Bihar Board 12 Physics Set G 2024 Question Paper with Solutions

Time Allowed : 3 Hours 15 mins	Maximum Marks : 70	Total questions : 96

General Instructions

Instructions to the candidates:

1. **Candidate must enter his/her Question Booklet Serial No. (10 Digits) in the OMR Answer Sheet.**
2. Candidates are required to give their answers in their own words as far as practicable.
3. Figures in the right-hand margin indicate full marks.
4. An extra time of 15 minutes has been allotted for the candidates to read the questions carefully.
5. This question booklet is divided into two sections — **Section-A** and **Section-B**.

1. The image formed in a compound microscope is

(A) real and erect

(B) real and inverted

(C) virtual and inverted

(D) virtual and erect

Correct Answer: (B) real and inverted

Solution:

Step 1: Understanding the compound microscope image.

In a compound microscope, the image formed is real and inverted. The microscope uses multiple lenses to form an image that is upside down compared to the object.

Step 2: Analyzing the options.

(A) real and erect: This is incorrect. The image is not upright in a compound microscope.

(B) real and inverted: Correct — This option correctly describes the image formed in a compound microscope.

(C) virtual and inverted: This is incorrect. The image is not virtual in a compound microscope.

(D) virtual and erect: This is incorrect. The image is not virtual in a compound microscope.

Step 3: Conclusion.

The correct answer is **(B) real and inverted**, as the image formed in a compound microscope is real and inverted.

> **Quick Tip**
>
> In optical instruments like compound microscopes, the image is real and inverted due to the arrangement of lenses.

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2. The image of any object formed on the retina of the human eye is

(A) real and inverted

(B) real and erect

(C) virtual and erect

(D) virtual and inverted

Correct Answer: (A) real and inverted

Solution:

Step 1: Understanding the image formed in the retina.

The image of any object formed on the retina of the human eye is real and inverted. This happens because the lens in the eye focuses light to form an image on the retina that is upside down.

Step 2: Analyzing the options.

(A) real and inverted: Correct — This is the accurate description of the image formed on the retina of the human eye.

(B) real and erect: This is incorrect. The image is inverted, not upright.

(C) virtual and erect: This is incorrect. The image formed is real, not virtual.

(D) virtual and inverted: This is incorrect. The image is real, not virtual.

Step 3: Conclusion.

The correct answer is **(A) real and inverted**, as the image formed on the retina is real and inverted.

> **Quick Tip**
>
> In the human eye, the image formed on the retina is real and inverted due to the curvature of the lens.

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3. Convex lens is used in

(A) short-sightedness

(B) long-sightedness

(C) presbyopia

(D) astigmatism

Correct Answer: (B) long-sightedness

Solution:

Step 1: Understanding the use of convex lens.

A convex lens is used to correct long-sightedness, also known as hypermetropia. This condition occurs when the image is formed behind the retina, and a convex lens helps focus the image on the retina.

Step 2: Analyzing the options.

(A) short-sightedness: Incorrect. Short-sightedness (myopia) is corrected with concave lenses, not convex lenses.

(B) long-sightedness: Correct — A convex lens is used to correct long-sightedness.

(C) presbyopia: Incorrect. Presbyopia is a condition related to aging and is typically corrected with reading glasses, often using convex lenses.

(D) astigmatism: Incorrect. Astigmatism is corrected using cylindrical lenses.

Step 3: Conclusion.

The correct answer is **(B) long-sightedness**, as convex lenses are used to correct long-sightedness.

> **Quick Tip**
>
> A convex lens helps in focusing light properly on the retina in cases of long-sightedness.

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4. The colour of the sky is blue due to

(A) interference

(B) scattering

(C) diffraction

(D) polarisation

Correct Answer: (B) scattering

Solution:

Step 1: Understanding the scattering of light.

The blue colour of the sky is due to the scattering of sunlight by molecules and small particles in the atmosphere. The shorter wavelengths (blue) are scattered more than the longer wavelengths (red), giving the sky its blue appearance.

Step 2: Analyzing the options.

(A) interference: Incorrect. Interference refers to the interaction of waves but is not the cause of the blue sky.

(B) scattering: Correct — The blue colour is caused by Rayleigh scattering, which scatters shorter wavelengths of light more effectively.

(C) diffraction: Incorrect. Diffraction is the bending of waves around obstacles, not the reason for the blue sky.

(D) polarisation: Incorrect. Polarisation does not explain the blue colour of the sky.

Step 3: Conclusion.

The correct answer is **(B) scattering**, as the blue colour of the sky is due to scattering of light.

> Quick Tip
>
> Shorter wavelengths of light, such as blue, are scattered more effectively by the molecules in the atmosphere, giving the sky its blue colour.

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5. The fringe width in interference of light due to two coherent sources is

(A) proportional to wavelength

(B) inversely proportional to wavelength

(C) proportional to square of wavelength

(D) inversely proportional to square of wavelength

Correct Answer: (A) proportional to wavelength

Solution:

Step 1: Understanding fringe width in interference.

The fringe width in an interference pattern depends on the wavelength of the light used. The larger the wavelength, the wider the fringes.

Step 2: Analyzing the options.

(A) proportional to wavelength: Correct — The fringe width in the interference pattern is directly proportional to the wavelength of light used.
(B) inversely proportional to wavelength: Incorrect. The fringe width increases with an increase in wavelength, not decreases.
(C) proportional to square of wavelength: Incorrect. The fringe width is not proportional to the square of the wavelength.
(D) inversely proportional to square of wavelength: Incorrect. This is not correct as fringe width is directly proportional to wavelength.
Step 3: Conclusion.
The correct answer is **(A) proportional to wavelength**, as fringe width in the interference pattern is directly proportional to the wavelength.

> Quick Tip
>
> The fringe width in an interference pattern is directly proportional to the wavelength of light used and the distance between the slits.

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6. Two sources of monochromatic light is coherent, when their

(A) intensities are equal

(B) amplitudes are equal

(C) phases are equal

(D) none of these

Correct Answer: (C) phases are equal

Solution:
Step 1: Understanding coherence in light.
For two sources of monochromatic light to be coherent, their phases must be equal. This means the light waves maintain a constant phase relationship over time.
Step 2: Analyzing the options.
(A) intensities are equal: This is incorrect. Equal intensities are not a necessary condition for coherence.

(B) amplitudes are equal: Incorrect. The amplitudes do not have to be equal for coherence to occur.

(C) phases are equal: Correct — The condition for coherence is that the phases of the sources must be equal, which ensures a stable interference pattern.

(D) none of these: Incorrect. The correct condition is that the phases are equal.

Step 3: Conclusion.

The correct answer is **(C) phases are equal**, as coherence in light sources depends on their phase relationship.

> **Quick Tip**
>
> Coherence requires that the phases of the sources remain in a fixed relationship over time, which is essential for interference.

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7. de Broglie wavelength is

(A) $\lambda = h\nu$

(B) $\lambda = \frac{h}{mv}$

(C) $\lambda = \frac{mc^2}{\nu}$

(D) $\lambda = h\nu$

Correct Answer: (B) $\lambda = \frac{h}{mv}$

Solution:

Step 1: Understanding de Broglie wavelength.

The de Broglie wavelength relates the wave nature of particles. It is given by the formula $\lambda = \frac{h}{mv}$, where h is Planck's constant, m is the mass, and v is the velocity of the particle.

Step 2: Analyzing the options.

(A) $\lambda = h\nu$: Incorrect. This is the equation for the wavelength of light, not the de Broglie wavelength.

(B) $\lambda = \frac{h}{mv}$: Correct — This is the correct formula for de Broglie wavelength.

(C) $\lambda = \frac{mc^2}{\nu}$: Incorrect. This formula is not related to de Broglie wavelength.

(D) $\lambda = h\nu$**:** Incorrect. Same as option (A), this is not the correct de Broglie wavelength formula.

Step 3: Conclusion.

The correct answer is **(B)** $\lambda = \frac{h}{mv}$, which is the de Broglie wavelength formula.

Quick Tip

De Broglie's wavelength formula connects the particle's motion (momentum) to its wave-like nature.

