# RADIANT 2026

Physics

## Magnetism

One Shot

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# TOPICS TO BE COVERED

1. Introduction
2. Induced Magnetism
3. Lines of Magnetic Field
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5 Magnetic Filed of Earth

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7 Permanent Magnet

8 Uses of Electromagnets

A

(Induced Magnetism and Neutral Points)

# Introduction

The first known magnets were the pieces of lodestone, an ore of iron oxide ($Fe_3O_4$) found in large quantities in Magnesia, in Asia Minor. This ore was found to possess two properties:

(i) It attracts small pieces of iron, and

(ii) It sets itself along a definite direction when it is suspended freely. The Chinese, earlier than 2500 B.C., used these pieces to guide their boats.

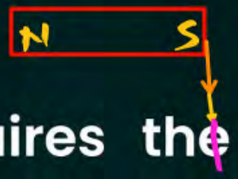
- The pieces of lodestone found in nature where later on called the natural magnets. The word magnet has been derived from magnesia.
- The natural magnets are found in quite irregular and odd shapes. They are not magnetically strong enough for use.

Therefore, for different uses, artificial magnets are prepared from iron in different convenient sizes and shapes such as bar magnet, horse shoe magnet, magnetic needle, magnetic compass, etc.

# Induced Magnetism


Induced magnetism (Magnetism induces by a bar magnet on the magnetic materials)

- The temporary magnetism acquired by a magnetic material when it is kept near (or in contact with) a magnet, is called induced magnetism.




- The process in which a piece of magnetic material acquires the magnetic properties temporarily in presence of another magnet near it, is called the magnetic induction.
- A magnetic pole induces an opposite polarity on the near end and a similar polarity on the farther end of the iron bar.

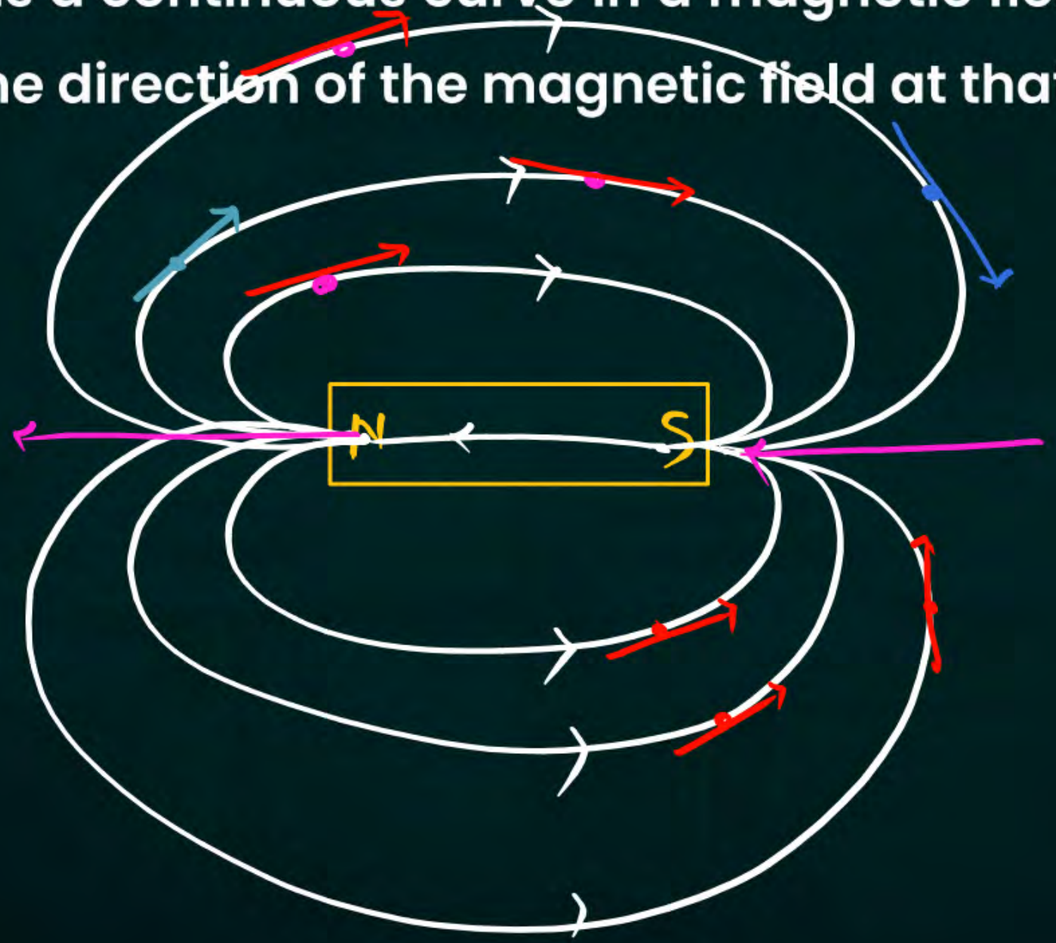
# Lines of Magnetic Field

- If a magnetic compass is placed on a table, it is found that its needle rests in geographic north south direction. But when it is placed near a magnet, the needle swings and then rests in some other direction.
- As the compass is placed at different positions around a magnet, the direction in which the needle rests, changes such that its one end always points towards the nearer pole of the magnet.
- This behaviour of needle is due to the influence of the magnet near it. The region in which the compass gets influenced is called the magnetic field of the magnet.
- The space around a magnet in which the needle of a compass rests in a direction other than the geographic north-south direction, is called magnetic field of the magnet.

- As the distance of point from the magnet increases, the effect of its magnetic field decreases.
- Magnetic field is a vector quantity. The magnitude of magnetic field at a point is measured by the force which a magnetic pole placed at that point, experiences, while the direction of magnetic field is the direction in which the needle of compass rests when it is placed at that point.

