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Class 9 Physics – Chapter 8: Magnetism
Detailed Notes

Physicist Hammad Shaukat

8.1 Domain Theory of Magnetism

1. **What is magnetism and how is it produced in atoms?**
   Magnetism is the force that attracts or repels magnetic materials. It is produced by the motion of charged particles like electrons moving around the nucleus in atoms.

2. **What is the role of electrons in producing magnetism?**
   Electrons have negative charge and move around the nucleus. Their motion and spin both create tiny magnetic fields which combine to produce the atom's overall magnetism.

3. **What is an orbital magnetic moment?**
   It is the magnetic effect caused by an electron orbiting around the nucleus. This is the main contributor to the atom's magnetism.

4. **What is a spin magnetic moment?**
   It is a very small magnetic field produced by the spinning of an electron. It also contributes to the total magnetism of the atom but is usually very weak.

5. **What is a magnetic domain?**
   A domain is a small region inside a material where a group of atoms have their magnetic fields aligned in the same direction.

6. **What happens to domains in unmagnetized material?**
   In unmagnetized material, the domains are randomly oriented, so their magnetic effects cancel out.

7. **How can a material be magnetized?**
   When placed in an external magnetic field, the domains align in the same direction, and the material becomes magnetic.

8. **Why is the spin motion of electrons usually neglected in magnetism?**
   Because the spin magnetic moment is much weaker than the orbital magnetic moment, it has a very small effect on the total magnetism.

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9. **What is meant by the term "domain" in magnetism?**
   A domain is a group of atoms whose magnetic poles are aligned in the same direction, forming a small magnet within the material.

8.1.1 Force Between Magnetic Poles

11. **Do all magnets have both poles?**
    Yes, every magnet, no matter how small, has both a north (N) and south (S) pole.

12. **What is the interaction between like and unlike magnetic poles?**
    Like poles repel each other, and unlike poles attract each other.

13. **How does a magnet attract magnetic materials?**
    Magnetic materials are attracted by the opposite pole of a magnet. The force is strongest at the poles.

14. **Can magnetic materials attract each other?**
    Yes, two magnetic materials can attract each other if opposite poles face each other.

8.2 Magnetic Field

15. **What is a magnetic field? How is it represented?**
    A magnetic field is the space around a magnet where it exerts force on other magnetic materials. It is represented by magnetic field lines which show the direction and strength of the field. The unit of magnetic field is tesla (T).

16. **What is the shape and direction of magnetic field lines?**
    Magnetic field lines are generally curved. Outside the magnet, they go from the north pole to the south pole. Inside the magnet, they return from south to north, forming closed loops. The tangent at any point gives the direction of the magnetic field at that point.

17. **How can we find the magnetic field around a current-carrying wire?**
    The magnetic field around a current-carrying wire forms concentric circles centered on the wire. We can find the direction using the right-hand rule: if the thumb points in the direction of current, curled fingers show the direction of the magnetic field lines.

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8.2.1 Magnetic Field of a Bar Magnet

18. **How can we observe the magnetic field of a bar magnet?**
A bar magnet's field can be observed by placing it on a paper surrounded by compass needles or iron fillings. The compass needles or iron filings align themselves in the direction of the magnetic field, clearly showing the field pattern from north to south.

8.2.2 Direction of Magnetic Field at a Point

19. **How can we find the direction of magnetic field at a point?**
The direction of magnetic field at a point is the direction in which a north pole would move if placed at that point. When a test north pole is placed near the north pole of another magnet, it gets repelled, and this repulsion direction gives the field direction at that location.

8.2.3 Relative Strength of Magnetic Field

20. **How can we determine the strength of a magnetic field?**
The strength of a magnetic field is indicated by how close the field lines are. A stronger magnetic field has lines that are closer together, while weaker fields have lines that are farther apart.

21. **How can we increase or decrease the strength of the magnetic field using poles?**
By placing like poles (e.g., N-N) close together, the field weakens and forms a neutral zone. But placing opposite poles (N-S) close enhances the field strength between them.

8.2.4 Magnetic Shielding

22. **What is magnetic shielding and why is it important?**
Magnetic shielding is the process of blocking external magnetic fields from reaching sensitive devices. It is done by creating a neutral zone using magnets or placing the device inside a shield made of soft iron. This prevents magnetic interference in scientific and electronic instruments.

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8.3 Induced Magnetism

23. **What is induced magnetism?**
When a material that is not normally magnetic becomes a magnet due to the influence of a magnetic field or technique, it is called induced magnetism. This magnetism is temporary and disappears when the cause is removed.

