SOUL-FOSSEE Project Summer Fellowship 2023

Report, IIT Bombay

Creating concept maps using Freeplane

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ACKNOWLEDGMENT

I would like to express my sincere gratitude to Prof. Kannan M. Moudgalya for giving me an opportunity to work on this project and also Dr. Rani Parvathy. Their invaluable guidance, support, and encouragement was present throughout this internship. Their expertise, insights, and consistent feedback have played a vital role in shaping the success of this project. Working as a team of three individuals during this internship has facilitated effective communication, idea-sharing, and knowledge exchange. The collaborative environment fostered a positive learning experience, enabling us to overcome challenges and accomplish our goals more efficiently.

Furthermore, I am thankful to Prof. Kannan Moudgalya again, IIT Bombay and FOSSEE for giving me the opportunity to contribute to the field of education through this project. The experience gained and the knowledge acquired will undoubtedly benefit me both academically and professionally,and I am grateful to have been a part of this meaningful endeavor.

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INTRODUCTION

The SOUL *(**S**cience **O**penso**U**rce Software for Teaching **L**earning)* project in FOSSEE (Free/Libre and Open Source Software for Education) encourages researchers, educators, and students to collaborate and contribute to the development of open-source resources for speech and language processing. By providing open-source tools and resources, the SOUL Project aims to promote the sharing of knowledge and advancements in the field of speech and language technology.

The purpose of creating concept maps for class XI and XII students is to address the common challenges they face in their studies, particularly in the subjects of Physics and Chemistry. These challenges include the complexity of concepts, difficulty in understanding interconnections between different topics, and the overwhelming amount of information to process. In addition, students may face difficulties in effectively revising the material, lacking clear strategies and resources to consolidate their knowledge. Connecting the different concepts and understanding their practical applications can also prove challenging. To address these problems, concept maps are created under the SOUL/Freeplane project, serving as powerful educational tools to alleviate these difficulties and enhance students' learning experience.

Freeplane is a popular open-source software application for creating concept maps. It provides tools and features that allow us to create, edit and share maps with different formats. Freeplane is an integral part of the SOUL Project, as it facilitates the visualization and organization of linguistic concepts, linguistic data, and research findings.

1.1 Importance of Concept Map

Concept maps play an important role in knowledge representation in a visual and interconnected manner. They help in representing and understanding complex ideas, relationships, and interconnections between various concepts. The Soul Project in FOSSEE recognizes the significance of concept maps in facilitating effective learning, knowledge sharing, and problem-solving.

Concept maps some key benefits:

- **Enhanced Understanding:** Concept maps help in breaking down complex information into manageable chunks, making it easier to comprehend and remember. By representing the relationships between concepts, it provides an overall hierarchy of that chapter or information.
- **Meaningful Learning:** Concept maps promote meaningful learning by encouraging learners to actively engage with the material. They facilitate the identification of key concepts, their relationships, and the overall structure of knowledge domains.
- **Knowledge Integration:** Concept maps allow learners to integrate new information with their existing knowledge framework.
- **Problem Solving:** Concept maps provide a structured approach to problem-solving. By visually mapping the components and relationships of a problem, it becomes easier to identify potential solutions, analyze their impact, and make informed decisions.

1.2 Benefits of Concept Map

- **Chapter Overview:** Provide students with a clear and concise overview of each chapter. Gives students a quick and comprehensive understanding of the chapter's content.
- **Simplifying Complex Concepts:** By breaking down the chapter into smaller, more manageable components and in concise. Students easily grasp the complex concepts.

- **Effective Revision:** Students can quickly review and reinforce their understanding of the topics.
- **Enhancing Exam Preparation:** By providing a comprehensive and structured resource, highlight the key concepts and their connections, allowing students to focus on the most important concepts from the chapter.
- **Visualization:** It makes students easier to understand and remember the content.
- **Conceptual Learning:** By focusing on the relationships between ideas rather than rote memorization. By visualizing the connections between different concepts, students develop a deeper understanding of the underlying principles and the overall structure of the subject.

By leveraging the benefits of concept maps, students can overcome the challenges they face in their studies and develop a stronger foundation of knowledge in these critical subjects.

ABSTRACT

This report summarizes my work during the summer fellowship internship in the Soul Project, where I created mind maps for five chapters from PHYSICS (Part I) textbook of class XII. The chapters covered were "Current Electricity," "Electric Charges and Fields," "Electromagnetic Waves," "Magnetism and Matter," and "Moving Charges and Magnetism."

The objective was to develop comprehensive concept maps to aid class 12 students in understanding these complex physics topics. The mind maps provided an overview of each chapter, highlighting key concepts, their interrelationships, and practical applications.

The mind maps for "Current Electricity" focused on electric current, resistance, Ohm's law, and circuits. "Electric Charges and Fields" explored electric charges, electric fields, and interactions using Coulomb's law and capacitors. "Electromagnetic Waves" covered properties and regions of electromagnetic waves. "Magnetism and Matter" included concepts of magnetism, magnetic fields, and their applications. "Moving Charges and Magnetism" dealt with the interaction between moving charges and magnetic fields.

Included detailed .pdf files for each chapter, accompanied by mind map images. These resources provide comprehensive explanations and visual representations

2.1 Electric Charge and Fields

Abstract :

This chapter introduces the fundamental concepts on electric charge, electric field, and their interactions. Based on that the map presents an organized overview of topics such as Coulomb's law, electric field intensity, Gauss's law, and the field due to various charge distributions.This map explores the key concepts covered in Chapter 1, 'Electric Charges and Fields', of the Class 12th NCERT Physics textbook.

