Unit # 08

Magnetism

Q# 01 How magnetism arises in an atom?

Ans: Magnetism arises due to motion of charge Particles like electrons moving around the nucleus in the atoms and charges moving in the wires in the form of electric current.

Q# 02 Explain the domain theory of magnetism?

Ans: Domain:

'A domain is the group of atoms in a material which have n-poles pointing in the same direction"

Explanation:

For a single atom, each electron produces a small amount of magnetism. For a single electron loop a tiny magnet is produced which has two poles called the north pole (N pole) and the south pole (S pole). The spinning nucleus also produces some amount of magnetic field but that is negligibly small and the spin motion of electrons also produces a tiny magnetism, hence we take the magnetic field of atoms only due to the orbital motion of electrons. In some atoms, electrons are so oriented that they may add up their magnetic field to make the atom with the net non-zero magnetic field, which makes the whole material as magnetic material.

In a sizeable piece of a material, a group of atoms having a parallel magnetic field makes a 'domain' (of roughly 1012 atoms and a size of a few mm). In unmagnetized material, the domains are randomly oriented while in a magnetized material (a material can be magnetized by placing it in an external magnetic field) the domains are aligned.

Q# 03 Write properties of Magnets?

Ans:

1) Magnets have two poles (n-pole and s-pole).
2) Like poles repeal each other.
3) Unlike pole attract each other.
4) Direction of magnetic field is from north to south pole.(outside)
5) Direction of magnetic field is from south to north pole. (Inside)
6) Mono- pole never exist in magnets.

Q# 04 Define the term magnetic field?

Ans: Def:

"The region or space around a magnet where it exerts a force on other magnetic poles is called a magnetic field."

Formula: B = F/ IL

SI unit: Tesla (N/Am)

Q# 05 Explain the magnetic effect of current?

Ans: Ampere discovered that:

- ⇨ when a current passes through a conductor, it produces magnetic field around it.
- ⇨ The lines of force of the magnetic field produced around the wire would be in the form of concentric circles.
- ⇨ The magnetic field produced is stronger near the current-carrying conductor and weaker farther away from it.
- ⇨ If we reverse the direction of the current by reversing the terminals of the battery, the magnetic field also reverses its direction

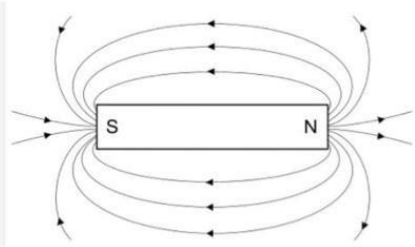
Q#06 State the rule by which the direction of the lines of force of the magnetic field around a current-carrying conductor can be determined?

Ans: It is determined with the help of Right hand rule:

"Grasp a wire with your right hand such that your thumb is pointed in the direction of current. Then curling fingers of your hand will point in the direction of the magnetic field."

Q#07 Explain the term magnetic field of a bar- magnet?

Ans: A bar magnet is a rectangular part of a material which shows permanent magnetic properties. The magnetic field of a bar magnet can be found by placing the magnet on a plane sheet such that it has compass needles around it. You will notice that all the compass needles point in a particular manner, which shows the magnetic field pattern of the bar magnet as shown in figure.



Q# 08 Define Strength of magnetic field ?

Ans: a "The relative strength of a magnetic field is the degree of closeness of the field lines. The field is stronger where the field lines are closer, while the field is weaker where the field lines are farther apart."

Q # 09 Define neutral zone or magnetic shielding ?

Ans: We can find a field-free region called a 'neutral zone' by placing two N-poles side by side, such that their field lines seem to repel each other, making a field-free region. This phenomenon is called shielding of the magnetic field.

Q# 10 what are shields?

Ans: Materials used for magnetic shielding are called shields. These materials are used for protecting sensitive circuits from unwanted parasitic magnetic fields, including power inverters, magnetic immunity, magnetic sensors, and EMI. The commonly used materials as shields are iron, nickel, and cobalt.

