CAREERS 360

PRACTICE Series

MP Board Class 12

Physics

Previous Year Questions with Detailed Solution

MP Board Class 12 Physics Question with Solution - 2024

1. Select and write the correct option from the options given in each question

(a) In depletion layer of $\mathrm{p-n}$ junction diode, there are -

(i) Electron

(ii) Protons

(iii) Mobile ions

(iv) Immobile ions

Solution:

The depletion layer contains immobile donor and acceptor ions, forming an electric field that prevents further carrier movement.

Hence, the answer is option (iv).

(b) The electric dipole moment per unit volume of a substance is called -

(i) Electric field

(ii) Polarisation

(iii) Potential

(iv) Electric capacitance

Solution :

Polarisation in a dielectric material refers to the alignment of its molecular dipoles under the influence of an external electric field. The electric dipole moment per unit volume is the measure of this alignment and is termed as polarisation (P). It quantifies the extent to which the dipoles within the material are aligned with the external field. Polarisation is a vector quantity and it is a key factor in determining the material's response to an electric field.

Hence, the answer is option (ii)

(c) The specific resistance of a wire depends on which of the following factors?

(i) Material of wire

(ii) Diameter of wire

(iii) Length of wire

(iv) Mass of wire

Solution:

Specific resistance (or resistivity) is a material property and depends only on the material of the wire, not its dimensions.

Hence, the answer is option (i)

(d) Who discovered the magnetic effect of current?

(i) Ampere

(ii) Lorentz

(iii) Faraday

(iv) Oersted

Solution :

Hans Christian Oersted discovered that electric current creates a magnetic field around a conductor.

Hence, the answer is option (iv)

(e) The correct relationship between the radius of curvature (R) and the focal length (f) of a spherical mirror is ________.

(i) $\mathrm{R} = 2\mathrm{f}$

(ii) $\mathrm{f} = 2\mathrm{R}$

(iii) $R = \frac{r}{2}$

(iv) $R = \frac{1}{\mathrm{f}}$

Solution :

For spherical mirrors, the radius of curvature (R) is twice the focal length (f).

Hence, the answer is option (ii)

(f) $^{3}_{1}\mathrm{H}$ **and** $^{3}_{2}\mathrm{He}$ **atoms are examples of which of the following concept?**

(i) Isotope

(ii) Isotonc

(iii) Isobar

(iv) Radioactivily

Solution :

Isobars are atoms with different elements having the same mass number but different atomic numbers.

Hence, the answer is option (iii)

2 Fill in the blanks with appropriate word and write :

(a) In reflective telescope a concave mirror is used as an______

(b) The energy band above the valence band is called ______band.

(c) In a p-type semiconductor. the concentration of ______ is more than the concentration of electron.

(d) Potential ______ on moving along the direction of electric field.

(e) The substances which have negative magnetic tendency are called ______ substances.

(f) Variable electric field produce______ current.

Solution :

(a) In reflective telescope a concave mirror is used as an **objective**.

(b) The energy band above the valence band is called **conduction** band.

(c) In a p-type semiconductor, the concentration of **holes** is more than the concentration of electrons.

(d) Potential **decreases** on moving along the direction of the electric field.

(e) The substances which have negative magnetic tendency are called **diamagnetic** substances.

(f) Variable electric field produces **displacement** current.

3 Write True or False :

(a) Silicon and Germanium both are examples of compound semiconductor.

(b) The electric field inside the cavity is always zero.

(c) Resistivity of semiconductors increases with increase in temperature.

(d) The Lorentz force on a stationary charge in any magnetic field is zero

(e) Electromagnetic waves cannot propagate through any physical medium other than vacuum.

Solution :

(a) Silicon and Germanium both are examples of compound semiconductor.

False

(b) The electric field inside the cavity is always zero.

True

(c) Resistivity of semiconductors increases with increase in temperature.

False

(d) The Lorentz force on a stationary charge in any magnetic field is zero.

True

(e) Electromagnetic waves cannot propagate through any physical medium other than vacuum.

False

4 Match the column ' A ' with column ' B ' and write the correct pair :

Column 'A'	Column ' B '
(a) Double-slit experiment of interference	(i) Einstein
(b) Dual nature of matter	(ii) Coulomb
(c) Mass-energy equivalence relation	(iii) Lenz
(d) Electrostatic force	(iv) De-Broglic
(e) Direction of induced current	(v) Maxwell
(f) Electromagnetic wave	(vi) Ohm
	(vii) Young

Solution :

The correctly matched list for the concepts and scientists you provided:

(a) Double-slit experiment of interference - (vii) Young
Thomas Young is known for his double-slit experiment demonstrating the wave nature of light.

(b) Dual nature of matter - (i) Einstein

Albert Einstein is associated with this concept through his explanation of the photoelectric effect, which supports the wave-particle duality.

(c) Mass-energy equivalence relation - (i) Einstein

Albert Einstein formulated the famous equation $E = mc^2$ which describes the relationship between mass and energy.

(d) Electrostatic force - (ii) Coulomb

Charles-Augustin de Coulomb formulated Coulomb's Law, describing the force between static electric charges.

(e) Direction of induced current - (iii) Lenz

Heinrich Lenz is known for Lenz's Law, which predicts the direction of an induced current in a conductor.

(f) Electromagnetic wave - (v) Maxwell

James Clerk Maxwell developed the theory of electromagnetic waves, which predicts that light and

other forms of electromagnetic radiation travel in waves.

This set should be accurate according to the known contributions of each scientist to their respective fields.

5 Write the answer of each question in one sentence :

(a) Which type of extrinsic semiconductor is obtained when pure semiconductor is doped with trivalent impurities?

(b) Write the value of total electric flux emanating from a unit positive charge in air.

(c) Write the name of instrument that measures current in an electric circuit.

(d) Write the value of power factor for a pure resistive circuit.

(e) In which position, the refracted ray inside the prism becomes parallel to prism base?

Solution :

(a) When pure semiconductor is doped with trivalent impurities, a p-type extrinsic semiconductor is obtained.

(b) The value of total electric flux emanating from a unit positive charge in air is According to Gauss's Law, the electric flux through a closed surface enclosing a charge is given by:

$$\Phi_E = \frac{q}{\epsilon_0}$$

For a unit positive charge ($q = +1$ C):

$$\Phi_E = \frac{1}{\epsilon_0}$$

where ϵ_0 is the permittivity of free space (air). The value of ϵ_0 is approximately $8.854 \times 10^{-12}\ \mathrm{F/m}$.

(c) The instrument that measures current in an electric circuit is called an ammeter.

(d) The value of the power factor for a pure resistive circuit is 1.

(e) The refracted ray inside the prism becomes parallel to the prism base when the angle of incidence is equal to the critical angle. This results in the ray undergoing total internal reflection within the prism, aligning parallel to its base.

6 Write the statement and mathematical form of Ampere's circuital law.

Solution :

Statement: Ampere's circuital law states that the line integral of the magnetic field $\mathbf{B}$ around a closed path is equal to μ_0 times the total current I enclosed by the path.

Mathematical Form:

$$\oint \mathbf{B} \cdot d\mathbf{l} = \mu_0 I_{\text{enc}}$$

OR

Write the statement and mathematical form of Gauss's law for magnetism.

Solution :

Statement: Gauss's law for magnetism states that the net magnetic flux through any closed surface is zero, implying that magnetic monopoles do not exist.

Mathematical Form:

$$\oint_{\text{surface}} \mathbf{B} \cdot d\mathbf{A} = 0$$

7 Which waves are also called heat waves? In which effect do these waves play an important role in maintaining the average temperature on earth?

Solution : Infrared waves are also called heat waves. These waves play an important role in the greenhouse effect in maintaining the average temperature on Earth.

OR

Write the name and one use of the highest frequency electromagnetic wave.

Solution : The highest frequency electromagnetic wave is the gamma ray. One use of gamma rays is in the sterilization of medical equipment.

8 If the lower half of the reflecting surface of a concave mirror is covered with an opaque material, what will it have on the image formed by the mirror of an object placed in front of the mirror? Write.

Solution :

If the lower half of the reflecting surface of a concave mirror is covered with an opaque material, the image will still form, but it will be less bright as only the upper half of the mirror is reflecting light. The size, position, and nature of the image remain unchanged, but the intensity of the image will be reduced.

OR

If a ray of light enters obliquely from an optically rarer medium to an optically denser medium. what will be the effect on the velocity and frequency of the light ray? Write.

Solution :

When a ray of light enters obliquely from an optically rarer medium to an optically denser medium, the velocity of the light ray decreases, while the frequency of the light ray remains unchanged.

9 Write two conclusions obtained from the alpha particle scattering experiment.

Solution:

1. **Nucleus Existence:** Most of the alpha particles passed through the gold foil undeflected, indicating that the atom is mostly empty space, but a few were deflected at large angles, indicating the presence of a small, dense, positively charged nucleus at the center of the atom.
2. **Nucleus Size:** The fact that only a small fraction of alpha particles were deflected suggested that the nucleus is very small compared to the overall size of the atom.

OR

Write two features of nuclear force.

Solution:

1. **Strong Force:** Nuclear force is the strongest force in nature, significantly stronger than the electromagnetic force, which holds electrons in atoms.
2. **Short Range:** Nuclear force operates only over very short distances.

10 Draw labelled circuit diagram of forward bias of $p-n$ junction diode.

Solution :

In the context of semiconductor electronics, forward bias refers to the application of a voltage across a p−np-np−n junction diode that reduces the width of the depletion zone, allowing current to flow easily from the ppp side to the nnn side. Here's a detailed explanation:

Concept of Forward Bias in a p−n Junction Diode

1. **Definition:** Forward bias is a condition where the positive terminal of the battery is connected to the ppp-type material and the negative terminal to the nnn-type material of the diode. This setup reduces the potential barrier at the p−np-np−n junction and promotes the movement of charge carriers, thus

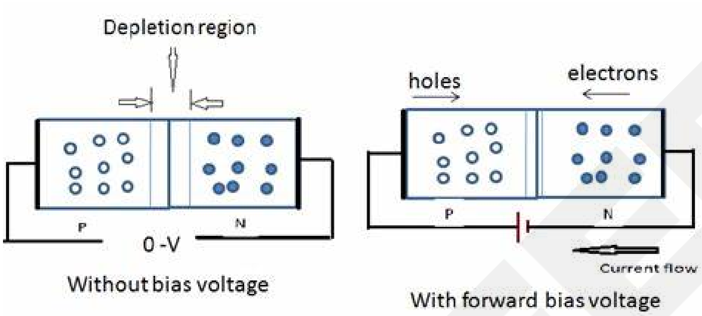
allowing current to flow through the diode.

2. **Mechanism:**

- When the p−np-np−n junction diode is forward biased, holes from the ppp-type side and electrons from the nnn-type side move towards the junction.
- At the junction, electrons from the nnn-side recombine with holes from the ppp-side, which facilitates current flow across the diode.
- The application of the forward voltage reduces the width of the depletion region formed by the immobile ions around the p−np-np−n junction. This reduction lowers the barrier that prevents charge flow, thereby increasing the ease with which the carriers can move across the junction.

3. **Effect on Depletion Region:** The forward bias voltage essentially 'pushes' the charge carriers towards the junction. For electrons in the nnn-type material, the negative voltage on the nnn-side repels them towards the junction, while the positive voltage on the ppp-side attracts them. The reverse happens for holes in the ppp-type material. This movement diminishes the depletion region, a zone void of free charge carriers that normally acts as a barrier to current flow.

4. **Current Flow:** Once the external voltage applied across the diode exceeds a certain threshold (typically around 0.7 volts for silicon diodes), the diode starts conducting, and a significant amount of current can flow through the circuit. This condition contrasts with reverse bias, where the diode blocks current flow.



OR

Draw labeiled circuit diagram of half-wave rectifier.

Solution :

A half-wave rectifier is a circuit that converts alternating current (AC) into direct current (DC) by allowing only one half-cycle of the AC voltage to pass, blocking the other half-cycle. Here's a detailed explanation of how it works and the key components involved:

Components of a Half-Wave Rectifier:

1. **Diode**: The central component, which conducts current in one direction only. It allows current to flow when forward biased (positive cycle of AC) and blocks current when reverse biased (negative cycle of AC).
2. **Load Resistor (R_L)**: This is where the rectified output is taken. The resistor also helps in the smoothing of the DC output.
3. **AC Source**: The input voltage source which is typically sinusoidal.

Operation:

- During the positive half-cycle of the AC input, the diode is forward-biased and conducts current to the load resistor. The output voltage across the load resistor during this time closely follows the positive half of the AC waveform.

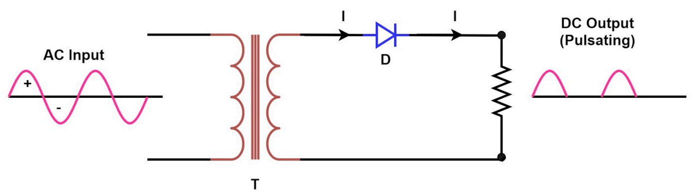
- During the negative half-cycle, the diode is reverse-biased and blocks current. No current flows through the load, and the output voltage is zero.

Output:

The output of a half-wave rectifier is a pulsating DC voltage that ideally pulses between 0 volts and the peak AC voltage minus the forward voltage drop of the diode. In reality, the voltage also drops slightly due to other components like the internal resistance of the source and the diode.

Applications:

Half-wave rectifiers are used in simple power supply circuits, signal demodulation, and wherever a cheap, simple rectifier is needed. However, due to their inefficiency in converting both halves of the AC signal, they are not suitable for applications requiring smooth and stable DC outputs.



Half Wave Rectifier

11 Write two characteristics of electric field lines.

Solution :

1. **Originate and Terminate:** Electric field lines originate from positive charges and terminate on negative charges. In the absence of charges, they extend to infinity.

2. **Non-Crossing:** Electric field lines never cross each other because at any point in space, the electric field must have a unique direction.

OR

Write two characteristics of equipotential surface.

Solution :

1. **Perpendicular to Field Lines:** Equipotential surfaces are always perpendicular to electric field lines, indicating that no work is done when moving a charge along an equipotential surface.

2. **Constant Potential:** Every point on an equipotential surface has the same electric potential, meaning that the potential difference between any two points on the surface is zero.

12 Write two differences between self induction and mutual induction.

Solution :

1. **Definition:**

- **Self-Induction:** The phenomenon where a changing current in a coil induces an emf in the same coil.
- **Mutual Induction:** The phenomenon where a changing current in one coil induces an emf in a nearby coil.

2. **Dependence:**

- **Self-Induction:** Depends on the rate of change of current in the same coil.
- **Mutual Induction:** Depends on the rate of change of current in the neighboring coil.

OR

Write two differences between step-up transformer and step-down transformer.

Solution :

1. **Voltage Change:**

- **Step-Up Transformer:** Increases the voltage from primary to secondary.
- **Step-Down Transformer:** Decreases the voltage from primary to secondary.

