Details of unit revision and its structure

Subject Name	Physics
Course Name	Physics 03 (**Physics Part 1,** Class XII)
Title	Revision Unit-03_Study Guide
Pre-requisites	eContent of Unit 03: Magnetic Effects of Current and Magnetism
Objectives	After going through this study guide, the learners will be able to: • Consolidate the unit • Enhance their learning
Keywords	

1. Development Team

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STUDY GUIDE

UNIT 03 Physics 03

Magnetic effects of current and magnetism

Unit Syllabus:

Chapter-4: Moving Charges and Magnetism

Concept of magnetic field, Oersted's experiment. Biot-Savart law and its application to current carrying circular loop.Amper's law and its applications to infinitely long straight wire. Straight and toroidal solenoids, Force on a moving charge in uniform magnetic and electric fields. Cyclotron, force on a current-carrying conductor in a uniform magnetic field. Force between two parallel current-carrying conductors-definition of ampere. Torque experienced by a current loop in uniform magnetic field; moving coil galvanometer-its current sensitivity and conversion to ammeter and voltmeter.

Chapter-5: Magnetism and Matter

Current loop as a magnetic dipole and its magnetic dipole moment. Magnetic dipole moment of a revolving electron. Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis. Torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid, magnetic field lines; Earth's magnetic field and magnetic elements.

Para, dia and ferro-magnetic substances, with examples; Electromagnets and factors affecting their strengths, permanent magnets.

Study list:

Following is the list of important concepts to be understood in this unit. The two sections of the unit

Moving Charges and Magnetism

Magnetism and Matter

The unit is important as it connects electricity and magnetism. Electric currents create magnetic fields. The unit helps us understand the idea of magnetic field like electric fields we had learnt in the earlier modules. It also helps us understand the mysterious magnetic field of the earth. Mysterious because we still do not have a reason for its existence.

Use the list as a check list for concepts. Use the list and tick against each after completing it.

1. Concept of magnetic field.
2. Oersted's experiment.
3. Biot-Savart law and its application to current carrying circular loop.
4. Ampere's law and its applications to infinitely long straight wire. Straight and toroidal solenoids
5. Force on a moving charge in uniform magnetic and electric fields
6. Cyclotron,
7. Force on a current-carrying conductor in a uniform magnetic field.
8. Force between two parallel current-carrying conductors
9. Definition of ampere.
10. Torque experienced by a current loop in uniform magnetic field;
11. Moving coil galvanometer-
12. Current sensitivity of moving coil galvanometer

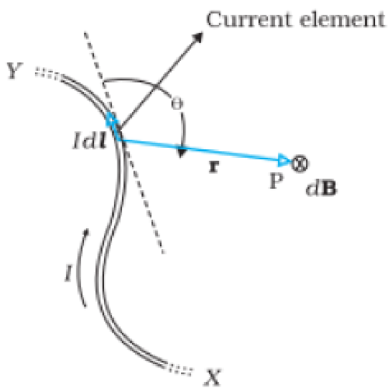
13. Conversion of moving coil galvanometer into ammeter and voltmeter.

Typically

14. What is meant by Magnetic force? Is it like mechanical forces?

15. Magnetic field B due to finite current carrying conductor

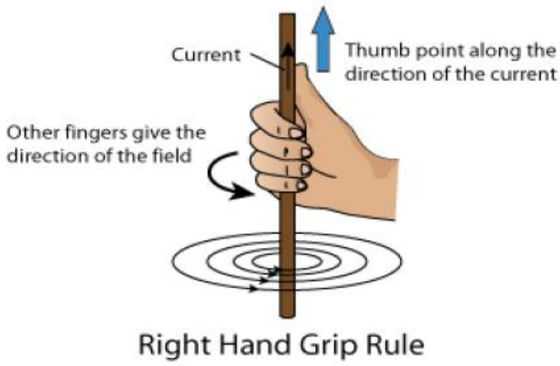
16. Biot Savart's Law



17. How do we describe and represent a Magnetic field

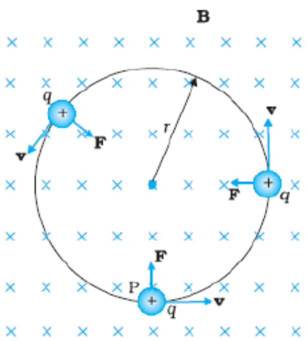
a) Maxwell's cork screw rule or right hand screw rule

b) Right hand thumb rule



18. What kind of force is Lorentz force? What kind of effect does it create on stationary / moving charged particle? Factors affecting its value?