# Lines of Magnetic Field

A magnetic field line is a continuous curve in a magnetic field such that tangent at any point of it gives the direction of the magnetic field at that point.




Outside → NS
Inside → SN
Curve close

# Properties of Magnetic Field Lines

The magnetic field lines have following properties:

(1) They are closed and continuous curves.

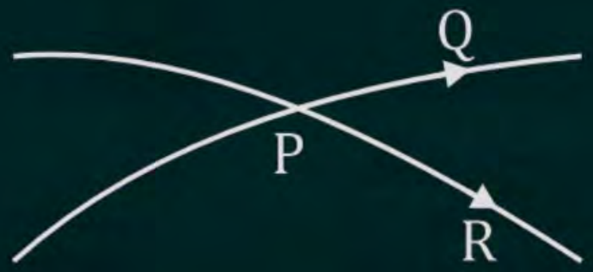
(2) Outside the magnet, they are directed from the north pole towards the south pole of the magnet.

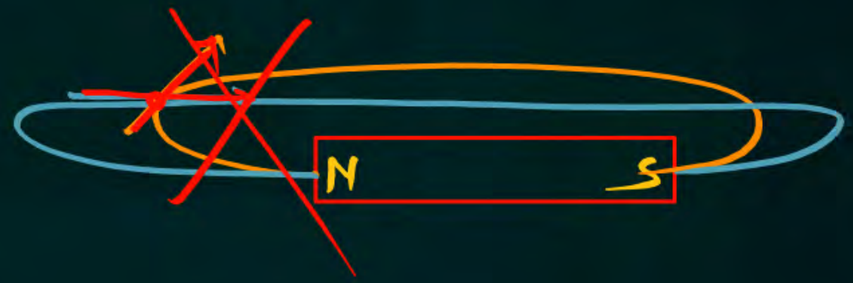
(3) The tangent at any point on a field line gives the direction of magnetic field at that point.

(4) They never intersect one another. If two field lines intersect, there would be two directions of the magnetic field at that point which is not possible. Figure shows two magnetic field lines PQ and PR intersecting.....

# Properties of Magnetic Field Lines

Each other at a point P. It would mean that if a compass needle is placed at the point P, north pole of its needle will point in two directions PQ and PR simultaneously which is not possible.




A compass needle placed at the point P cannot show the two directions PQ and PR simultaneously

# Properties of Magnetic Field Lines

5. They are crowded near the poles of the magnet where the magnetic field is strong and are far separated near the middle of the magnet and far from the magnet, where the magnetic field is weak.
6. Parallel and equi-distant field lines represent a uniform magnetic field. The earth's magnetic field in a limited space is uniform.
7. They behave like the stretched elastic rubber strings.

# Magnetic Filed Lines of Earth (Evidences of existence of earth's magnetic field)

Our earth itself has a magnetic field and it behaves like a magnet. The existence of earth's magnetic field is based on the following facts:

(i) A freely suspended magnetic needle always rests in geographic north-south direction.

(ii) An iron rod buried inside the earth along north-south direction becomes a magnet.

(iii) Neutral points are obtained on plotting the field lines of a magnet where the net magnetic field in zero.

(iv) A magnetic needle rests with its geometric axis making different angles with horizontal when suspended at different places on the earth.

# Magnetic Filed Lines of Earth (Evidences of existence of earth's magnetic field)

(i) A freely suspended magnetic needle always rests in geographic north-south direction.

# Magnetic Filed Lines of Earth (Evidences of existence of earth's magnetic field)

(ii) **An iron rod buried inside the earth along north-south direction becomes a magnet**

If an iron rod is buried few matres inside the earth keeping it along north-south direction, after some days it is found that the rod becomes a weak magnet. If is possible only if the earth itself behaves like a magnet.

# Magnetic Filed Lines of Earth
# (Evidences of existence of earth's magnetic field)

(iii) Neutral points are obtained on plotting the field lines of a magnet-

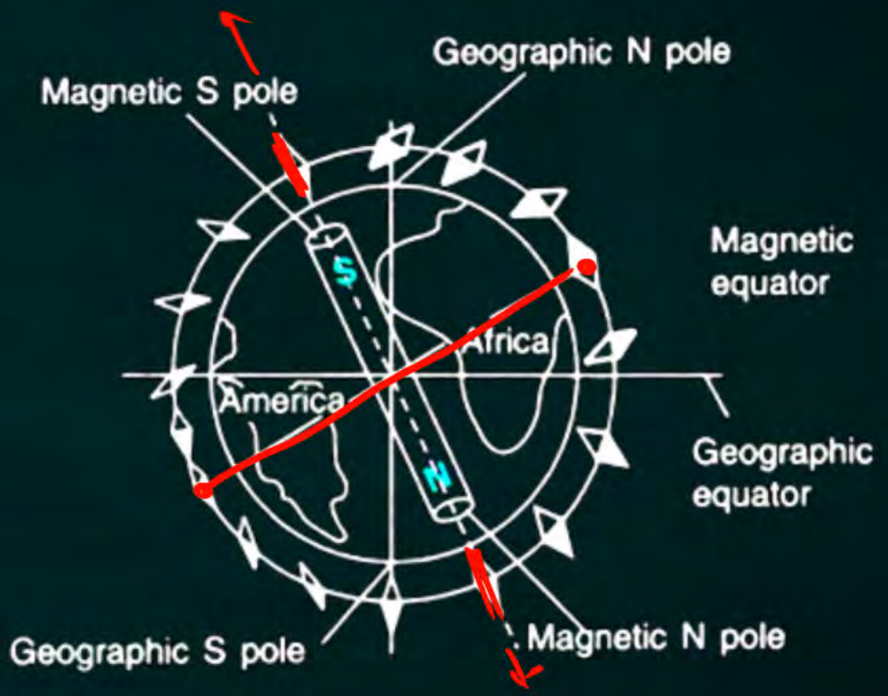
If a magnet is placed

# Magnetic Filed Lines of Earth
# (Evidences of existence of earth's magnetic field)

(iv) A magnetic needle rests making different angles with horizontal when suspended at different place of the earth.