NODES :

- Electric Charge
- Conductors
- Inductors
- Coulomb's Law
- Electric Field
- Electric Field Lines
- Electric Flux
- Electric Dipole
- Continuous Charge Distributions
- Gauss's Law

Electric Charge: Electric charge is a fundamental property of matter. It can be positive or negative, and like charges repel while opposite charges attract.

Conductors: Conductors are materials that allow the easy flow of electric charges. They have loosely bound electrons Electric Charge: Electric charge is a fundamental property of matter. It can be positive or negative, and like charges repel while opposite charges attract.

Inductors: Inductors are devices that store electrical energy in the form of a magnetic field. They consist of coils of wire and are commonly used in electronic circuits.

Coulomb's Law: Coulomb's Law states that the force between two charged objects is directly proportional to the product of their charges and inversely proportional to the square of the distance between them. It can be expressed as

F = k * (q1 * q2) / r^2

Where F is the force, q1 and q2 are the charges, r is the distance and k is the electrostatic constant

Electric Field: The electric field is a region around a charged object where it exerts a force on other charged objects. It is a vector quantity and is measured in newtons per coulomb (N/C).

Electric Field Lines: Electric field lines are imaginary lines used to represent the direction and strength of the electric field. They originate from positive charges and terminate on negative charges. The density of the field lines indicates the field's strength, with closely spaced lines representing a stronger field.

Electric Flux: Electric flux is a measure of the electric field passing through a given area. It is calculated by taking the dot product of the electric field vector and the differential area vector. Electric flux is measured in units of N C^(-1) m^2.

Electric Dipole: An electric dipole consists of two equal and opposite charges separated by a distance. It has a dipole moment that represents the strength and direction of the dipole. Electric dipoles experience torque and can interact with electric fields.

Continuous Charge Distributions: Continuous charge distributions refer to situations where charges are distributed continuously over a region rather than being discrete. Examples include charged rods, plates, or spheres.

Gauss's Law: Gauss's Law relates the electric flux passing through a closed surface to the total charge enclosed by that surface. It states that the electric flux is proportional to the total charge divided by the permittivity of free space. Gauss's Law is a powerful tool for calculating electric fields and understanding the behavior of electric charges.

Chapter Link : https://ncert.nic.in/ncerts/l/leph101.pdf

PHET Simulation : **Coulombs Law**

https://phet.colorado.edu/en/simulations/coulombs-law

Attachment are downloaded from :

Electric_Field_Lines.png

https://commons.wikimedia.org/wiki/File:Fhsst_electrost14.png

Electric_flux.jpg

https://commons.wikimedia.org/wiki/File:Electric-flux.jpg

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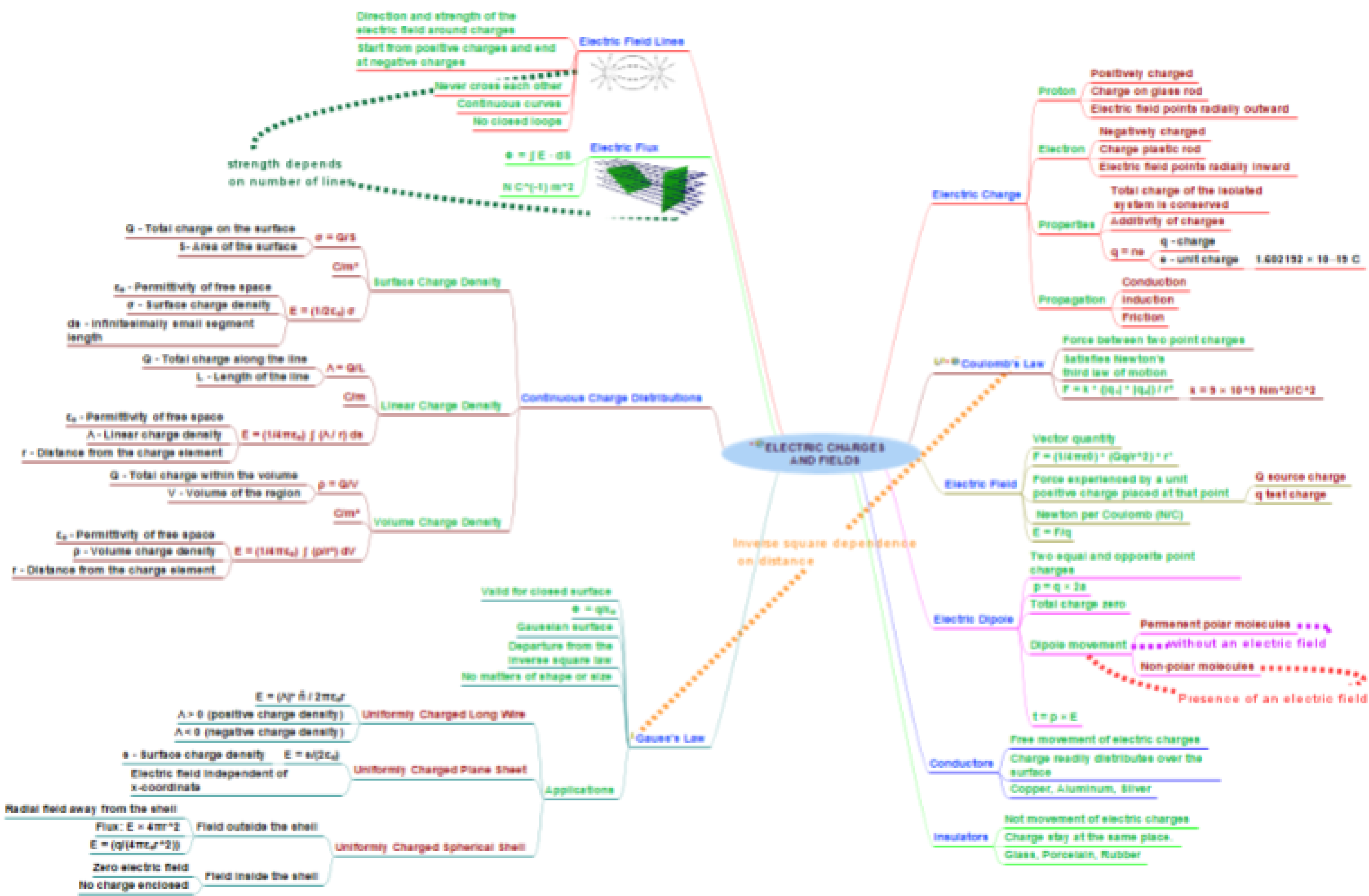
Image : Mind Map on Electric Charges and Fields



