2025-26

Physics 9

Comprehensive Notes with Short Questions, Long Questions, MCQs, and Problems

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***1. What is magnetism?**
Magnetism is a force that acts at a distance upon magnetic materials. These materials are attracted to magnets and are called **magnetic materials**.

2. What materials are considered magnetic and non-magnetic?
Materials such as iron, nickel, and cobalt are **magnetic materials** because they are attracted to magnets.

Non-magnetic materials include brass, copper, wood, glass, and plastic as they are not attracted to magnets.

3. What did the Greeks discover over 1000 years ago regarding magnetism?
Over 1000 years ago, the Greeks discovered a rock called **lodestone** or **magnetite** that could attract materials containing iron. They also found that if this rock was suspended from a string, it would settle in the **north-south** direction. This property led to the creation of the **compass**, which was used for navigation.

**** 4. How can you identify whether an object is a magnet or a magnetic material?**
To identify whether an object is a **magnet** or a **magnetic material**, we need to consider the following:

(i) Magnet: A magnet is an object that produces a magnetic field, which exerts a force on magnetic materials. A key property of a magnet is that it has north and south poles.

Magnets attract magnetic materials even when they are not in direct contact, and the force they exert can be observed by their effect on magnetic materials like iron, nickel, or cobalt.

(ii) Magnetic Material: Magnetic materials, such as **iron, nickel**, and **cobalt**, are attracted by magnets.

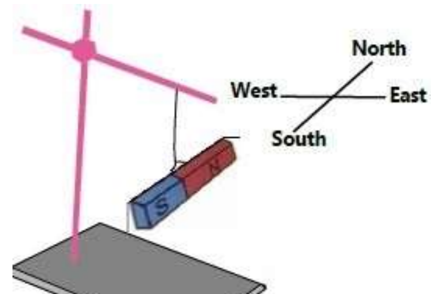
These materials do not generate a magnetic field of their own but are drawn to the magnetic force when a magnet is nearby. They become **magnetized** in the presence of a magnetic field, but they do not retain their magnetism once the magnet is removed.

If perform activity with a **permanent magnet**:

- A **magnet** will attract magnetic materials (e.g., iron filings) and cause them to align along the magnetic field lines.
- **Magnetic materials**, like **iron** or **nickel**, will also be attracted by a magnet, but they will not show any **north** or **south pole** on their own.

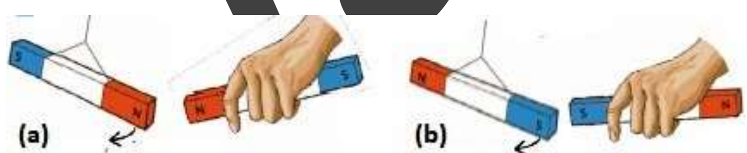
***5. What are the properties of magnets?**
The magnets exhibit the following properties:
(i) Magnetic Poles
(ii) Attraction and Repulsion of Magnetic Poles
(iii) Identification of a Magnet
(iv) Is Isolated Magnetic Pole Possible?

Magnetic Poles: If a bar magnet is suspended horizontally through a string and allowed to come to rest, it will point in north-south direction.

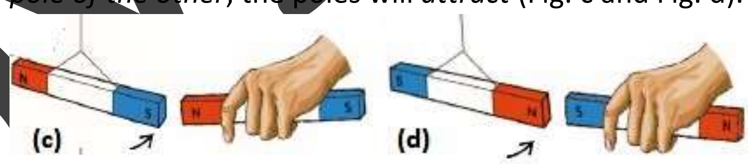


The end of the magnet that points north is called the north magnetic pole (N), and the end that points south is the south magnetic pole (S).

Attraction and Repulsion of Magnetic Poles: When two freely suspended bar magnets are placed close to each other, the *two north poles will repel* each other (Fig. a). So will the *two south poles* (Fig. b).



However, if the *north pole of one* is placed near the *south pole of the other*, the poles will *attract* (Fig. c and Fig. d).



We can say that:

Like poles repel and unlike poles attract.

Identification of a Magnet: To identify whether an object is a magnet or simply a magnetic material, we can bring its one end close to any pole of a suspended bar magnet.

