cooktop does not get heated.	3
12	0.5 marks for each of the following: -P and R: south pole -Q and S: north pole	1
13	They will repel each other.	1
	The right end of magnet X and the left end of magnet Y are both north poles since field lines start from there.	1
14	The galvanometer will not show any deflection.	0.5
	Since the coil and the magnet are moved at the same speed, there is no relative motion between them and no current is induced in the coil. Therefore, there is no deflection in the galvanometer.	0.5
15	In DC, the magnitude of current is constant and hence it produces a constant magnetic field. Current can be induced only by a changing magnetic field. Since DC produces a constant magnetic field, it cannot induce current and hence the current clamp cannot measure DC. (1 mark for each statement.)	2

Q.No	Teacher should award marks if students have done the following:	Marks
16	**(a)**  	1
	(b) The field lines on the left side of X are crowded compared to the right side indicating a stronger field.	0.5
	(c) The wire experiences a force towards the left.	0.5
	(d) Fleming's left hand rule. According to this rule, if we stretch the thumb, the forefinger and the middle finger of the left hand such that they are mutually perpendicular to each other and the forefinger points in the direction of magnetic field and the second finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor. **(Do not award any marks for just naming the rule and not stating it.)**	1