24. **What are the methods to induce magnetism?**
Magnetism can be induced by several methods:

- Stroking method
- Hammering in magnetic field
- Heating
- Placing the material inside a solenoid with current

Stroking Method

25. **How does the stroking method induce magnetism?**
In this method, a permanent magnet is rubbed along a steel bar from one end to the other in one direction. The alignment of domains causes the bar to become magnetized. The end where stroking stops becomes the opposite pole.

Hammering Method

26. **How is magnetism induced by hammering?**
A metal bar is placed in a strong magnetic field and gently hammered. This helps align the magnetic domains in the direction of the field. Heating the bar slightly before hammering improves the effect. This method is mostly used for steel.

Heating Method

27. **How does heating affect magnetism in a material?**
Heating generally demagnetizes a magnet by disturbing the aligned domains. However, heating under specific conditions can induce magnetism. This is known as thermo-magnetism or the Seebeck effect.

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8.3.1 Solenoid and Its Use in Magnetization

28. **What is a solenoid and how is it used for magnetization?**
A solenoid is a coil of wire wound around a cylindrical shape. When an electric current passes through the coil, it generates a magnetic field similar to that of a bar magnet. The solenoid can then behave like a magnet and is commonly used to magnetize materials by placing them inside or near the coil. This magnetic field acts on the domains in the material, aligning them and inducing magnetism. When the current is stopped, the magnetic field disappears unless the material becomes permanently magnetized.

29. **What is the effect of direct and alternating current on a solenoid?**
In case of direct current (DC), the polarity of the solenoid remains the same, so the magnetic field is consistent in one direction. This helps in magnetizing the material in one direction. In alternating current (AC), the polarity changes every half cycle. So, in the first half, the material gets magnetized in one direction and then demagnetized in the next half. Repeated cycles of magnetization and demagnetization prevent permanent magnetization.

30. **What are soft and hard magnetic materials?**
Soft magnetic materials, like soft iron, can easily be magnetized and demagnetized. They are used where temporary magnetism is required, such as in electromagnets. Hard magnetic materials, like steel, are difficult to magnetize but retain their magnetism for a long time. They are used to make permanent magnets.

31. **What are the uses of solenoids in daily life?**
Solenoids are used in many devices such as electric motors, buzzers, magnetic locks, and relays. In electric motors, when current passes through the coil, the magnetic force generated causes movement, which is used to run machines like hair dryers, razors, trimmers, and fans.

8.3.2 Magnetic Field Formulas

32. **What is the formula for the magnetic field inside a solenoid?**
The strength of the magnetic field (B) inside a solenoid is given by the formula:

$$B = \mu_0 n I$$

Where:

- B is the magnetic field in tesla (T)

- μ_0 is the permeability of free space ($4\pi \times 10^{-7}$ NA^{-2})
- $n = \dfrac{N}{L}$, the number of turns per unit length
- I is the current in amperes (A)

33. **What is the formula for the magnetic field around a current-carrying wire?**
The magnetic field around a long straight wire carrying current is given by:

$$B = \frac{\mu_0 I}{2\pi r}$$

Where:

- B is the magnetic field (T)
- μ_0 is the permeability of free space
- I is the current in amperes
- r is the radial distance from the wire in meters

This field forms concentric circles around the wire, and its direction is given by the right-hand rule.

Solenoid Method

34. **How does a solenoid work to magnetize a material?**
A solenoid is a coil of wire wound in a cylindrical shape. When current flows through the wire, it produces a magnetic field similar to that of a bar magnet. The solenoid acts like a magnet only when current flows through it.

35. **What is the difference between DC and AC in a solenoid?**
In Direct Current (DC), the magnetic field remains in the same direction and continuously magnetizes the material. In Alternating Current (AC), the polarity reverses every half cycle, so the material gets magnetized in one direction and then demagnetized in the next.

36. **What are soft and hard magnetic materials?**
Soft magnetic materials (like soft iron) can be easily magnetized and demagnetized. Hard magnetic materials (like steel) retain their magnetism for a long time and are hard to demagnetize.

Formulas Related to Magnetic Field

37. **What is the formula for the magnetic field inside a solenoid?**
The magnetic field inside a solenoid is given by:

$$B = \mu_0 n I$$

where B is the magnetic field, μ_0 is the permeability of free space, n is the number of turns per unit length, and I is the current flowing.

38. **How do we calculate the number of turns per unit length in a solenoid?**
It is calculated by the formula:

$$n = \frac{N}{L}$$

where N is the total number of turns and L is the length of the solenoid.