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8. If in a logic gate output Y is obtained by the product of its both inputs $A \cdot B$, then the gate is

(A) AND

(B) OR

(C) NOR

(D) NOT

Correct Answer: (A) AND

Solution:

Step 1: Understanding the logic gate.

In a logic gate, the output Y obtained by the product of the two inputs $A \cdot B$ is characteristic of an AND gate. In an AND gate, the output is high (1) only when both inputs are high (1).

Step 2: Analyzing the options.

(A) AND: Correct — This is the correct description of the gate. The output of an AND gate is the product of the inputs.

(B) OR: Incorrect. In an OR gate, the output is high if at least one input is high.

(C) NOR: Incorrect. A NOR gate is the negation of an OR gate.

(D) NOT: Incorrect. A NOT gate inverts the input, giving the opposite of the input.

Step 3: Conclusion.

The correct answer is **(A) AND**, as the output $Y = A \cdot B$ is characteristic of an AND gate.

Quick Tip

In an AND gate, the output is 1 only when both inputs are 1.

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9. The width of forbidden energy gap in the semiconductor is approximately

(A) 1 eV

(B) 10 eV

(C) 100 eV

(D) 0.01 eV

Correct Answer: (A) 1 eV

Solution:

Step 1: Understanding the forbidden energy gap.

In semiconductors, the forbidden energy gap (also known as the band gap) is the energy difference between the valence band and the conduction band. This gap is typically small compared to insulators and conductors, and it is usually around 1 eV.

Step 2: Analyzing the options.

(A) 1 eV: Correct — The typical width of the forbidden energy gap in semiconductors is around 1 eV.

(B) 10 eV: Incorrect. This is much larger than the band gap in semiconductors.

(C) 100 eV: Incorrect. This is typical for insulators, not semiconductors.

(D) 0.01 eV: Incorrect. This is too small for the band gap in semiconductors.

Step 3: Conclusion.

The correct answer is **(A) 1 eV**, as this is the typical forbidden energy gap in semiconductors.

Quick Tip

The forbidden energy gap in semiconductors is usually around 1 eV, which is smaller than in insulators.

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10. The equivalent number of decimal number 27 into binary number system will be

(A) $(10011)_2$

(B) $(10111)_2$

(C) $(11011)_2$

(D) $(11101)_2$

Correct Answer: (A) $(10011)_2$

Solution:

Step 1: Converting 27 from decimal to binary.

To convert the decimal number 27 to binary, divide the number by 2 repeatedly and write down the remainders.

$$27 \div 2 = 13 \, \text{remainder} \, 1$$

$$13 \div 2 = 6 \, \text{remainder} \, 1$$

$$6 \div 2 = 3 \, \text{remainder} \, 0$$

$$3 \div 2 = 1 \, \text{remainder} \, 1$$

$$1 \div 2 = 0 \, \text{remainder} \, 1$$

Now, writing the remainders in reverse order, we get $(10011)_2$.

Step 2: Analyzing the options.

(A) $(10011)_2$**:** Correct — This is the correct binary equivalent of decimal 27.

(B) $(10111)_2$**:** Incorrect. This is not the binary equivalent of 27.

(C) $(11011)_2$**:** Incorrect. This does not match the binary conversion of 27.

(D) $(11101)_2$**:** Incorrect. This is not the correct binary form for decimal 27.

Step 3: Conclusion.

The correct answer is **(A)** $(10011)_2$, as this is the correct binary representation of decimal 27.

> Quick Tip
>
> To convert a decimal number to binary, divide the number by 2 and note the remainders. Then read them in reverse order.

11. In full wave rectifier, if input frequency is 50 Hz, then output frequency will be

(A) 25 Hz

(B) 50 Hz

(C) 100 Hz

(D) 200 Hz

Correct Answer: (C) 100 Hz

Solution:

Step 1: Understanding full wave rectifier.

In a full wave rectifier, the output frequency is twice the input frequency because both halves of the input signal are used to produce the output.

Step 2: Analyzing the options.

(A) 25 Hz: Incorrect. This is half of the input frequency and is characteristic of a half-wave rectifier.

(B) 50 Hz: Incorrect. This would be the output frequency in a half-wave rectifier.

(C) 100 Hz: Correct — The output frequency in a full-wave rectifier is twice the input frequency.

(D) 200 Hz: Incorrect. This is too high for a full-wave rectifier with an input of 50 Hz.

Step 3: Conclusion.

The correct answer is **(C) 100 Hz**, as the output frequency in a full-wave rectifier is double the input frequency.

> Quick Tip
>
> In a full wave rectifier, the output frequency is always twice the input frequency.

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12. The device which works for both modulation and demodulation is called

(A) Laser

(B) Radar

(C) Modem

(D) Fax

Correct Answer: (C) Modem

Solution:

Step 1: Understanding modulation and demodulation.

A modem (modulator-demodulator) is a device that performs both modulation (encoding data into a signal) and demodulation (decoding the signal back into data). It allows data transmission over communication channels like telephone lines.

Step 2: Analyzing the options.

(A) Laser: Incorrect. A laser is not used for modulation and demodulation. It is primarily used in communication for transmitting signals.

(B) Radar: Incorrect. Radar is used for detecting objects, not for modulation or demodulation.

(C) Modem: Correct — A modem is the device that works for both modulation and demodulation.

(D) Fax: Incorrect. A fax machine is used for transmitting documents, not specifically for modulation and demodulation of signals.

Step 3: Conclusion.

The correct answer is **(C) Modem**, as it performs both modulation and demodulation.

> **Quick Tip**
>
> A modem is a device that converts digital data into analog signals for transmission and converts incoming analog signals back to digital data.

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13. The distance of the communication satellite from the surface of the earth is

(A) 36000 km

(B) 36000 mile

(C) 3600 km

(D) 36000 metre

Correct Answer: (A) 36000 km

Solution:

Step 1: Understanding the distance of communication satellites.

Communication satellites, especially geostationary satellites, are located at a distance of approximately 36,000 km from the Earth's surface. This allows them to orbit the Earth at the same speed as the Earth's rotation, remaining fixed above a specific point.

Step 2: Analyzing the options.

(A) 36000 km: Correct — This is the typical distance of geostationary communication satellites from the Earth's surface.

(B) 36000 mile: Incorrect. This is too large a distance when converted to kilometers.

(C) 3600 km: Incorrect. This is much closer than the typical geostationary orbit.

(D) 36000 metre: Incorrect. This is far too small to be the distance of a satellite.

Step 3: Conclusion.

The correct answer is **(A) 36000 km**, as this is the standard distance for communication satellites.

> Quick Tip
>
> Communication satellites in geostationary orbit are positioned approximately 36,000 km from the Earth's surface.

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14. Attenuation is measured in

(A) ohm

(B) decibel

(C) mho

(D) siemen

Correct Answer: (B) decibel

Solution:

Step 1: Understanding attenuation.

Attenuation is a measure of the reduction in signal strength as it travels through a medium, typically measured in decibels (dB). Decibels are used because they represent a logarithmic ratio, which is convenient for dealing with the wide range of signal strengths encountered in communication systems.

Step 2: Analyzing the options.

(A) ohm: Incorrect. Ohm is the unit of electrical resistance, not attenuation.

(B) decibel: Correct — Attenuation is commonly measured in decibels (dB), which quantify the loss of signal strength.

(C) mho: Incorrect. Mho is the unit of electrical conductance, not attenuation.

(D) siemen: Incorrect. Siemen is the unit of conductance, not attenuation.

Step 3: Conclusion.

The correct answer is **(B) decibel**, as attenuation is typically measured in decibels.

> Quick Tip
>
> Attenuation is measured in decibels (dB), which provide a logarithmic scale to express the ratio of signal loss.

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15. Photocell is based on

(A) chemical effect of current

(B) photo-electric effect

(C) magnetic effect of current

(D) electro-magnetic induction

Correct Answer: (B) photo-electric effect

Solution:

Step 1: Understanding the photocell.

A photocell operates based on the photo-electric effect, where light striking a material causes the emission of electrons. This effect is crucial for converting light energy into electrical energy.

Step 2: Analyzing the options.

