IIT-JEE / MEDICAL

PHYSICS

KEY TERMS

Magnetic Effect of Current and Magnetism

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1. **Magnetic flux (ϕ).**The total number of magnetic lines of force passing through a surface is called magnetic flux. The SI unit of magnetic flux is weber (Wb).
2. **Magnetic flux density (B).** The total number of magnetic lines of force passing normally through a unit area of a substance is called **magnetic flux density.** SI unit of B is Wm^{-2} or T i.e. tesla.

   Notes: Magnetic flux density B is often called as **magnetic field or magnetic induction. Dimension of B =** $[MA^{-1}T^{-2}]$.
3. **Magnetic permeability (μ).**The degree or extent to which magnetic lines of force can enter a substance is Known as magnetic permeability.

   Or

   The power of conducting magnetic lines of force by a substance is known as magnetic permeability.
4. **Intensity of Magnetising Field or Magnetic Intensity(H)**

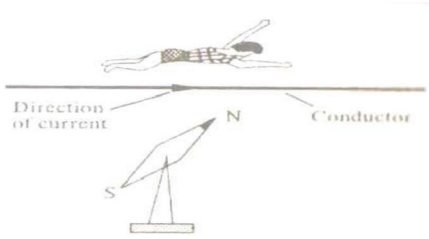
   The degree or extent to which the magnetising field can magnetise a substance is known as the intensity of magnetising field. The magnetic field which magnetises a substance placed in it is called the magnetising field.
5. **Intensity of Magnetisation or Magnetisation (I).** The degree or extent to which a substance is magnetised when placed in the magnetising field is called intensity of Magnetisation.

   Notes : Intensity of magnetisation is equal to the pole strength per unit area of cross- section of the substance.
6. **Magnetic Susceptibility (X_m)**

   It is property of a substance which shows how easily the substance can be magnetized

   when placed in the magnetising field.

   Notes : Magnetic susceptibility is equal to the ratio of intensity of magnetization (I) to the intensity of magnetising field (H).
7. **Ampere's Swimming Rule.** Imagine a man who swims along the conductor in the direction of current facing the needle such that current enters his feet then North of needle will deflect towards his left hand.



Notes : This rule is also referred to as **SNOW** rule i.e.,if current flows from **South** to **North i**n a wire kept **Over** a magnetic needle, the north of the needle will deflect towards **West .**

8. **Biot Savant's Law.** Strength of magnetic field dB due to a small length dl of current carrying conductor at some point distant r from it is given by,

$$dB = \frac{k\ Idl\sin\theta}{r^2}$$ where I is the current through the conductor, θ is the angle between $\vec{dl}$ & $\vec{r}$ and k is a constant of proportionality given by $\frac{\mu_0}{4\pi}$

9. **Current element.** It is a vector quantity having magnitude equal to the product of current and small length of conductor in the direction of the flow of current.
10. **Ampere's Circuital Law** states that the line integral of the magnetic field (B) around any closed path in free space is equal to absolute permeability (μ_0) times the net current (I) enclosed by the path i.e.,

$$\oint \vec{B}.\vec{dl} = \mu_0 I$$

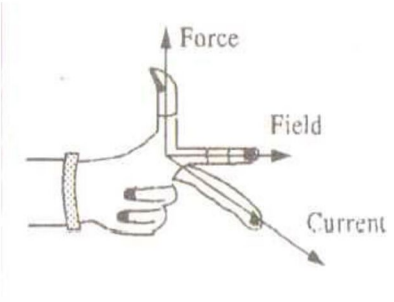
11. **Solenoid.** A cylindrical coil of many tightly wound turns of insulated wire with generally diameter of the coil smaller than its length are called a **Solenoid.**
12. **Toroid.** It can be considered as the ring shaped closed solenoid.
13. **Magnetic Lorentz force.** A charge + q moving with velocity $\vec{v}$ in magnetic field $\vec{B}$ such that $\vec{v}$ makes an angle θ with B experiences a magnetic force given

$$\vec{F}_m = q(\vec{v} \times \vec{B}) \quad \text{i.e.} \quad F_m = qvB\sin\theta$$

The direction of force $\vec{F}$ is perpendicular to the plane containing $\vec{v}$ and $\vec{B}$. This direction can be found by right handed screw rule.

14. **Fleming's left hand rule** states,

'Stretch the left hand such that the fore-finger, the central finger and the thumb are mutually perpendicular to each other. When fore –finger points in the direction of magnetic field and central-finger points in the direction of current, then the thumb gives the direction of the force acting on the conductor.'