2.2 Current and Electricity

Abstract :

The chapter 'Current Electricity' delves into the principles and phenomena associated with electric currents. It covers topics on Ohm's law, resistors, circuits, Kirchhoff's rules, Wheatstone bridge, and the concept of electrical power. It also introduces the concept of conductivity and its relation to resistivity. Based on this chapter the created map covers the key concepts covered in this Chapter.

Map Nodes :

- Electric Current
- Ohm's Law and Formulas
- Ohm's law Limitation
- Electrolytic cells
- Electrical Energy and Power
- Kirchhoff's Rules
- Wheatstone Bridge

Description :

Current and Current in conductor: Current is defined as the rate of flow of charge through a given cross-section in a conductor. For a steady current, the net amount of charge flowing across an area in a given time interval is proportional to that interval. The SI unit of current is the ampere (A). Conductors allow the movement of charged particles due to their loosely bound electrons, resulting in the development of electric currents.

Ohm's Law: Ohm's Law states that the potential difference (V) across the ends of a conductor is directly proportional to the current (I) flowing through it, and the constant of proportionality is the resistance (R) of the conductor. Expressed as V = RI.

Resistance (R): Resistance is the property of a conductor that opposes the flow of electric current. It depends on the material and dimensions of the conductor. The SI unit of resistance is the ohm (Ω).

Resistivity (ρ): Relationship between resistance, length, and cross-sectional area: For a conductor of length (l) and cross-sectional area (A), the resistance is given by R = ρ(l/A), where ρ is the resistivity of the material. The resistivity (ρ) depends on the material but not on the dimensions of the conductor.

Current Density (j): The current per unit area normal to the current flow. It is denoted by j and is given by j = I/A, where I is the current and A is the cross-sectional area.

Conductivity (σ): Conductivity (s) is the reciprocal of resistivity and represents the ability of a material to conduct electric current. It is given by s = 1/ρ.

Vector form of Ohm's Law: Ohm's Law can be expressed in vector form as E = jρ, where E is the electric field vector, j is the current density vector, and ρ is the resistivity.

Drift Velocity: Electrons in a conductor experience collisions with fixed ions, resulting in random directions. However, when an electric field is applied, electrons acquire an average drift velocity (vd) in the opposite direction of the field. vd = (I/neA)

Mobility : Conductivity arises from mobile charge carriers in different materials.

The mobility (μ) is a quantity that represents the magnitude of the drift velocity per unit electric field. The SI unit of mobility is m^2/Vs. Represent as vd = μE

Resistivity and Temperature :

Resistivity (ρ) of a material is dependent on temperature.

Different materials have different temperature dependencies.

For metallic conductors, resistivity is approximately given by: $\rho(T) = \rho_0[1 + \alpha(T - T_0)]$ where ρ(T) is the resistivity at temperature T, ρ_0 is the resistivity at reference temperature T_0, and α is the temperature coefficient of resistivity.

Electrolytic cells: These cells involve the use of electrolytes to facilitate chemical reactions and produce electrical energy. The EMF (electromotive force) in an electrolytic cell represents the potential difference between the positive and negative electrodes. It is calculated using the equation $\varepsilon = V + Ir$, where ε is the EMF, V is the potential difference, I is the current, and r is the internal resistance. The unit of EMF is the volt (V).

Voltage across external resistance: The voltage (V_{ext}) across the external resistance (R) in an electrolytic cell is given by the formula $V_{ext} = (\varepsilon R) / (R + r)$, where ε is the EMF, and r is the internal resistance.

Series combination of cells: In a series combination of n cells, the equivalent EMF (ε_{eq}) is the sum of their individual EMFs ($\varepsilon_1, \varepsilon_2, \varepsilon_3, ..., \varepsilon_n$). Similarly, the equivalent internal resistance (r_{eq}) is the sum of their individual internal resistances ($r_1, r_2, r_3, ..., r_n$).