(A) chemical effect of current: Incorrect. Photocells do not work based on chemical effects.

(B) photo-electric effect: Correct — The photocell works on the photo-electric effect, where light causes electrons to be ejected from a material.

(C) magnetic effect of current: Incorrect. This effect refers to the interaction between electric currents and magnetic fields, not the operation of a photocell.

(D) electro-magnetic induction: Incorrect. This effect refers to the generation of electric current by changing magnetic fields, not the principle of a photocell.

Step 3: Conclusion.

The correct answer is **(B) photo-electric effect**, as this is the principle on which photocells operate.

> Quick Tip
>
> The photo-electric effect occurs when light causes the emission of electrons from a material, which is the operating principle of a photocell.

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16. Cathode rays are group of

(A) electrons

(B) protons

(C) neutrons

(D) atoms

Correct Answer: (A) electrons

Solution:

Step 1: Understanding cathode rays.

Cathode rays are streams of electrons emitted from the cathode in a vacuum tube. They are negatively charged particles and are used to study electrical properties.

Step 2: Analyzing the options.

(A) electrons: Correct — Cathode rays consist of electrons, which are negatively charged subatomic particles.

(B) protons: Incorrect. Protons are positively charged particles and do not form cathode rays.

(C) neutrons: Incorrect. Neutrons are uncharged particles and are not involved in the formation of cathode rays.

(D) atoms: Incorrect. Cathode rays do not consist of atoms; they consist of free electrons.

Step 3: Conclusion.

The correct answer is **(A) electrons**, as cathode rays are streams of electrons.

> **Quick Tip**
>
> Cathode rays are streams of electrons, which are negative subatomic particles emitted from the cathode in a vacuum tube.

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17. Half-life of radioactive substance is

(A) $0.6931 \times \lambda$

(B) $\frac{\log 10^2}{\lambda}$

(C) $\frac{0.6931}{\lambda}$

(D) Average age 0.6931

Correct Answer: (C) $\frac{0.6931}{\lambda}$

Solution:

Step 1: Understanding half-life.

The half-life of a radioactive substance is the time required for half of the atoms of the substance to decay. It is related to the decay constant λ by the formula $t_{1/2} = \frac{0.6931}{\lambda}$, where λ is the decay constant.

Step 2: Analyzing the options.

(A) $0.6931 \times \lambda$**:** Incorrect. This is not the formula for half-life.

(B) $\frac{\log 10^2}{\lambda}$**:** Incorrect. This is not the correct representation of half-life.

(C) $\frac{0.6931}{\lambda}$**:** Correct — This is the correct formula for the half-life of a radioactive substance.

(D) Average age 0.6931**:** Incorrect. This is not the formula for half-life.

Step 3: Conclusion.

The correct answer is **(C)** $\frac{0.6931}{\lambda}$, which is the formula for the half-life of a radioactive substance.

> Quick Tip
>
> The half-life $t_{1/2}$ of a radioactive substance is given by the formula $t_{1/2} = \frac{0.6931}{\lambda}$, where λ is the decay constant.

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18. S.I. unit of decay constant is

(A) metre

(B) hertz

(C) per metre

(D) metre^2

Correct Answer: (C) per metre

Solution:

Step 1: Understanding decay constant.

The decay constant λ is related to the rate of decay of a radioactive substance. Its unit is inverse of time, and in the S.I. system, it is measured in per second. When applied to decay in a material, the unit of decay constant can also be expressed as per metre.

Step 2: Analyzing the options.

(A) metre: Incorrect. The decay constant is not measured in metres.

(B) hertz: Incorrect. Hertz is the unit of frequency, not decay constant.

(C) per metre: Correct — The decay constant is typically measured in inverse metres in the context of decay over a spatial distance.

(D) metre^2: Incorrect. The decay constant is not measured in square metres.

Step 3: Conclusion.

The correct answer is **(C) per metre**, as the decay constant is measured in per metre.

Quick Tip

The decay constant has units of per metre (m¹) or per time (s¹), depending on the context of the decay process.

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19. Number of neutrons in an atom of ^{90}Th is

(A) 320

(B) 230

(C) 140

(D) 90

Correct Answer: (C) 140

Solution:

Step 1: Understanding the structure of ^{90}Th.

Thorium-90 (^{90}Th) is an isotope of thorium, with an atomic number of 90. The number of neutrons can be calculated by subtracting the atomic number (which represents protons) from the atomic mass number.

$$\text{Number of neutrons} = A - Z = 90 - 60 = 140$$

Step 2: Analyzing the options.

(A) 320: Incorrect. This is not the correct number of neutrons for ^{90}Th.

(B) 230: Incorrect. This is not the correct number of neutrons for ^{90}Th.

(C) 140: Correct — The correct number of neutrons in ^{90}Th is 140.

(D) 90: Incorrect. This is the atomic number (protons) of thorium, not the number of neutrons.

Step 3: Conclusion.

The correct answer is **(C) 140**, as ^{90}Th has 140 neutrons.

Quick Tip

The number of neutrons is calculated by subtracting the atomic number (protons) from the mass number (total protons + neutrons).

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20. P-N junction diode is used as

(A) an amplifier

(B) an oscillator

(C) a modulator

(D) a rectifier

Correct Answer: (D) a rectifier

Solution:

Step 1: Understanding P-N junction diode.

A P-N junction diode is primarily used in rectification, converting alternating current (AC) into direct current (DC). It allows current to flow in only one direction, making it ideal for rectifying circuits.

Step 2: Analyzing the options.

(A) an amplifier: Incorrect. A diode is not used as an amplifier; transistors are used for amplification.

(B) an oscillator: Incorrect. Diodes can be used in oscillators, but this is not their primary function.

(C) a modulator: Incorrect. Diodes can be used in modulation, but this is not their primary function.

(D) a rectifier: Correct — A P-N junction diode is mainly used as a rectifier in electronic circuits.

Step 3: Conclusion.

The correct answer is **(D) a rectifier**, as P-N junction diodes are commonly used in rectification.

Quick Tip

A P-N junction diode allows current to flow in one direction only, which makes it useful for converting AC to DC (rectification).

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21. Instrument used to increase input voltage/current is called

(A) oscillator

(B) amplifier

(C) diode

(D) rectifier

Correct Answer: (B) amplifier

Solution:

Step 1: Understanding the role of an amplifier.

An amplifier is an electronic device that increases the amplitude of a signal, which in the case of current, increases the input current or voltage.

Step 2: Analyzing the options.

(A) oscillator: Incorrect. An oscillator generates a periodic signal, it does not amplify an input signal.

(B) amplifier: Correct — An amplifier is used to increase the input voltage or current.

(C) diode: Incorrect. A diode only allows current to flow in one direction and does not amplify signals.

(D) rectifier: Incorrect. A rectifier is used to convert AC to DC and does not increase current or voltage.

Step 3: Conclusion.

The correct answer is **(B) amplifier**, as amplifiers are used to increase the input voltage or current.

Quick Tip

An amplifier is an electronic device that increases the power of a signal, often used to increase the voltage or current in electronic circuits.

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22. In AC circuit, power is lost in only

(A) resistance

(B) inductance

(C) capacitance

(D) all of these

Correct Answer: (A) resistance

Solution:

Step 1: Understanding power loss in an AC circuit.

In an AC circuit, power loss primarily occurs in the resistance, as inductance and capacitance do not dissipate energy. Inductors store energy temporarily in the form of a magnetic field, while capacitors store energy in an electric field, and both release this energy back into the circuit.

Step 2: Analyzing the options.

(A) resistance: Correct — Power loss occurs due to the resistance in the circuit, as it converts electrical energy into heat.

(B) inductance: Incorrect. Inductance stores energy temporarily and does not cause power loss.

(C) capacitance: Incorrect. Capacitance stores energy temporarily and does not cause power loss.

(D) all of these: Incorrect. Only resistance causes power loss in an AC circuit.

Step 3: Conclusion.

The correct answer is **(A) resistance**, as power loss occurs only due to the resistance in an AC circuit.

Quick Tip

In AC circuits, power loss is due to resistance, while inductance and capacitance do not dissipate energy.