# Magnetic Filed Lines of Earth (Evidences of existence of earth's magnetic field)

- Two places where the magnetic needle becomes vertical are called the magnetic poles.
- The line joining the places where the magnetic needle becomes horizontal, is called the magnetic equator.



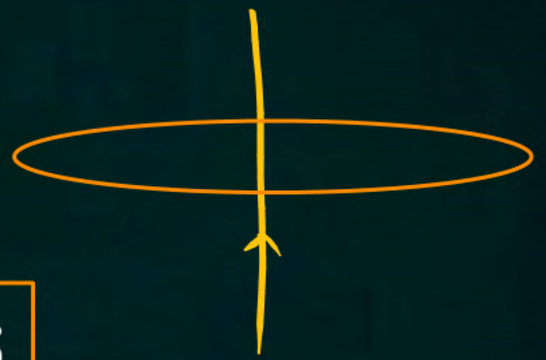

The magnetic needle at different places on earth

# Magnetic Filed Lines of Earth

- In a limited space, the magnetic field lines of earth are parallel and equidistant to each other as shown in Figure. They are always directed from the geographic south to the geographic north. They are horizontal at the magnetic equator and vertical at the magnetic poles, but at any other point, they are inclined to the horizontal.
- The magnetic field lines of the earth are normal to earth surface near the magnetic poles and parallel to earth surface near the magnetic equator.

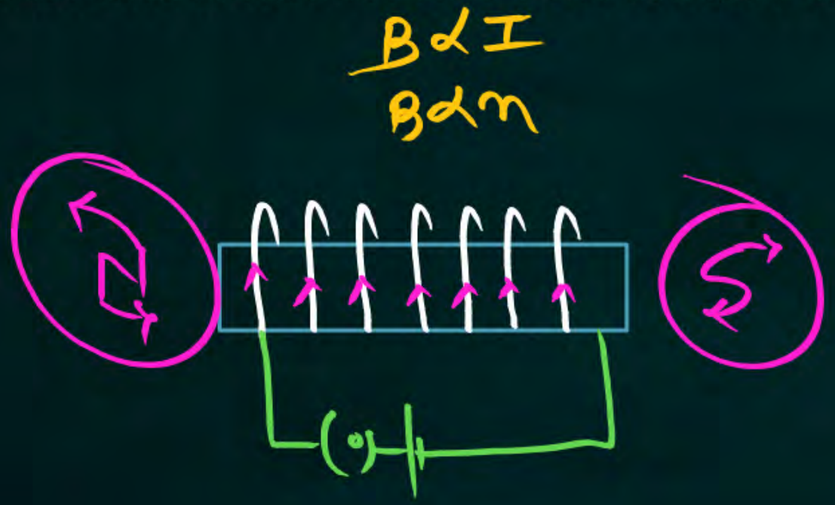
B

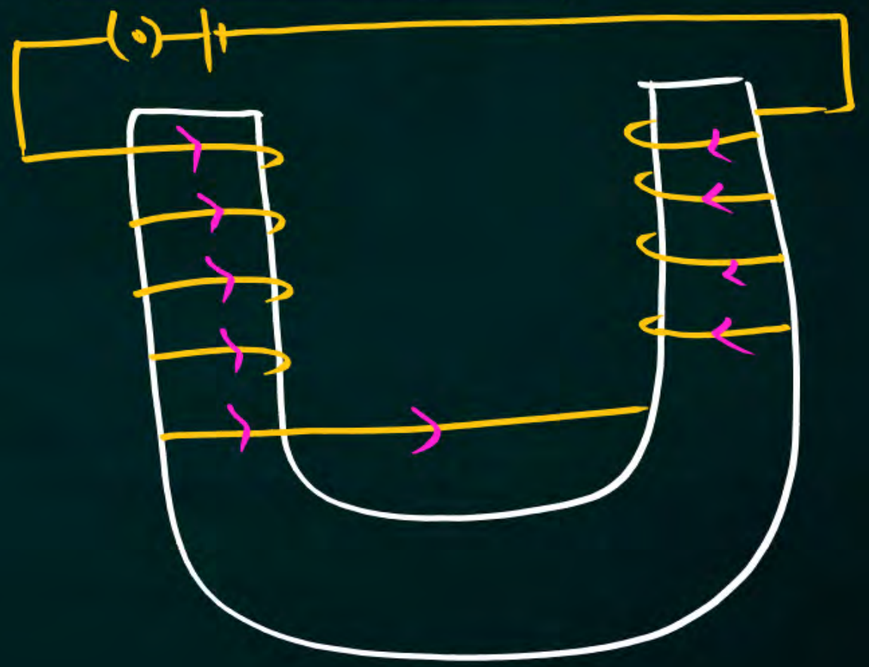
# Electromaget and Its Uses



# Electromagnet

An electromagnet is a temporary strong magnet made from a piece of soft iron when current flows in the coil would around it. It is an artificial magnet.