19. Motion of a charged particle in a in a magnetic field



Factors which affect the

a) Trajectory

b) Radius of circular trajectory

c) Frequency of revolution in a circular trajectory

Factors which affect the trajectory of a charged particle in a uniform magnetic field

a) Direction of external magnetic field

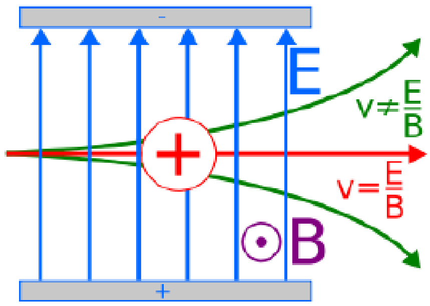
b) Angle between B and direction of charged particle entering the magnetic field

c) Nature of charged particle

d) Magnitude of charge on the particle

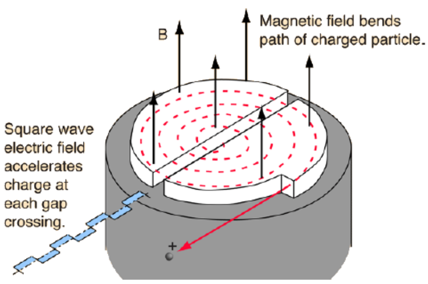
e) Speed of motion of charged particle

20. Motion in a combined electric and magnetic field



21. Velocity selector- an application of effect on combination of electric and magnetic fields on a moving charged particle

22. Cyclotron



Schematic sketch of the cyclotron

a) Purpose

b) Design

c) Principle

d) Schematic design

e) Working

f) Cyclotron frequency

g) Factors influencing maximum kinetic energy of charged particle

h) Limitations of cyclotron

i) Why can we not accelerate electrons using a cyclotron?

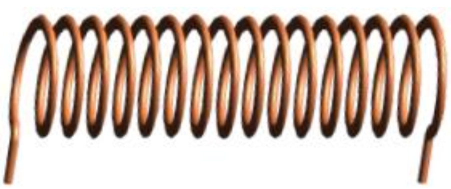
23. Ampere's circuital law

$$\int B.dl = \mu_0 I$$

Another method of determining the value of B due to current in a conductor

Meaning of permeability, difference between permittivity and permeability

24. The solenoid



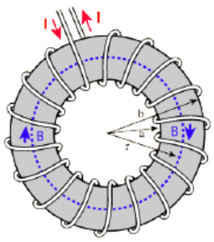
a) Magnetic field due to current in a solenoid

b) Factors affecting the value of B due to current in a solenoid

c) Speciality of magnetic field due to current in a solenoid

d) Application of solenoids

25. The toroid



a) Magnetic field due to current in a solenoid

b) Factors affecting the value of B due to current in a solenoid

c) Speciality of magnetic field due to current in a toroid

d) Application of toroids

26. Torque on current loop in a magnetic field

27. Current loop as a magnetic dipole m = I x A

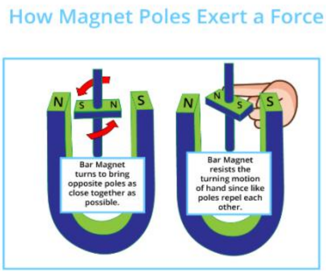
28. Magnetic dipole of a revolving electron

29. Moving coil galvanometer

Purpose

Design

Principle



Schematic design

Working

Galvanometer resistance

Galvanometer scale

Figure of merit

Sensitivity of galvanometer

Conversion of galvanometer into an ammeter and a voltmeter

See the ppt on why should voltmeters have high resistance? Can we make the resistance of the galvanometer infinite?

30. Experiment in the laboratory using galvanometers, in each case study the purpose of the galvanometer. Why does the galvanometer scale have a zero centre?

2. **To find resistance of a given wire using metre bridge and hence determine the resistivity (specific resistance) of its material.**

3. To verify the laws of combination (series) of resistances using a metre bridge.

4. To verify the laws of combination (parallel) of resistances using a metre bridge.

5. To compare the EMF of two given primary cells using potentiometer.

6. To determine the internal resistance of given primary cell using potentiometer.

7. To determine resistance of a galvanometer by half-deflection method and to find its figure of merit.

8. To convert the given galvanometer (of known resistance and figure of merit) into a voltmeter of desired range and to verify the same.

9. To convert the given galvanometer (of known resistance and figure of merit) into an ammeter of desired range and to verify the same.

Magnetism and Matter

Current loop as a magnetic dipole and its magnetic dipole moment. Magnetic dipole moment of a revolving electron. Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis. Torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid, magnetic field lines; Earth's magnetic field and magnetic elements.

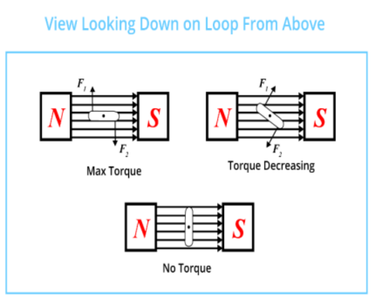
Para, dia and ferro-magnetic substances, with examples; Electromagnets and factors affecting their strengths, permanent magnets