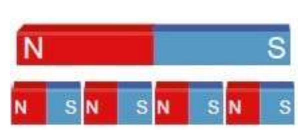
If it is $attracted$, then we can conclude that the end of the object is either of opposite pole to that of the suspended magnet or it is simply a $magnetic\ material$.

Then we should bring the same end of the object close to the other end of the suspended magnet.

- If the object is again $attracted$, it is not a magnet but it is a $magnetic\ material$.
- If it is $repelled$ by the other end of the suspended magnet, then the object is a $magnet$.

The repulsion between the like poles is a real test to identify a magnet.

Is Isolated Magnetic Pole Possible? *If we break a bar magnet into two equal pieces, can we get N-pole and S-pole separately?*



No, it is not possible. Each piece will have its two poles, i.e., N-$pole$ and S-$pole$.

Even if a magnet is divided into $thousands\ of\ pieces$, each piece will be a complete magnet with its N and S poles.

***6. Differentiate between temporary magnets and permanent magnets. Also give examples.**

***Temporary magnets** are the magnets that work only in the presence of a magnetic field of permanent magnets. Once the magnetic field vanishes, they lose their magnetic properties.*

- Usually, soft iron is used to make temporary magnets.
- Paper clips, office pins, and iron nails can easily be made temporary magnets.
- Electromagnets are also good examples of temporary magnets.

***Permanent magnets** are those which retain their magnetic properties forever.*

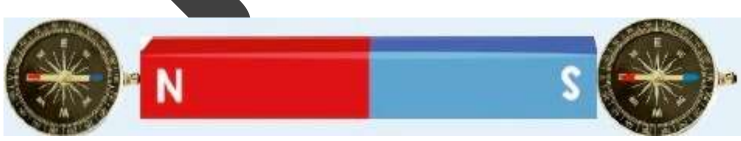
- They are either found in nature or artificially made by placing objects made of steel and some special alloys in a strong magnetic field for a sufficient time.
- There are many types of permanent magnetic materials. For example: cobalt, alnico, and ferrite.

***7. What is magnetization and how can it be demonstrated using a compass and an iron nail?**

Magnetic material such as iron or steel can be made a magnet. This is known as magnetization. In other words, we can say that magnetism has been induced in the material.

The process of **induced magnetism** can be understood as follows:

1. A $magnetic\ compass$ is placed on a table to determine which end of its needle points north. The N-pole of the needle is usually coloured red.
2. When a $bar\ magnet$ is placed on the table and the compass is brought near to its N-pole, the N-pole of the needle is repelled and points away from it.

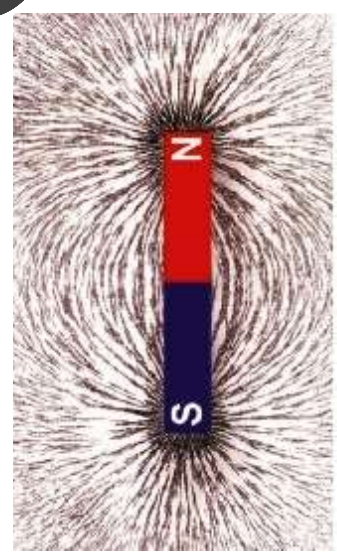


3. When the compass is brought near to the S-pole of the bar magnet, the N-pole of the compass needle is attracted and points towards it.
4. Now, if an $iron\ nail$ is placed such that its head is in contact with any pole of the bar magnet, magnetism is induced in the nail.

5. When the compass is brought near to the pointed end of the iron nail, the N-pole of the compass needle responds to the nail, indicating that the nail has become a magnet. This shows that magnetism has been induced in the nail.
6. If the bar magnet is removed from contact with the nail and the compass is again brought near the ends of the nail, it is observed that the nail no longer shows magnetic behaviour. This means that the **induced magnetism vanishes** when the true magnet is removed.

***8. A magnet attracts only a magnet. Explain the statement.**

A magnetic field is the region around a magnet where another magnetic object experiences a force on it.



The **pattern of a magnetic field** around a bar magnet can be seen very easily by a simple experiment. If **iron filings** are sprinkled on a thin glass plate placed over a bar magnet, the filings become tiny magnets through magnetic induction. Now if the glass surface is gently tapped, the filings form a pattern. This pattern is known as the **magnetic field pattern**. This pattern can be better shown by lines that correspond to the path of the filings. These lines are called **magnetic lines of force**.