2. **Turns Ratio:**

- **Step-Up Transformer:** Has more turns in the secondary coil than in the primary coil.
- **Step-Down Transformer:** Has fewer turns in the secondary coil than in the primary coil.

13 Write three experimental observations of photoelectric effect.

Solution :

1. **Instantaneous Emission:** Photoelectrons are emitted almost instantaneously when light of sufficient frequency hits the metal surface, regardless of light intensity.

2. **Threshold Frequency:** There is a minimum frequency of incident light, called the threshold frequency, below which no photoelectrons are emitted regardless of the light intensity.

3. **Kinetic Energy:** The kinetic energy of the emitted photoelectrons depends on the frequency of the incident light and not on its intensity. Higher frequency light results in higher kinetic energy of the photoelectrons.

OR

Write three characteristics of photon.

Solution :

1. **Instantaneous Emission:** Photoelectrons are emitted almost instantaneously when light of sufficient frequency hits the metal surface, regardless of light intensity.

2. **Threshold Frequency:** There is a minimum frequency of incident light, called the threshold frequency, below which no photoelectrons are emitted regardless of the light intensity.

3. **Kinetic Energy:** The kinetic energy of the emitted photoelectrons depends on the frequency of the incident light and not on its intensity. Higher frequency light results in higher kinetic energy of the photoelectrons.

14 Establish the relation between EMF. terminal voltage and internal resistance of a cell.

Solution :

The relation between EMF (E), terminal voltage (V), and internal resistance (r) of a cell is given by:

V=E−Ir

Where:

- E is the electromotive force (EMF) of the cell.
- V is the terminal voltage.
- I is the current flowing through the circuit.
- r is the internal resistance of the cell.

OR

Draw the labelled diagram of wheatstone bridge and write the necessary condition for the balance of wheatstone bridge.

Solution :

Wheatstone Bridge Circuit Diagram:

The Wheatstone bridge is a fundamental electrical circuit used to precisely measure electrical resistances. Below, I'll explain the components of a Wheatstone bridge and provide the necessary condition for its balance.

Components of the Wheatstone Bridge:

1. **Four Resistors**: These resistors are arranged in a quadrilateral. Typically, one of these resistors is unknown, one is adjustable, and the others are known.
2. **Galvanometer**: Connected between the two middle points of the quadrilateral, used to detect the presence of current.
3. **Voltage Source**: Provides a voltage across the bridge.

Circuit Configuration:

The four resistors are labeled R1,R2,R3,and R4. They are connected as follows:

- R1 and R2 form one pair connected in series.
- R3 and R4 form another pair connected in series.
- The galvanometer connects the junction between R1 and R2 to the junction between R3and R4

Necessary Condition for Balance:

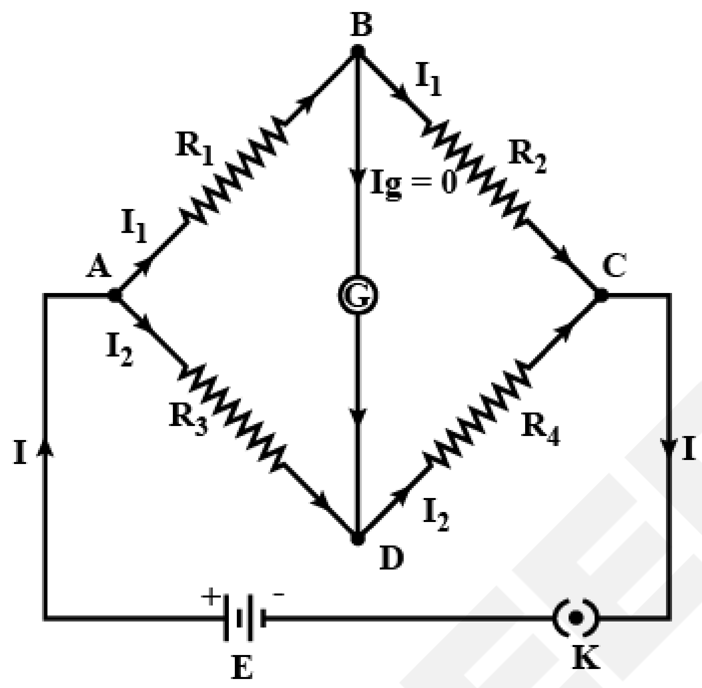
The Wheatstone bridge is said to be in balance when there is no current flowing through the galvanometer. This occurs when the ratio of the resistances in one pair is equal to the ratio of the resistances in the other pair. Mathematically, the condition for balance is given by: $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

When this condition is met, the potential difference between the middle points (where the galvanometer is connected) is zero, thus no current flows through the galvanometer, indicating a balanced bridge.

Use in Measurements:

The balanced condition of the Wheatstone bridge allows for the precise measurement of an unknown resistance. By adjusting one of the known resistances until the galvanometer shows zero current, the unknown resistance can be calculated using the balance condition formula.

Wheatstone's network:



15. A solenoid of length 2 meter and 100 turns carries a current 10 A. Calculate the magnitude of the magnetic field inside the solenoid. $\left(\mu_0 = 4\pi \times 10^{-7}\right)$

Solution :

The magnetic field inside a solenoid is given by $B = \mu_0 \cdot n \cdot I$.

For a solenoid of length 2 meters with 100 turns carrying a current of 10 A, the magnitude of the magnetic field is:

$$B = \mu_0 \cdot \frac{N}{L} \cdot I = 4\pi \times 10^{-7} \cdot \frac{100}{2} \cdot 10 = 2\pi \times 10^{-4}\ \mathrm{T}$$

The magnitude of the magnetic field inside the solenoid is $2\pi \times 10^{-4}\ \mathrm{T}$.

OR

A long straight wire carries a current of 30 A . Calculate the magnitude of magnetic field at a poin 30 cm from the wire.

Solution :

The magnetic field around a long straight wire is given by $B = \frac{\mu_0 I}{2\pi r}$.

For a wire carrying a current of 30 A at a distance of 30 cm:

$$B = \frac{4\pi \times 10^{-7} \times 30}{2\pi \times 0.3} = 2 \times 10^{-5}\ \mathrm{T}$$

The magnitude of the magnetic field at a point 30 cm from the wire is $2 \times 10^{-5}\ \mathrm{T}$.

16 Describe total internal reflection of light on the basis of following points :

(i) Definition

(ii) An application

Solution :

Total internal reflection (TIR) is a phenomenon that occurs when a light ray traveling in a denser medium strikes the boundary with a less dense medium at an angle exceeding a certain critical angle. Below, I'll detail the definition and an application of total internal reflection:

Definition:

Total internal reflection occurs when the angle of incidence within the denser medium is greater than the critical angle specific to the pair of media.

Application: Optical Fibers

One of the most important applications of total internal reflection is in the field of telecommunications, particularly in optical fibers. Optical fibers are thin strands of glass or plastic that transmit light over long distances, carrying vast amounts of data. Here's how TIR is utilized in optical fibers:

- **Light Transmission**: Light signals entering an optical fiber are kept within the core by total internal reflection. The core of the fiber has a higher refractive index than the surrounding cladding, ensuring that light traveling through the core is continually reflected back into the core whenever it encounters the core-cladding boundary at angles greater than the critical angle.
- **Data Transmission**: This property allows light to travel through the fiber with minimal loss over great distances, making optical fibers ideal for internet and telecommunications networks, where they transmit information encoded in light pulses.

OR

Describe huygen's principle on the basis of following points :

(i) Definition of wave front

(ii) Ray diagram of spherical wave emanating from point source.

(iii) Emanation of secondary wavelets.

Solution:

Huygens' Principle is a fundamental concept in wave theory that provides a method for understanding the propagation of waves through a medium. Below, I'll explain each point based on your request:

(i) Definition of Wave Front

A wave front is defined as a surface over which the phase of the wave is constant. In simpler terms, it represents the locus of all points reached by the wave at the same time, effectively marking the positions where the wave has traveled through the medium. For waves emanating from a point source, the wave front is typically spherical, with the source at the center. For plane waves, the wave front is flat.

(ii) Ray Diagram of Spherical Wave Emanating from Point Source

A spherical wave emanating from a point source can be visualized as a series of concentric circles (in two dimensions) or spheres (in three dimensions) expanding outward. Each circle or sphere represents a wave front. The rays, which are perpendicular to the wave fronts, illustrate the direction of wave propagation. This diagram helps in visualizing how the wave spreads out in all directions from the source.

(iii) Emanation of Secondary Wavelets

Huygens' Principle states that every point on a given wave front can be considered as a secondary source of wavelets. These wavelets spread out in the forward direction with the same speed as the wave itself. After a small interval of time, the new position of the wave front is the envelope of all these secondary wavelets. This part of Huygens' Principle helps to explain not only the linear propagation of waves but also phenomena like refraction and diffraction, where the direction of wave propagation changes.

17 Write two shortcomings of Rutherford's nuclear model and explain how Bohr's model of hydrogen atom overcome these shortcomings?

Solution :

Shortcomings of Rutherford's Nuclear Model and Bohr's Solutions

Shortcomings of Rutherford's Nuclear Model:

1. **Instability of Atom**: According to classical physics, electrons moving in circular orbits should continuously emit electromagnetic radiation. As a result, electrons would lose energy and eventually spiral into the nucleus, leading to the collapse of the atom. This does not occur, indicating a fundamental flaw in the model.
2. **Discrete Spectra**: Rutherford's model could not explain why atoms emitted light at specific wavelengths, or why the energy levels in atoms were quantized. This was evident from the observation of discrete spectral lines rather than a continuous spectrum.

Bohr's Model Solutions:

1. **Quantized Orbits**: Bohr introduced the concept of quantized orbits, where electrons can only orbit the nucleus in certain allowed paths without emitting radiation. Only when jumping between these orbits would an electron absorb or emit energy in discrete amounts (quanta), thereby maintaining the stability of the atom.
2. **Energy Levels**: Bohr's model proposed that electrons exist in specific energy levels which correspond to different orbits. The energy emitted or absorbed as electrons transition between these levels matches the observed spectral lines. This quantization explains the discrete nature of atomic spectra.

OR

Explain the nuclear fusion and fission with the help of one example each.

Solution :

Nuclear Fusion:

- **Definition**: Fusion is the process where two light atomic nuclei combine to form a heavier nucleus, releasing a substantial amount of energy due to the mass defect and conversion into energy as per Einstein's E=mc2
- **Example**: The Sun, where hydrogen nuclei fuse under high temperature and pressure to form helium, releasing energy that powers the solar radiation.

Nuclear Fission:

- **Definition**: Fission is the process where a heavy nucleus splits into two or more lighter nuclei, along with the emission of neutrons, photons (in the form of gamma rays), and other fragments, releasing a large amount of energy.
- **Example**: Uranium-235 undergoing fission when struck by a neutron to produce krypton-92, barium-141, three neutrons, and a large amount of energy.

18 Two point charges $q_A = 2\mu\mathrm{C}$ and $q_B = -2\mu\mathrm{C}$ are located 40 cm apart in vacuum. Find the intensity of the electric field at the midpoint of the line joining these two charges.

Solution :

Given:
- Two point charges $q_1 = +2\mu\mathrm{C}$ and $q_2 = -2\mu\mathrm{C}$
- Distance between the charges, $d = 40\ \mathrm{cm} = 0.4\ \mathrm{m}$

The midpoint between the charges is at a distance of $0.2\ \mathrm{m}$ from each charge.

The electric field due to a point charge q at a distance r is given by $E = \frac{kq}{r^2}$, where $k = 9 \times 10^9\ \mathrm{N\,m^2/C^2}$.

Electric field due to q_1 at the midpoint:

$$E_1 = \frac{9 \times 10^9 \times 2 \times 10^{-6}}{(0.2)^2} = \frac{18 \times 10^3}{0.04} = 4.5 \times 10^5\ \mathrm{N/C}$$

Electric field due to q_2 at the midpoint:

$$E_2 = \frac{9 \times 10^9 \times (-2) \times 10^{-6}}{(0.2)^2} = -4.5 \times 10^5\ \mathrm{N/C}$$

Since E_1 and E_2 are in opposite directions, their magnitudes add up:

Total electric field intensity at the midpoint:

$$E = E_1 + E_2 = 4.5 \times 10^5 \mathrm{~N/C} + 4.5 \times 10^5 \mathrm{~N/C} = 9 \times 10^5 \mathrm{~N/C}$$

The intensity of the electric field at the midpoint of the line joining the two charges is $9 \times 10^5 \mathrm{~N/C}$.

OR

The capacitor of capacitance 3 pl .4 pl and 5 pl are connected in parallel to a 120 V ballen find the total capacitance of the combination and charge on cach capacitor

Solution:

Given capacitors: $C_1 = 3\,\mathrm{pF}, \quad C_2 = 4\,\mathrm{pF}, \quad C_3 = 5\,\mathrm{pF}$

Total capacitance for capacitors in parallel:

$C_{\text{total}} = C_1 + C_2 + C_3 = 3\,\mathrm{pF} + 4\,\mathrm{pF} + 5\,\mathrm{pF} = 12\,\mathrm{pF}$

Voltage across each capacitor: $V = 120\,\mathrm{V}$

Charge on each capacitor is given by $Q = CV$

$Q_1 = C_1 \times V = 3\,\mathrm{pF} \times 120\,\mathrm{V} = 360\,\mathrm{pC}$

$Q_2 = C_2 \times V = 4\,\mathrm{pF} \times 120\,\mathrm{V} = 480\,\mathrm{pC}$

$Q_3 = C_3 \times V = 5\,\mathrm{pF} \times 120\,\mathrm{V} = 600\,\mathrm{pC}$

19 Deduce an expression for motional electromotive force induced across a straight conductor moving in any uniform magnetic field.

Solution:

The motional electromotive force (emf) $\mathcal{E}$ induced in a straight conductor moving through a uniform magnetic field is given by:

$$\mathcal{E} = B \cdot l \cdot v \cdot \sin(\theta)$$

Where:
- B is the magnetic field strength.
- l is the length of the conductor.
- v is the velocity of the conductor.
- θ is the angle between the direction of velocity and the magnetic field.

OR

Find the expression of resultant voltage. impedance and phase difference between current and voltage with the help of phaser diagram in series LCR circuit.

Solution:

The resultant voltage in a series LCR circuit is $V = \sqrt{(V_R^2 + (V_L - V_C)^2)}$.

Impedance Z is given by $Z = \sqrt{R^2 + (X_L - X_C)^2}$ with $X_L = \omega L$ and $X_C = \frac{1}{\omega C}$.

The phase difference ϕ between current and voltage is $\tan(\phi) = \frac{X_L - X_C}{R}$.

In a phasor diagram, the voltage vectors V_R, V_L, and V_C are represented with their relative angles.

20 Establish the expression for the net power of combination of two thin lenses kept in contact.

Solution :

The net power P of two thin lenses in contact is the sum of their individual powers.

$$P = P_1 + P_2$$

Where P_1 and P_2 are the powers of the first and second lenses, respectively.