# Electromagnet

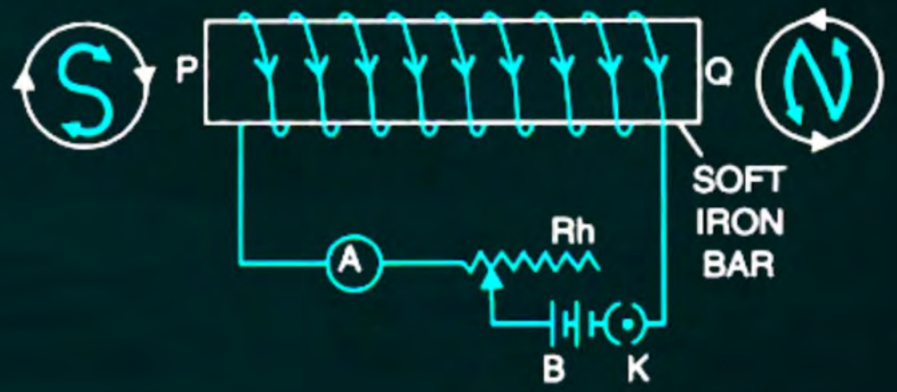
And electromagnet can be made in any shape but usually the following two shapes of electromagnet are in use:

(a) I-shape (or bar) magnet, and

(b) U-shape (or horse-shoe) magnet

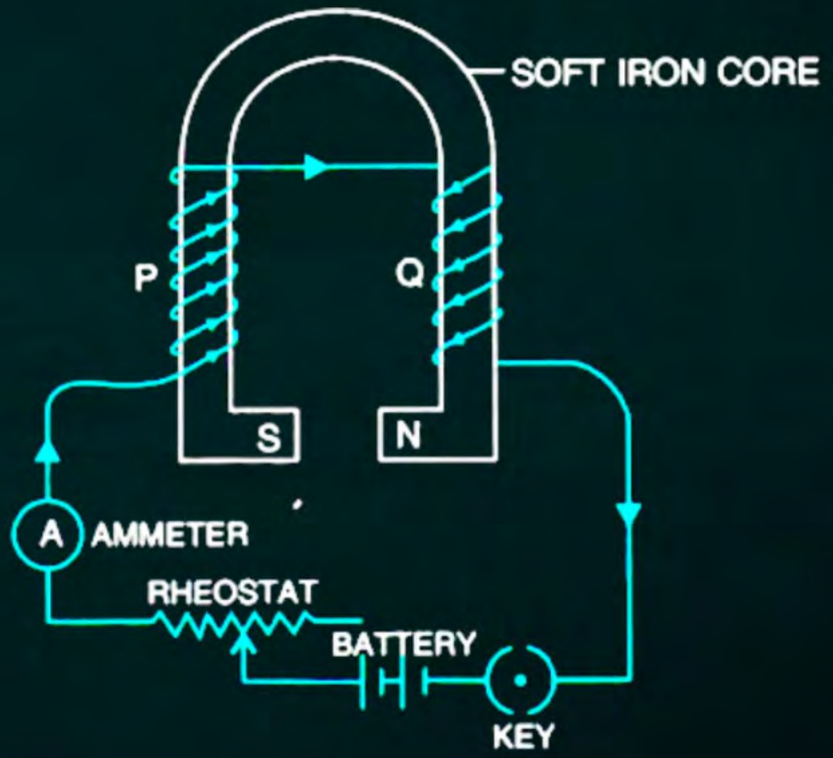
# Electromagnet

(a) construction of I-shaped (or bar) electromagnet



# Electromagnet

## (b) Construction of the U-shaped (or horse-shoe) electromagnet



# Electromagnet

## Whys of increasing the magnetic field of an electromagnet

The magnetic field of an electromagnet (I or U-shpaed) can be increased by the following two ways: $B \propto n$

(i) By increasing the number of turns of winding in the solenoid, and

(ii) By increasing the current through the solenoid. $B \propto I$

# Permanent Magnet

- A permanent magnet is a naturally occurring magnet. Since it is not strong enough and of required shape for many purposes, so a strong permanent magnet is made like an electromagnet using steel instead of soft iron.
- A coil of insulated copper wire is wound around the steel piece and then current is passed in the coil. Once magnetised, it does not lose its magnetism easily (since steel has more retentivity than soft iron) so it becomes a permanent magnet.
- The permanent magnets are used in electric meters (e.g., galvanometer, ammeter, voltmeter) and in magnetic compass, etc.

# Comparison of An Electro-Magnet With a Permanent Magnet

| | Electromagnet | | Permanent Magnet |
|---|---|---|---|
| 1 | It is made of soft iron | 1 | It is made of steel. |
| 2 | It produces the magnetic field so long as current flows in its coil. i.e. it produces the temporary magnetic | 2 | It produces a permanent magnetic field. |
| 3 | The magnetic field strength can be changed | 3 | The magnetic field strength cannot be changed |
| 4 | The magnetic field of an electromagnet can be very strong. | 4 | The magnetic field of a permanent magnet is not so strong. |
| 5 | The polarity of an electromagnet can be reversed. | 5 | The polarity of a permanent magnet can not be reversed. |
| 6 | It can easily be demagnetized by switching off the current | 6 | It can not be easily demagnetized. |

# Advantages of An Electro-Magnet Over A Permanent Magnet

An electromagnet has the following advantages over a permanent magnet:

(i) An electromagnet can produce a strong magnetic field.

(ii) The strength of the magnetic field of an electromagnet can easily be changed by changing the current (or the number of turns) in its solenoid.

(iii) The polarity of the electromagnet can be reversed by reversing the direction of current in its solenoid.