***9. How can magnetic lines of force be drawn and what do they indicate?**

Magnetic lines of force around a bar magnet can be drawn by using a **small compass**. The needle of the compass moves along the magnetic lines of force. The compass needle is symbolized by an arrow showing the north pole as shown in Fig. b.

The magnetic field at a point has both a magnitude and a direction. The direction is indicated by the N-pole of a magnetic compass needle placed at that point.

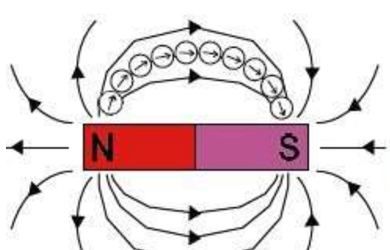


Fig. a

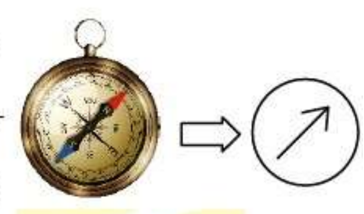


Fig. b

Fig. a shows that field lines appear to originate from the north pole and end on the south pole. The magnetic field extends in space all around the magnet, but the figure shows the field in **one plane only**.

***10. Describe the strength of a magnetic field in terms of magnetic lines of force. Explain it by drawing a few diagrams for the fields as examples.**

The strength of the magnetic field is proportional to the number of magnetic lines of force passing through unit area placed perpendicular to the lines.

The field is **stronger** where the lines are **close** together and **weaker** where they are **far apart**.

For example, in Figure a, the lines are closest together near the north and south poles, indicating that the strength of the magnetic field is stronger in these regions. Away from the poles, the magnetic field becomes weaker.

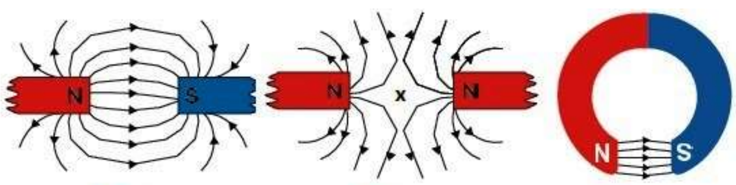


Fig. a Fig. b Fig. c

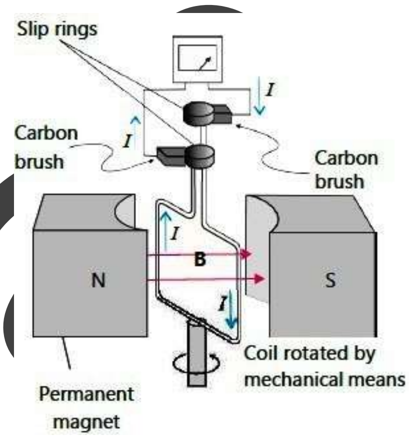
If **two magnets** are placed close to each other, their combined magnetic field can also be drawn by using a compass needle.

- Figure a and Figure b show the patterns of the combined magnetic field of two magnets placed in different orientations.
- In Figure b, point '**x**' is called a **neutral point** because the field due to one magnet cancels out that due to the other magnet.
- Figure c represents the field pattern of a **horse-shoe magnet**. The field is almost uniform between the poles, except near the edges.

11. What are the uses of permanent magnets?
There are many uses of permanent magnets such as:

1. They are the essential parts of **D.C motors**, and **A.C and D.C electric generators**.
2. Permanent magnets are used in the **moving coil loud-speakers**.
3. These are very commonly used in **door catchers**.
4. **Magnetic strips** are fitted to the doors of **refrigerators and freezers** to keep the door closed tightly.
5. They are commonly used to **separate iron objects from different mixtures**. **Flourmills** use permanent magnets to remove **iron nails**, etc., from the grains before grinding.
6. In the **medical field**, they are used to **remove iron splinters from the eyes**.
7. A piece of permanent magnet is used to **reset the iron pointer in a maximum and minimum thermometer**.