OR

Draw a labelled ray diagram for formation of image from simple microscope and establish an expression for the magnification of a simple mieroscope when image is formed at (a) intinity and (b) least distance of distinct vision

Solution:

Magnification of a Simple Microscope

A simple microscope consists of a single convex lens. The magnification achieved by this microscope depends on where the image is formed relative to the eye. There are two primary conditions to consider:

Image Formed at Infinity
When the object is placed at the focal point of the lens, the image is formed at infinity, and the magnification M is given by:

$$M = \frac{D}{f}$$

where D is the least distance of distinct vision (typically 25 cm for the normal human eye), and f is the focal length of the lens.

\subsection {Image Formed at the Least Distance of Distinct Vision}
When the image is formed at the nearest distance the eye can clearly see without strain (also around 25 cm), the magnification M is enhanced and calculated by:

$$M = 1 + \frac{D}{f}$$

This formula helps us understand the effectiveness of the lens in bringing the image to a point where the eye perceives it with maximum clarity and minimum effort.

MP Board Class 12 Physics Question with Solution -2023

1. Select and write the correct option from the options given in each question :

(a) Bhabha Atomic Research Centre is situated in -

(i) New Delhi

(ii) Mumbai

(iii) Kotkata

(iv) Bangalor

Solution:

Bhabha Atomic Research Centre, a premier nuclear research facility, is situated in Mumbai, India.

Hence, the answer is option (ii).

(b) Forbidden energy gap for Germanium semi conductor is -

(i) 1.1 eV

(ii) 1.9 eV

(iii) 0.72 eV

(iv) 0.75 eV

Solution:

The forbidden energy gap for Germanium semiconductor is approximately 0.72 eV.

Hence, the answer is option (iii)

(c) Which device is used as a rectifier?

(i) Junction diode

(ii) Transformer

(iii) Zener diode

(iv) Photo diode

Solution:

A junction diode is used to rectify AC to DC, acting as a rectifier.

Hence, the answer is option (i)

(d) The focal length of eye piece in telescope______ the focal length of the objective.

(i) is less than

(ii) is more than

(iii) is equal

(iv) none of these

Solution:

The eyepiece focal length is shorter than the objective to achieve higher magnification in telescopes.

Hence, the answer is option (i)

(e) The mass of a Neutron is -

(i) 1.67×10^{-31} kg

(ii) 1.67×10^{-27} kg

(iii) 1.67×10^{-9} kg

(iv) 1.67×10^{-23} kg

Solution:
The mass of a neutron is approximately 1.67 \times 10^{-27}

Hence, the answer is option (ii)

(f) S.I. unit of current density is - ,

(i) Coluomb / meter

(ii) Ampere $/$ **meter** ^{2}

(iii) Coluomb $/$ **meter** ^{2}

(iv) Ampere $/$ **meter**

Solution:

The SI unit of current density is Ampere per square meter

Hence, the answer is option (ii)

(g) The phase difference between flowing current and applied voltage in alternating circuit containing pure capacitor is -

(i) 0

(ii) 1

(iii) $\pi/2$

(iv) $-\pi/2$

Solution:
In a pure capacitor, the voltage lags the current by radians in an AC circuit}.

Hence, the answer is option (iv)

2. Fill in the blanks and write

(i) The frequency of a Direct Current is _______

(ii) Electromagnetic wave of highest frequenes is . _______

(iii) The frequency of the light wave is order of _______ .

(iv)The velocity of light _______ when it goes to rare medium to denser.

(v) Magnetic field is a _______ quantits.

(vi) The _______ of the galvanometer is reduced by the use of shunt.

(vii) The ohmic resistance of an ideal inductance is _______ .

Solution:

(i) The frequency of a Direct Current is zerozero

(ii) Electromagnetic wave of highest frequency is γ rays.

(iii) The frequency of the light wave is order of 10^14 to 10^15 Hz

(iv) The velocity of light decreases when it goes from a rare medium to a denser medium.

(v) Magnetic field is a vector quantity.

(vi) Thesensitivity of the galvanometer is reduced by the use of shunt.

(vii) The ohmic resistance of an ideal inductance is zero.

3. Write True or False :

(i) In an intrinsic semiconductor the number of free electron is equal to the number of holes.

(ii) Voltmeter is more superior to potentiometer.

(iii) De-broglic waves are an clectromagnetic wave.

(iv) Atom is a positive particle.

(v) The average power supplied to an inductor over one complete cycle is zero.

(vi) Working of microwave oven is based on Radio wave.

(vii) Infrared radiation is invented by scientist Retar.

Solution:

(i) In an intrinsic semiconductor the number of free electrons is equal to the number of holes.
True
Explanation: In intrinsic semiconductors, electrons and holes are created in pairs.

(ii) Voltmeter is more superior to potentiometer.
False
Explanation: Potentiometers are more accurate for measuring voltage as they don't draw current from the circuit.

(iii) De Broglie waves are an electromagnetic wave.
False
Explanation: De Broglie waves are matter waves, not electromagnetic.

(iv) Atom is a positive particle.
False
Explanation: Atoms are neutral overall, containing both positive protons and negative electrons.

(v) The average power supplied to an inductor over one complete cycle is zero.
True
Explanation: In ideal inductors, the energy is stored and returned, resulting in zero average power.

(vi) Working of microwave oven is based on Radio wave.
False
Explanation: Microwave ovens use microwaves, which are higher frequency than radio waves.

(vii) Infrared radiation is invented by scientist Retar.
False
Explanation: Infrared radiation was discovered by William Herschel.

4. Write ammet of cach question in one sentence

(i) What is diffraction?

(ii) What is the umit wh power at lens?

(iii) What is the magnetic dipole moment of magnet

(iv) How galvanomter is changed in a votmeter

(v) What is the effect of temperature in drift velocity

(vi) Give relation between energy and freqeuncy of a radiation

(vii) What is threshold frequency?

Solution:

(i) Diffraction is the bending of waves around obstacles and the spreading of waves past small openings.

(ii) The unit of power of a lens is diopter (D).

(iii) The magnetic dipole moment of a magnet is a measure of the strength and direction of its magnetic field.

(iv) A galvanometer is changed into a voltmeter by connecting a high resistance in series with it.

(v) The drift velocity decreases as temperature increases due to increased collisions between electrons and atoms.

(vi) The energy (E) of a radiation is directly proportional to its frequency (f), given by E=hf, where hhh is Planck's constant.

(vii) Threshold frequency is the minimum frequency of light required to eject electrons from a metal surface in the photoelectric effect.

5. Write Biort-savart expansion in vector form.

Solution:

The Biot-Savart law in vector form is used to determine the magnetic field B\mathbf{B}B generated by a steady current. The law states that the magnetic field at a point in space due to a small segment of current-carrying wire is proportional to the current, the length of the segment, and the sine of the angle between the segment and the line connecting the segment to the point. Mathematically, it is expressed as:

$$\mathbf{dB} = \frac{\mu_0}{4\pi} \frac{I\, d\mathbf{l} \times \mathbf{r}}{r^3}$$

OR

Why there is no end point of magnetic field lines.

Solution:

Magnetic field lines have no end points because magnetic monopoles (isolated north or south poles) do not exist. Magnetic field lines form continuous loops that start from the north pole and end at the south pole, continuing through the magnet and looping back to the north pole. This property reflects the fundamental nature of magnetic fields, where every north pole is paired with a south pole, ensuring the field lines always form closed loops.

6. A light bulb is rated at 200 W for a 220 V supply. Find the resistance of the bulb.

Solution:

To find the resistance R of the light bulb, we use the formula:

$$P = \frac{V^2}{R}$$

Rearranging to solve for R:

$$R = \frac{V^2}{P}$$

Substituting the given values:

$$R = \frac{220^2}{200}$$

$$R = \frac{48400}{200}$$

$$R = 242\,\Omega$$

Therefore, the resistance of the bulb is:

$$R = 242\,\Omega$$

OR

A light bulb is related at 200 W for a 220 V supply. lind the rms current through the bulb.

Solution:

$$P = V \times I$$

$$I = \frac{P}{V}$$

$$I = \frac{200 \text{ W}}{220 \text{ V}}$$

$$I \approx 0.909 \text{ A}$$

7. What is Conjugate focus?

Solution:

Conjugate focus in optics refers to the relationship between two points, specifically the object point and the image point, where the rays emanating from one point are precisely focused at the other point. In simpler terms, if light rays leave one point, they are brought into focus at the conjugate point after passing through an optical system, like a lens or mirror.

In a typical optical setup, there are two primary conjugate foci:

1. **Object Focus**: This is where the object is placed so that its image is well-focused at a desired location. This point is usually at a certain distance from the optical element.
2. **Image Focus**: This is where the image of the object forms after light rays have interacted with the optical system. The position of the image depends on the characteristics of the optical system and the position of the object.

The concept of conjugate foci is critical in designing optical instruments, such as microscopes, telescopes, and cameras, ensuring that the object being observed or imaged is in clear focus.

OR

Write any two difference between refractive telescope and retractive reflective telescope.

Solution:

- **Optical Design**:

  - **Refractive telescopes** use lenses to bend (refract) light to form an image. The primary optical element in a refractor is a convex lens, which gathers light and focuses it to a point behind the lens.
  - **Reflective telescopes**, on the other hand, use mirrors to reflect light to form an image. The primary optical element in a reflector is a concave mirror that collects light and focuses it onto a secondary mirror, which then directs the image to the eyepiece.
- **Chromatic Aberration**:

  - **Refractive telescopes** are susceptible to chromatic aberration, where different colors of light do not come to the same focal point, resulting in a rainbow halo around images. This is due to the different wavelengths of light being refracted by different amounts.
  - **Reflective telescopes** largely eliminate chromatic aberration because mirrors reflect all wavelengths of light equally, so all colors focus at the same point. This makes them particularly useful for high-contrast astronomical observations.

8. What is Photoelectric effect? Write IEinstein photoelectric equation

Solution:

The photoelectric effect is a phenomenon in which electrons are emitted from the surface of a material, typically a metal, when it is exposed to light of sufficient frequency. This effect was first observed by Heinrich Hertz in 1887 and later explained by Albert Einstein in 1905, for which he received the Nobel Prize in Physics in 1921.

Einstein's explanation was revolutionary because it supported the quantum theory of light by suggesting that light could be thought of as consisting of discrete packets of energy, called photons, rather than just waves. The energy of these photons is directly proportional to the frequency of the light.

Einstein’s photoelectric equation describes how the energy of the photons that strike the metal is used to free electrons from the surface. The equation is:

$$E = h\nu = \phi + KE$$

Where:
- E is the energy of the photon.
- h is Planck's constant (6.626×10^{-34} Joule seconds).
- ν (or f in some texts) is the frequency of the incident light.
- ϕ is the work function of the metal, which is the minimum energy needed to remove an electron from the surface.
- KE is the kinetic energy of the emitted electron.

According to this equation, the energy of the incoming photon must be greater than the work function of the metal for electrons to be emitted. Any excess energy appears as the kinetic energy of the emitted electrons.

OR

What is de-broglie matter wave Write de-broglie wave relation

Solution:

The concept of de Broglie matter waves, also known as the de Broglie hypothesis, is a fundamental principle in quantum mechanics proposed by the French physicist Louis de Broglie in 1924. De Broglie suggested that particles of matter, such as electrons or protons, can exhibit wave-like properties under certain conditions. This hypothesis was revolutionary because it extended the wave-particle duality concept, previously observed only in light (photons), to all particles of matter.

The de Broglie hypothesis forms the basis for the theory of wave mechanics, which treats particles as waves that have a wavelength associated with their motion. This wavelength is not a property of the particle alone but results from its momentum, reflecting the particle's wave-like behavior.

De Broglie's wavelength equation (the de Broglie wavelength relation) expresses the wavelength associated with a particle. The equation is given as:

$$\lambda = \frac{h}{p}$$

Where:
- λ is the wavelength of the particle,
- h is Planck's constant (6.626×10^{-34} Joule seconds),
- p is the momentum of the particle.

This relationship implies that every moving particle or object has an associated wavelength, but the effect is significant only for particles at the atomic or subatomic level, where their wave-like properties become observable.

9. Write any two Postulate of Bohr's model.

Solution:

Niels Bohr proposed his model of the hydrogen atom in 1913, which incorporated quantum theory to explain the stability of the atom and the emission spectrum of hydrogen. Among the several postulates that formed the basis of his model, two are particularly significant:

1. Quantized Orbits Bohr postulated that electrons in an atom move in certain fixed orbits known as "stationary orbits" without the emission of radiant energy, contrary to the laws of classical mechanics and electrodynamics. These orbits are quantized, meaning that only certain allowed circular orbits with specific quantized angular momenta are permissible for the electron. The angular momentum L of an electron in a stationary orbit is quantized and given by the equation:

$$L = n\frac{h}{2\pi}$$

where n is the principal quantum number (an integer), and h is Planck's constant.

2. Energy Quantization: When an electron transitions between these quantized orbits, the atom either absorbs or emits energy in discrete amounts, called quanta. The energy difference between the initial and final orbit of the electron is emitted or absorbed as electromagnetic radiation of frequency ν, given by the relation:

$$\Delta E = h\nu$$

where ΔE is the difference in energy between two energy levels, and h is Planck's constant.

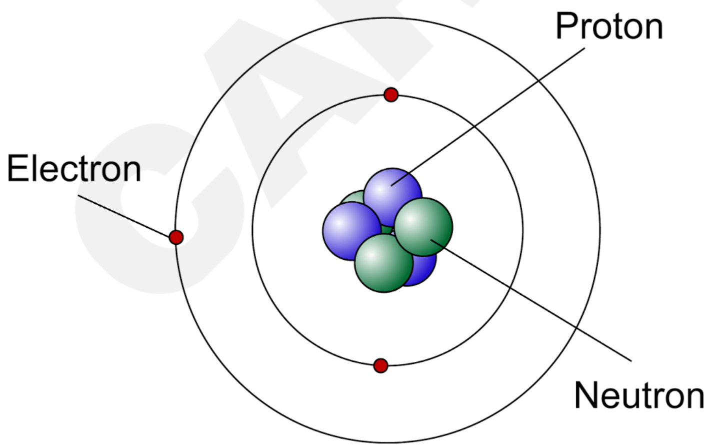
These postulates addressed several unexplained phenomena and significantly advanced the understanding of atomic structure and quantum mechanics.

OR

Who discovered the nucleus model of atom ? Draw its diagram

Solution:

The nucleus model of the atom was discovered by Ernest Rutherford in 1911. He proposed this model based on observations from his gold foil experiment, which showed that atoms have a small, dense, positively charged nucleus at their center. This experiment was a pivotal moment in the development of atomic physics, significantly altering the understanding of atomic structure at the time.



10. What is isotopes? Write any two isotopes of hydrogen atom.

Solution:

Isotopes are variants of a particular chemical element that have the same number of protons but different numbers of neutrons in their nuclei. This results in isotopes having the same atomic number but different mass numbers.