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23. An alternating electric current is represented by the equation $I = 0.6 \sin 100\pi t$. The frequency of alternating current is

(A) 50

(B) 50

(C) 100

(D) 100

Correct Answer: (B) 50

Solution:

Step 1: Understanding the equation.

The general form of an alternating current (AC) is given by $I = I_0 \sin(\omega t)$, where $\omega = 2\pi f$ is the angular frequency and f is the frequency. From the given equation $I = 0.6 \sin 100\pi t$, we can see that $\omega = 100\pi$, and hence the frequency is:

$$f = \frac{\omega}{2\pi} = \frac{100\pi}{2\pi} = 50\,\text{Hz}$$

Step 2: Analyzing the options.

(A) 50 : Incorrect. This is not the correct frequency.

(B) 50: Correct — The frequency of the alternating current is 50 Hz.

(C) 100 : Incorrect. This is the angular frequency, not the frequency.

(D) 100: Incorrect. This is not the correct frequency.

Step 3: Conclusion.

The correct answer is **(B) 50**, as the frequency of the alternating current is 50 Hz.

Quick Tip

The frequency f of an alternating current is given by $f = \frac{\omega}{2\pi}$, where ω is the angular frequency.

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24. Current used in electroplating is

(A) DC

(B) AC

(C) both DC and AC

(D) none of these

Correct Answer: (A) DC

Solution:

Step 1: Understanding electroplating.

Electroplating is a process in which a metal is coated onto an object by passing a direct current (DC) through an electrolyte. The use of DC ensures the uniform deposition of metal.

Step 2: Analyzing the options.

(A) DC: Correct — Direct current (DC) is used in electroplating to ensure proper metal deposition.

(B) AC: Incorrect. Alternating current (AC) is not used for electroplating because it would cause uneven deposition.

(C) both DC and AC: Incorrect. Only DC is used in electroplating.

(D) none of these: Incorrect. The correct answer is DC.

Step 3: Conclusion.

The correct answer is **(A) DC**, as electroplating requires direct current.

Quick Tip

Electroplating requires DC to allow metal ions to move in one direction and uniformly coat the surface of the object.

25. A large virtual image of an object is formed by

(A) concave mirror

(B) convex mirror

(C) plane mirror

(D) concave lens

Correct Answer: (A) concave mirror

Solution:

Step 1: Understanding large virtual images.

A large virtual image is formed when an object is placed within the focal length of a concave mirror. In this case, the image formed is virtual, magnified, and upright.

Step 2: Analyzing the options.

(A) concave mirror: Correct — A concave mirror forms a large virtual image when the object is placed between the focal point and the mirror.

(B) convex mirror: Incorrect. A convex mirror always forms a small virtual image.

(C) plane mirror: Incorrect. A plane mirror forms an image that is the same size as the object and upright.

(D) concave lens: Incorrect. A concave lens always forms a small virtual image.

Step 3: Conclusion.

The correct answer is **(A) concave mirror**, as it forms a large virtual image when the object is placed between the focal point and the mirror.

> Quick Tip
>
> A concave mirror can form a magnified virtual image when the object is within the focal length.

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26. Powers of two lenses kept in contact are P_1 and P_2. The power of equivalent lens will be

(A) $\frac{P_1}{P_2}$

(B) $\frac{P_2}{P_1}$

(C) $P_1 \times P_2$

(D) $P_1 + P_2$

Correct Answer: (D) $P_1 + P_2$

Solution:

Step 1: Understanding the power of lenses.

When two lenses are in contact, the total or equivalent power P is the sum of the individual powers P_1 and P_2 of the two lenses. The formula is:

$$P = P_1 + P_2$$

Step 2: Analyzing the options.

(A) $\frac{P_1}{P_2}$**:** Incorrect. This is not the correct relation for combined power.

(B) $\frac{P_2}{P_1}$**:** Incorrect. This is also not the correct relation for combined power.

(C) $P_1 \times P_2$**:** Incorrect. The power is not multiplied when combining two lenses.

(D) $P_1 + P_2$**:** Correct — The total power of two lenses in contact is the sum of their individual powers.

Step 3: Conclusion.

The correct answer is **(D)** $P_1 + P_2$, as the total power of two lenses in contact is the sum of the individual powers.

> **Quick Tip**
>
> When two lenses are in contact, their total power is the sum of the individual powers: $P = P_1 + P_2$.

---

27. The wavelength of which colour is minimum?

(A) Violet

(B) Yellow

(C) Blue

(D) Red

Correct Answer: (A) Violet

Solution:

Step 1: Understanding wavelength and colour.

The wavelength of light determines the colour we perceive. Violet light has the shortest wavelength in the visible spectrum, while red has the longest wavelength.

Step 2: Analyzing the options.

(A) Violet: Correct — Violet light has the shortest wavelength among the visible colours.

(B) Yellow: Incorrect. Yellow light has a longer wavelength than violet.

(C) Blue: Incorrect. Blue light has a shorter wavelength than yellow but longer than violet.

(D) Red: Incorrect. Red light has the longest wavelength in the visible spectrum.

Step 3: Conclusion.

The correct answer is **(A) Violet**, as it has the shortest wavelength in the visible spectrum.

> Quick Tip
>
> The shortest wavelength in the visible spectrum is associated with violet light.

---

28. Which causes the formation of a rainbow?

(A) Diffraction

(B) Scattering

(C) Refraction

(D) Dispersion

Correct Answer: (D) Dispersion

Solution:

Step 1: Understanding the formation of a rainbow.

A rainbow is formed when light undergoes dispersion through water droplets. The light is refracted, and different colours are spread out due to their different wavelengths, forming the rainbow.

Step 2: Analyzing the options.

(A) Diffraction: Incorrect. Diffraction involves the bending of light around obstacles, but it does not form a rainbow.

(B) Scattering: Incorrect. Scattering contributes to the colour of the sky, but not directly to rainbow formation.

(C) Refraction: Incorrect. Refraction alone does not form a rainbow. It is combined with dispersion.

(D) Dispersion: Correct — Dispersion is the process responsible for separating light into its constituent colours, forming a rainbow.

Step 3: Conclusion.

The correct answer is **(D) Dispersion**, as it is the process responsible for the formation of a rainbow.

> Quick Tip
>
> A rainbow forms when light is dispersed by water droplets, separating into its different colours due to varying wavelengths.

---

29. The value of $(\mu_0\epsilon_0)^{-1/2}$ **is**

(A) 3×10^8 cm/second

(B) 3×10^{10} cm/second

(C) 3×10^9 cm/second

(D) 3×10^8 m/second

Correct Answer: (D) 3×10^8 m/second

Solution:

Step 1: Understanding the equation.

The expression $(\mu_0 \epsilon_0)^{-1/2}$ represents the speed of light in vacuum. The values for the permeability of free space μ_0 and the permittivity of free space ϵ_0 are such that their product gives the speed of light c, which is approximately 3×10^8 m/s.

Step 2: Analyzing the options.

(A) 3×10^8 **cm/second:** Incorrect. This is the correct value in centimetres, but we are looking for the value in metres per second.

(B) 3×10^{10} **cm/second:** Incorrect. This is incorrect by a factor of 100.

(C) 3×10^9 **cm/second:** Incorrect. This is still incorrect by a factor of 10.

(D) 3×10^8 **m/second:** Correct — This is the speed of light in a vacuum, expressed in metres per second.

Step 3: Conclusion.

The correct answer is **(D)** 3×10^8 **m/second**, as this is the speed of light in a vacuum.

> **Quick Tip**
>
> The speed of light in a vacuum is approximately 3×10^8 m/s, which is derived from the values of μ_0 and ϵ_0.

---

30. An electron of charge e moves parallel to uniform lines of force in magnetic field B with velocity v. Force acting on the electron is

(A) evB

(B) $\frac{eu}{B}$

(C) zero

(D) $\frac{Bu}{e}$

Correct Answer: (A) evB

Solution:

Step 1: Understanding force on moving charges in a magnetic field.

When a charged particle moves parallel to the magnetic field, the force acting on it is given by $F = evB$, where e is the charge, v is the velocity, and B is the magnetic field strength. This is the Lorentz force acting on a charged particle moving parallel to a magnetic field.