Parallel combination of cells: In a parallel combination of n cells, the equivalent EMF (ε_{eq}) is equal to the individual EMFs ($\varepsilon_1, \varepsilon_2, \varepsilon_3, ..., \varepsilon_n$). The equivalent internal resistance (r_{eq}) is calculated using the formula $1/r_{eq} = 1/r_1 + 1/r_2 + 1/r_3 + ... + 1/r_n$.

Kirchhoff's Rules: Kirchhoff's Junction Rule states that the sum of currents entering a junction (node) in a circuit is equal to the sum of currents leaving that junction. Kirchhoff's Loop Rule states that the algebraic sum of changes in potential (voltage) around any closed loop in a circuit is zero.

Wheatstone Bridge: The Wheatstone Bridge is a circuit arrangement consisting of four resistors (R1, R2, R3, and R4). It is commonly used to measure unknown resistances. The bridge is balanced when the ratio R1/R2 is equal to the ratio R3/R4. The junction rule implies that the currents I1 and I3 are equal, and I2 and I4 are equal.

Chapter Link :

https://ncert.nic.in/ncerts/l/leph103.pdf

Attachments are downloaded from

Electric-Current-PNG.png

https://www.pngall.com/electricity-png/download/36261

Wheatstone Bridge.jpg

http://i.stack.imgur.com/YzdWY.jpg

kirchhoffs_laws.jpeg

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Conductor-current-flow.png

https://www.sepam.com.br/blog/wp-content/uploads/2020/11/Conductor-current-flow-1024x392-1-768x294.png

PHET Simulations :

Ohms Law

https://phet.colorado.edu/en/simulations/ohms-law

Resistance in a Wire

https://phet.colorado.edu/en/simulations/resistance-in-a-wire

Icons

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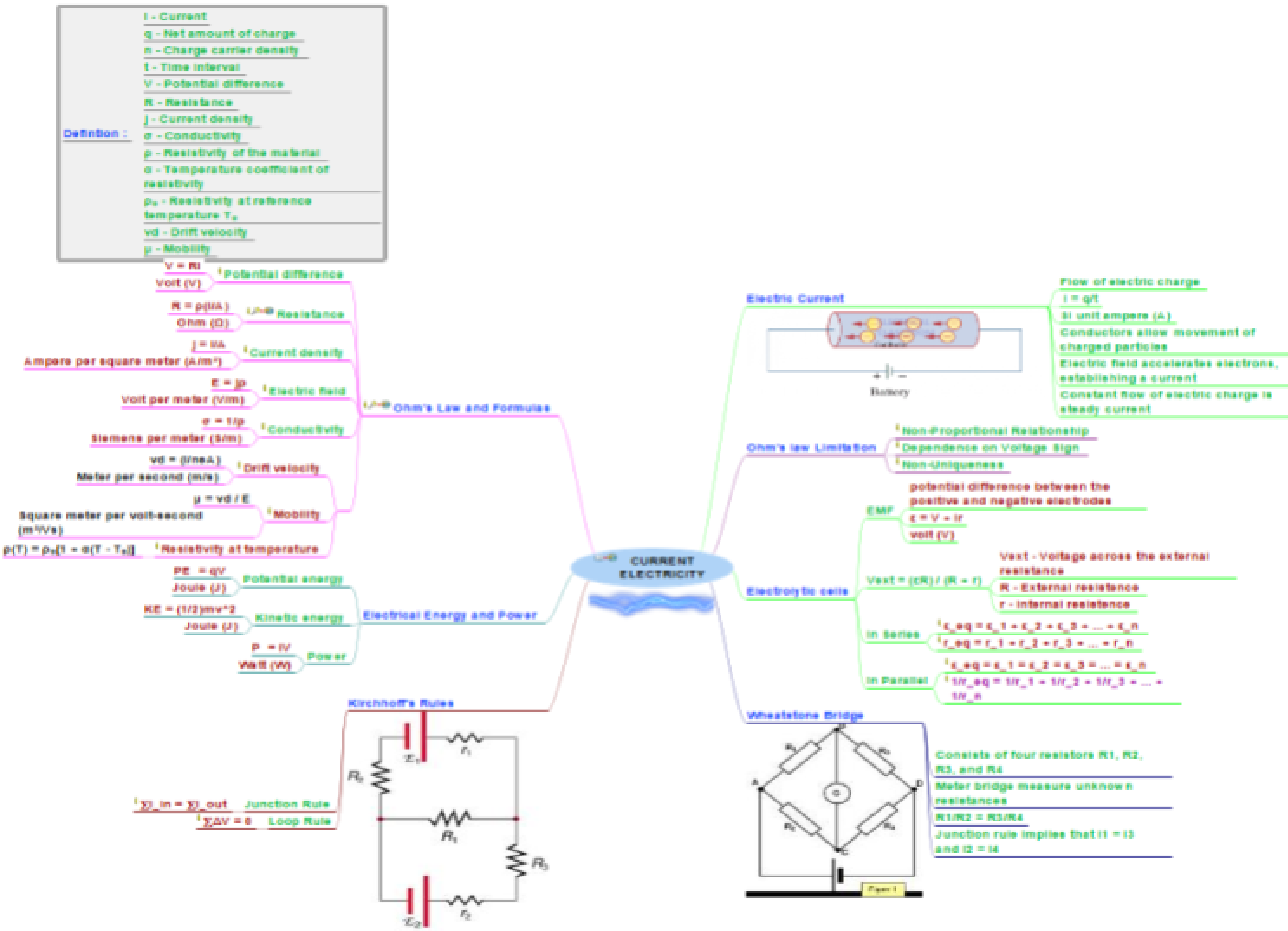
Image : Mind Map on Current Electricity



2.3 Moving Charges and Magnetism

Abstract :

The chapter "Moving Charges and Magnetism" explores the behavior of charged particles in magnetic fields. It covers various topics such as the Lorentz force, motion in magnetic fields, the Biot-Savart law, Ampere's Circuital Law, solenoids, torque on current-carrying loops, magnetic dipoles, and galvanometers. The chapter provides an understanding of the principles and phenomena associated with moving charge.