Q# 11 Define induced magnetism. Also, explain some of the methods for induced magnetism.

Ans: When a non-magnetic material is placed in a magnetic field, it can become magnetized for as long as it remains within that field. This phenomenon is known as induced magnetism.

There are many ways to make an object an induced magnet. Some of these are

1) **Stroking Method:**

This is the way of aligning the poles. of a material by a process called stroking for induced magnetism. A permanent' magnet is stroked in this process from one end of a bar of some metal to the other end to magnetize it. After rubbing one pole of the magnet on the bar of material from one end to the other then lift the magnet.

2) **Hammering method**:

In this method a bar of metal is placed inside a strong magnetic field and hammered gently. The domains will begin to line up in the direction of applied magnetic field and hence metal bar becomes magnetized. This method is mainly used for magnetization of steel. The magnetization can be increased by heating the metal bar slightly before hammering.

3) **Heating method:**

This method is usually used to demagnetize a material, as heat speeds up the movements of already aligned domains which results in misaligrment of domains and hence material loses its magnetization. However in recent

Past scientists have provided the evidences of generating magnetic field by the process of heating. This phenomenon is referred to as the 'magnetic

Seebeck effect' or 'thermo-magnetism'.

4) **Solenoid:**

This is the most common method used for the magnetization metals. A solenoid is a coil of wire wrapped around cylindrical coil. The magnetic field of the solenoid resembles with the field of a bar magnet. When We wrap a conducting wire (say a copper wire) around a metal with insulation the domains of the metal get aligned. In this process when a current flows through the wire it generates a magnetic field which Behaves as external field to the domains of metal placed inside which aligns the domains.

Q# 12 Difference between soft and hard magnetic materials?

Ans:

Soft magnetic material:

Materials which easily magnetize and demagnetize are called soft

Magnetic materials **Example**: soft iron

Hard magnetic materials:

Material which cannot magnetize and Demagnetize easily are called hard magnetic materials **Example** steel.

Q# 13 How we calculate the magnetic field of wire and solenoid?

Ans: Magnetic field of solenoid can b calculated using

$$B=\mu nI$$

Magnetic field of wire can b calculated by using

$$B = \mu I/2 \pi r$$

Q# 14 Define permeability?

Ans: Permeability is the property of a material to its response towards a magnetic field, i.e how much a material permits magnetic field to pass through it.

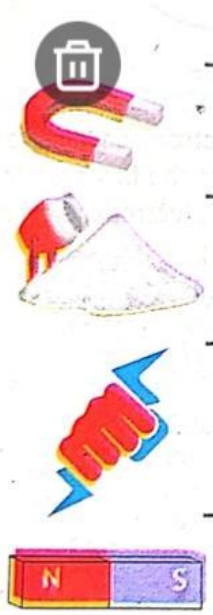
It symbol is μ and its value is $4\pi \times 10^{7} N/A^{2}$

Q# 15 what are temporary or Electromagnet?

Ans: "Magnetic materials which do not retain their magnetization after removal of external magnetic field or applied current (as in case of solenoid) are called temporary magnets"

Q# 16 Difference between Permanent and Electromagnet .

Ans:



PERMANENT MAGNET	ELECTROMAGNET
Permanently magnetized	Temporarily magnetized
Made of hard magnetic materials	Made of soft magnetic materials
Magnetism does not vary in strength	Magnetism can be varied in strength according to need
Magnets' poles can not be altered	Magnets' poles can be changed

Q#17 write use of Permanent and Electromagnet ?

Ans: Uses of Permanent:

Permanent magnets are used in induction cooker, MRI machines particle accelerators transformers etc. and in automotive, aerospace, medical, semiconductor and energy industries.

Uses of Electromagnet:

Most of the home appliances use electromagnetism as the basic working principle, like electric fan, electric motors and door bells. In medical fields electromagnets are used in MRI scan. Electromagnets are also used in communication devices and power circuits.