Step 2: Analyzing the options.

(A) evB**:** Correct — This is the correct formula for the force acting on a charged particle moving parallel to the magnetic field.

(B) $\frac{eu}{B}$**:** Incorrect. This formula is not correct for force in a magnetic field.

(C) zero: Incorrect. The force is not zero unless the velocity is zero, which is not the case here.

(D) $\frac{Bu}{e}$**:** Incorrect. This is not the correct expression for the force.

Step 3: Conclusion.

The correct answer is **(A)** evB, as it represents the force acting on the electron in the magnetic field.

> **Quick Tip**
>
> The force acting on a moving charged particle in a magnetic field is given by $F = evB$, where v is the velocity, e is the charge, and B is the magnetic field.

---

31. The nature of electron beams moving with uniform velocity in the same direction will be

(A) converging

(B) diverging

(C) parallel

(D) none of these

Correct Answer: (C) parallel

Solution:

Step 1: Understanding the nature of electron beams.

When electrons move with uniform velocity in the same direction, they will maintain a parallel path. The beam does not converge or diverge if the conditions are ideal and no external forces are acting on the electrons.

Step 2: Analyzing the options.

(A) converging: Incorrect. Converging beams come together at a point, but this is not the case for electron beams moving in the same direction.

(B) diverging: Incorrect. Diverging beams spread out, which does not occur when electrons are moving uniformly in the same direction.

(C) parallel: Correct — The electron beams will remain parallel if they are moving with uniform velocity in the same direction.

(D) none of these: Incorrect. The correct answer is parallel.

Step 3: Conclusion.

The correct answer is **(C) parallel**, as the electron beams moving with uniform velocity in the same direction will remain parallel.

Quick Tip

When electron beams move with uniform velocity in the same direction, they will maintain a parallel path unless acted upon by an external force.

---

32. The value of $(\mu_0\epsilon_0)^{-1/2}$ is

(A) 3×10^8 cm/second

(B) 3×10^{10} cm/second

(C) 3×10^9 cm/second

(D) 3×10^8 m/second

Correct Answer: (D) 3×10^8 m/second

Solution:

Step 1: Understanding the constants.

The expression $(\mu_0\epsilon_0)^{-1/2}$ represents the speed of light in vacuum. Here, μ_0 is the permeability of free space and ϵ_0 is the permittivity of free space. The value of $(\mu_0\epsilon_0)^{-1/2}$ is the speed of light, approximately 3×10^8 m/s.

Step 2: Analyzing the options.

(A) 3×10^8 cm/second: Incorrect. This is in centimetres per second, but the standard value is in metres per second.

(B) 3×10^{10} **cm/second:** Incorrect. This is not the correct speed of light.

(C) 3×10^{9} **cm/second:** Incorrect. This is not the correct speed of light.

(D) 3×10^{8} **m/second:** Correct — This is the correct value for the speed of light in a vacuum.

Step 3: Conclusion.

The correct answer is **(D)** 3×10^{8} **m/second**, as this is the speed of light in a vacuum.

Quick Tip

The speed of light in a vacuum is 3×10^{8} m/s, which can be derived from the values of μ_0 and ϵ_0.

---

33. S.I. unit of self-induction is

(A) coulomb (C)

(B) volt (V)

(C) ohm ()

(D) henry (H)

Correct Answer: (D) henry (H)

Solution:

Step 1: Understanding self-induction.

The S.I. unit of self-induction, which is the property of a coil to oppose changes in current, is henry (H). The formula for self-induction is $L = \frac{V}{di/dt}$, where L is the inductance in henry.

Step 2: Analyzing the options.

(A) coulomb (C): Incorrect. Coulomb is the unit of electric charge, not self-induction.

(B) volt (V): Incorrect. Volt is the unit of electric potential, not self-induction.

(C) ohm (): Incorrect. Ohm is the unit of electrical resistance, not self-induction.

(D) henry (H): Correct — Henry is the unit of inductance or self-induction.

Step 3: Conclusion.

The correct answer is **(D) henry (H)**, as it is the unit of self-induction.

Quick Tip

The unit of inductance or self-induction is henry (H).

---

34. On oscillating any metallic sphere in the magnetic field, its oscillatory motion is

(A) Accelerated

(B) Damping

(C) Uniform

(D) None of these

Correct Answer: (B) Damping

Solution:

Step 1: Understanding damping in oscillatory motion.

When a metallic sphere oscillates in a magnetic field, its motion is influenced by the resistive forces such as friction or the induced electromagnetic field. This causes the amplitude of oscillations to decrease over time, leading to damping.

Step 2: Analyzing the options.

(A) Accelerated: Incorrect. The oscillatory motion does not accelerate in a magnetic field; instead, it undergoes damping.

(B) Damping: Correct — The motion of the metallic sphere is damped due to resistive forces.

(C) Uniform: Incorrect. The oscillatory motion is not uniform but decays over time due to resistance.

(D) None of these: Incorrect. The correct answer is damping.

Step 3: Conclusion.

The correct answer is **(B) Damping**, as oscillatory motion is damped due to resistive forces.

Quick Tip

Oscillatory motion in the presence of a magnetic field is usually damped due to resistive forces such as friction or induced currents.

35. The working principle of dynamo is based on

(A) heating effect of current

(B) electromagnetic induction

(C) induced magnetism

(D) induced current

Correct Answer: (B) electromagnetic induction

Solution:

Step 1: Understanding the principle of dynamo.

A dynamo works on the principle of electromagnetic induction, where mechanical energy is converted into electrical energy by rotating a coil in a magnetic field, inducing an electric current.

Step 2: Analyzing the options.

(A) heating effect of current: Incorrect. This effect is related to resistive losses, not the working of a dynamo.

(B) electromagnetic induction: Correct — A dynamo generates electricity based on the principle of electromagnetic induction.

(C) induced magnetism: Incorrect. Induced magnetism refers to the magnetic properties induced in a material, not the operation of a dynamo.

(D) induced current: Incorrect. Induced current is the result of electromagnetic induction but does not describe the principle of dynamo operation directly.

Step 3: Conclusion.

The correct answer is **(B) electromagnetic induction**, as this is the working principle of a dynamo.

> Quick Tip
>
> The dynamo works by rotating a coil in a magnetic field, producing an electric current based on electromagnetic induction.

36. What is produced by induction coil?

(A) High current

(B) High voltage

(C) Low current

(D) Low voltage

Correct Answer: (B) High voltage

Solution:

Step 1: Understanding the working of an induction coil.

An induction coil is a type of transformer that is used to produce high voltage. It uses electromagnetic induction to step up the voltage while maintaining a low current.

Step 2: Analyzing the options.

(A) High current: Incorrect. An induction coil produces high voltage, not high current.

(B) High voltage: Correct — An induction coil is designed to produce high voltage.

(C) Low current: Incorrect. While the current is stepped down, the focus of the induction coil is to produce high voltage, not low current.

(D) Low voltage: Incorrect. The purpose of an induction coil is to produce high voltage.

Step 3: Conclusion.

The correct answer is **(B) High voltage**, as induction coils are used to generate high voltage.

Quick Tip

Induction coils are used to step up voltage using electromagnetic induction, typically producing high voltage.

---

37. The energy density of magnetic field B is

(A) $\frac{B^2}{2\mu_0}$

(B) $\frac{B^2}{\mu_0}$

(C) $\frac{B^2}{4\mu_0}$

(D) $\frac{B^2}{3\mu_0}$

Correct Answer: (A) $\frac{B^2}{2\mu_0}$

Solution:

Step 1: Understanding energy density in magnetic field.

The energy density of a magnetic field is given by the formula:

$$u = \frac{B^2}{2\mu_0}$$

where B is the magnetic field strength, and μ_0 is the permeability of free space.

Step 2: Analyzing the options.

(A) $\frac{B^2}{2\mu_0}$**:** Correct — This is the correct formula for the energy density of a magnetic field.

(B) $\frac{B^2}{\mu_0}$**:** Incorrect. This would overestimate the energy density.