# Uses of Electromagnets

Electromagnets are mainly used for the following purposes:

(i) For lifting and transporting heavy iron scrap, girders, plates, etc. particularly when it is not convenient to take the help of human labour. Electromagnets are used to lift as much as 20,000 kg of iron in a single lift. To unload the iron objects at the desired place, the current in the electromagnet is switched off so that the iron objects get detached.

(ii) For loading the furnaces with iron.

(iii) For separating the iron pieces from debris and ores, where iron exists as impurities (e.g., for separating iron from the crushed copper ore in copper mines).

(iv) For removing pieces of iron from wounds.

(v) In scientific research, to study the magnetic properties of a substance in a magnetic field.

(vi) In several electrical devices such as electric bell, telegraph, electric tram, electric motor, relay, microphone, loud speaker, etc.

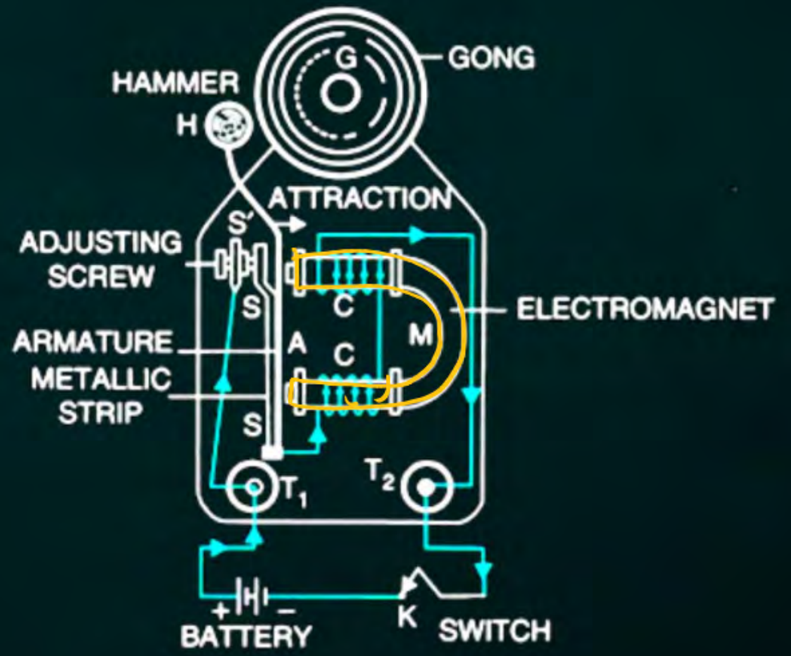
**Use of electromagnet in an electric bell**

An electric bell is one of the most commonly used application of an electromagnet.

# Construction and Wiring

An electric bell is shown in figure. The main parts of the bell are:

(i) A horse-shoe electromagnet M, having a soft iron core,



# QUESTION

The first known magnets were pieces of:

A bauxite

B lodestone

C limestone

D None of the above

# QUESTION

The first known magnets were pieces of:

A bauxite

B lodestone

C limestone

D None of the above

**Answer** (B) The first known magnets were pieces of loadstone, an ore of iron oxide ($Fe_3O_4$) found in large quantities in Magnesia, in Asia Minor.

# QUESTION

**If a magnet is suspended with a silk thread such that it is free to rotate in a horizontal plane, it sets itself always pointing in the:**

**A** geographic east-west direction

**B** magnetic east-west direction

**C** geographic north-south direction

**D** None of the above

**Answer** (C) If a magnet is suspended with a silk thread such that it is free to rotate in a horizontal plane, it will align itself in the geographic north-south direction. This alignment is due to the Earth's magnetic field, which exerts a force on the magnet and causes it to align along the magnetic field lines.

# QUESTION

The ..... magnetism acquired by a magnetic material when it is kept near a magnet is called ..... magnetism.

A temporary, induced

B permanent, induced

C temporary, permanent

D None of the above

**Answer** (A) Due to magnetic induction, a piece of magnetic material acquires the magnetic properties temporarily in presence of another magnet near it.

# QUESTION

**Two like magnetic poles:**

**A** repel each other

**B** attract each other

**C** first attract each other, then repel

**D** neither attract nor repel.

# QUESTION

**Two like magnetic poles:**

**A** repel each other

**B** attract each other

**C** first attract each other, then repel

**D** neither attract nor repel.

**Answer** **(A) Two like magnetic poles, meaning two north poles or two south poles, repel each other.**

# QUESTION

A magnetic pole induces ..... polarity on the near end and a ..... polarity on the farther end of the iron bar.

**A** opposite, opposite

**B** similar, similar

**C** opposite, similar

**D** similar, opposite

# QUESTION

A magnetic pole induces ..... polarity on the near end and a ..... polarity on the farther end of the iron bar.

**A** opposite, opposite

**B** similar, similar

**C** opposite, similar

**D** similar, opposite

**Answer** (C) A magnetic pole induces opposite polarity on the near end and a similar polarity on the farther end of the iron bar.

# QUESTION

Out of the following, the incorrect statement(s) is/are :

(i) Magnetic field lines are open and continuous curves.

(ii) Outside the magnet, magnetic field lines are directed from the south pole to the north pole of the magnet.

**A** (i)

**B** (ii)

**C** both (i) and (ii)

**D** none of the above

**Answer**

(C) The correct statements are:

1. They are closed and continuous curves.
2. Outside the magnet, they are directed from the north pole towards the south pole of the magnet.

# QUESTION

An iron rod buried inside the earth along ..... direction becomes a magnet.

A east-west

B equatorial

C north-south

D any direction

**Answer** (C) The Earth itself acts as a giant magnet. When the iron rod is aligned in the same direction as the Earth's magnetic field lines (i.e., north-south direction), it gets magnetised due to magnetic induction.