Description :

Lorentz Force: Describes the force experienced by a charged particle moving in a magnetic field.The equation $F = q(E + v \times B)$ represents the magnetic force.Magnetic force depends on charge, velocity, and magnetic field strength.

Magnetic Field: The magnetic field is measured in tesla (T), where 1 tesla = 10,000 gauss = $N/A{\cdot}m = V{\cdot}s/m^2$. The equation $B = F/(qv \sin\theta)$ relates magnetic field strength to force, charge, velocity, and angle.

Motion in a Magnetic Field: No work is done by the magnetic force when it is perpendicular to the velocity.

In a uniform magnetic field: If velocity is perpendicular to the magnetic field, the motion is circular. If velocity is parallel to the magnetic field, the motion is helical. Angular velocity and pitch are important parameters in describing motion in a magnetic field.

Biot-Savart Law: Describes the magnetic field produced by a current-carrying element. The equation $dB = (\mu_0 / 4\pi) * (I\times dl \times r) / r^3$ represents the Biot-Savart law. The product of permeability of free space (μ_0) and permittivity of free space (ε_0) is reciprocal to the square of the speed of light (c^2).

Ampere's Circuital Law: States that the line integral of the magnetic field around a closed loop is equal to the product of permeability of free space (μ_0) and total current (I). Applicable for steady currents and symmetric fields.

Solenoid: A helical coil of wire with closely spaced turns. Produces a uniform magnetic field inside the solenoid. The equation $B = \mu_0 nI$ represents the magnetic field inside the solenoid.

Two Parallel Currents Carrying Wire: The force between two parallel current-carrying conductors depends on current, length, and distance between them.

Torque: A current-carrying loop experiences magnetic torque. The torque depends on current, magnetic field, and the orientation of the loop.

Magnetic Dipole: A magnetic dipole is described by the equation m = I × A, where I is the current and A is the area.

Galvanometer: A coil with many turns used to detect and measure current flow. It can function as an ammeter or a voltmeter by using appropriate connections.

Chapter Link :

https://ncert.nic.in/ncerts/l/leph104.pdf

Attachments are downloaded from :

Galvanometer_diagram.png

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Galvanometer_to_Ammeter.gif

https://i.stack.imgur.com/sLf6M.gif

Galvanometer_to_Voltmeter.gif

https://i.stack.imgur.com/UzXH9.gif

Solenoid.png

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Biot_Savart.png

https://www.tau.ac.il/~tsirel/dump/Static/knowino.org/w/images/thumb/Biot_Savart.png/250px-Biot_Savart.png

parallel current carrying .png

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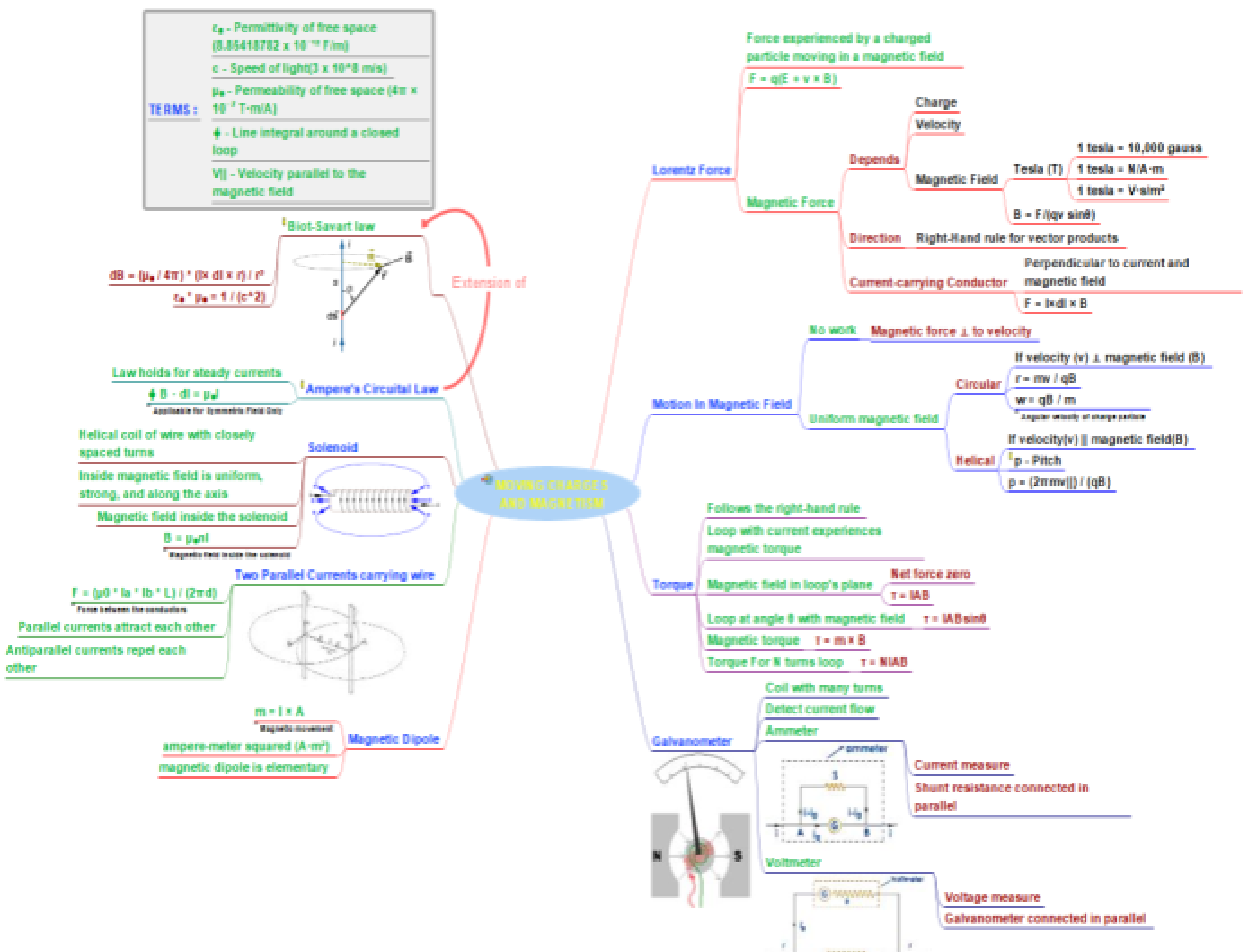
Image : Mind Map on Moving Charges And Magnetism