39. **What is the formula for the magnetic field around a current-carrying wire?**
The magnetic field around a straight wire carrying current is given by:

$$B = \frac{\mu_0 I}{2\pi r}$$

where r is the distance from the wire, I is the current, and μ_0 is the permeability of free space.

8.3.1 Temporary and Permanent Magnets

40. **What is the difference between temporary and permanent magnets?**
Temporary magnets, such as electromagnets, only behave like magnets when current flows through them. Permanent magnets retain their magnetic properties even without any external power.

41. **How do temporary and permanent magnets differ in material and strength?**
Temporary magnets are made of soft magnetic materials and can vary in strength with current. Permanent magnets are made from hard magnetic materials and have fixed strength.

8.3.2 Uses of Permanent Magnets and Electromagnets

42. **What are the applications of permanent magnets?**
Permanent magnets are used in devices like MRI machines, induction cookers, par-

ticle accelerators, transformers, and electric motors where constant magnetism is needed.

43. **Where are electromagnets commonly used?**
Electromagnets are used in electric fans, hair dryers, trimmers, door locks, and communication devices. They are useful where magnetism is needed only during operation.

8.3.3 Applications of Magnets

44. **How is magnetism used in magnetic recording?**
Magnetic recording is the process of saving sounds or data by using magnetic fields to align domains on a tape. When current flows through the tape head, it aligns the domains and stores information.

45. **How do speakers work using magnets?**
Speakers use a permanent magnet and an electromagnet. When current flows through the electromagnet, it interacts with the permanent magnet and causes the diaphragm to vibrate, producing sound.

46. **How do door locks use electromagnets?**
Electromagnets are used in electric door locks. When current flows, the electromagnet attracts the metal plate on the door, locking it. To open the door, current is stopped, which releases the metal plate.

8.3.1 Temporary and Permanent Magnetics

47. **What is a temporary magnet?**
A temporary magnet is a material that behaves like a magnet only when electric current flows through it. Once the current is removed, it loses its magnetism. An example is a solenoid.

48. **What is an electromagnet?**
An electromagnet is a type of temporary magnet in which magnetic field is produced due to the flow of electric current through a coil.

49. **Give examples of temporary magnets.**
Temporary magnets include objects like iron nails, screws, metal bolts, and kitchen utensils when placed inside a magnetic field.

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50. **What is a permanent magnet?**
A permanent magnet is made of material that remains magnetized for a long time even after the removal of the external magnetic field.

51. **Give examples of permanent magnetic materials.**
Examples include iron ore, cobalt, nickel, and Alnico.

52. **How do permanent magnets differ from electromagnets?**
Permanent magnets are always magnetized and made from hard magnetic materials, whereas electromagnets are temporarily magnetized and made from soft magnetic materials.

8.3.2 Uses and Applications of Magnets

53. **What are the uses of permanent magnets?**
Permanent magnets are used in MRI machines, particle accelerators, induction cookers, transformers, motors, aerospace, semiconductors, and medical devices.

54. **What are the uses of electromagnets?**
Electromagnets are used in electric fans, motors, doorbells, MRI scanners, and communication devices. They require electric current to generate a magnetic field.

55. **What is magnetic recording?**
Magnetic recording is a process of storing data in the form of magnetic patterns. A tape head magnetizes specific regions of a moving tape to record sound or data.

56. **What are magnetic tapes and how do they work?**
Magnetic tapes consist of material coated with magnetic emulsion. As the tape moves, the tape head changes the domain alignment in the material to record information.

57. **How are speakers based on magnetism?**
Speakers use a permanent magnet and an electromagnet. The interaction between their magnetic fields causes vibrations in the diaphragm, producing sound.

58. **How do microphones use magnets?**
In microphones, the diaphragm vibrates due to sound waves. These vibrations cause relative movement in the magnetic field, generating an electric current.

59. **How do door locks use electromagnets?**
Electromagnetic door locks attract a metal plate to keep the door locked. Cutting off the current removes the magnetic field and releases the lock.

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8.4 Types of Magnetic Materials

60. **What are diamagnetic materials?**
Diamagnetic materials have atoms whose electron motions cancel each other's magnetic effects, resulting in no net magnetism. They are slightly repelled by magnetic fields.

61. **Give examples of diamagnetic materials.**
Examples include copper, zinc, bismuth, silver, gold, marble, water, and wood.