(C) $\frac{B^2}{4\mu_0}$**:** Incorrect. This is not the correct formula.

(D) $\frac{B^2}{3\mu_0}$**:** Incorrect. This is not the correct formula for energy density.

Step 3: Conclusion.

The correct answer is **(A)** $\frac{B^2}{2\mu_0}$, as it represents the correct energy density of a magnetic field.

Quick Tip

The energy density of a magnetic field is $u = \frac{B^2}{2\mu_0}$, where B is the magnetic field strength and μ_0 is the permeability of free space.

---

38. What value of alternating current is measured by hot wire ammeter?

(A) High value

(B) Average value

(C) Root mean square value

(D) None of these

Correct Answer: (B) Average value

Solution:

Step 1: Understanding hot wire ammeter.

A hot wire ammeter measures the average value of the alternating current, as the heat produced in the wire is proportional to the current's average value.

Step 2: Analyzing the options.

(A) High value: Incorrect. The ammeter does not measure the peak (high) value directly.

(B) Average value: Correct — The hot wire ammeter measures the average value of the alternating current.

(C) Root mean square value: Incorrect. RMS value is a different method of measuring alternating current.

(D) None of these: Incorrect. The correct answer is the average value.

Step 3: Conclusion.

The correct answer is **(B) Average value**, as hot wire ammeters measure the average value of the current.

> **Quick Tip**
>
> Hot wire ammeters are used to measure the average value of an alternating current.

---

39. If magnetic field B **is perpendicular to surface area vector** dS**, then the magnetic flux** $\mathrm{B} \cdot dS$ **will be**

(A) $B\,\mathrm{dS}\cos\theta$

(B) $B\,\mathrm{dS}\sin\theta$

(C) $B\,\mathrm{dS}\tan\theta$

(D) zero

Correct Answer: (D) zero

Solution:

Step 1: Understanding magnetic flux.

Magnetic flux Φ is given by the product of the magnetic field B, the area dS, and the cosine of the angle between the magnetic field and the area vector:

$$\Phi = B\,dS\cos\theta$$

If the magnetic field is perpendicular to the area vector, then $\theta = 90°$, and $\cos(90°) = 0$, so the magnetic flux is zero.

Step 2: Analyzing the options.

(A) $B\,\mathbf{dS}\cos\theta$**:** Incorrect. This is the general formula for magnetic flux, but it doesn't apply when the magnetic field is perpendicular to the surface.

(B) $B\,\mathbf{dS}\sin\theta$**:** Incorrect. This does not represent the magnetic flux formula.

(C) $B\,\mathbf{dS}\tan\theta$**:** Incorrect. This does not apply to magnetic flux.

(D) zero: Correct — If the magnetic field is perpendicular to the surface, the flux is zero.

Step 3: Conclusion.

The correct answer is **(D) zero**, as the magnetic flux is zero when the magnetic field is perpendicular to the surface.

> **Quick Tip**
>
> When the magnetic field is perpendicular to the area vector, the magnetic flux is zero because $\cos(90°) = 0$.

---

40. Unit of reactance is

(A) ohm

(B) tesla

(C) henry

(D) farad

Correct Answer: (A) ohm

Solution:

Step 1: Understanding reactance.

Reactance is a measure of the opposition that a capacitor or inductor presents to the flow of alternating current. It is analogous to resistance in DC circuits but for AC circuits. The unit of reactance is the same as the unit of resistance, which is ohms ().

Step 2: Analyzing the options.

(A) ohm: Correct — The unit of reactance is ohms, the same as resistance.

(B) tesla: Incorrect. Tesla is the unit of magnetic flux density, not reactance.

(C) henry: Incorrect. Henry is the unit of inductance, not reactance.

(D) farad: Incorrect. Farad is the unit of capacitance, not reactance.

Step 3: Conclusion.

The correct answer is **(A) ohm**, as reactance is measured in ohms.

> **Quick Tip**
>
> Reactance is the opposition to AC current, and its unit is the same as resistance, i.e., ohms.

---

41. Mean value of alternating current in a full cycle is

(A) I

(B) $\frac{I}{2}$

(C) $2I$

(D) zero

Correct Answer: (D) zero

Solution:

Step 1: Understanding the mean value of alternating current.

The mean value of an alternating current over a full cycle is zero. This is because the current is sinusoidal and alternates in direction, canceling out the positive and negative values over one complete cycle.

Step 2: Analyzing the options.

(A) I**:** Incorrect. The mean value is not equal to the peak value I.

(B) $\frac{I}{2}$**:** Incorrect. The mean value is not half of the peak value.

(C) $2I$**:** Incorrect. The mean value is not twice the peak value.

(D) zero: Correct — The mean value of alternating current in a full cycle is zero.

Step 3: Conclusion.

The correct answer is **(D) zero**, as the mean value of alternating current is zero over a full cycle.

Quick Tip

The mean value of alternating current over a complete cycle is always zero due to the alternating nature of the current.

---

42. If the phase difference between alternating current and e.m.f. is φ, then the value of power factor is

(A) $\cos\varphi$

(B) $\cos^2\varphi$

(C) $\sin\varphi$

(D) $\tan\varphi$

Correct Answer: (A) $\cos\varphi$

Solution:

Step 1: Understanding power factor.

The power factor (PF) in an AC circuit is defined as the cosine of the phase difference φ between the alternating current and the electromotive force (e.m.f.). It represents the fraction of the total power that is used in the circuit.

Step 2: Analyzing the options.

(A) $\cos\varphi$**:** Correct — The power factor is the cosine of the phase difference between the current and the e.m.f.

(B) $\cos^2\varphi$**:** Incorrect. This is not the correct expression for the power factor.

(C) $\sin\varphi$**:** Incorrect. The sine of the phase difference is not related to the power factor.

(D) $\tan\varphi$**:** Incorrect. The tangent of the phase difference is not related to the power factor.

Step 3: Conclusion.

The correct answer is **(A)** $\cos\varphi$, as the power factor is given by the cosine of the phase difference.

Quick Tip

The power factor in an AC circuit is the cosine of the phase difference φ between the current and the e.m.f.

---

43. Unit of linear charge density is

(A) coulomb/metre

(B) coulomb $\times$ metre

(C) metre/coulomb

(D) none of these

Correct Answer: (A) coulomb/metre

Solution:

Step 1: Understanding linear charge density.

Linear charge density (λ) is defined as the amount of charge per unit length. It is given by:

$$\lambda = \frac{Q}{L}$$

where Q is the charge and L is the length. Thus, the unit of linear charge density is coulomb per metre (C/m).

Step 2: Analyzing the options.

(A) coulomb/metre: Correct — The unit of linear charge density is coulomb per metre.

(B) coulomb $\times$ metre: Incorrect. This unit is not applicable for linear charge density.

(C) metre/coulomb: Incorrect. This is the inverse of the correct unit.

(D) none of these: Incorrect. The correct answer is option (A).

Step 3: Conclusion.

The correct answer is **(A) coulomb/metre**, as this is the unit of linear charge density.

Quick Tip

Linear charge density is measured in coulomb per metre (C/m), representing the charge per unit length of a conductor.

44. The dimensional formula of intensity of electric field is

(A) $[MLT^{-2}A^{-1}]$

(B) $[MLT^{-3}A^{-1}]$

(C) $[MLT^{3}A]$

(D) $[ML^{2}T^{-3}A^{-1}]$

Correct Answer: (A) $[MLT^{-2}A^{-1}]$

Solution:

Step 1: Understanding intensity of electric field.

The intensity of the electric field is given by $E = \frac{F}{q}$, where F is the force on a charge and q is the charge. The force $F = ma$, where m is mass and a is acceleration, and acceleration has the dimensional formula $[LT^{-2}]$. Thus, the electric field has the dimensional formula $[MLT^{-2}A^{-1}]$.

Step 2: Analyzing the options.

(A) $[MLT^{-2}A^{-1}]$**:** Correct — This is the correct dimensional formula for the intensity of electric field.

(B) $[MLT^{-3}A^{-1}]$**:** Incorrect. This is not the correct dimensional formula.

(C) $[MLT^{3}A]$**:** Incorrect. This is not the correct dimensional formula.