2.4 Magnetism and Matter

Abstract :

Chapter Five "Magnetism and Matter" covers important topics such as magnetic fields, magnetic dipole moments, the bar magnet, Earth's magnetism, magnetic properties of materials, dia, para, and ferromagnetism. The chapter provides a comprehensive understanding of the fundamental principles and phenomena governing magnetism and its manifestations in various substances.

Description :

Field Lines: Magnetic field lines form continuous closed loops. The tangent to the field lines indicates the direction of the magnetic field, while the density of the lines represents the strength of the field. Field lines do not intersect.

Dipole: A magnetic dipole is characterized by its magnetic moment (m). The magnetic potential energy (Um) of a dipole in a magnetic field (B) is given by -m · B. The torque (t) experienced by a dipole in a magnetic field is given by t = m × B. A dipole is stable at an angle of 0° and unstable at an angle of 180°.

Electrostatic Analogy: The equatorial field (BE) of a magnetic dipole is given by BE = $-\mu_0 m / 4\pi r^3$, while the axial field (BA) is given by BA = $2\mu_0 m / 4\pi r^3$. This analogy relates the behavior of magnetic dipoles to electrostatics.

Magnetic Flux: Magnetic flux (Φ) is defined as the dot product of the magnetic field (B) and the differential area (ΔS). It is measured in Weber (W). The net magnetic flux through a closed surface is zero, and there are no isolated magnetic poles. The number of magnetic field lines leaving a surface is equal to the number entering it.

Magnetic Intensity: Magnetic intensity (H) is defined as H = (B/μ) * (−M). It is measured in A m^{-1} and has the same dimensions as magnetization.

Magnetic Susceptibility: Magnetic susceptibility (χ) is a dimensionless quantity that describes the response of a material to an applied magnetic field. Paramagnetic materials have weak magnetization in the same direction as the field, while diamagnetic materials have weak magnetization in the opposite direction. Ferromagnetic materials exhibit strong magnetization. The susceptibility values and magnetic properties differ for each type of material.

Magnetization: Magnetization (M) represents the magnetic moment per unit volume and is related to magnetic susceptibility. It is measured in A m^{-1}.

Magnetic Permeability: Magnetic permeability (μ) is a measure of a material's ability to conduct magnetic flux. It is given by $\mu = \mu_0(1 + \chi)$, where μ_0 is the permeability of free space. It is measured in N/A^2 or T m A^{-1}.

Relative Magnetic Permeability: Relative magnetic permeability (μ_r) is the ratio of a material's permeability to the permeability of free space. It is dimensionless and is equal to $1 + \chi$.

Chapter Link :

https://ncert.nic.in/ncerts/l/leph105.pdf

PHET Simulations :

Faraday's Law

https://phet.colorado.edu/en/simulations/faradays-law

Attachments are downloaded from :

magnet_field_lines.png

https://upload.wikimedia.org/wikipedia/commons/thumb/1/1c/VFPt_cylindrical_magnets_parallel.svg/768px-VFPt_cylindrical_magnets_parallel.svg.png