12. How do some common devices use permanent magnets?
Let us see how some of the following devices use permanent magnets:

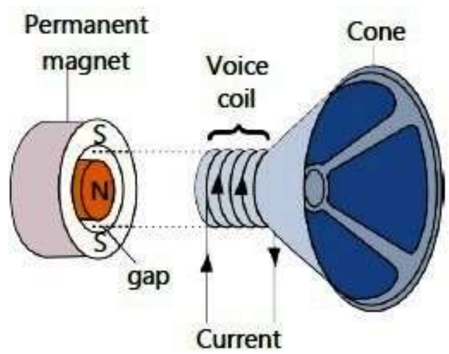


Electric Generator: When a **coil** is rotated between the poles of a permanent magnet, the magnetic field through the coil changes, and an **emf is induced** between the ends of the coil (Fig. 8.13).

On connecting these ends to an external circuit, an **alternating current (A.C)** flows through the circuit.

Electric Motor: It is the **reverse process** of an electric generator.

When an A.C is passed through a coil placed between the poles of a permanent magnet, the coil starts rotating.



Loudspeaker: A **voice coil** attached to the cone of the speaker is slipped over one pole (N) of a radial permanent magnet.

Sound signals in the form of varying A.C current pass through the voice coil inserted in the gap of the magnet.

This A.C interacts with the magnetic field to generate a varying force that **pushes and pulls** the voice coil and the attached cone.

The cone $vibrates\ back\ and\ forth$ to produce **sound in the air**.

OR

Uses of Permanent Magnets: Permanent magnets are used in electric motors, electric generators, moving coil loudspeakers, separating iron objects from different mixtures etc.

***13. What is an electromagnet and how is it formed?**

Electromagnets are a kind of temporary magnets. An iron nail or rod becomes a magnet when an electric current passes through a coil of wire wound around it. This setup is called an electromagnet.

When **current flows through the coil**, a magnetic field is produced inside the coil, which magnetizes the iron nail. The magnetic properties of an electromagnet are temporary, so the iron object remains magnetic only while the current is passing through the coil. Once the current is **stopped**, it **no longer remains a magnet**.

14. What are the uses of electromagnets?

Electromagnets are used in many electrical and mechanical devices. Common **uses of electromagnets** include:

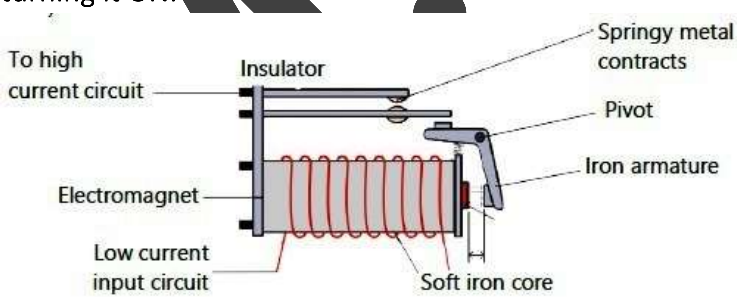
- Electric bell
- Telephone receiver
- Simple magnetic relay
- Circuit breaker
- Reed switches
- Cranes
- Tape recorder
- Maglev trains

They are also used in **many other devices** where temporary magnetic action is required.

***15. What is a magnetic relay and how does it work?**

*A magnetic relay is a type of **switch** that operates using an electromagnet. It is used as an input circuit that works with a low current for safety purposes.*

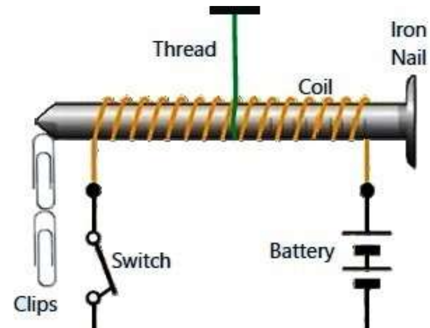
When the relay is turned ON, the input circuit supplies a small current to the electromagnet. This electromagnet attracts an iron armature, which is **pivoted**. The other end of the armature moves up and pushes metal contacts to join together. This closes the high current circuit, turning it ON.