For hydrogen, the most common isotopes are:

1. **Protium (1^H)**: This is the most abundant isotope of hydrogen, consisting of only one proton and no neutrons.
2. **Deuterium (2^H, also denoted as D)**: This isotope of hydrogen has one proton and one neutron. It's used in various scientific applications, including nuclear fusion experiments.
3. **Tritium (3^H, also denoted as T)**: This rarer isotope has one proton and two neutrons and is radioactive. Tritium is used in research and in devices like self-lighting exit signs.

OR

What is Isobar? Give example.

Solution:

An isobar is a line on a map connecting points of equal atmospheric pressure. Isobars are used in meteorology to represent areas of constant pressure on weather maps. They help meteorologists understand and predict weather patterns by indicating areas of high and low pressure, as well as the strength and direction of winds.

Example:

On a weather map, isobars are typically drawn at intervals of 4 millibars (mb) or hectopascals (hPa). For instance, if there are areas with pressures of 1000 mb, 1004 mb, 1008 mb, etc., isobars would be drawn to connect points with these specific pressure values.

Illustration:

Imagine a weather map with the following pressure readings at various points:

- Point A: 1000 mb
- Point B: 1004 mb
- Point C: 1008 mb
- Point D: 1012 mb

The isobar at 1000 mb would connect all points with a pressure of 1000 mb. Similarly, isobars at 1004 mb, 1008 mb, and 1012 mb would connect points with those pressures, forming concentric lines around areas of low and high pressure.

11. What is a fundamental charge ? Write its value.

Solution:

The fundamental charge, often referred to as the \textbf{elementary charge}, is the electric charge carried by a single proton, or equivalently, the negative of the charge carried by a single electron. This charge is a fundamental constant in physics and is crucial for the structure of atomic particles.

The value of the elementary charge is:

$$e = 1.602176634 \times 10^{-19} tcoulombs$$

This value is considered a basic physical constant and plays a vital role in the electromagnetic interactions between particles.

OR

Where will an electron move in an electric field either high potential side or low potential side? and why?

Solution:

An electron will move toward the high potential side in an electric field. This direction can be understood by considering that an electric field points from a region of higher electric potential to a region of lower electric potential. Since the force on a charged particle in an electric field is given by the equation:

$$\vec{F} = q\vec{E}$$

where q is the charge of the particle and $\vec{E}$ is the electric field vector, the force on a negatively charged electron (where q is negative) will be in the direction opposite to $\vec{E}$. Thus, an electron moves toward higher potential because it moves opposite to the field direction, seeking to minimize its potential energy.

12. What is an electric cell? give example

Solution:

An electric cell is a device that converts chemical energy into electrical energy through an electrochemical reaction. It consists of two different metals (the electrodes) immersed in an electrolyte solution, which facilitates the flow of ions. The chemical reactions at the electrodes create a potential difference between them, allowing the cell to produce an electric current when connected in a circuit.

Example of an Electric Cell:

- **Dry Cell (Zinc-Carbon Battery)**: This is a common type of electric cell used in many portable electronic devices like flashlights and remote controls. The zinc container acts as the anode, the carbon rod in the center serves as the cathode, and the electrolyte is a moist paste of ammonium chloride mixed with manganese dioxide. The chemical reaction between these components produces electrical energy that powers devices.

OR

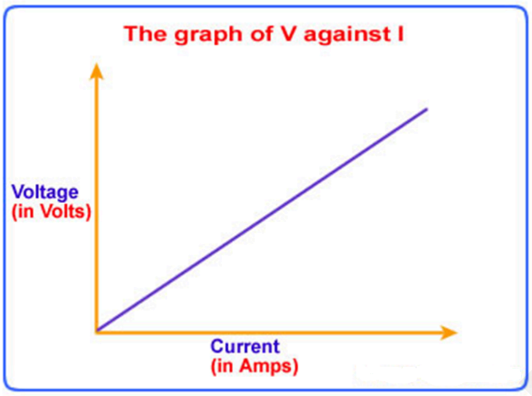
Write Ohms law and also draw praph between woltage and current

Solution:

Ohm's Law is a fundamental principle in the field of electrical engineering and physics. It states that the current flowing through a conductor between two points is directly proportional to the voltage across the two points, provided the temperature remains constant. Mathematically, Ohm's Law is expressed as:

V=IR

where:

- V is the voltage across the conductor (measured in volts, V),
- I is the current flowing through the conductor (measured in amperes, A),
- R is the resistance of the conductor (measured in ohms)
- 

13. The radii of curvatures of the focus of a double convex lens are 10 cm and 15 cm its focal length is 12 cm . What is the refractive index of glass. (refractive index of air $= 1$)

Solution:

To find the refractive index of glass for a double convex lens, we can use the lens maker's formula:

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

where:
- f is the focal length of the lens,
- n is the refractive index of the glass,
- R_1 and R_2 are the radii of curvature of the lens surfaces.

Given:
- $f = 12\,\text{cm}$,
- $R_1 = 10\,\text{cm}$,
- $R_2 = -15\,\text{cm}$ (since the second surface is concave relative to the incident light).

Substituting these values into the lens maker's formula:

$$\frac{1}{12} = (n-1)\left(\frac{1}{10} - \frac{1}{-15}\right)$$

Simplifying the terms inside the parentheses:

$$\frac{1}{10} - \frac{1}{-15} = \frac{1}{10} + \frac{1}{15} = \frac{3}{30} + \frac{2}{30} = \frac{5}{30} = \frac{1}{6}$$

So the equation becomes:

$$\frac{1}{12} = (n-1) \cdot \frac{1}{6}$$

Solving for n:

$$(n-1) = \frac{1}{12} \cdot 6 = \frac{6}{12} = \frac{1}{2}$$

$$n = \frac{1}{2} + 1 = \frac{3}{2} = 1.5$$

Thus, the refractive index of the glass is \(n = 1.5)

OR

A convex lens has 20 cm focal length in air. What is focal leneth in water? (Refractive index of air-water $= 1.33$, refractive index for air-glass $= 1.5$)

Solution:

To determine the focal length of a convex lens in water, we use the relationship between the refractive indices and the focal lengths in different media. The formula relating the focal length in air (f_{air}) to the focal length in water (f_{water}) is given by:

$$\frac{f_{\text{water}}}{f_{\text{air}}} = \frac{\left(\frac{n_{\text{glass}}}{n_{\text{water}}} - 1\right)}{\left(\frac{n_{\text{glass}}}{n_{\text{air}}} - 1\right)}$$

Given:
- Focal length in air, $f_{\text{air}} = 20\,\text{cm}$
- Refractive index of air, $n_{\text{air}} = 1$
- Refractive index of water, $n_{\text{water}} = 1.33$
- Refractive index of glass, $n_{\text{glass}} = 1.5$

Let's calculate the focal length in water (f_{water}).

First, calculate the ratios of the refractive indices:

$$\frac{n_{\text{glass}}}{n_{\text{water}}} = \frac{1.5}{1.33}$$

$$\frac{n_{\text{glass}}}{n_{\text{air}}} = \frac{1.5}{1} = 1.5$$

Now, use these ratios in the formula:

$$\frac{f_{\text{water}}}{20} = \frac{\left(\frac{1.5}{1.33} - 1\right)}{(1.5 - 1)}$$

Simplify the fraction inside the parentheses:

$$\frac{1.5}{1.33} \approx 1.1278$$

$$1.1278 - 1 \approx 0.1278$$

So the equation becomes:

$$\frac{f_{\text{water}}}{20} = \frac{0.1278}{0.5}$$

$$f_{\text{water}} = 20 \times \frac{0.1278}{0.5} = 20 \times 0.2556 = 5.112\,\text{cm}$$

Thus, the focal length of the convex lens in water is approximately \(5.112 \, \text{

14. Derive an expression for the Coulomb's law of electrostatic by Gauss law.

Solution:

To derive Coulomb's Law from Gauss's Law, we can apply Gauss's Law to a point charge and consider the electric field it creates.

Gauss's Law
Gauss's Law states that the total electric flux through a closed surface is proportional to the charge enclosed within that surface. Mathematically, it is expressed as:

$$\oint_S \mathbf{E} \cdot d\mathbf{A} = \frac{Q_{\text{enc}}}{\epsilon_0}$$

where:
- $\oint_S \mathbf{E} \cdot d\mathbf{A}$ is the electric flux through a closed surface S,
- Q_{enc} is the charge enclosed within the surface,
- ϵ_0 is the permittivity of free space.

Applying Gauss's Law to a Point Charge

Consider a point charge Q located at the center of a spherical Gaussian surface of radius r. By symmetry, the electric field $\mathbf{E}$ due to a point charge is radial and has the same magnitude at every point on the surface of the sphere. The surface area $d\mathbf{A}$ is also radial. Therefore, the dot product $\mathbf{E} \cdot d\mathbf{A}$ simplifies to $E \cdot dA$.

The total electric flux through the spherical surface is:

$$\oint_S \mathbf{E} \cdot d\mathbf{A} = E \oint_S dA$$

The surface area of a sphere is $4\pi r^2$, so:

$$\oint_S dA = 4\pi r^2$$

Thus, Gauss's Law becomes:

$$E \cdot 4\pi r^2 = \frac{Q}{\epsilon_0}$$

Solving for the electric field E:

$$E = \frac{Q}{4\pi\epsilon_0 r^2}$$

coulomb's Law

Coulomb's Law states that the magnitude of the electrostatic force F between two point charges Q_1 and Q_2 separated by a distance r is given by:

$$F = k_e \frac{Q_1 Q_2}{r^2}$$

where k_e is Coulomb's constant. We know that $k_e = \frac{1}{4\pi\epsilon_0}$, thus:

$$E = \frac{Q}{4\pi\epsilon_0 r^2} = k_e \frac{Q}{r^2}$$

Therefore, the electric field due to a point charge Q is:

$$\mathbf{E} = k_e \frac{Q}{r^2} \hat{r}$$

where $\hat{r}$ is the unit vector in the radial direction. This directly leads to Coulomb's Law for the force between two point charges:

$$\mathbf{F} = Q_1 \mathbf{E} = Q_1 k_e \frac{Q_2}{r^2} \hat{r} = k_e \frac{Q_1 Q_2}{r^2} \hat{r}$$

This derivation uses Gauss's Law to establish the electric field due to a point charge and shows how this field relates to Coulomb's Law.

OR

What is Capacity of a conductor ? Write the factor affecting the capacity of a conductor.

Solution:

Capacity of a Conductor

The capacity of a conductor, commonly referred to as its capacitance, is a measure of its ability to store electric charge. Capacitance is defined as the amount of charge stored per unit voltage across the conductor. It is denoted by C and measured in farads (F). The capacitance C of a conductor is given by the formula:

$$C = \frac{Q}{V}$$

where:
- Q is the charge stored on the conductor,
- V is the potential difference (voltage) across the conductor.

Factors Affecting the Capacitance of a Conductor

1. Geometry of the Conductor
   - Shape and Size: The capacitance of a conductor is directly proportional to its surface area. A larger surface area allows the conductor to store more charge, thereby increasing its capacitance.
   - Distance Between Conductors In the case of a capacitor, which consists of two conductors separated by an insulating material, the capacitance is inversely proportional to the distance between the conductors. Closer conductors result in higher capacitance because the electric field strength is higher.

2. Dielectric Material:
   - The type of dielectric material (the insulating material placed between the conductors in a capacitor) significantly affects the capacitance. Different materials have different dielectric constants (κ). A higher dielectric constant increases the capacitance as it allows the conductor to store more charge for a given voltage.

3. Dielectric Thickness
   - For capacitors, the thickness of the dielectric material also affects the capacitance. Thinner dielectric layers result in higher capacitance, as the electric field is stronger and the potential difference required to store a certain amount of charge is lower.

4. Environmental Factors:
   Temperature: Changes in temperature can affect the dielectric properties of materials and thus influence capacitance. Typically, higher temperatures can decrease the dielectric strength.
   - Humidity and External Conditions: External environmental factors such as humidity can also affect the dielectric properties of the air or other surrounding mediums, thus altering capacitance.

Understanding these factors is crucial for designing electrical and electronic systems, especially where precise control over capacitance is required for functionality, such as in tuning circuits, filters, and energy storage devices.

15. Write any three differences between electromotive force and potential difference.

Solution:

- **Source vs. Consumption**:

- **Electromotive Force (emf)**: Defined as the energy supplied by a source per unit charge. It is essentially the voltage generated by a power source like a battery or generator.
- **Potential Difference**: Defined as the energy difference required to move a charge between two points in a circuit. It measures the work done per unit charge in moving the charge between two points against an electric field.

- **Dependency**:

- **Electromotive Force (emf)**: Independent of the circuit elements and depends solely on the characteristics of the source itself.
- **Potential Difference**: Dependent on the path taken by the charge and the circuit elements such as resistors, capacitors, and inductors through which the charge moves.

- **Circuit Role**:

- **Electromotive Force (emf)**: Causes current to flow in a circuit and is not consumed by components; rather, it provides the energy that drives the circuit.
- **Potential Difference**: Typically results from the consumption of energy by circuit elements; it reflects how much energy per unit charge is used by components within the circuit.

OR

Write any three differences between Resistance and Specific Resistance.

Solution:

- **Definition**:

- **Resistance**: Resistance is a measure of how much a specific object or component opposes the flow of electric current. It depends on the material, length, and cross-sectional area of the conductor. Resistance is denoted by RRR and is measured in ohms (Ω
- **Specific Resistance (Resistivity)**: Resistivity is an intrinsic property of a material that quantifies how strongly the material itself opposes the flow of electric current. It is independent of the shape and size of the material. Resistivity is denoted by ρ and is measured in ohm-meters $(\Omega \cdot m)$.

- **Dependence on Dimensions**:

- **Resistance**: Resistance depends on the dimensions of the conductor. It varies directly with the length (L) of the conductor and inversely with its cross-sectional area (A). The relationship is given by R=ρLA
- **Specific Resistance (Resistivity)**: Resistivity does not depend on the dimensions of the conductor. It is a material-specific property and remains constant for a given material under specified conditions, typically temperature.

- **Applications and Use**:

- **Resistance**: Resistance is used to describe how much a particular component (like a resistor) opposes the flow of electric current in a circuit. It is a practical, measurable value used in circuit design and analysis.
- **Specific Resistance (Resistivity)**: Resistivity is used to compare different materials in terms of their ability to conduct electricity. It helps in selecting appropriate materials for various electrical applications based on their conductive or resistive properties. Resistivity is fundamental in material science and engineering to understand and predict the behavior of materials under different conditions.

16. Compare the resistance of 100 watt and 400 watt of two bulbs if their voltage is same.

Solution:

To compare the resistance of two bulbs rated at 100 watts and 400 watts operating at the same voltage, we can use the formula that relates power (P), voltage (V), and resistance (R):

$$P = \frac{V^2}{R}$$

Rearranging this formula to solve for resistance, we get:

$$R = \frac{V^2}{P}$$

Let's denote the resistances of the 100-watt and 400-watt bulbs as R_{100} and R_{400}, respectively. Given that the voltage (V) is the same for both bulbs, we have:

$$R_{100} = \frac{V^2}{100}$$

$$R_{400} = \frac{V^2}{400}$$

To find the ratio of these resistances, we can divide R_{100} by R_{400}:

$$\frac{R_{100}}{R_{400}} = \frac{\frac{V^2}{100}}{\frac{V^2}{400}} = \frac{400}{100} = 4$$

Thus, the resistance of the 100-watt bulb is four times greater than the resistance of the 400-watt bulb.