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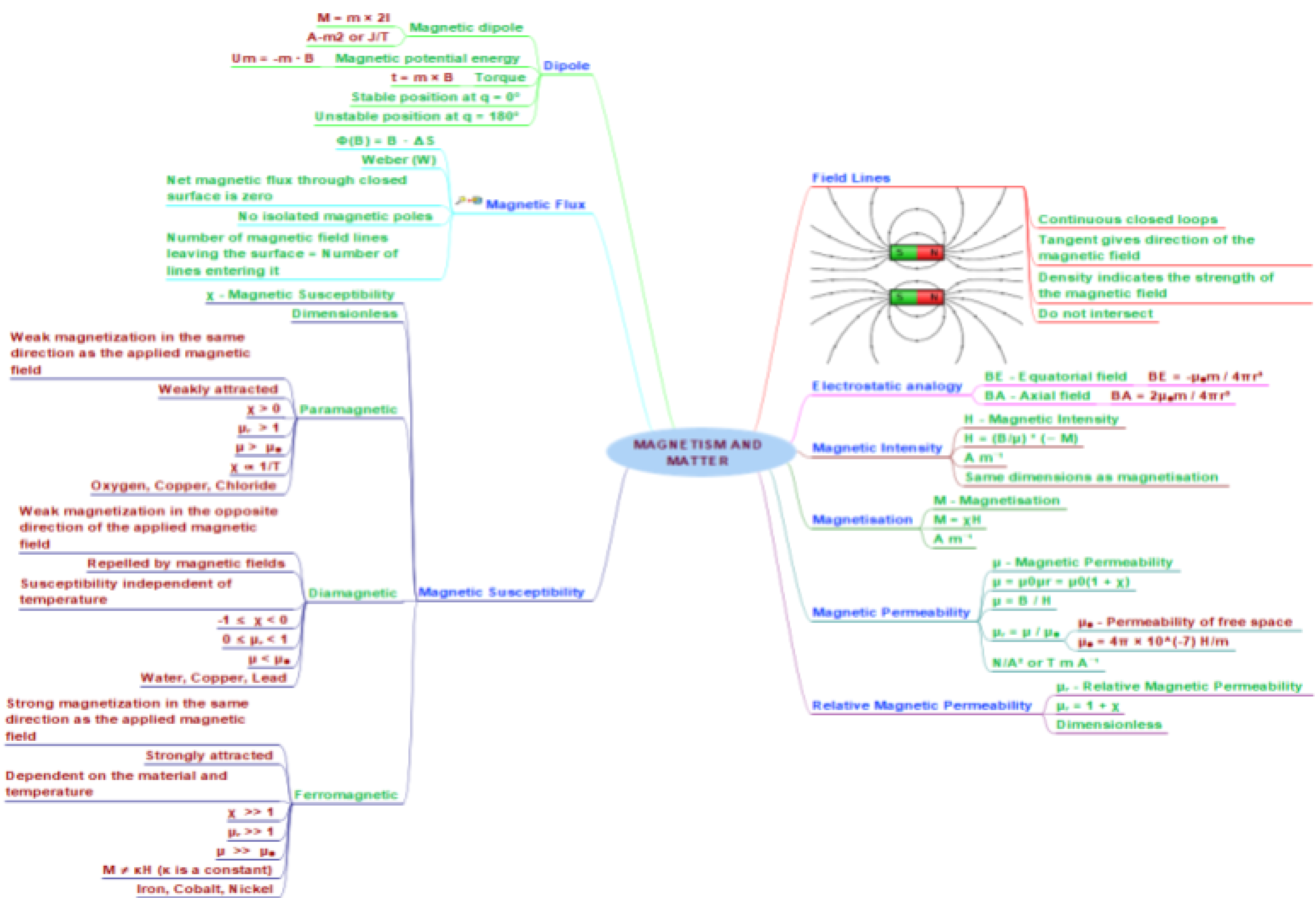
Image : Mind Map on Magnetism and Matter



2.5 Electromagnetic Wave

Abstract :

The chapter 'Electromagnetic Wave' introduces the world of electromagnetic waves and explores their fundamental properties and behaviors. It covers topics such as the relationship between changing electric fields and magnetic fields, Maxwell's equations, Ampere's circuital law, displacement current, and the symmetry between electric and magnetic fields. Based on this chapter the created map covers the key concepts covered in Chapter 8,

'Electromagnetic Waves' of the Class 12th NCERT textbook.

Description :

- **Displacement of Current:** The concept of displacement current is an important aspect of electromagnetism. It refers to the time-varying electric flux through a surface, which creates an additional current that complements the conduction current. Given by the equation $i_d = \varepsilon_0 * (d\Phi E)/dt$ where ε_0 is the vacuum permittivity and d(Φ_E) / dt represents the rate of change of electric flux through a surface.

- **Electromagnetic Spectrum:** The electromagnetic spectrum encompasses a wide range of electromagnetic waves, ordered based on their wavelengths or frequencies. It includes radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays. Each type of wave has a distinct wavelength, frequency, and energy associated with it. The spectrum plays a fundamental role in various fields, such as telecommunications, remote sensing, and medical imaging.

- **Properties :**

  Wavelength and Frequency: Electromagnetic waves exhibit a range of wavelengths and frequencies. Wavelength represents the distance between successive wave peaks, while frequency denotes the number of wave cycles occurring per second. They are inversely related by the equation $c = \lambda * f$, where c is the speed of light.

  Speed of Light: Electromagnetic waves, including light, travel through a vacuum at a constant speed denoted by 'c', which is approximately 3.00 x 10^8 meters per second. This speed is a fundamental constant in physics and plays a vital role in the relationship between wavelength and frequency.

Nature :

Electromagnetic waves exhibit transverse nature, meaning that the oscillations of the wave occur perpendicular to the direction of wave propagation.

Electric Fields:

Electric fields (Ex) are an integral part of electromagnetic waves. These fields arise due to the presence of electric charges and play a crucial role in the generation, propagation, and interaction of electromagnetic waves.

Magnetic Fields:

Similarly, magnetic fields (By) are also present in electromagnetic waves. These fields are created by moving charges or changing electric fields and are essential for the complete description of electromagnetic wave behavior.