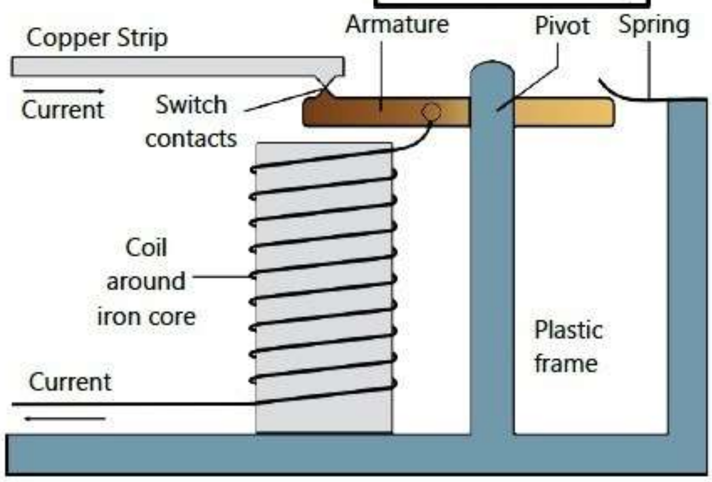


**** 16. What is a circuit breaker and how does it protect electric appliances?**

*A circuit breaker is a **safety device** designed to allow only a certain maximum current to pass through it. If the current becomes excessive, it automatically switches OFF the circuit, thereby protecting electric appliances from damage or burning.*

As shown in figure, the current flows through a **copper strip**, then passes through the iron armature and the coil of an electromagnet. If the current is too high, the electromagnet becomes strong enough to attract the armature. This causes the armature to detach from the copper strip, breaking the circuit and stopping the flow of current.

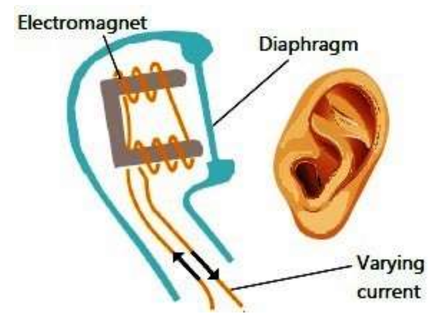




17. How does a telephone receiver produce sound using an electromagnet?

A telephone receiver contains an **iron diaphragm** placed above an $electromagnet$. The microphone on the other side of the handset sends a varying electric current according to the sound signals it receives.

When this **varying current** passes through the coil of the electromagnet in the receiver, it causes the magnetic force to change continuously. As a result, the **iron diaphragm** $vibrates\ back\ and\ forth$, producing sound waves that can be heard by the listener.



18. How are huge electromagnets used in cranes?

Huge electromagnets are used in cranes at scrapyards, steel works, and ships.

These electromagnets are powerful enough to lift heavy iron and steel objects such as cars. After lifting and moving the objects to the required place, they are released easily by **switching OFF the current**, which turns **off the magnetic field**.

19. What is a Maglev train and how does it use electromagnets?
A Maglev train is a magnetically levitated train that floats above the track using **electromagnets**. It has **no wheels** and faces **no friction**, allowing it to reach speeds up to $400\ kmh^{-1}$. Levitation electromagnets lift the train, while **propulsion electromagnets** push and pull it forward along the guideway.

20. What is the Domain Theory of Magnetism?
It is observed that the magnetic field of a bar magnet is similar to that of a solenoid carrying current. This suggests that magnetism is caused by **moving charges**. In a solenoid, charges move through the wire, while in a bar magnet, magnetism is due to spinning and revolving electrons within atoms.

An electron, being a **charged particle**, generates a magnetic field as it spins and orbits the nucleus. If the spins and orbits of electrons in an atom **align**, the atom acts as a **tiny magnet**, known as a **magnetic dipole**.

**** 21. What are paramagnetic materials?**
If the **orbital** and **spin axes** of the **electrons** in an atom are so oriented that their fields support one another and the atom behaves like a tiny magnet, the materials with such atoms are called **paramagnetic materials**, such as aluminium and lithium.

**** 22. What are diamagnetic materials?**
Magnetic fields produced by both **orbital** and **spin motions** of the **electrons** in an atom may **add up to zero**. In this case, the atom has $no\ resultant\ field$. The materials with such atoms are called **diamagnetic materials**. Some of their examples are copper, bismuth, water, etc.