# QUESTION

**The sum of all magnetic fields adds up to zero at the:**

**A** north pole

**B** south pole

**C** equator

**D** neutral points

# QUESTION

The sum of all magnetic fields adds up to zero at the:

A north pole

B south pole

C equator

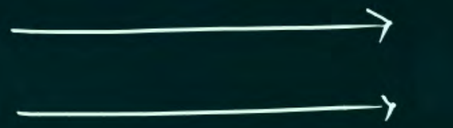
D neutral points

**Answer** (D) At each neutral points, the resultant magnetic field is zero.

# QUESTION

**In a uniform magnetic field, the field lines are:**

**A** curved



**B** parallel and equidistant straight lines

**C** parallel, but non-equispaced straight lines

**D** nothing can be said.

# QUESTION

**In a uniform magnetic field, the field lines are:**

**A** curved

**B** parallel and equidistant straight lines

**C** parallel, but non-equispaced straight lines

**D** nothing can be said.

**Answer** **(B) Parallel and equidistant field lines represent a uniform magnetic field.**

# QUESTION

**The magnetic field lines in a non-uniform magnetic field are:**

**A** either converging or diverging

**B** parallel and equispaced

**C** only converging

**D** only diverging

**Answer** (A) The magnetic field around a bar magnet (or horse shoe magnet) is non-uniform. The magnetic field lines in a non-uniform magnetic field are not equispaced and parallel, but they are curved (either converging or diverging).

# QUESTION

The magnetic field lines of the earth are ..... to the earth's surface near the magnetic poles and ..... to the earth's surface near the magnetic equator.

A parallel, normal

B normal, parallel

C normal, normal

D parallel, parallel

**Answer** (B) The magnetic field lines of the earth are normal to the earth's surface near the magnetic poles and parallel to the earth's surface near the magnetic equator.

# QUESTION

**The direction of a magnetic field at a point on a magnetic field line is given by:**

**A** a tangent at that point

**B** a normal bisector at that point

**C** both tangent and normal bisector at that point

**D** none of the above

# QUESTION

**The direction of a magnetic field at a point on a magnetic field line is given by:**

**A** a tangent at that point

**B** a normal bisector at that point

**C** both tangent and normal bisector at that point

**D** none of the above

**Answer** **(A) A magnetic field line is a continuous curve in magnetic field such that tangent at any point of the curve gives the direction of the magnetic field at that point.**

# QUESTION

**A soft iron bar is tied by a thread in the middle and is suspended from a rigid support such that it is free to rotate in a horizontal plane. It shall come to rest:**

**A** along north-south direction

**B** along east-west direction

**C** equally inclined to N-S and E-W direction

**D** in any direction

# QUESTION

**A soft iron bar is tied by a thread in the middle and is suspended from a rigid support such that it is free to rotate in a horizontal plane. It shall come to rest:**

**A** along north-south direction

**B** along east-west direction

**C** equally inclined to N-S and E-W direction

**D** in any direction

**Answer** **(D) As the soft iron bar is not magnetised, hence it will not align itself with the Earth's magnetic field and will come to rest in any direction.**

# QUESTION

In figure below, draw at least two magnetic field lines between the two magnets.

(a)


(b)

## Answer

(a) As the north pole of both the magnets are facing each other so they will repel. The magnetic field lines between the two magnets are shown below.


(b) As opposite poles of both the magnets are facing each other so they will attract. the magnetic field lines between the two magnets are shown below.

# QUESTION

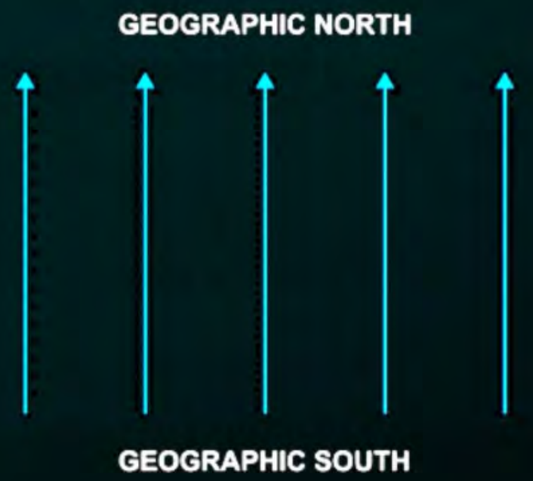
Sketch four magnetic field lines as obtained in a limited space on a horizontal plane in the earth's magnetic field alone.

# QUESTION

Sketch four magnetic field lines as obtained in a limited space on a horizontal plane in the earth's magnetic field alone.

## Answer

Magnetic field lines as obtained in a limited space on a horizontal plane in the earth's magnetic field alone are shown below:



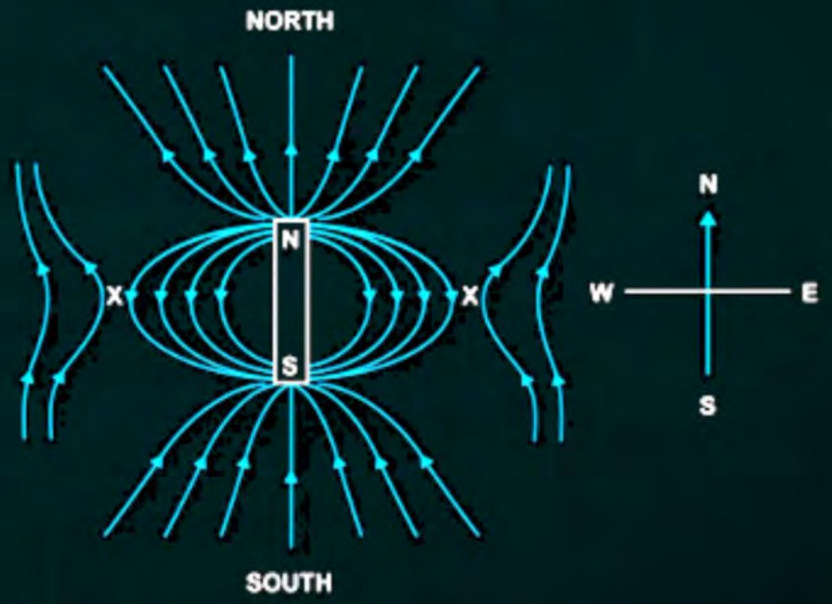
# QUESTION

(a) Draw the pattern of magnetic field lines near a bar magnet placed with it's north pole pointing towards the geographic north. Indicate the position of neutral points by marking x.