15. **Moving coil galvanometer.** It is a device used to detect small electric currents in an electric circuit.
16. **Sensitivity of a galvanometer.** A galvanometer is said to be sensitive if a small current flowing through the coil of galvanometer produces a large deflection in it.
    i. **Current Sensitivity.** The current sensitivity of a galvanometer is defined as the defection produced in the galvanometer per unit current flowing through it.
    ii. **Voltage Sensitivity.** Voltage sensitivity of a galvanometer is defined as the deflection produced in the galvanometer per unit voltage applied to it.
17. **Ammeter.** It is an instrument used measure electric current in an electric circuit.
18. **Voltmeter.** It is an instrument used to measure the potential difference across a current carrying element.
19. **Cyclotron. Cyclotron** is a device used to accelerate positively charged particles (like protons, α - particles, deuteron etc.) to acquire enough energy to carry out nuclear disintegrations etc.
20. **Magnet.** In general, a substance which can attract small pieces of iron, steel, nickel, cobalt etc. and rests in the North-South direction when freely suspended is called a **Magnet.**
21. **Coulombs Law for magnetic force.** The force between two magnetic poles of strengths $m_1$and m_2 lying at a distance r is directly proportional to the product of pole strengths and inversely proportional to the square of distance between their centres.

    The force between the poles can be attractive or repulsive according to the nature of the poles. Mathematically,

$$F \propto \frac{m_1 m_2}{r^2} \text{ or } F = K\frac{m_1 m_2}{r^2}$$

In S.I. **units** magnetic force constant $K = \frac{\mu_0}{4\pi} = 10^{-7} WbA^{-1}m^{-1}$

22. **A magnetic dipole.** Consists of a pair of magnetic poles of equal and opposite strength separated by a small distance.

    Examples of magnetic dipoles are magnetic needle, bar magnet, current carrying solenoid, a current loop etc. Atom is also considered to behave like a dipole so the fundamental magnetic dipole in nature is associated with the electrons.

23. **Magnetic dipole moment** is defined as the product of the pole strength of either pole and distance between the poles. Distance between the two poles is called magnetic length and is shown as 2l.

24. **Magnetic Elements of the Earth**

    The magnitude and direction of the magnetic field of the earth at a place are completely given by certain quantities known as **magnetic elements.** These are:

    (i) **Magnetic Declination (θ).** Magnetic declination at a place is defined as the angle between geographic meridian and magnetic meridian at that place.

    (ii) **Magnetic Inclination or Dip (δ).** Magnetic dip is angle between the direction of total intensity of magnetic field of earth and a horizontal line in the magnetic meridian.

    (iii) **Horizontal Component of Earth's Magnetic field (B_H).** The component of total intensity of magnetic field of earth in horizontal direction in magnetic meridian is called as horizontal component of earth's magnetic field.

25. **Neutral points.** The points where net magnetic field due to a magnet and earth are zero are called neutral point.

26. **Curie's Law.** It can be stated as, magnetic susceptibility of a material voles inversely with temperature (in Kelvin) of the material.

    i.e., $X_m = \frac{C}{T}$ where C is Curie constant

27. **Ferromagnetic Materials.** The materials which are strongly magnetized in the direction of the applied magnetic field are known as Ferromagnetic Materials.

    Examples: Iron, steel, nickel, cobalt and alloys like alnico (aluminum + nickel + Cobalt) are ferromagnetic materials.

28. **Paramagnetic Material.** The materials which are weakly magnetized in the direction of applied magnetic field are known as Paramagnetic Materials.

    Examples: Aluminium, chromium, manganese, platinum, antimony, sodium, copper Chloride, salt solutions of iron and nickel, liquid oxygen, crown glass etc. are paramagnetic materials.

29. **Diamagnetic Material.** The materials which are weakly magnetized in a direction opposites to the direction of applied magnetic field are known as Diamagnetic Materials.

    Examples: Gold, silver zine, lead, bismuth, mercury, marble, glass, quartz, water, alcohol, air, helium, argon, hydrogen, salts like sodium chloride are diamagnetic materials.

30. **Retentivity.** The magnetism retained by the specimen even when magnetizing field is reduced to zero is called residual magnetism of the material and this property of the magnetic material is known as **Retentivity.**

31. **Coercivity.** The property of a magnetic material which depends upon the value of reverse magnetizing field required to reduce the residual magnetism to zero is known as Coercivity.

Note : if any mistake on this, kindly inform on the mail id :

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Your Observation! Our Correction !!