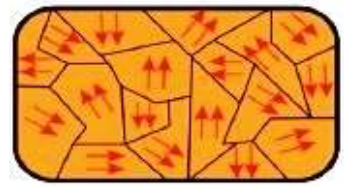
**** 23. What are ferromagnetic materials? What are magnetic domains?**
There are some solid substances such as $iron$, $steel$, $nickel$, $cobalt$, etc. in which **cancellation** of any type does not occur for large groups of neighbouring atoms of the order of 10^{16} because they have **electron spins** that are naturally aligned **parallel** to each other. These are known as **ferromagnetic materials**.

"The group of atoms in this type of material form a region of about $0.1\ mm$ size that is highly $magnetized$. This region is called a **magnetic domain**. Each domain behaves as a small magnet with its own north and south poles."

OR

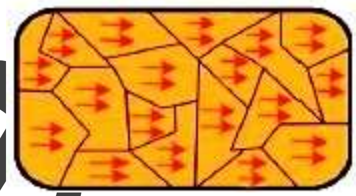
The materials in which large groups of atoms of the order of 10^{16} have their electrons spin naturally aligned parallel to each other are called **ferromagnetic materials**. These groups are called **magnetic domains.**

24. Why ferromagnetic materials are suitable for making magnets?



The $domains$ in a ferromagnetic material are randomly oriented as shown in figure. The magnetic fields of the domains **cancel each other**, so the material does not display any magnetism. However, an unmagnetized piece of iron can be magnetized by placing it in an external magnetic field provided by a permanent magnet or an **electromagnet**.

The external magnetic field **penetrates** the iron and induces magnetism by causing two effects:



(i) Domains aligned **parallel** or nearly parallel to the field grow in size,

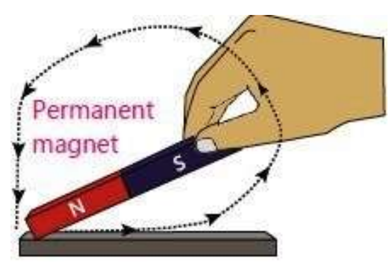
(ii) Others **rotate** and become oriented in the field's direction as shown in figure.
As a result, the iron is magnetized and behaves like a magnet with its own north and south poles.

25. How do soft iron and steel differ in terms of magnetic domain alignment?
In soft iron, the domains are easily oriented on applying an external field and **return to random** positions when the field is removed. This is desirable in electromagnets and transformers.

In contrast, **steel** is not so easily oriented. It requires a very strong external field, but once aligned, it retains the alignment. That is why, steel is used to make **permanent magnets**.

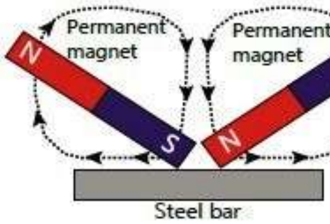
26. Why magnetism cannot be induced in non-ferromagnetic materials?
In $non\text{-}ferromagnetic$ materials, such as aluminium and copper, the $formation$ of **magnetic domains** does not occur, so magnetism cannot be induced into these substances.

27. What are the two methods used for magnetizing a steel bar?
The two methods used for **magnetizing** a **steel bar** are:
(i) Stroking
(ii) Using a Solenoid
Stroking Method: The steel bar is placed on a horizontal surface and **stroked** with a $permanent$ magnet.



(a) Single Touch Method: Stroke the bar from one end to the other several times in the same direction, using the **same pole** (e.g., north pole) of the magnet. After each stroke, lift the magnet up before repeating.

(b) Double Touch Method: Stroking is done from the centre outward with the **unlike poles** of two magnets at the same time (Fig. 8.22).



In both cases, the poles produced at the ends of the bar are **opposite** to the stroking pole.

Using a Solenoid: In this method, a steel bar to be magnetised is placed inside a **solenoid** (a long coil of wire), as shown in figure. The solenoid should have several hundred turns of insulated copper wire. When direct current is passed through the solenoid, the steel bar becomes a magnet.