(b) State whether the magnetic field lines in part (a) represent a uniform magnetic field or non-uniform magnetic field?

## Answer

(a) Below diagram shows the magnetic field lines near a bar magnet placed with it's north pole pointing towards the geographic north. The position of neutral points is marked with x:



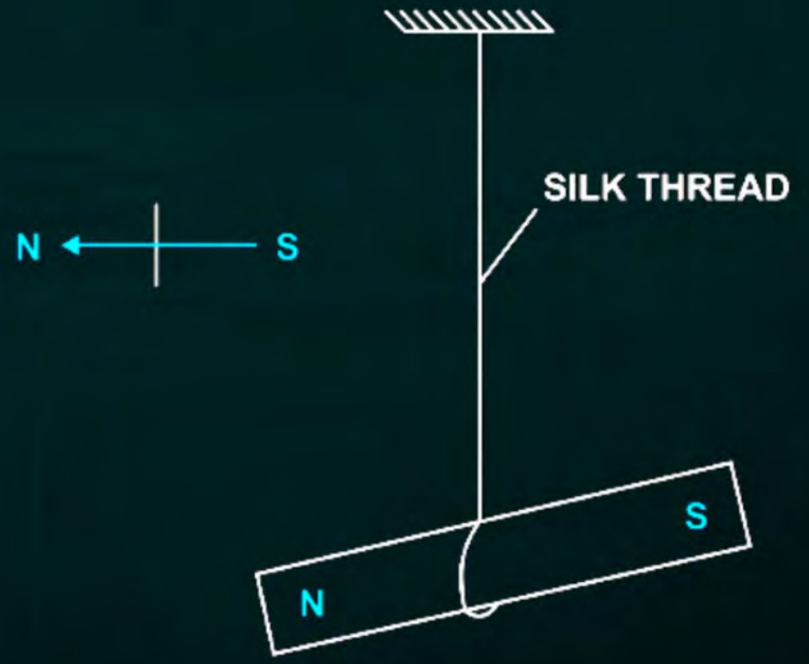

(b) The magnetic field lines as shown in part (a) are non-uniform.

# QUESTION

A small magnet is suspended by a silk thread from a rigid support such that the magnet can freely swing. How will it rest? Draw a diagram to show it.

## Answer

When a magnet is suspended with a silk thread such that it is free to rotate in a horizontal plane, it will rest in the geographical north-south direction with north pole towards the geographic north, making some angle with the horizontal.



# QUESTION

A small iron bar is kept near the north pole of a bar magnet. How does the iron bar acquire magnetism? Draw a diagram to show the polarity on the iron bar. What will happen if the magnet is removed?

## Answer

When a small iron bar is kept near the north pole of a bar magnet as shown below, the bar becomes a magnet due to magnetic induction i.e., it acquires the property of attracting iron fillings when they are brought near it's ends.

- Polarity developed at the end A of the bar AB is north (opposite to the polarity of the magnet near end A) and the polarity at end B is south (i.e. similar to the polarity at the end of the magnet near end A).
- If the magnet is now removed, the bar will lose it's magnetism.
- Thus, the bar of a magnetic material behaves like a magnet so long it is kept near or in contact with a magnet.
- The magnetism so produced is called induced magnetism.

# QUESTION

As electromagnet is a temporary strong magnet made from:

A Steel

B Aluminium

C Copper

D Soft Iron

# QUESTION

As electromagnet is a temporary strong magnet made from:

A Steel

B Aluminium

C Copper

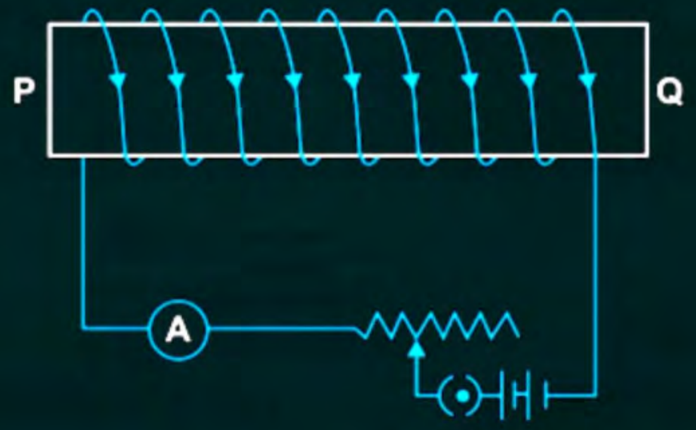
D Soft Iron

**Answer** (D) An electromagnet is a temporary strong magnet made from a piece of soft iron when current flows in the coil wound around it. It is an artificial magnet.

# QUESTION

Look at the figure and answer the following question.

(i) The end P becomes:




A South pole

B North pole

C Cannot say

D None of the above

# QUESTION

**(ii) The end Q becomes:**

A South pole

B North pole

C Cannot say

D None of the above

# QUESTION

A coil of insulated copper wire is wound around a piece of soft iron and current is passed in the coil from a battery. What name is given to the device so obtained? Give one use of the device mentioned by you.