31. The Bar magnet

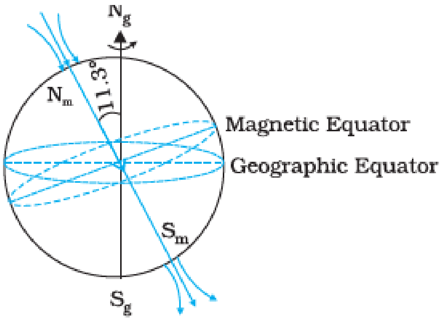
32. The magnetic field lines

33. Bar magnet as an equivalent solenoid

34. The dipole in a uniform magnetic field



35. The electrostatic analog



36. Magnetism and Gauss's law

37. The Earth's magnetism

38. Magnetism declination and dip

39. Magnetisation and magnetic intensity

40. Diamagnetism and magnetic intensity

41. Magnetism susceptibility

42. Diamagnetism

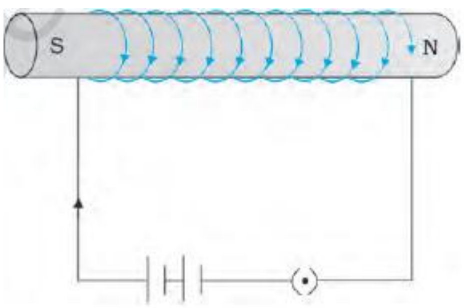
43. Curries constant

44. Ferromagnetism

45. Retentivity or remanence

46. Hysteresis

47. Permanent magnet and electromagnet



A soft iron core in solenoid acts as an electromagnet

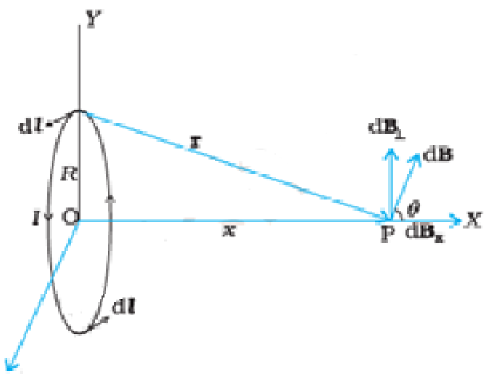
List of the derivations:

The following is the list of important derivations which are incorporated in the different modules of the unit after doing these derivations it will be easier for you to attempt the related problems and enhance your understanding to the topic.

So do all the derivations and tick against each after completing it.

1. Magnetic force on a current carrying conductor
2. Motion in a magnetic field

3. Motion in a combined electric and magnetic field
4. Magnetic field at the axis of current carrying loop



5. Force between two parallel currents
6. Torque on a rectangular current loop in a uniform magnetic field
7. Circular current loop as a magnetic dipole
8. Magnetic dipole movement of a revolving electron
9. Calculation of torque on a rectangular current loop in a uniform magnetic field
10. Torque on a current carrying coil in a magnetic field when area vector makes an angle θ with magnetic field
11. Conversion of galvanometer into ammeter
12. Conversion of galvanometer into voltmeter
13. Torque on a current loop in a uniform magnetic field.

Important formula list:

1. Lorentz force $\boldsymbol{F} = \boldsymbol{q}(\boldsymbol{v} \times \boldsymbol{B} + \boldsymbol{E})$

   Total force on a charge is the sum of electric field and magnetic field
2. Force on a straight current carrying conductor of length l

$$\boldsymbol{F} = \boldsymbol{I}\boldsymbol{l} \times \boldsymbol{B}$$

3. Frequency of uniform circular motion/ cyclotron frequency

$$\boldsymbol{\nu}_c = \frac{\boldsymbol{qB}}{\boldsymbol{2\pi m}}$$

4. Magnetic field dB due to an element d l carrying a steady current I (Biot-Savart law)-

$$\boldsymbol{dB} = \frac{\boldsymbol{\mu_0}}{\boldsymbol{4\pi}}\boldsymbol{I}\frac{\boldsymbol{dl} \times \boldsymbol{r}}{\boldsymbol{r}^3}$$

5. Magnetic field due to a circular coil of radius R

   - at an axial distance x from the centre of the coil

$$B = \frac{\mu_0 I R^2}{2(x^2 + R^2)^{3/2}}$$

- at the centre of the coil

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

6. Ampere's circuital law

$$\oint_c B.dl = \mu_0 I$$

Where I is the current passing through the open surface S

7. Magnetic field at a distance R form a long straight wire carrying current I-

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

8. Magnetic field inside a long current carrying **solenoid-**

$$B = \mu_0 n I$$

Where n is the number of turns per unit length

For a toroid-

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

Where N is the total number of turns and r is the average radius

9. The magnetic field due to the bar magnet

Along the axis-

$$B = \frac{\mu_0 m}{2\pi r^3}$$

Along the equator-

$$B = -\frac{\mu_0 m}{4\pi r^3}$$

10. Net magnetic flux through any closed surface is zero (Gauss law for magnetism)

$$\emptyset = \sum_{\Delta s} B.\Delta S = 0$$

11. The magnetic intensity

$$H = \frac{B_0}{\mu_0}$$

12. Magnetic field B in the material

$$B = \mu_0(H + M)$$

13. For linear materials magnetisation-

$$M = \chi H$$

Where χ is the magnetic susceptibility of the material..

14. $\boldsymbol{\mu_r = 1 + \chi}$, where μ_r is the relative magnetic permeability

All the best **Enjoy !!**