The **polarity** of the magnetised steel bar is found by applying the **Right Hand Grip Rule**, which is stated as:

*Grip the solenoid with the right hand such that the fingers are curled along the direction of current (from the positive to the negative terminal of the battery) in the solenoid, then the thumb points to the **N-pole** of the bar end.*

OR

Grip the solenoid with the right hand so fingers curl in the direction of current, and the thumb points to the N-pole.

28. How can a magnet be demagnetised?

Heating: Thermal vibrations tend to disturb the order of the magnetic domains. Therefore, if a magnet is heated strongly, it loses its magnetism very quickly.

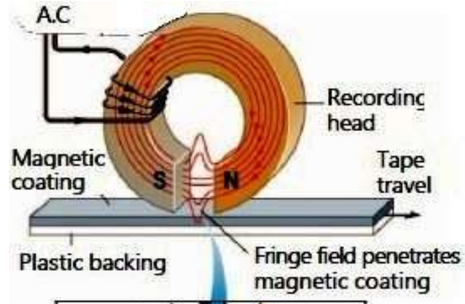
Hammering: If we beat a magnet, the magnetic domains lose their alignment, and the magnet gets *demagnetised*. This method is also called **hammering**.

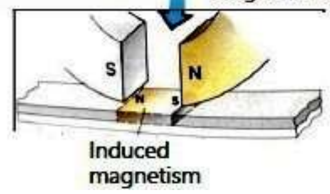
Alternating Current: When an alternating current (A.C.) is passed through a long solenoid, and a magnet is *slowly* **moved out** from inside the solenoid, it becomes demagnetised.

29. In which recording mediums are electromagnets commonly used?

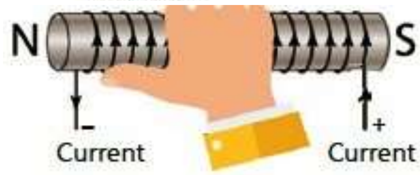
Electromagnets are widely used in recording technology. Such recording mediums are audio/video magnetic tapes, hard disks of computers and other data storing devices.

30. What is magnetic tape recording and how does it work?



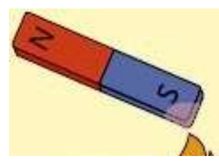


Magnetic tape recording uses **induced magnetism**. The recording and playing head is a coil of wire wrapped around a horse-shoe shaped iron core with a narrow gap between its ends.



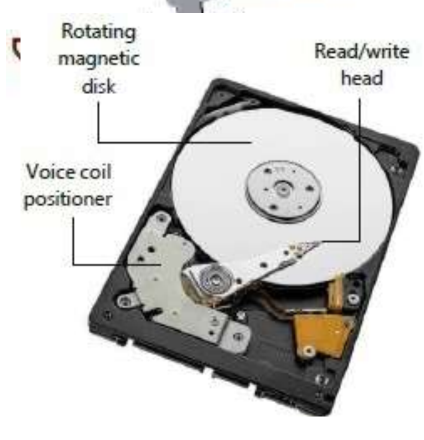
Audio and video tapes are synthetic tapes coated with a layer of ferromagnetic material. Sound or picture is first changed into electrical signals as varying currents. These currents are sent to the head, which becomes an electromagnet with a north pole (N) at one end and a south pole (S) at the other.

The **magnetic field lines** pass through the iron core and cross the gap. Some field lines curve outward in the gap (as shown in Fig). This curved part is called the **fringe field**, which penetrates the magnetic coating on the moving tape and induces magnetism in it. This induced magnetism is retained even when the tape moves away from the head.



In the **reverse process**, the varying magnetism on the tape is converted back into varying current, and then changed into sound or picture.

31. What is a hard disk and how does hard disk recording work?



Hard disks are circular flat plates made of aluminium, glass, or plastic, coated on both sides with **iron oxide**. Hard disks can store **terabytes** of information.

A magnetic head, which is a **small electromagnet**, writes binary digits (1 or 0) by magnetizing tiny spots on the spinning disk in different directions, and reads them by detecting the magnetization direction of those spots.

The term hard disk also refers to the **entire internal data storage** of a computer.