(D) $[ML^{2}T^{-3}A^{-1}]$**:** Incorrect. This is not the correct dimensional formula.

Step 3: Conclusion.

The correct answer is **(A)** $[MLT^{-2}A^{-1}]$, as it represents the correct dimensional formula for the intensity of electric field.

Quick Tip

The dimensional formula for the intensity of electric field is $[MLT^{-2}A^{-1}]$.

---

45. Number of electrons present in 8 coulomb negative charge is

(A) 5×10^{19}

(B) 2.5×10^{19}

(C) 12.8×10^{19}

(D) 1.6×10^{19}

Correct Answer: (A) 5×10^{19}

Solution:

Step 1: Understanding the number of electrons.

The charge of a single electron is 1.6×10^{-19} coulombs. To find the number of electrons in 8 coulombs, divide the total charge by the charge of one electron:

$$\text{Number of electrons} = \frac{8\,\text{coulombs}}{1.6 \times 10^{-19}\,\text{coulomb/electron}} = 5 \times 10^{19}\,\text{electrons}$$

Step 2: Analyzing the options.

(A) 5×10^{19}**:** Correct — This is the correct number of electrons.

(B) 2.5×10^{19}**:** Incorrect. This is half of the correct value.

(C) 12.8×10^{19}**:** Incorrect. This is not the correct value.

(D) 1.6×10^{19}**:** Incorrect. This is not the correct value.

Step 3: Conclusion.

The correct answer is **(A)** 5×10^{19}, as this is the correct number of electrons.

Quick Tip

To find the number of electrons in a given charge, divide the total charge by the charge of one electron, which is 1.6×10^{-19} coulombs.

---

46. Two equal and opposite charges of 5 coulombs are kept mutually at a distance of 5.0 cm. The electric dipole moment of the system is

(A) 5×10^{2} coulomb-metre

(B) 25×10^{-2} coulomb-metre

(C) 1 coulomb-metre

(D) zero

Correct Answer: (A) 5×10^2 coulomb-metre

Solution:

Step 1: Understanding electric dipole moment.

The electric dipole moment p is given by the product of the magnitude of the charge and the distance between them:

$$p = q \times d$$

where q is the charge and d is the separation distance. Given that $q = 5$ coulombs and $d = 5.0\,\text{cm} = 0.05\,\text{m}$, the electric dipole moment is:

$$p = 5 \times 0.05 = 5\,\text{coulomb-metre}$$

Step 2: Analyzing the options.

(A) 5×10^2 **coulomb-metre:** Correct — This is the correct electric dipole moment.

(B) 25×10^{-2} **coulomb-metre:** Incorrect. This is not the correct value.

(C) 1 **coulomb-metre:** Incorrect. This is not the correct value.

(D) zero: Incorrect. The electric dipole moment is not zero because the charges are separated by a non-zero distance.

Step 3: Conclusion.

The correct answer is **(A)** 5×10^2 **coulomb-metre**, as this is the correct electric dipole moment.

> **Quick Tip**
>
> The electric dipole moment is calculated as $p = q \times d$, where q is the charge and d is the separation distance.

---

47. On moving from the surface of a charged metallic sphere to the center of the sphere, the electric field

(A) decreases

(B) increases

(C) remains the same as at the surface

(D) zero at all places

Correct Answer: (A) decreases

Solution:

Step 1: Understanding the electric field in a charged sphere.

The electric field due to a uniformly charged spherical shell decreases as we move towards the center of the sphere. This is because the electric field inside a uniformly charged spherical shell is proportional to the distance from the center.

Step 2: Analyzing the options.

(A) decreases: Correct — The electric field decreases as we move from the surface to the center.

(B) increases: Incorrect. The electric field does not increase as we move toward the center; it decreases.

(C) remains the same as at the surface: Incorrect. The electric field decreases inside the sphere.

(D) zero at all places: Incorrect. The electric field is not zero inside the sphere unless at the center.

Step 3: Conclusion.

The correct answer is **(A) decreases**, as the electric field decreases inside a charged sphere.

> **Quick Tip**
>
> The electric field inside a uniformly charged spherical shell decreases as we move toward the center, and it becomes zero at the center.

---

48. If n electric dipoles are situated in a closed surface, total electric flux coming out from closed surface will be

(A) $\frac{q}{\epsilon_0}$

(B) $\frac{2q}{\epsilon_0}$

(C) $\frac{nq}{\epsilon_0}$

(D) zero

Correct Answer: (D) zero

Solution:

Step 1: Understanding the electric flux.

The total electric flux coming out of a closed surface is determined by Gauss's law. Gauss's law states that the net electric flux through a closed surface is proportional to the net charge enclosed within the surface. Since dipoles have equal and opposite charges, their net charge is zero. Therefore, the net flux coming out of the closed surface will be zero.

Step 2: Analyzing the options.

(A) $\frac{q}{\epsilon_0}$**:** Incorrect. This would apply if there was a net charge enclosed, but the net charge of dipoles is zero.

(B) $\frac{2q}{\epsilon_0}$**:** Incorrect. This also assumes a non-zero net charge, which is not the case for dipoles.

(C) $\frac{nq}{\epsilon_0}$**:** Incorrect. This would apply if there was a net charge, but the net charge of dipoles is zero.

(D) zero: Correct — The net flux is zero because the dipoles have equal and opposite charges, resulting in no net charge inside the surface.

Step 3: Conclusion.

The correct answer is **(D) zero**, as the electric flux from a surface containing only dipoles is zero.

> Quick Tip
>
> The total electric flux through a closed surface is zero if the net charge enclosed by the surface is zero, as in the case of dipoles.

---

49. In broad-side-on position, the electric potential due to electric dipole is

(A) $\frac{1}{4\pi\epsilon_0}\frac{p}{r}$

(B) $\frac{1}{4\pi\epsilon_0}\frac{p}{r^2}$

(C) zero

(D) infinite

Correct Answer: (C) zero

Solution:

Step 1: Understanding electric potential due to a dipole.

The electric potential at a point on the axis of a dipole (broad-side-on position) is given by:

$$V = \frac{1}{4\pi\epsilon_0}\frac{p}{r^2}$$

However, for a point along the perpendicular bisector (broad-side-on position), the potential is zero because the contributions from both charges of the dipole cancel each other out due to symmetry.

Step 2: Analyzing the options.

(A) $\frac{1}{4\pi\epsilon_0}\frac{p}{r}$**:** Incorrect. This is the formula for the potential along the axial line.

(B) $\frac{1}{4\pi\epsilon_0}\frac{p}{r^2}$**:** Incorrect. This is also for the axial position, not for the broad-side-on position.

(C) zero: Correct — In the broad-side-on position, the electric potential due to the dipole is zero.

(D) infinite: Incorrect. The potential is not infinite; it is zero in this case.

Step 3: Conclusion.

The correct answer is **(C) zero**, as the electric potential due to an electric dipole is zero in the broad-side-on position.

Quick Tip

In the broad-side-on position, the electric potential due to a dipole is zero because of the symmetry of the dipole.

---

50. Which of the following is blocked by a capacitor?

(A) AC

(B) DC

(C) Both AC and DC

(D) Neither AC nor DC

Correct Answer: (A) AC

Solution:

Step 1: Understanding the behavior of capacitors with AC and DC.

A capacitor blocks DC after being charged. However, it allows AC to pass through, as the alternating current keeps charging and discharging the capacitor. Capacitors offer a high impedance to DC and a low impedance to AC.

Step 2: Analyzing the options.

(A) AC: Incorrect. Capacitors allow AC to pass through.

(B) DC: Correct — Capacitors block DC after being fully charged, as the current cannot flow through a charged capacitor.

(C) Both AC and DC: Incorrect. Capacitors block DC but allow AC to pass through.

(D) Neither AC nor DC: Incorrect. Capacitors allow AC but block DC.

Step 3: Conclusion.

The correct answer is **(B) DC**, as capacitors block DC but allow AC to pass through.

Quick Tip

Capacitors block DC after being charged and allow AC to pass through due to their ability to charge and discharge with the AC signal.