62. **What are paramagnetic materials?**
Paramagnetic materials have electrons whose magnetic effects do not fully cancel out. They are weakly attracted to magnetic fields and align slightly with the external field.

63. **Give examples of paramagnetic materials.**
Examples include tungsten, aluminum, lithium, and sodium.

64. **What are ferromagnetic materials?**
Ferromagnetic materials show strong magnetism even without an external magnetic field. They retain magnetization for a long time and are strongly attracted to magnets.

65. **Give examples of ferromagnetic materials.**
Examples include iron, cobalt, nickel, and certain metallic alloys.

8.5 Earth's Magnetic Field

66. **Does Earth have a magnetic field?**
Yes, Earth has a magnetic field, which is essential for the survival of life on it. This magnetic field acts like a giant magnet surrounding the planet.

67. **What causes Earth's magnetic field?**
Earth's core contains molten iron. The slow movement of this molten iron creates electric currents, which in turn generate the magnetic field. This is known as the *dynamo effect*.

68. **What is the function of Earth's magnetic field?**
The magnetic field acts as a protective shield around the Earth. It saves life by protecting us from harmful cosmic rays, solar radiations, and charged particles coming from the Sun.

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69. **What is meant by geomagnetic field?**
The Earth's magnetic field is also called the **geomagnetic field**. It extends millions of kilometers into space, although its strength is very small.

70. **How does Earth's magnetic field resemble a bar magnet?**
The magnetic field of Earth looks similar to the field lines of a bar magnet. The field lines emerge near the South Pole and enter near the North Pole, forming closed loops around the Earth.

71. **What happens to Earth's field on the Sun-facing side?**
On the side facing the Sun, the magnetic field is compressed due to solar wind and radiation. On the opposite side, the field stretches several million kilometers into space.

8.5.1 Geographical and Magnetic Poles of the Earth

72. **What are geographical poles?**
The geographical poles of Earth are the North Pole (at the Arctic) and the South Pole (at the Antarctic), shown on maps and globes.

73. **Are geographical poles the same as magnetic poles?**
No, the magnetic poles of Earth are different from geographical poles. Magnetic poles are where the magnetic field lines emerge and re-enter the Earth.

74. **What is the angle of inclination between geographical and magnetic poles?**
The magnetic poles of Earth are inclined at an angle of **11.3°** to the geographical poles.

75. **Why does a compass not point exactly to the geographical North Pole?**
The compass needle aligns with the magnetic field lines and points towards the magnetic North Pole, which is about 11.3° away from the geographical North Pole.

8.5.2 Bio-Magnetism

76. **What is bio-magnetism?**
Bio-magnetism refers to the magnetic fields produced by living organisms, especially by the human heart and brain.

77. **What role does bio-magnetism play in living organisms?**
It plays a vital role in the survival and behavior of many species. In humans, the magnetic fields are important for proper functioning of the heart and brain.

78. **How is bio-magnetism used in medical science?**
Magnetic fields produced by the brain and heart are used in diagnostic techniques like ECG (Electrocardiogram) and EEG (Electroencephalogram).

Chapter 8: Magnetism – Formula Sheet

Formula	Description
$B = \mu_0 n I$	Magnetic field inside a solenoid
$n = \dfrac{N}{L}$	Number of turns per unit length of a solenoid
$\mu_0 = 4\pi \times 10^{-7}\ \text{NA}^{-2}$	Permeability of free space
$B = \dfrac{\mu_0 I}{2\pi r}$	Magnetic field due to a current-carrying straight wire
$F = BIl\sin\theta$	Magnetic force on a current-carrying conductor in a magnetic field
$F = qvB\sin\theta$	Magnetic force on a moving charge in a magnetic field
Relative Strength $\propto$ Closeness of field lines	Relative strength of magnetic field

This formula sheet covers all the essential equations related to magnetic field strength, solenoids, permeability, and magnetic forces.

Instructor's Remarks

Dear Students,

Congratulations on completing Chapter 8: **Magnetism**. This chapter is not only fundamental in understanding the behavior of magnets and magnetic fields, but also crucial for building your concepts in electromagnetism, which you will explore in higher grades. I hope the diagrams, explanations, solved examples, and formulas provided have helped you grasp each topic clearly and thoroughly.

As your instructor, I advise you to revise these concepts regularly, use the formula sheet smartly during practice, and attempt the assessment numericals provided. Apply your understanding not only in exams but also observe the use of magnetism around you—in home appliances, industrial machines, or natural systems.

Physicist Hammad Shaukat
Instructor – Physics
`https://physicisthammad.com`