Speed of Propagation:

The speed at which electromagnetic waves propagate through a medium is determined by the properties of that medium, such as its permittivity (ε) and magnetic permeability (μ). The speed of propagation of an electromagnetic wave is given by the equation $v = 1/\sqrt{(\mu\varepsilon)}$, where v represents the velocity of the wave.

Linear Momentum:

When an electromagnetic wave interacts with a surface, it delivers linear momentum (p) to that surface. The linear momentum (p) is related to the energy of the electromagnetic wave (U) and the speed of light in a vacuum (c) through the equation $p = U/c$. This equation demonstrates the connection between the energy and momentum carried by electromagnetic waves.

Chapter Link :

https://ncert.nic.in/ncerts/l/leph108.pdf

Attachments are downloaded from

Electromagnetic_spectrum_Flickr
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EM-Wave_wiki.gif

https://commons.wikimedia.org/wiki/File:EM-Wave_noGIF.svg

Maxwell_integral_displacement_current.svg

https://upload.wikimedia.org/wikipedia/commons/4/4f/Maxwell_integral_displacement_current.svg

PHET Simulations :

Faradays Law

https://phet.colorado.edu/en/simulations/faradays-law

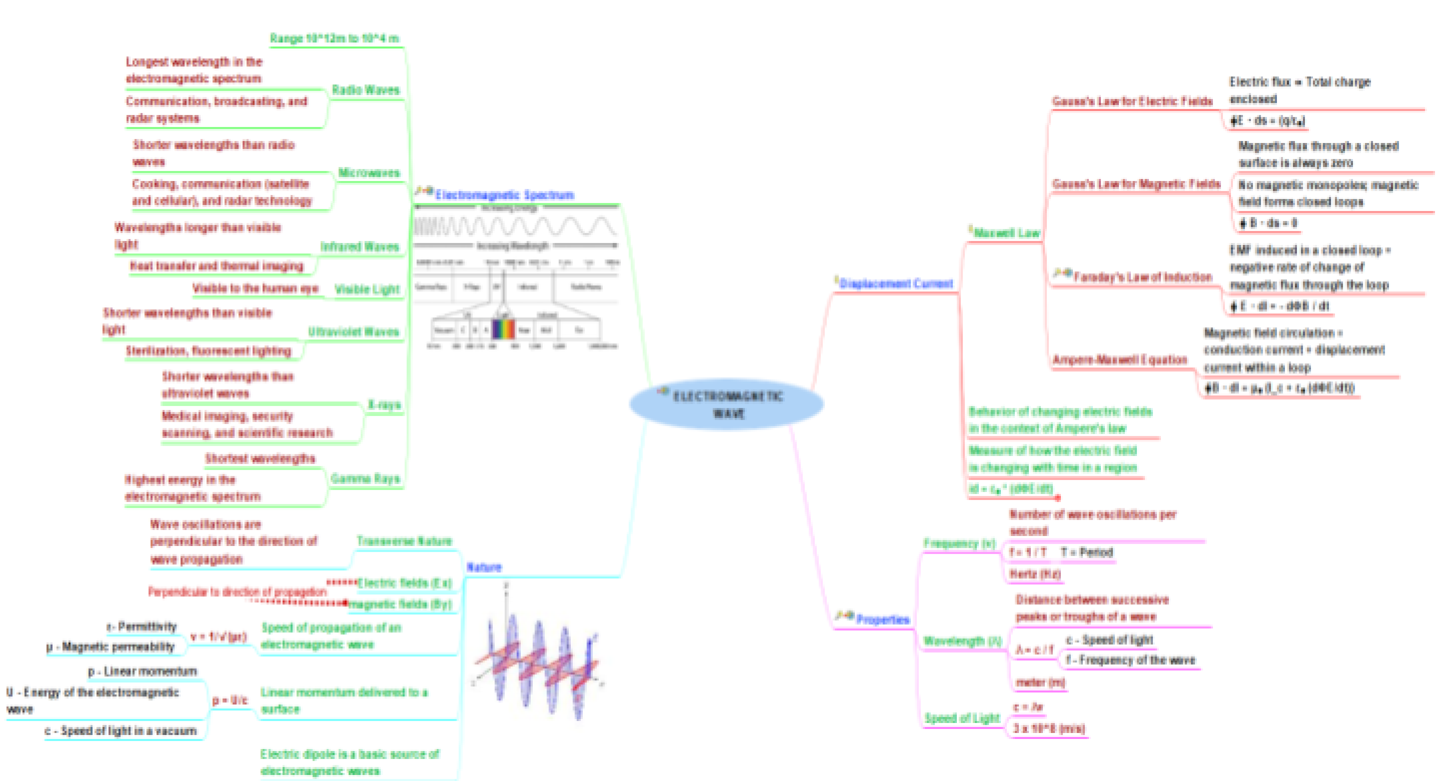
Wave Intro

https://phet.colorado.edu/en/simulations/waves-intro

Blackbody Spectrum

https://phet.colorado.edu/en/simulations/blackbody-spectrum/activities

Image : Mind Map on Electromagnetic Wave



CONCLUSION

In conclusion, the concept maps developed during the internship will definitely be helpful for students. These concept maps, accompanied by the supporting .docx files, will prove to be valuable resources for class 12 students, aiding them in their academic journey and empowering them to excel in their studies. Overall, the project has been a fulfilling experience, contributing to the educational resources. It is my hope that the concept maps created during this internship will continue to benefit students in their learning journey.