Summary
- Resistance of 100-watt bulb: $R_{100} = \frac{V^2}{100}$
- Resistance of 400-watt bulb: $R_{400} = \frac{V^2}{400}$
- Ratio of resistances: $\frac{R_{100}}{R_{400}} = 4$

Therefore, $R_{100} = 4 \times R_{400}$.

OR

What will be the resistance of al wire if the cin length change to half of their original length and cross sectional area change two times of original.

Solution:

To determine the new resistance of an aluminum wire when its length is halved and its cross-sectional area is doubled, we use the formula for resistance:

$$R = \rho \frac{L}{A}$$

where:
- R is the resistance,
- ρ is the resistivity of the material,
- L is the length of the conductor,
- A is the cross-sectional area.

Let R_0, L_0, and A_0 be the original resistance, length, and cross-sectional area of the wire, respectively. The new length L' is $\frac{1}{2}L_0$ and the new area A' is $2A_0$.

The new resistance R' can be calculated using the new dimensions:

$$R' = \rho\frac{L'}{A'}$$

Substitute the new length and area into the equation:

$$R' = \rho\frac{\frac{1}{2}L_0}{2A_0}$$

$$R' = \rho\frac{L_0}{4A_0}$$

The original resistance R_0 is:

$$R_0 = \rho\frac{L_0}{A_0}$$

To find the ratio of the new resistance to the original resistance:

$$\frac{R'}{R_0} = \frac{\rho\frac{L_0}{4A_0}}{\rho\frac{L_0}{A_0}} = \frac{1}{4}$$

Thus, the new resistance R' is one quarter of the original resistance. This means that if the length of the aluminum wire is halved and its cross-sectional area is doubled, its resistance will be reduced to one quarter of its original value.

17. Write the differences between intrinsic semiconductor and extrinsic semi conductor,

Solution:

- **Purity and Composition**:
  - **Intrinsic Semiconductors**: These are pure forms of semiconductor materials without any significant impurities. Silicon (Si) and Germanium (Ge) in their pure form are common examples. The electrical conductivity in intrinsic semiconductors is solely due to the charge carriers generated by thermal energy, meaning electrons are excited from the valence band to the conduction band, leaving behind holes.
  - **Extrinsic Semiconductors**: These are semiconductors that have been intentionally doped with impurities to alter their electrical properties. The impurities added are typically of two types, resulting in either p-type or n-type semiconductors. In p-type, trivalent impurities are added, creating more holes as majority carriers, whereas in n-type, pentavalent impurities are added, creating more free electrons as majority carriers.
- **Electrical Conductivity**:
  - **Intrinsic Semiconductors**: They have lower electrical conductivity under normal conditions, as it is highly temperature-dependent. The number of charge carriers (both electrons and holes) is relatively low because it relies on the thermal generation of carriers.
  - **Extrinsic Semiconductors**: These have much higher electrical conductivity than intrinsic semiconductors because the addition of impurities introduces additional charge carriers that facilitate

current flow. The conductivity is less sensitive to temperature changes compared to intrinsic semiconductors.

- **Charge Carriers**:

  - **Intrinsic Semiconductors**: The charge carriers are electrons and holes generated through the excitation of electrons from the valence band to the conduction band due to thermal energy. The number of electrons and holes are equal, making them equally contribute to conductivity.
  - **Extrinsic Semiconductors**: The type and concentration of impurities determine the majority charge carriers. In n-type semiconductors, electrons are the majority carriers, whereas in p-type semiconductors, holes are the majority carriers. This imbalance greatly enhances their conductivity and allows for the creation of p-n junctions, which are crucial in modern electronics.

- **Applications**:

  - **Intrinsic Semiconductors**: They are less commonly used directly in applications due to their lower and unstable conductivity. They are mostly used in pure form for research and specific applications where very controlled semiconductor properties are necessary.
  - **Extrinsic Semiconductors**: These are extensively used in the manufacturing of electronic devices such as diodes, transistors, solar cells, and integrated circuits. The ability to control the type and amount of impurities allows engineers to precisely control the electrical properties of the semiconductor.

OR

What is P-N function diode ? Describe its use as a full wave rectifier with dagram.

Solution:

A P-N junction diode is a semiconductor device that consists of a p-type semiconductor and an n-type semiconductor joined together, creating a junction. This junction forms a depletion region where charge carriers (holes and electrons) recombine, creating an electric field that acts as a barrier to the movement of charge carriers.

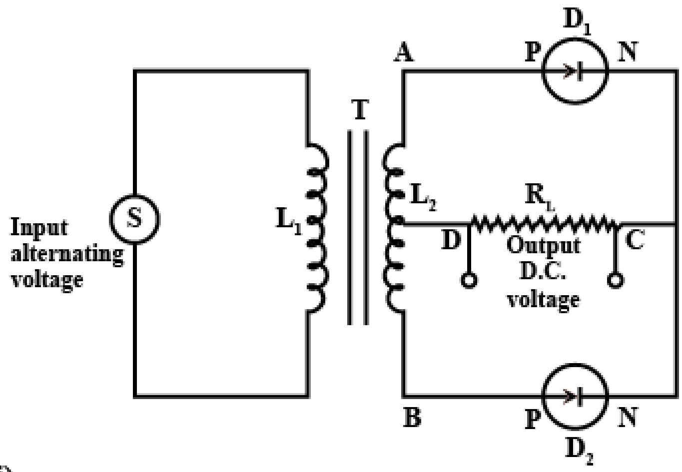
Function of a P-N Junction Diode:

- When forward-biased (positive voltage applied to the p-side and negative to the n-side), the depletion region narrows, allowing current to flow through the diode.
- When reverse-biased (positive voltage applied to the n-side and negative to the p-side), the depletion region widens, preventing current flow.

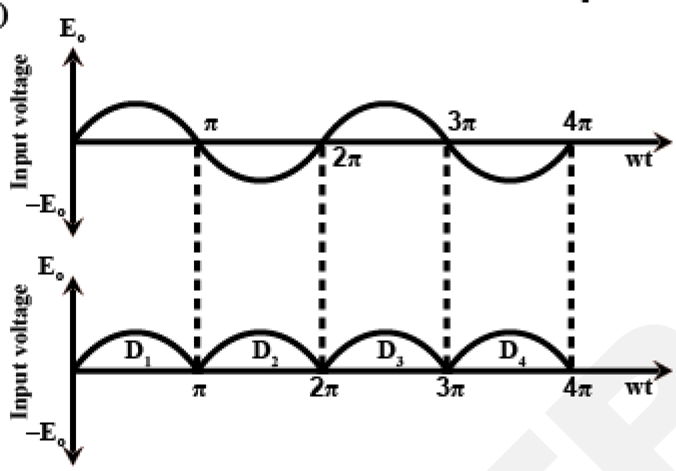
Use of P-N Junction Diode as a Full Wave Rectifier

A full wave rectifier converts an alternating current (AC) input signal into a direct current (DC) output signal. This is achieved by using two diodes in a center-tapped transformer configuration or four diodes in a bridge configuration.

(i)



(iii)



18. "what is Self inductance ? We rise an expression for the self inductance of solenoid. Also write the factor affectme it

Solution:

Self-inductance is the property of a coil (or solenoid) that enables it to induce an electromotive force (emf) in itself when the current flowing through it changes. It is a measure of how effectively a coil can induce an emf due to its own changing current.

The self-inductance L of a solenoid can be derived as follows:

1. Expression for Magnetic Field Inside a Solenoid:
   The magnetic field B inside a long solenoid is given by:

$$B = \mu_0 n I$$

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

2. Flux Linkage:
The magnetic flux Φ through a single loop of the solenoid is:

$$\Phi = B \cdot A = \mu_0 n I \cdot A$$

where A is the cross-sectional area of the solenoid.

For a solenoid with N turns, the total flux linkage λ is:

$$\lambda = N \cdot \Phi = N \cdot \mu_0 n I \cdot A$$

3. Self-Inductance:
The self-inductance L is defined as the ratio of the total flux linkage to the current:

$$L = \frac{\lambda}{I} = \frac{N \cdot \mu_0 n I \cdot A}{I} = \mu_0 n N A$$

For a solenoid of length l, the number of turns per unit length n is $\frac{N}{l}$. Therefore:

$$L = \mu_0 \left(\frac{N}{l}\right) N A = \mu_0 \frac{N^2 A}{l}$$

Factors Affecting Self-Inductance:
1. Number of Turns (N): Self-inductance is directly proportional to the square of the number of turns in the solenoid.
2. Cross-sectional Area (A): Self-inductance is directly proportional to the cross-sectional area of the solenoid.
3. Length of the Solenoid (l): Self-inductance is inversely proportional to the length of the solenoid.
4. Permeability of the Core (μ): Self-inductance is directly proportional to the permeability of the material inside the solenoid (for a core with permeability μ, replace μ_0 with μ).

OR

What is Transformer? Describe its principle and different types of energy losses in it.

Solution:

A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Transformers are used to increase (step up) or decrease (step down) voltages and currents in an AC (alternating current) electrical circuit. They are essential components in the transmission and distribution of electric power.

Principle of Operation

The basic principle of a transformer is based on Faraday's Law of Electromagnetic Induction, which states that a change in the magnetic flux through a coil induces a voltage across the coil. A transformer consists of two or more coils wound on a common core. When an alternating current flows through one of the coils, known as the primary coil, it creates a changing magnetic field around the coil. This changing magnetic field induces a changing magnetic flux in the core, which then induces a voltage in the other coil(s), called the secondary coil(s).

Types of Energy Losses in Transformers

Transformers are highly efficient, but they do experience some energy losses, which can be categorized as follows:

1. **Core Losses (or Iron Losses)**:
   - **Hysteresis Loss**: Occurs due to the resistance of the core material to changes in magnetization. Each time the magnetic field reverses (with each cycle of the AC), a small amount of energy is lost due to the molecular friction of realigning the magnetic domains.
   - **Eddy Current Loss**: Caused by circulating currents produced within the core due to the alternating magnetic field. These currents generate heat within the core material.
2. **Copper Losses (or Winding Losses)**:
   - These losses occur due to the ohmic resistance of the wires used in the windings. As electrical current flows through the primary and secondary windings, heat is produced in the resistance of the wires, leading to energy loss.
3. **Stray Losses**:
   - Stray losses are caused by stray flux that leaks from the core and induces currents in nearby metallic parts of the transformer, such as the tank, clamps, or other structural components.
4. **Dielectric Losses**:
   - These losses occur in the insulation materials of the transformer due to the heat produced when the insulating material is subjected to an electric field.
5. **Cooling and Other Mechanical Losses**:
   - Includes losses due to the energy used in cooling systems (like oil pumps and fans) and mechanical vibrations.

19. Derive an expression for the refractive index of glass prism

$$\mu=\frac{\sin\left(\frac{1+\sin}{2}\right)}{\sin 1/2}$$

Solution:

To derive the expression for the refractive index μ of a glass prism, we need to consider the geometry and principles of light refraction through the prism. Here's a detailed step-by-step derivation:

Geometry of the Prism:

Consider a glass prism with apex angle A. When a light ray enters the prism, it bends towards the normal due to the higher refractive index of the prism material compared to air. Snell's Law at the First Interface:

When the light enters the prism, Snell's law can be applied:

$$n_1 \sin i_1 = n_2 \sin r_1$$

Here, n_1 is the refractive index of air (approximately 1), i_1 is the angle of incidence, n_2 is the refractive index of the prism (μ), and r_1 is the angle of refraction inside the prism.

Therefore, we have:

$$\sin i_1 = \mu \sin r_1$$

Path of Light Inside the Prism:

Inside the prism, the light ray travels and reaches the second interface. The angle of incidence at the second interface is r_2. The sum of the angles inside the prism must equal the apex angle A of the prism:

$$r_1 + r_2 = A$$

Snell's Law at the Second Interface:

At the second interface, the light exits the prism and bends away from the normal. Applying Snell's law again:

$$\mu \sin r_2 = \sin i_2$$

Here, r_2 is the angle of incidence inside the prism at the second interface, and i_2 is the angle of refraction in air.

Minimum Deviation Condition:

For the minimum deviation D_m, the angles of incidence and emergence are equal ($i_1 = i_2$). Additionally, the light path is symmetrical, so $r_1 = r_2$.

Therefore:

$$r_1 = r_2 = \frac{A}{2}$$

Calculating Minimum Deviation:

The angle of minimum deviation D_m is given by:

$$D_m = 2i - A$$

Expression for Refractive Index:
Combining the above equations, we can express the refractive index μ in terms of the angles A and D_m. From Snell's law and the symmetrical path:

$$\sin i = \mu \sin\left(\frac{A}{2}\right)$$

Since at minimum deviation, $i_1 = i_2 = i$:

$$i = \frac{A + D_m}{2}$$

Substituting this into Snell's law:

$$\sin\left(\frac{A + D_m}{2}\right) = \mu \sin\left(\frac{A}{2}\right)$$

Final Expression:
Solving for μ, we get:

$$\mu = \frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

This is the expression for the refractive index of a glass prism in terms of its apex angle A and the angle of minimum deviation D_m.

OR

Derive lens maker formula for thin lens.

$$\frac{\mu}{v_1} - \frac{1}{u} = \frac{\mu - 1}{R_1}$$

Solution:

Derivation of Lens Maker's Formula for a Thin Lens

To derive the Lens Maker's Formula for a thin lens, we will consider a lens made of a material with refractive index μ surrounded by air (refractive index 1). The lens has two spherical surfaces with radii of curvature R_1 and R_2.

Refraction at the First Surface
Consider a point object O placed on the principal axis of the lens. Light from O refracts at the first surface of the lens (radius of curvature R_1). Let P be the point where the refracted ray intersects the principal axis after refraction through the first surface.

Using the refraction formula at a spherical surface:

$$\frac{\mu}{v_1} - \frac{1}{u} = \frac{\mu - 1}{R_1}$$

Here, u is the object distance, and v_1 is the image distance after refraction at the first surface.

Refraction at the Second Surface
The image formed by the first surface acts as the virtual object for the second surface. Let Q be the final image point after refraction through the second surface (radius of curvature R_2).

Using the refraction formula at the second spherical surface:

$$\frac{1}{v} - \frac{\mu}{v_1} = \frac{1 - \mu}{R_2}$$

Here, v is the final image distance after refraction through the second surface.