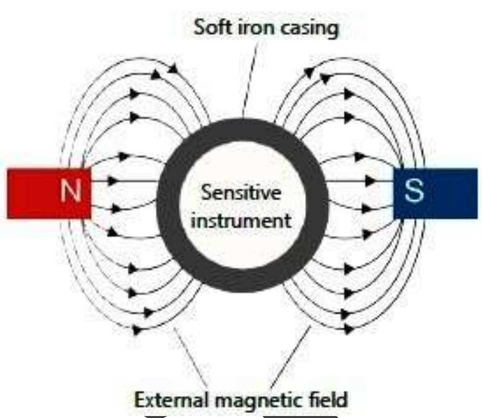
31. What is the advantage of magnetic disks over tape recorders?
Magnetic disk devices can $read$ or $write$ data **instantly**, whereas finding desired information on a **tape recorder** may take many $minutes$.

32. How can electronic devices be protected from magnetic effects?
Electronic devices can be protected from strong magnetic effects by enclosing them in boxes made of soft iron.

33. What is a fringe field?
A $fringe\ field$ is the curved part of the magnetic field that comes out from the gap between the poles of a magnet. It helps to **magnetize the tape** by entering the magnetic coating during recording.

34. Why is soft iron used as a magnetic shield and in electromagnets?

Soft iron has high magnetic permeability. ***Permeability*** *is the ability of a material to allow magnetic flux or lines of force to pass through it when placed inside a magnetic field.*



When a piece of $soft\ iron$ is placed in a magnetic field, it becomes **magnetized** and generates its own magnetic field. If a sensitive magnetic device is enclosed in a soft iron casing, the magnetic flux flows through the soft iron instead of the device. This **shields the device** from the external magnetic field.

Figure shows this phenomenon. A soft iron casing is placed between the opposite poles of two bar magnets. Since the **magnetic permeability** of soft iron is higher than air, the magnetic flux passes through the soft iron casing, protecting the device inside. The casing usually has **rounded corners** to help magnetic field lines pass smoothly.

Soft iron is commonly used in the cores of transformers and electromagnets because of its high permeability. In an electromagnet, the soft iron core is easily magnetized when current flows and quickly loses magnetism when the current stops.

Because of this property, electromagnets are used in electric bells, loudspeakers, cranes for picking iron scraps, and many other devices. The sensitivity of a moving coil galvanometer is also increased by placing a **soft iron core** inside the coil.

**** 35. What are temporary and permanent magnets?**
Temporary Magnets: Temporary magnets are the magnets that work only in the presence of a magnetic field of permanent magnets. Once the magnetic field vanishes, they lose their magnetic properties.

Permanent Magnets: Permanent magnets are those which retain their magnetic properties forever.

**** 36. Define magnetic field of a magnet.**
A **magnetic field** is the region around a magnet where another magnetic object experiences a force on it.

**** 37. What are magnetic lines of force?**
The pattern of a magnetic field around a bar magnet can be seen by sprinkling iron filings on a thin glass plate placed over it. These filings form a pattern known as the **magnetic field pattern**, represented by **magnetic lines of force**.

**** 38. Name some uses of permanent magnets and electromagnets.**
Permanent magnets are used in:
1. D.C motors, A.C and D.C electric generators.
2. Moving coil loudspeakers.
3. Door catchers.
4. Magnetic strips on refrigerator doors.
5. Separating iron objects from mixtures (e.g., in flour mills).
6. Medical applications (removing iron splinters from eyes).
7. Resetting iron pointers in maximum and minimum thermometers.

Electromagnets are used in:
1. Electric bell
2. Telephone receiver
3. Simple magnetic relay
4. Circuit breaker
5. Reed switches
6. Cranes
7. Tape recorder
8. Maglev trains

**** 39. Which type of magnetic field is formed by a current-carrying long coil?**
A current-carrying long coil (solenoid) produces a magnetic field similar to that of a bar magnet, with defined north and south poles.

**** 40. Differentiate between paramagnetic and diamagnetic materials.**
Paramagnetic Materials: Paramagnetic materials (e.g., aluminium, lithium) have atoms that behave like tiny magnets due to aligned electron spins and orbits.

Diamagnetic materials: Diamagnetic materials (e.g., copper, bismuth, water) have atoms with no resultant magnetic field because electron spins and orbits cancel each other out.