Q # 17 Write some application of magnets.

Ans: Magnets have wide range of applications in our daily life:

1) Magnetic recording
2) Speakers
3) Door locks etc

Q# 18 Write types of Magnetic materials.

Ans : Magnetic materials are classified into three types:

1) **Diamagnetic materials**:

⇨ Materials in which the spin and orbital motions electrons are so oriented that they cancel each other's effect and the net magnetic field at a of single atom level becomes zero, such materials are called Diamagnetic materials.

⇨ Their magnetic field intensity is very small and opposite to the external Magnetic field.

⇨ Such materials which have zero magnetic field (B=0) in the absence of external field.

⇨ Examples of diamagnetic materials are cooper, zinc, Bismuth, silver, gold, marble, water, glass and wood etc

2) **Paramagnetic materials:**

⇨ Materials which have electrons, whose spin and orbital axis cannot completely cancel each other, in spite of it they add up their magnetic field, are Called paramagnetic Materials.

⇨ Their magnetic field intensity is small and along the direction of external magnetic field.

⇨ Such materials which have non-zero magnetic field (B#0) in the absence of external field are called magnetic material.

⇨ Examples of paramagnetic Ferromagnetic materials materials are tungsten, aluminum, lithium and sodium etc.

3) **Ferromagnetic materials:**

⇨ Materials which have a net magnetism at the atomic Level, even in the absence of external magnetic field are called ferromagnetic materials.

⇨ Their magnetic field intensity is very large and along the direction of external magnetic field.

⇨ They retain their magnetization even after removal of applied magnetic field.

⇨ Examples of these materials include iron, cobalt, nikal and some metallic alloys.

Q# 19 Difference between magnetic and non- magnetic materials.

MAGNETIC AND NON-MAGNETIC MATERIALS	
Magnetic Materials	Non-magnetic materials
Materials which are attracted to a magnet are known as magnetic materials	Materials which are not attracted to a magnet are known as non-magnetic materials
The atomic states of a magnetic material are aligned	The atomic states of a non-magnetic material are in random
They respond to a magnetic field	They do not respond to a magnetic field
Magnetic materials have field (magnetic field) around them	Non-magnetic materials do not have field (magnetic field) around them
Magnetic materials can attract and repel other magnetic materials	Non-magnetic cannot attract or repel any magnetic material
Examples of magnetic materials are: Nickel, Cobalt, Steel and Iron.	Examples of magnetic materials are: Rubber, Plastic, Wood and Copper.

Q# 20 What is meant by dynamo effect.

Ans: The core of Earth is mainly consists of molten iron, electrical currents flowing in the slowly moving molten iron generate the magnetic field of Earth, called “dynamo effect”

Explanation:

Earth’s field is also known as Geomagnetic field. The presence of Magnetic field acts like a Protective shield around the Earth, Which saves life on Earth from Harmful cosmic rays coming from The outer space and the charge Particles and radiations coming From the Sun.

Q# 21 What is meant by term Aurora?

Ans: Aurora (the dancing lights in the sky) at the northern and southern poles of Earth forms due to the magnetic field pattern of Earth. As shown here the charged particles coming from the Sun hit the Earth at poles due to polar cusps of earth's magnetic field. When these particles enter the atmosphere they ionize the atoms of air (gases) and hence produce light of different colours depending the nature of gas.

Q# 22 Write Relationship Between Geographical and Magnetic Poles? **Ans:** The geographic poles define the Earth's axis of rotation, the magnetic poles define the Earth's magnetic field. This distinction is crucial for navigation since compass needles point towards the magnetic north pole, not the geographic north pole. The angle between geographic north and magnetic north, known as magnetic declination, varies depending on one's location on Earth.

Understanding the Earth's magnetic field and its relationship to the geographical and magnetic poles is essential for various applications, including navigation, geology, and space science.

Q# 23 Explain how birds and other migrating animals use Earth's magnetic field to navigate.