{Combining the Two Equations}
Substitute $\frac{\mu}{v_1}$ from the first equation into the second equation:

$$\frac{1}{v} - \left(\frac{1}{u} + \frac{\mu - 1}{R_1}\right) = \frac{1 - \mu}{R_2}$$

Rearrange the terms:

$$\frac{1}{v} = \frac{1}{u} + \frac{\mu - 1}{R_1} + \frac{1 - \mu}{R_2}$$

{Lens Maker's Formula}
For a lens, the focal length f is related to the object and image distances by the lens formula:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Substitute the combined equation into the lens formula:

$$\frac{1}{f} = \left(\frac{1}{u} + \frac{\mu - 1}{R_1} + \frac{1 - \mu}{R_2}\right) - \frac{1}{u}$$

Simplify the equation:

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

{Final Expression}
Therefore, the Lens Maker's Formula for a thin lens is:

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

MP Board Class 12 Physics Question with Solution - 2022

1. Select and write the correct option from the options given in each question :

(a) Bhabha Atomic Research Centre is situated in -

(i) New Delhi

(ii) Mumbai

(iii) Kotkata

(iv) Bangalor

Solution:

Bhabha Atomic Research Centre, a premier nuclear research facility, is situated in Mumbai, India.

Hence, the answer is option (ii).

(b) Forbidden energy gap for Germanium semi conductor is -

(i) 1.1 eV

(ii) 1.9 eV

(iii) 0.72 eV

(iv) 0.75 eV

Solution:

The forbidden energy gap for Germanium semiconductor is approximately 0.72 eV.

Hence, the answer is option (iii)

(c) Which device is used as a rectifier?

(i) Junction diode

(ii) Transformer

(iii) Zener diode

(iv) Photo diode

Solution:

A junction diode is used to rectify AC to DC, acting as a rectifier.

Hence, the answer is option (i)

(d) The focal length of eye piece in telescope______ the focal length of the objective.

(i) is less than

(ii) is more than

(iii) is equal

(iv) none of these

Solution:

The eyepiece focal length is shorter than the objective to achieve higher magnification in telescopes.

Hence, the answer is option (i)

(e) The mass of a Neutron is -

(i) 1.67×10^{-31} kg

(ii) 1.67×10^{-27} kg

(iii) 1.67×10^{-9} kg

(iv) 1.67×10^{-23} kg

Solution:
The mass of a neutron is approximately 1.67 \times 10^{-27}

Hence, the answer is option (ii)

(f) S.I. unit of current density is - ,

(i) Coluomb / meter

(ii) Ampere / **meter** ^{2}

(iii) Coluomb / **meter** ^{2}

(iv) Ampere / **meter**

Solution:

The SI unit of current density is Ampere per square meter

Hence, the answer is option (ii)

(g) The phase difference between flowing current and applied voltage in alternating circuit containing pure capacitor is -

(i) 0

(ii) 1

(iii) $\pi/2$

(iv) $-\pi/2$

Solution:
In a pure capacitor, the voltage lags the current by radians in an AC circuit}.

Hence, the answer is option (iv)

2. Fill in the blanks and write

(i) The frequency of a Direct Current is _______

(ii) Electromagnetic wave of highest frequenes is . _______

(iii) The frequency of the light wave is order of _______ .

(iv)The velocity of light _______ when it goes to rare medium to denser.

(v) Magnetic field is a _______ quantits.

(vi) The _______ of the galvanometer is reduced by the use of shunt.

(vii) The ohmic resistance of an ideal inductance is _______ .

Solution:

(i) The frequency of a Direct Current is zerozero

(ii) Electromagnetic wave of highest frequency is γ rays.

(iii) The frequency of the light wave is order of 10^14 to 10^15 Hz

(iv) The velocity of light decreases when it goes from a rare medium to a denser medium.

(v) Magnetic field is a vector quantity.

(vi) Thesensitivity of the galvanometer is reduced by the use of shunt.

(vii) The ohmic resistance of an ideal inductance is zero.

3. Write True or False :

(i) In an intrinsic semiconductor the number of free electron is equal to the number of holes.

(ii) Voltmeter is more superior to potentiometer.

(iii) De-broglic waves are an clectromagnetic wave.

(iv) Atom is a positive particle.

(v) The average power supplied to an inductor over one complete cycle is zero.

(vi) Working of microwave oven is based on Radio wave.

(vii) Infrared radiation is invented by scientist Retar.

Solution:

(i) In an intrinsic semiconductor the number of free electrons is equal to the number of holes.
True
Explanation: In intrinsic semiconductors, electrons and holes are created in pairs.

(ii) Voltmeter is more superior to potentiometer.
False
Explanation: Potentiometers are more accurate for measuring voltage as they don't draw current from the circuit.

(iii) De Broglie waves are an electromagnetic wave.
False
Explanation: De Broglie waves are matter waves, not electromagnetic.

(iv) Atom is a positive particle.
False
Explanation: Atoms are neutral overall, containing both positive protons and negative electrons.

(v) The average power supplied to an inductor over one complete cycle is zero.
True
Explanation: In ideal inductors, the energy is stored and returned, resulting in zero average power.

(vi) Working of microwave oven is based on Radio wave.
False
Explanation: Microwave ovens use microwaves, which are higher frequency than radio waves.

(vii) Infrared radiation is invented by scientist Retar.
False
Explanation: Infrared radiation was discovered by William Herschel.

4. Write ammet of cach question in one sentence

(i) What is diffraction?

(ii) What is the umit wh power at lens?

(iii) What is the magnetic dipole moment of magnet

(iv) How galvanomter is changed in a votmeter

(v) What is the effect of temperature in drift velocity

(vi) Give relation between energy and freqeuncy of a radiation

(vii) What is threshold frequency?

Solution:

(i) Diffraction is the bending of waves around obstacles and the spreading of waves past small openings.

(ii) The unit of power of a lens is diopter (D).

(iii) The magnetic dipole moment of a magnet is a measure of the strength and direction of its magnetic field.

(iv) A galvanometer is changed into a voltmeter by connecting a high resistance in series with it.

(v) The drift velocity decreases as temperature increases due to increased collisions between electrons and atoms.

(vi) The energy (E) of a radiation is directly proportional to its frequency (f), given by E=hf, where hhh is Planck's constant.

(vii) Threshold frequency is the minimum frequency of light required to eject electrons from a metal surface in the photoelectric effect.

5. Write Biort-savart expansion in vector form.

Solution:

The Biot-Savart law in vector form is used to determine the magnetic field B\mathbf{B}B generated by a steady current. The law states that the magnetic field at a point in space due to a small segment of current-carrying wire is proportional to the current, the length of the segment, and the sine of the angle between the segment and the line connecting the segment to the point. Mathematically, it is expressed as:

$$d\mathbf{B} = \frac{\mu_0}{4\pi} \frac{I\, d\mathbf{l} \times \mathbf{r}}{r^3}$$

OR

Why there is no end point of magnetic field lines.

Solution:

Magnetic field lines have no end points because magnetic monopoles (isolated north or south poles) do not exist. Magnetic field lines form continuous loops that start from the north pole and end at the south pole, continuing through the magnet and looping back to the north pole. This property reflects the fundamental nature of magnetic fields, where every north pole is paired with a south pole, ensuring the field lines always form closed loops.

6. A light bulb is rated at 200 W for a 220 V supply. Find the resistance of the bulb.

Solution:

To find the resistance R of the light bulb, we use the formula:

$$P = \frac{V^2}{R}$$

Rearranging to solve for R:

$$R = \frac{V^2}{P}$$

Substituting the given values:

$$R = \frac{220^2}{200}$$

$$R = \frac{48400}{200}$$

$$R = 242\,\Omega$$

Therefore, the resistance of the bulb is:

$$R = 242\,\Omega$$

OR

A light bulb is related at 200 W for a 220 V supply. lind the rms current through the bulb.

Solution:

$$P = V \times I$$

$$I = \frac{P}{V}$$

$$I = \frac{200\text{ W}}{220\text{ V}}$$

$$I \approx 0.909\text{ A}$$

7. What is Conjugate focus?

Solution:

Conjugate focus in optics refers to the relationship between two points, specifically the object point and the image point, where the rays emanating from one point are precisely focused at the other point. In simpler terms, if light rays leave one point, they are brought into focus at the conjugate point after passing through an optical system, like a lens or mirror.

In a typical optical setup, there are two primary conjugate foci:

1. **Object Focus**: This is where the object is placed so that its image is well-focused at a desired location. This point is usually at a certain distance from the optical element.
2. **Image Focus**: This is where the image of the object forms after light rays have interacted with the optical system. The position of the image depends on the characteristics of the optical system and the position of the object.

The concept of conjugate foci is critical in designing optical instruments, such as microscopes, telescopes, and cameras, ensuring that the object being observed or imaged is in clear focus.

OR

Write any two difference between refractive telescope and retractive reflective telescope.

Solution:

- **Optical Design**:
  - **Refractive telescopes** use lenses to bend (refract) light to form an image. The primary optical element in a refractor is a convex lens, which gathers light and focuses it to a point behind the lens.
  - **Reflective telescopes**, on the other hand, use mirrors to reflect light to form an image. The primary optical element in a reflector is a concave mirror that collects light and focuses it onto a secondary mirror, which then directs the image to the eyepiece.
- **Chromatic Aberration**:
  - **Refractive telescopes** are susceptible to chromatic aberration, where different colors of light do not come to the same focal point, resulting in a rainbow halo around images. This is due to the different wavelengths of light being refracted by different amounts.
  - **Reflective telescopes** largely eliminate chromatic aberration because mirrors reflect all wavelengths of light equally, so all colors focus at the same point. This makes them particularly useful for high-contrast astronomical observations.

8. What is Photoelectric effect? Write IEinstein photoelectric equation

Solution:

The photoelectric effect is a phenomenon in which electrons are emitted from the surface of a material, typically a metal, when it is exposed to light of sufficient frequency. This effect was first observed by Heinrich Hertz in 1887 and later explained by Albert Einstein in 1905, for which he received the Nobel Prize in Physics in 1921.

Einstein's explanation was revolutionary because it supported the quantum theory of light by suggesting that light could be thought of as consisting of discrete packets of energy, called photons, rather than just waves. The energy of these photons is directly proportional to the frequency of the light.

Einstein’s photoelectric equation describes how the energy of the photons that strike the metal is used to free electrons from the surface. The equation is:

$$E = h\nu = \phi + KE$$

Where:
- E is the energy of the photon.
- h is Planck's constant (6.626×10^{-34} Joule seconds).
- ν (or f in some texts) is the frequency of the incident light.
- ϕ is the work function of the metal, which is the minimum energy needed to remove an electron from the surface.
- KE is the kinetic energy of the emitted electron.

According to this equation, the energy of the incoming photon must be greater than the work function of the metal for electrons to be emitted. Any excess energy appears as the kinetic energy of the emitted electrons.

OR

What is de-broglie matter wave Write de-broglie wave relation

Solution:

The concept of de Broglie matter waves, also known as the de Broglie hypothesis, is a fundamental principle in quantum mechanics proposed by the French physicist Louis de Broglie in 1924. De Broglie suggested that particles of matter, such as electrons or protons, can exhibit wave-like properties under certain conditions. This hypothesis was revolutionary because it extended the wave-particle duality concept, previously observed only in light (photons), to all particles of matter.

The de Broglie hypothesis forms the basis for the theory of wave mechanics, which treats particles as waves that have a wavelength associated with their motion. This wavelength is not a property of the particle alone but results from its momentum, reflecting the particle's wave-like behavior.

De Broglie's wavelength equation (the de Broglie wavelength relation) expresses the wavelength associated with a particle. The equation is given as:

$$\lambda = \frac{h}{p}$$

Where:
- λ is the wavelength of the particle,
- h is Planck's constant (6.626×10^{-34} Joule seconds),
- p is the momentum of the particle.

This relationship implies that every moving particle or object has an associated wavelength, but the effect is significant only for particles at the atomic or subatomic level, where their wave-like properties become observable.

9. Write any two Postulate of Bohr's model.

Solution:

Niels Bohr proposed his model of the hydrogen atom in 1913, which incorporated quantum theory to explain the stability of the atom and the emission spectrum of hydrogen. Among the several postulates that formed the basis of his model, two are particularly significant:

1. Quantized Orbits Bohr postulated that electrons in an atom move in certain fixed orbits known as "stationary orbits" without the emission of radiant energy, contrary to the laws of classical mechanics and electrodynamics. These orbits are quantized, meaning that only certain allowed circular orbits with specific quantized angular momenta are permissible for the electron. The angular momentum L of an electron in a stationary orbit is quantized and given by the equation:

$$L = n\frac{h}{2\pi}$$

where n is the principal quantum number (an integer), and h is Planck's constant.

2. Energy Quantization: When an electron transitions between these quantized orbits, the atom either absorbs or emits energy in discrete amounts, called quanta. The energy difference between the initial and final orbit of the electron is emitted or absorbed as electromagnetic radiation of frequency ν, given by the relation:

$$\Delta E = h\nu$$

where ΔE is the difference in energy between two energy levels, and h is Planck's constant.

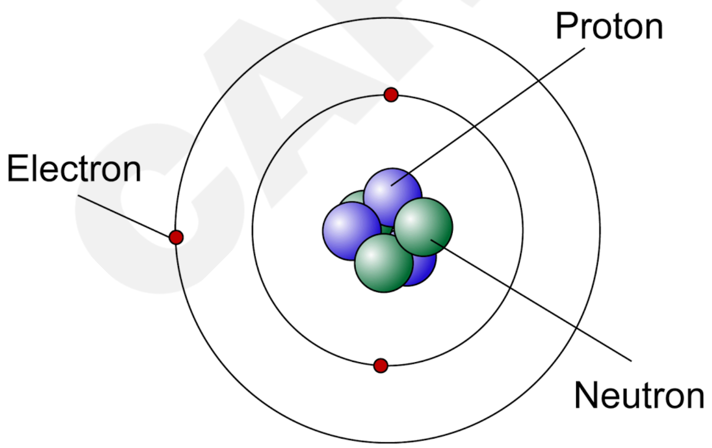
These postulates addressed several unexplained phenomena and significantly advanced the understanding of atomic structure and quantum mechanics.

OR

Who discovered the nucleus model of atom ? Draw its diagram

Solution:

The nucleus model of the atom was discovered by Ernest Rutherford in 1911. He proposed this model based on observations from his gold foil experiment, which showed that atoms have a small, dense, positively charged nucleus at their center. This experiment was a pivotal moment in the development of atomic physics, significantly altering the understanding of atomic structure at the time.



10. What is isotopes? Write any two isotopes of hydrogen atom.

Solution:

Isotopes are variants of a particular chemical element that have the same number of protons but different numbers of neutrons in their nuclei. This results in isotopes having the same atomic number but different mass numbers.

For hydrogen, the most common isotopes are:

1. **Protium (1^H)**: This is the most abundant isotope of hydrogen, consisting of only one proton and no neutrons.
2. **Deuterium (2^H, also denoted as D)**: This isotope of hydrogen has one proton and one neutron. It's used in various scientific applications, including nuclear fusion experiments.
3. **Tritium (3^H, also denoted as T)**: This rarer isotope has one proton and two neutrons and is radioactive. Tritium is used in research and in devices like self-lighting exit signs.

OR

What is Isobar? Give example.