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## Answer

This device is called an electromagnet.

Electromagnets are used in electrical devices such as electric bell, electric motor, relay, microphone, etc.

# QUESTION

Name one device that uses an electromagnet.

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Name one device that uses an electromagnet.

**Answer**

An electric bell uses an electromagnet to function.

# QUESTION

Why is soft iron used as the core of the electromagnet in an electric bell?

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Why is soft iron used as the core of the electromagnet in an electric bell?

## Answer

The soft iron bar acquires the magnetic properties only when an electric current flows through the solenoid and loses the magnetic properties as soon as the current is switched off. That's why soft iron is used as the core of the electromagnet in an electric bell.

# QUESTION

What is an electromagnet?

# QUESTION

What is an electromagnet?

## Answer

An electromagnet is a temporary strong magnet made from a piece of soft iron when current flows in the coil wound around it. It is an artificial magnet.

# QUESTION

How is an electromagnet made? Name two factors on which the strength of the magnetic field of an electromagnet depends.

## Answer

An electromagnet can be made in the following two shapes:

1. I-shape or bar magnet
2. U-shape or horse-shoe magnet.

The principle behind making both the magnets is the same. An electromagnet can be made by winding an insulated copper wire over a piece of soft iron in U-shape or a solenoid.

The factors on which the strength of the magnetic field of an electromagnet depends are -

1. The number of turns of wire wound around the coil - By increasing the number of turns of wire wound around the coil, the magnetic field of an electromagnet can be increased.
2. The amount of current flowing through the wire - By increasing the current through the wire, the magnetic field of an electromagnet can be increased.

# QUESTION

You are required to make an electromagnet from a soft iron bar by using a cell, an insulated coil of copper wire and a switch. (a) Draw a circuit diagram to present the process. (b) Label the poles of the electromagnet.

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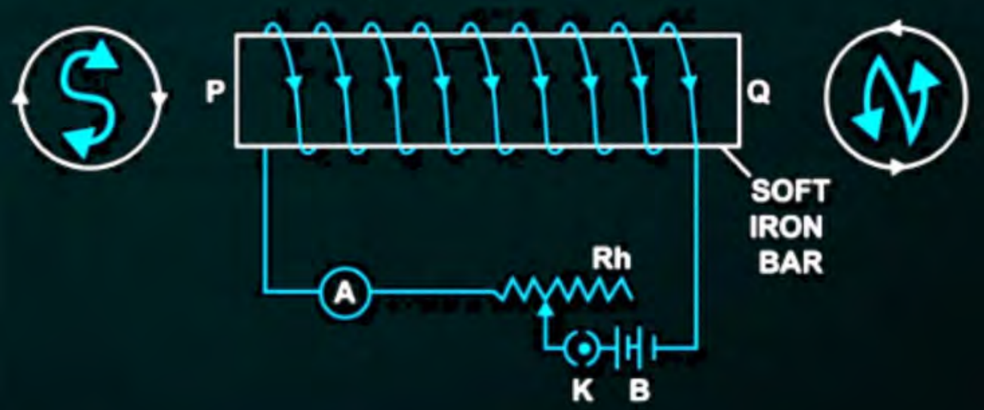
You are required to make an electromagnet from a soft iron bar by using a cell, an insulated coil of copper wire and a switch. (a) Draw a circuit diagram to present the process. (b) Label the poles of the electromagnet.

## Answer

The labelled circuit diagram for making an electromagnet from a soft iron bar is shown below.



# QUESTION

State two differences between an electromagnet and a permanent magnet.

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State two differences between an electromagnet and a permanent magnet.

## Answer

The differences are as follows-

| Electromagnet | Permanent magnet |
|---|---|
| It is made of soft iron | It is made of steel |
| It produces magnetic field so long as current flows in it's coil, i.e., it produces temporary magnetic field | It produces a permanent magnetic field. |

# QUESTION

Show with the aid of a diagram how a wire is wound on a U-shaped piece of soft iron in order to make it an electromagnet. complete the circuit diagram and label the poles of the electromagnet.

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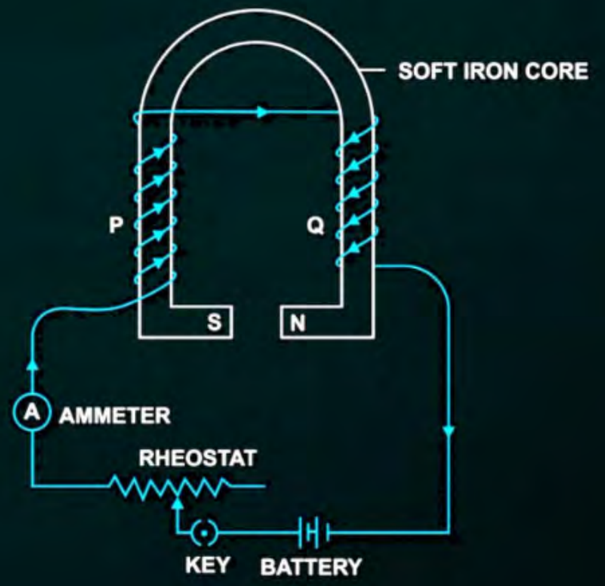
Show with the aid of a diagram how a wire is wound on a U-shaped piece of soft iron in order to make it an electromagnet. complete the circuit diagram and label the poles of the electromagnet.

## Answer

Below labelled circuit diagram shows an electromagnet made by winding a wire on a U-shaped piece of soft iron.



# THANK YOU