Ans: Iron crystals are found in the beaks of pigeons. These crystals give the bird a nose for the north. Pigeons can sense Earth's magnetic field. With the help of this magnetic navigation, pigeons locate their molecule in their eyes, which is sensitive to magnetism.

Conceptual Questions

Q.1: Can two magnetic field lines intersect each other? Justify your answer.

Ans: According to the laws of electromagnetism, two magnetic field lines cannot intersect each other. If they were to intersect, it would imply that the magnetic field would have two different directions at that point, which is not possible.

Q.2: A freely suspended magnet always points along the north-south direction. Why?

Ans: A freely suspended magnet aligns itself with Earth's magnetic field, pointing along the north-south direction. This alignment occurs because the magnet's north pole is attracted to Earth's magnetic south pole, and its south pole is attracted to Earth's magnetic north pole. This phenomenon is due to Earth's magnetic field, which acts as a reference for the magnet's orientation.

Q.3: What is the neutral zone or field-free region of the magnetic field?

Ans: The neutral zone, also known as the field-free region, refers to the area where the magnetic field strength is effectively zero. In this region, the magnetic sources cancel

each other out, resulting in no net magnetic field. This can occur between two magnets of opposite polarity or in certain configurations of magnetic materials. In practical terms, the neutral zone is a region where magnetic interactions are minimized or negligible.

Q.4: Is there any material which does not have any magnetic behavior? Justify your answer.

Ans: Yes, there are materials that do not exhibit any magnetic behavior; these materials are called diamagnetic materials. Unlike ferromagnetic or paramagnetic materials, which are attracted to or repelled by magnets, diamagnetic materials are weakly repelled by magnetic fields.

Q.5: A proton is also a charged particle and spins like an electron. Why is its effect neglected in the study of magnetism?

Ans: The effect of proton spin in magnetism is usually neglected because protons have greater mass and their spins cancel out within the nucleus where as electrons, with their smaller mass, contribute significantly to magnetic properties due to their orbital and spin magnetism.

Q.6: What is the geomagnetic reversal phenomenon? Explain.

Ans: Geomagnetic reversal is when Earth's magnetic field flips its polarity, causing the magnetic north and south poles to switch places. This natural phenomenon has occurred multiple times in Earth's history, with the magnetic field weakening, becoming disorganized, and then re-establishing with opposite polarity over thousands of years.

Q.7: Why the Earth spins about its geographical axis instead of its magnetic axis? Explain.

Ans: The Earth spins around its geographical axis because of its physical shape and gravitational forces, not its magnetic axis.

Q.8: Why the Earth's geographical and magnetic axes are not coincident? Explain.

Ans: The Earth's geographical and magnetic axes are not coincident because the Earth's magnetic field is generated by movement within its liquid outer core. This movement, driven by convection currents of molten iron and nickel, creates the magnetic field, which is not perfectly aligned with the planet's rotational axis. This misalignment results in variation between the geographical and magnetic poles.

Q.9: What is the difference between paramagnetic field of an electromagnet materials?

Ans: already done

Q.10: On what factors the strength of the magnetic field of an electromagnet depends?

Ans: The strength of the magnetic field of an electromagnet depends upon several factors:

1) Number of turns.
2) Material of coil.
3) Length of core.
4) Current flowing through the coil.
5) Cross sectional area of oil.

Q # 11: Draw magnetic field lines of two solenoids placed near each other (i) facing same poles to each other. (ii) facing opposite poles to each other.

Ans: When two solenoids face each other with the same poles, they repel each other.

- ⇨ The magnetic field lines will emerge from one solenoid's north pole and connect to the other solenoid's north pole, forming a loop between them.
- ⇨ Similarly, magnetic field lines will emerge from one solenoid's south pole and connect to the other solenoid's south pole forming a loop between them.

When two solenoids are facing each other with opposite poles, they attract each other.

- ⇨ The magnetic field lines will emerge from one solenoid's north pole and connect to the other solenoid's south pole, forming a continuous loop between them.