Solution:

An isobar is a line on a map connecting points of equal atmospheric pressure. Isobars are used in meteorology to represent areas of constant pressure on weather maps. They help meteorologists understand and predict weather patterns by indicating areas of high and low pressure, as well as the strength and direction of winds.

Example:

On a weather map, isobars are typically drawn at intervals of 4 millibars (mb) or hectopascals (hPa). For instance, if there are areas with pressures of 1000 mb, 1004 mb, 1008 mb, etc., isobars would be drawn to connect points with these specific pressure values.

Illustration:

Imagine a weather map with the following pressure readings at various points:

- Point A: 1000 mb
- Point B: 1004 mb
- Point C: 1008 mb
- Point D: 1012 mb

The isobar at 1000 mb would connect all points with a pressure of 1000 mb. Similarly, isobars at 1004 mb, 1008 mb, and 1012 mb would connect points with those pressures, forming concentric lines around areas of low and high pressure.

11. What is a fundamental charge ? Write its value.

Solution:

The fundamental charge, often referred to as the \textbf{elementary charge}, is the electric charge carried by a single proton, or equivalently, the negative of the charge carried by a single electron. This charge is a fundamental constant in physics and is crucial for the structure of atomic particles.

The value of the elementary charge is:

$$e = 1.602176634 \times 10^{-19}\, tcoulombs$$

This value is considered a basic physical constant and plays a vital role in the electromagnetic interactions between particles.

OR

Where will an electron move in an electric field either high potential side or low potential side? and why?

Solution:

An electron will move toward the high potential side in an electric field. This direction can be understood by considering that an electric field points from a region of higher electric potential to a region of lower electric potential. Since the force on a charged particle in an electric field is given by the equation:

$$\vec{F} = q\vec{E}$$

where q is the charge of the particle and $\vec{E}$ is the electric field vector, the force on a negatively charged electron (where q is negative) will be in the direction opposite to $\vec{E}$. Thus, an electron moves toward higher potential because it moves opposite to the field direction, seeking to minimize its potential energy.

12. What is an electric cell? give example

Solution:

An electric cell is a device that converts chemical energy into electrical energy through an electrochemical reaction. It consists of two different metals (the electrodes) immersed in an electrolyte solution, which facilitates the flow of ions. The chemical reactions at the electrodes create a potential difference between them, allowing the cell to produce an electric current when connected in a circuit.

Example of an Electric Cell:

- **Dry Cell (Zinc-Carbon Battery)**: This is a common type of electric cell used in many portable electronic devices like flashlights and remote controls. The zinc container acts as the anode, the carbon rod in the center serves as the cathode, and the electrolyte is a moist paste of ammonium chloride mixed with manganese dioxide. The chemical reaction between these components produces electrical energy that powers devices.

OR

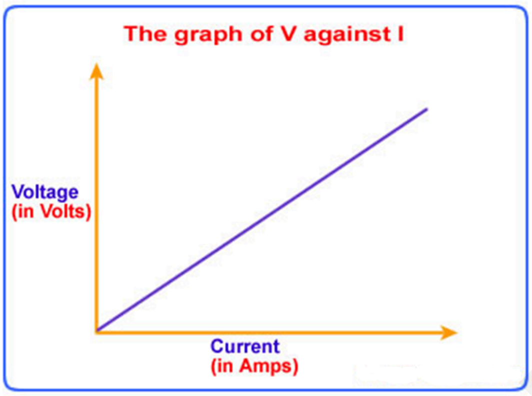
Write Ohms law and also draw praph between woltage and current

Solution:

Ohm's Law is a fundamental principle in the field of electrical engineering and physics. It states that the current flowing through a conductor between two points is directly proportional to the voltage across the two points, provided the temperature remains constant. Mathematically, Ohm's Law is expressed as:

V=IR

where:

- V is the voltage across the conductor (measured in volts, V),
- I is the current flowing through the conductor (measured in amperes, A),
- R is the resistance of the conductor (measured in ohms)
- 

13. The radii of curvatures of the focus of a double convex lens are 10 cm and 15 cm its focal length is 12 cm . What is the refractive index of glass. (refractive index of air $= 1$)

Solution:

To find the refractive index of glass for a double convex lens, we can use the lens maker's formula:

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

where:
- f is the focal length of the lens,
- n is the refractive index of the glass,
- R_1 and R_2 are the radii of curvature of the lens surfaces.

Given:
- $f = 12\,\text{cm}$,
- $R_1 = 10\,\text{cm}$,
- $R_2 = -15\,\text{cm}$ (since the second surface is concave relative to the incident light).

Substituting these values into the lens maker's formula:

$$\frac{1}{12}=(n-1)\left(\frac{1}{10}-\frac{1}{-15}\right)$$

Simplifying the terms inside the parentheses:

$$\frac{1}{10}-\frac{1}{-15}=\frac{1}{10}+\frac{1}{15}=\frac{3}{30}+\frac{2}{30}=\frac{5}{30}=\frac{1}{6}$$

So the equation becomes:

$$\frac{1}{12}=(n-1)\cdot\frac{1}{6}$$

Solving for n:

$$(n-1)=\frac{1}{12}\cdot 6=\frac{6}{12}=\frac{1}{2}$$

$$n=\frac{1}{2}+1=\frac{3}{2}=1.5$$

Thus, the refractive index of the glass is \(n = 1.5)

OR

A convex lens has 20 cm focal length in air. What is focal leneth in water? (Refractive index of air-water $=1.33$, refractive index for air-glass $=1.5$)

Solution:

To determine the focal length of a convex lens in water, we use the relationship between the refractive indices and the focal lengths in different media. The formula relating the focal length in air (f_{air}) to the focal length in water (f_{water}) is given by:

$$\frac{f_{\text{water}}}{f_{\text{air}}}=\frac{\left(\frac{n_{\text{glass}}}{n_{\text{water}}}-1\right)}{\left(\frac{n_{\text{glass}}}{n_{\text{air}}}-1\right)}$$

Given:
- Focal length in air, $f_{\text{air}}=20\,\text{cm}$
- Refractive index of air, $n_{\text{air}}=1$
- Refractive index of water, $n_{\text{water}}=1.33$
- Refractive index of glass, $n_{\text{glass}}=1.5$

Let's calculate the focal length in water (f_{water}).

First, calculate the ratios of the refractive indices:

$$\frac{n_{\text{glass}}}{n_{\text{water}}}=\frac{1.5}{1.33}$$

$$\frac{n_{\text{glass}}}{n_{\text{air}}} = \frac{1.5}{1} = 1.5$$

Now, use these ratios in the formula:

$$\frac{f_{\text{water}}}{20} = \frac{\left(\frac{1.5}{1.33} - 1\right)}{(1.5 - 1)}$$

Simplify the fraction inside the parentheses:

$$\frac{1.5}{1.33} \approx 1.1278$$

$$1.1278 - 1 \approx 0.1278$$

So the equation becomes:

$$\frac{f_{\text{water}}}{20} = \frac{0.1278}{0.5}$$

$$f_{\text{water}} = 20 \times \frac{0.1278}{0.5} = 20 \times 0.2556 = 5.112\,\text{cm}$$

Thus, the focal length of the convex lens in water is approximately \(5.112 \, \text{

14. Derive an expression for the Coulomb's law of electrostatic by Gauss law.

Solution:

To derive Coulomb's Law from Gauss's Law, we can apply Gauss's Law to a point charge and consider the electric field it creates.

Gauss's Law

Gauss's Law states that the total electric flux through a closed surface is proportional to the charge enclosed within that surface. Mathematically, it is expressed as:

$$\oint_S \mathbf{E} \cdot d\mathbf{A} = \frac{Q_{\text{enc}}}{\epsilon_0}$$

where:
- $\oint_S \mathbf{E} \cdot d\mathbf{A}$ is the electric flux through a closed surface S,
- Q_{enc} is the charge enclosed within the surface,
- ϵ_0 is the permittivity of free space.

Applying Gauss's Law to a Point Charge

Consider a point charge Q located at the center of a spherical Gaussian surface of radius r. By symmetry, the electric field $\mathbf{E}$ due to a point charge is radial and has the same magnitude at every point on the surface of the sphere. The surface area $d\mathbf{A}$ is also radial. Therefore, the dot product $\mathbf{E} \cdot d\mathbf{A}$ simplifies to $E \cdot dA$.

The total electric flux through the spherical surface is:

$$\oint_S \mathbf{E} \cdot d\mathbf{A} = E \oint_S dA$$

The surface area of a sphere is $4\pi r^2$, so:

$$\oint_S dA = 4\pi r^2$$

Thus, Gauss's Law becomes:

$$E \cdot 4\pi r^2 = \frac{Q}{\epsilon_0}$$

Solving for the electric field E:

$$E = \frac{Q}{4\pi\epsilon_0 r^2}$$

coulomb's Law

Coulomb's Law states that the magnitude of the electrostatic force F between two point charges Q_1 and Q_2 separated by a distance r is given by:

$$F = k_e \frac{Q_1 Q_2}{r^2}$$

where k_e is Coulomb's constant. We know that $k_e = \frac{1}{4\pi\epsilon_0}$, thus:

$$E = \frac{Q}{4\pi\epsilon_0 r^2} = k_e \frac{Q}{r^2}$$

Therefore, the electric field due to a point charge Q is:

$$\mathbf{E} = k_e \frac{Q}{r^2} \hat{r}$$

where $\hat{r}$ is the unit vector in the radial direction. This directly leads to Coulomb's Law for the force between two point charges:

$$\mathbf{F} = Q_1 \mathbf{E} = Q_1 k_e \frac{Q_2}{r^2} \hat{r} = k_e \frac{Q_1 Q_2}{r^2} \hat{r}$$

This derivation uses Gauss's Law to establish the electric field due to a point charge and shows how this field relates to Coulomb's Law.

OR

What is Capacity of a conductor ? Write the factor affecting the capacity of a conductor.

Solution:

Capacity of a Conductor

The capacity of a conductor, commonly referred to as its capacitance, is a measure of its ability to store electric charge. Capacitance is defined as the amount of charge stored per unit voltage across the conductor. It is denoted by C and measured in farads (F). The capacitance C of a conductor is given by the formula:

$$C = \frac{Q}{V}$$

where:
- Q is the charge stored on the conductor,
- V is the potential difference (voltage) across the conductor.

Factors Affecting the Capacitance of a Conductor

1. Geometry of the Conductor
   - Shape and Size: The capacitance of a conductor is directly proportional to its surface area. A larger surface area allows the conductor to store more charge, thereby increasing its capacitance.
   - Distance Between Conductors In the case of a capacitor, which consists of two conductors separated by an insulating material, the capacitance is inversely proportional to the distance between the conductors. Closer conductors result in higher capacitance because the electric field strength is higher.

2. Dielectric Material:
   - The type of dielectric material (the insulating material placed between the conductors in a capacitor) significantly affects the capacitance. Different materials have different dielectric constants (κ). A higher dielectric constant increases the capacitance as it allows the conductor to store more charge for a given voltage.

3. Dielectric Thickness
   - For capacitors, the thickness of the dielectric material also affects the capacitance. Thinner dielectric layers result in higher capacitance, as the electric field is stronger and the potential difference required to store a certain amount of charge is lower.

4. Environmental Factors:
   Temperature: Changes in temperature can affect the dielectric properties of materials and thus influence capacitance. Typically, higher temperatures can decrease the dielectric strength.
   - Humidity and External Conditions: External environmental factors such as humidity can also affect the dielectric properties of the air or other surrounding mediums, thus altering capacitance.

Understanding these factors is crucial for designing electrical and electronic systems, especially where precise control over capacitance is required for functionality, such as in tuning circuits, filters, and energy storage devices.

15. Write any three differences between electromotive force and potential difference.

Solution:

- **Source vs. Consumption**:

- **Electromotive Force (emf)**: Defined as the energy supplied by a source per unit charge. It is essentially the voltage generated by a power source like a battery or generator.
- **Potential Difference**: Defined as the energy difference required to move a charge between two points in a circuit. It measures the work done per unit charge in moving the charge between two points against an electric field.

- **Dependency**:

- **Electromotive Force (emf)**: Independent of the circuit elements and depends solely on the characteristics of the source itself.
- **Potential Difference**: Dependent on the path taken by the charge and the circuit elements such as resistors, capacitors, and inductors through which the charge moves.

- **Circuit Role**:

- **Electromotive Force (emf)**: Causes current to flow in a circuit and is not consumed by components; rather, it provides the energy that drives the circuit.
- **Potential Difference**: Typically results from the consumption of energy by circuit elements; it reflects how much energy per unit charge is used by components within the circuit.

OR

Write any three differences between Resistance and Specific Resistance.

Solution:

- **Definition**:

- **Resistance**: Resistance is a measure of how much a specific object or component opposes the flow of electric current. It depends on the material, length, and cross-sectional area of the conductor. Resistance is denoted by RRR and is measured in ohms (Ω
- **Specific Resistance (Resistivity)**: Resistivity is an intrinsic property of a material that quantifies how strongly the material itself opposes the flow of electric current. It is independent of the shape and size of the material. Resistivity is denoted by ρ and is measured in ohm-meters $(\Omega \cdot m)$.

- **Dependence on Dimensions**:

- **Resistance**: Resistance depends on the dimensions of the conductor. It varies directly with the length (L) of the conductor and inversely with its cross-sectional area (A). The relationship is given by R=ρLA
- **Specific Resistance (Resistivity)**: Resistivity does not depend on the dimensions of the conductor. It is a material-specific property and remains constant for a given material under specified conditions, typically temperature.

- **Applications and Use**:

- **Resistance**: Resistance is used to describe how much a particular component (like a resistor) opposes the flow of electric current in a circuit. It is a practical, measurable value used in circuit design and analysis.
- **Specific Resistance (Resistivity)**: Resistivity is used to compare different materials in terms of their ability to conduct electricity. It helps in selecting appropriate materials for various electrical applications based on their conductive or resistive properties. Resistivity is fundamental in material science and engineering to understand and predict the behavior of materials under different conditions.

16. Compare the resistance of 100 watt and 400 watt of two bulbs if their voltage is same.

Solution:

To compare the resistance of two bulbs rated at 100 watts and 400 watts operating at the same voltage, we can use the formula that relates power (P), voltage (V), and resistance (R):

$$P = \frac{V^2}{R}$$

Rearranging this formula to solve for resistance, we get:

$$R = \frac{V^2}{P}$$

Let's denote the resistances of the 100-watt and 400-watt bulbs as R_{100} and R_{400}, respectively. Given that the voltage (V) is the same for both bulbs, we have:

$$R_{100} = \frac{V^2}{100}$$

$$R_{400} = \frac{V^2}{400}$$

To find the ratio of these resistances, we can divide R_{100} by R_{400}:

$$\frac{R_{100}}{R_{400}} = \frac{\frac{V^2}{100}}{\frac{V^2}{400}} = \frac{400}{100} = 4$$

Thus, the resistance of the 100-watt bulb is four times greater than the resistance of the 400-watt bulb.

Summary
- Resistance of 100-watt bulb: $R_{100} = \frac{V^2}{100}$
- Resistance of 400-watt bulb: $R_{400} = \frac{V^2}{400}$
- Ratio of resistances: $\frac{R_{100}}{R_{400}} = 4$

Therefore, $R_{100} = 4 \times R_{400}$.

OR

What will be the resistance of al wire if the cin length change to half of their original length and cross sectional area change two times of original.

Solution:

To determine the new resistance of an aluminum wire when its length is halved and its cross-sectional area is doubled, we use the formula for resistance:

$$R = \rho \frac{L}{A}$$

where:
- R is the resistance,
- ρ is the resistivity of the material,
- L is the length of the conductor,
- A is the cross-sectional area.

Let R_0, L_0, and A_0 be the original resistance, length, and cross-sectional area of the wire, respectively. The new length L' is $\frac{1}{2}L_0$ and the new area A' is $2A_0$.

The new resistance R' can be calculated using the new dimensions:

$$R' = \rho\frac{L'}{A'}$$

Substitute the new length and area into the equation:

$$R' = \rho\frac{\frac{1}{2}L_0}{2A_0}$$

$$R' = \rho\frac{L_0}{4A_0}$$

The original resistance R_0 is:

$$R_0 = \rho\frac{L_0}{A_0}$$

To find the ratio of the new resistance to the original resistance:

$$\frac{R'}{R_0} = \frac{\rho\frac{L_0}{4A_0}}{\rho\frac{L_0}{A_0}} = \frac{1}{4}$$

Thus, the new resistance R' is one quarter of the original resistance. This means that if the length of the aluminum wire is halved and its cross-sectional area is doubled, its resistance will be reduced to one quarter of its original value.

17. Write the differences between intrinsic semiconductor and extrinsic semi conductor,

Solution:

- **Purity and Composition**:
  - **Intrinsic Semiconductors**: These are pure forms of semiconductor materials without any significant impurities. Silicon (Si) and Germanium (Ge) in their pure form are common examples. The electrical conductivity in intrinsic semiconductors is solely due to the charge carriers generated by thermal energy, meaning electrons are excited from the valence band to the conduction band, leaving behind holes.
  - **Extrinsic Semiconductors**: These are semiconductors that have been intentionally doped with impurities to alter their electrical properties. The impurities added are typically of two types, resulting in either p-type or n-type semiconductors. In p-type, trivalent impurities are added, creating more holes as majority carriers, whereas in n-type, pentavalent impurities are added, creating more free electrons as majority carriers.
- **Electrical Conductivity**:
  - **Intrinsic Semiconductors**: They have lower electrical conductivity under normal conditions, as it is highly temperature-dependent. The number of charge carriers (both electrons and holes) is relatively low because it relies on the thermal generation of carriers.
  - **Extrinsic Semiconductors**: These have much higher electrical conductivity than intrinsic semiconductors because the addition of impurities introduces additional charge carriers that facilitate

current flow. The conductivity is less sensitive to temperature changes compared to intrinsic semiconductors.

- **Charge Carriers**:
  - **Intrinsic Semiconductors**: The charge carriers are electrons and holes generated through the excitation of electrons from the valence band to the conduction band due to thermal energy. The number of electrons and holes are equal, making them equally contribute to conductivity.
  - **Extrinsic Semiconductors**: The type and concentration of impurities determine the majority charge carriers. In n-type semiconductors, electrons are the majority carriers, whereas in p-type semiconductors, holes are the majority carriers. This imbalance greatly enhances their conductivity and allows for the creation of p-n junctions, which are crucial in modern electronics.
- **Applications**:
  - **Intrinsic Semiconductors**: They are less commonly used directly in applications due to their lower and unstable conductivity. They are mostly used in pure form for research and specific applications where very controlled semiconductor properties are necessary.
  - **Extrinsic Semiconductors**: These are extensively used in the manufacturing of electronic devices such as diodes, transistors, solar cells, and integrated circuits. The ability to control the type and amount of impurities allows engineers to precisely control the electrical properties of the semiconductor.

OR

What is P-N function diode ? Describe its use as a full wave rectifier with dagram.

Solution:

A P-N junction diode is a semiconductor device that consists of a p-type semiconductor and an n-type semiconductor joined together, creating a junction. This junction forms a depletion region where charge carriers (holes and electrons) recombine, creating an electric field that acts as a barrier to the movement of charge carriers.

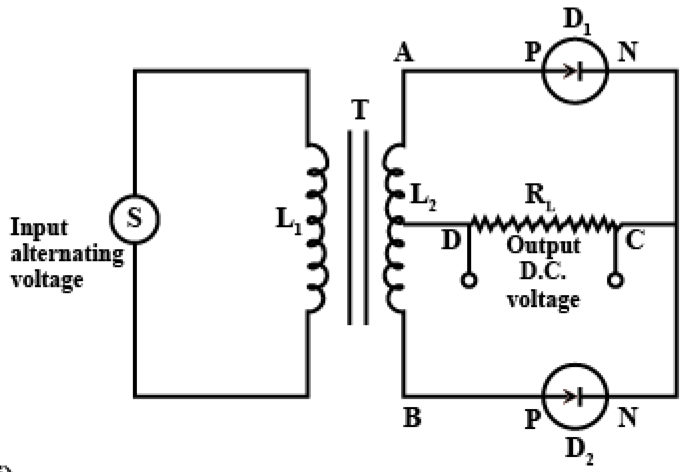
Function of a P-N Junction Diode:

- When forward-biased (positive voltage applied to the p-side and negative to the n-side), the depletion region narrows, allowing current to flow through the diode.
- When reverse-biased (positive voltage applied to the n-side and negative to the p-side), the depletion region widens, preventing current flow.

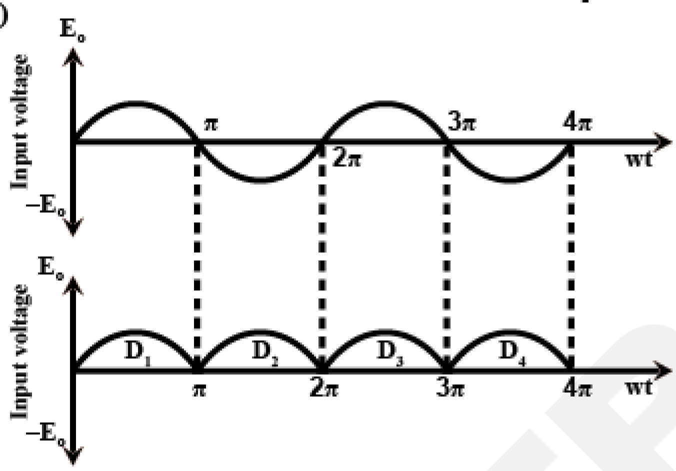
Use of P-N Junction Diode as a Full Wave Rectifier

A full wave rectifier converts an alternating current (AC) input signal into a direct current (DC) output signal. This is achieved by using two diodes in a center-tapped transformer configuration or four diodes in a bridge configuration.

(i)



(iii)



18. "what is Self inductance ? We rise an expression for the self inductance of solenoid. Also write the factor affectme it

Solution:

Self-inductance is the property of a coil (or solenoid) that enables it to induce an electromotive force (emf) in itself when the current flowing through it changes. It is a measure of how effectively a coil can induce an emf due to its own changing current.

The self-inductance L of a solenoid can be derived as follows:

1. Expression for Magnetic Field Inside a Solenoid:
   The magnetic field B inside a long solenoid is given by:

$$B = \mu_0 n I$$

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

2. Flux Linkage:
The magnetic flux Φ through a single loop of the solenoid is:

$$\Phi = B \cdot A = \mu_0 n I \cdot A$$

where A is the cross-sectional area of the solenoid.

For a solenoid with N turns, the total flux linkage λ is:

$$\lambda = N \cdot \Phi = N \cdot \mu_0 n I \cdot A$$

3. Self-Inductance:
The self-inductance L is defined as the ratio of the total flux linkage to the current:

$$L = \frac{\lambda}{I} = \frac{N \cdot \mu_0 n I \cdot A}{I} = \mu_0 n N A$$

For a solenoid of length l, the number of turns per unit length n is $\frac{N}{l}$. Therefore:

$$L = \mu_0 \left(\frac{N}{l}\right) N A = \mu_0 \frac{N^2 A}{l}$$

Factors Affecting Self-Inductance:
1. Number of Turns (N): Self-inductance is directly proportional to the square of the number of turns in the solenoid.
2. Cross-sectional Area (A): Self-inductance is directly proportional to the cross-sectional area of the solenoid.
3. Length of the Solenoid (l): Self-inductance is inversely proportional to the length of the solenoid.
4. Permeability of the Core (μ): Self-inductance is directly proportional to the permeability of the material inside the solenoid (for a core with permeability μ, replace μ_0 with μ).

OR

What is Transformer? Describe its principle and different types of energy losses in it.

Solution:

A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Transformers are used to increase (step up) or decrease (step down) voltages and currents in an AC (alternating current) electrical circuit. They are essential components in the transmission and distribution of electric power.

Principle of Operation

The basic principle of a transformer is based on Faraday's Law of Electromagnetic Induction, which states that a change in the magnetic flux through a coil induces a voltage across the coil. A transformer consists of two or more coils wound on a common core. When an alternating current flows through one of the coils, known as the primary coil, it creates a changing magnetic field around the coil. This changing magnetic field induces a changing magnetic flux in the core, which then induces a voltage in the other coil(s), called the secondary coil(s).

Types of Energy Losses in Transformers

Transformers are highly efficient, but they do experience some energy losses, which can be categorized as follows:

1. **Core Losses (or Iron Losses)**:
   - **Hysteresis Loss**: Occurs due to the resistance of the core material to changes in magnetization. Each time the magnetic field reverses (with each cycle of the AC), a small amount of energy is lost due to the molecular friction of realigning the magnetic domains.
   - **Eddy Current Loss**: Caused by circulating currents produced within the core due to the alternating magnetic field. These currents generate heat within the core material.
2. **Copper Losses (or Winding Losses)**:
   - These losses occur due to the ohmic resistance of the wires used in the windings. As electrical current flows through the primary and secondary windings, heat is produced in the resistance of the wires, leading to energy loss.
3. **Stray Losses**:
   - Stray losses are caused by stray flux that leaks from the core and induces currents in nearby metallic parts of the transformer, such as the tank, clamps, or other structural components.
4. **Dielectric Losses**:
   - These losses occur in the insulation materials of the transformer due to the heat produced when the insulating material is subjected to an electric field.
5. **Cooling and Other Mechanical Losses**:
   - Includes losses due to the energy used in cooling systems (like oil pumps and fans) and mechanical vibrations.

19. Derive an expression for the refractive index of glass prism

$$\mu = \frac{\sin\left(\frac{1+\sin}{2}\right)}{\sin 1/2}$$

Solution:

To derive the expression for the refractive index μ of a glass prism, we need to consider the geometry and principles of light refraction through the prism. Here's a detailed step-by-step derivation:

Geometry of the Prism:

Consider a glass prism with apex angle A. When a light ray enters the prism, it bends towards the normal due to the higher refractive index of the prism material compared to air. Snell's Law at the First Interface:

When the light enters the prism, Snell's law can be applied:

$$n_1 \sin i_1 = n_2 \sin r_1$$

Here, n_1 is the refractive index of air (approximately 1), i_1 is the angle of incidence, n_2 is the refractive index of the prism (μ), and r_1 is the angle of refraction inside the prism.

Therefore, we have:

$$\sin i_1 = \mu \sin r_1$$

Path of Light Inside the Prism:
Inside the prism, the light ray travels and reaches the second interface. The angle of incidence at the second interface is r_2. The sum of the angles inside the prism must equal the apex angle A of the prism:

$$r_1 + r_2 = A$$

Snell's Law at the Second Interface:
At the second interface, the light exits the prism and bends away from the normal. Applying Snell's law again:

$$\mu \sin r_2 = \sin i_2$$

Here, r_2 is the angle of incidence inside the prism at the second interface, and i_2 is the angle of refraction in air.

Minimum Deviation Condition:
For the minimum deviation D_m, the angles of incidence and emergence are equal ($i_1 = i_2$). Additionally, the light path is symmetrical, so $r_1 = r_2$.

Therefore:

$$r_1 = r_2 = \frac{A}{2}$$

Calculating Minimum Deviation:
The angle of minimum deviation D_m is given by:

$$D_m = 2i - A$$

Expression for Refractive Index:
Combining the above equations, we can express the refractive index μ in terms of the angles A and D_m. From Snell's law and the symmetrical path:

$$\sin i = \mu \sin\left(\frac{A}{2}\right)$$

Since at minimum deviation, $i_1 = i_2 = i$:

$$i = \frac{A + D_m}{2}$$

Substituting this into Snell's law:

$$\sin\left(\frac{A + D_m}{2}\right) = \mu \sin\left(\frac{A}{2}\right)$$

Final Expression:
Solving for μ, we get:

$$\mu = \frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

This is the expression for the refractive index of a glass prism in terms of its apex angle A and the angle of minimum deviation D_m.

OR

Derive lens maker formula for thin lens.

$$\frac{\mu}{v_1} - \frac{1}{u} = \frac{\mu - 1}{R_1}$$

Solution:

Derivation of Lens Maker's Formula for a Thin Lens

To derive the Lens Maker's Formula for a thin lens, we will consider a lens made of a material with refractive index μ surrounded by air (refractive index 1). The lens has two spherical surfaces with radii of curvature R_1 and R_2.

Refraction at the First Surface
Consider a point object O placed on the principal axis of the lens. Light from O refracts at the first surface of the lens (radius of curvature R_1). Let P be the point where the refracted ray intersects the principal axis after refraction through the first surface.

Using the refraction formula at a spherical surface:

$$\frac{\mu}{v_1} - \frac{1}{u} = \frac{\mu - 1}{R_1}$$

Here, u is the object distance, and v_1 is the image distance after refraction at the first surface.

Refraction at the Second Surface
The image formed by the first surface acts as the virtual object for the second surface. Let Q be the final image point after refraction through the second surface (radius of curvature R_2).

Using the refraction formula at the second spherical surface:

$$\frac{1}{v} - \frac{\mu}{v_1} = \frac{1 - \mu}{R_2}$$

Here, v is the final image distance after refraction through the second surface.

{Combining the Two Equations}
Substitute $\frac{\mu}{v_1}$ from the first equation into the second equation:

$$\frac{1}{v} - \left(\frac{1}{u} + \frac{\mu - 1}{R_1}\right) = \frac{1 - \mu}{R_2}$$

Rearrange the terms:

$$\frac{1}{v} = \frac{1}{u} + \frac{\mu - 1}{R_1} + \frac{1 - \mu}{R_2}$$

{Lens Maker's Formula}
For a lens, the focal length f is related to the object and image distances by the lens formula:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Substitute the combined equation into the lens formula:

$$\frac{1}{f} = \left(\frac{1}{u} + \frac{\mu - 1}{R_1} + \frac{1 - \mu}{R_2}\right) - \frac{1}{u}$$

Simplify the equation:

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

{Final Expression}
Therefore, the Lens Maker's Formula for a thin lens is:

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$