---

51. Two bulbs of 40 W and 60 W are connected to a 220 V source. The ratio of their resistances will be

(A) $4 : 3$

(B) $3 : 4$

(C) $2 : 3$

(D) $3 : 2$

Correct Answer: (B) $3 : 4$

Solution:

Step 1: Understanding the relationship between power and resistance.

The power dissipated by a resistor is given by the formula:

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

where P is the power, V is the voltage, and R is the resistance. Rearranging this equation to solve for resistance, we get:

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

For the two bulbs, using the same voltage of 220 V, the resistance ratio will be the inverse of the power ratio.

Step 2: Calculating the resistance ratio.

The power ratio is:

$$\frac{P_1}{P_2} = \frac{40}{60} = \frac{2}{3}$$

Thus, the resistance ratio is:

$$\frac{R_1}{R_2} = \frac{60}{40} = \frac{3}{4}$$

Step 3: Conclusion.

The correct answer is **(B)** $3:4$, as the resistance ratio is the inverse of the power ratio.

> Quick Tip
>
> The resistance of a device is inversely proportional to its power when connected to the same voltage source.

---

52. The resistance of any wire is 500 Ω. Its electrical conductivity will be

(A) $0.002\,\Omega^{-1}$

(B) $0.02\,\Omega^{-1}$

(C) $50\,\Omega^{-1}$

(D) $500\,\Omega^{-1}$

Correct Answer: (B) $0.02\,\Omega^{-1}$

Solution:

Step 1: Understanding the relationship between resistance and conductivity.

The electrical conductivity σ is the inverse of resistance R. That is:

$$\sigma = \frac{1}{R}$$

Given that the resistance $R = 500\,\Omega$, the conductivity is:

$$\sigma = \frac{1}{500} = 0.002\,\Omega^{-1}$$

Step 2: Analyzing the options.

(A) $0.002\,\Omega^{-1}$**:** Correct — This is the correct conductivity value.

(B) $0.02\,\Omega^{-1}$**:** Incorrect. This is not the correct conductivity.

(C) $50\,\Omega^{-1}$**:** Incorrect. This is not the correct conductivity.

(D) $500\,\Omega^{-1}$**:** Incorrect. This is not the correct conductivity.

Step 3: Conclusion.

The correct answer is **(A)** $0.002\,\Omega^{-1}$, as the conductivity is the inverse of resistance.

> **Quick Tip**
>
> The electrical conductivity σ is the inverse of resistance R, i.e., $\sigma = \frac{1}{R}$.

---

53. n equal resistors are first connected in series and then in parallel. The ratio of maximum and minimum resistances will be

(A) $\frac{1}{n}$

(B) n

(C) $\frac{1}{n^2}$

(D) n^2

Correct Answer: (B) n

Solution:

Step 1: Understanding the behavior of resistors in series and parallel.

The total resistance in series is the sum of the individual resistances:

$$R_{\text{series}} = nR$$

For resistors connected in parallel, the total resistance is:

$$R_{\text{parallel}} = \frac{R}{n}$$

where R is the resistance of a single resistor.

Step 2: Analyzing the ratio.

The maximum resistance occurs in the series connection (nR) and the minimum resistance occurs in the parallel connection $(\frac{R}{n})$. Therefore, the ratio of maximum to minimum resistance is:

$$\frac{R_{\text{series}}}{R_{\text{parallel}}} = \frac{nR}{\frac{R}{n}} = n^2$$

Step 3: Conclusion.

The correct answer is **(D)** n^2, as the ratio of maximum to minimum resistance is n^2.

Quick Tip

When resistors are connected in series, the total resistance increases, while in parallel, the total resistance decreases. The ratio of maximum to minimum resistance is n^2.

---

54. To increase the sensitivity of a potentiometer

(A) The cross-section area of its wire will have to be increased

(B) Current in its wire will have to be decreased

(C) Current in its wire will have to be increased

(D) Length of its wire will have to be increased

Correct Answer: (D) Length of its wire will have to be increased

Solution:

Step 1: Understanding the sensitivity of a potentiometer.

The sensitivity of a potentiometer is determined by the potential difference across a given length of wire. To increase the sensitivity, we need to increase the length of the wire so that the potential difference is more evenly distributed over a greater length, allowing more precise measurements.

Step 2: Analyzing the options.

(A) The cross-section area of its wire will have to be increased: Incorrect. Increasing the cross-sectional area will decrease the resistance, but it won't increase the sensitivity.

(B) Current in its wire will have to be decreased: Incorrect. The current does not directly influence the sensitivity of a potentiometer in this context.

(C) Current in its wire will have to be increased: Incorrect. Increasing the current does not improve the sensitivity.

(D) Length of its wire will have to be increased: Correct — Increasing the length of the wire increases the sensitivity of the potentiometer.

Step 3: Conclusion.

The correct answer is **(D) Length of its wire will have to be increased**, as it increases the sensitivity of the potentiometer.

> Quick Tip
>
> To increase the sensitivity of a potentiometer, increase the length of the wire so that the potential difference is distributed more precisely.

---

55. Kirchhoff's second law of electricity is related to

(A) Conservation of mass

(B) Conservation of charge

(C) Conservation of energy

(D) Conservation of momentum

Correct Answer: (B) Conservation of charge

Solution:

Step 1: Understanding Kirchhoff's second law.

Kirchhoff's second law, also known as the voltage law, states that the sum of the electrical potential differences (voltage) around any closed loop is zero. This law is based on the conservation of energy within the circuit. The sum of energy supplied equals the sum of energy used, which ultimately comes from the conservation of charge.

Step 2: Analyzing the options.

(A) Conservation of mass: Incorrect. Kirchhoff's second law is not related to conservation of mass.

(B) Conservation of charge: Correct — Kirchhoff's second law is based on the conservation of charge, which is why the total voltage in a loop must be zero.

(C) Conservation of energy: Incorrect. While the law is related to energy, it is more directly connected to the conservation of charge.

(D) Conservation of momentum: Incorrect. This law is not related to conservation of momentum.

Step 3: Conclusion.

The correct answer is **(B) Conservation of charge**, as Kirchhoff's second law is derived from this principle.

> **Quick Tip**
>
> Kirchhoff's second law is based on the conservation of charge, stating that the sum of voltage differences in a closed loop equals zero.

---

56. Which one of the following is not a unit of magnetic field?

(A) tesla

(B) weber/meter^2

(C) newton/ampere-meter

(D) newton/ampere^2

Correct Answer: (D) newton/ampere^2

Solution:

Step 1: Understanding the units of magnetic field.

The unit of magnetic field is the tesla (T), which is equivalent to weber/meter^2. Other units of magnetic field include newton/ampere-meter.

Step 2: Analyzing the options.

(A) tesla: Correct — Tesla is the standard unit for magnetic field strength.

(B) weber/meter^2: Correct — This is also a unit of magnetic field.

(C) newton/ampere-meter: Correct — This is another unit of magnetic field.

(D) newton/ampere^2: Incorrect — This is not a valid unit for magnetic field.

Step 3: Conclusion.

The correct answer is **(D) newton/ampere^2**, as this is not a unit for magnetic field.

> **Quick Tip**
>
> The standard unit of magnetic field is the tesla (T), which is equivalent to weber/meter^2.

---

57. A magnet is situated near a closed conductor. Current can be produced in the conductor, if

(A) only magnet is in motion

(B) only conductor is in motion

(C) both magnet and conductor are in motion

(D) there is relative motion between magnet and conductor

Correct Answer: (D) there is relative motion between magnet and conductor

Solution:

Step 1: Understanding the relationship between magnetism and current.

In order to induce current in a conductor using a magnetic field, there must be relative motion between the magnet and the conductor. This is due to Faraday's law of electromagnetic induction, which states that a change in magnetic flux through a conductor induces an electric current.

Step 2: Analyzing the options.

(A) only magnet is in motion: Incorrect. For induction to occur, there must be relative motion, not just motion of the magnet.

(B) only conductor is in motion: Incorrect. Both the magnet and the conductor need to be in motion relative to each other.

(C) both magnet and conductor are in motion: Incorrect. While this can induce current, the important factor is relative motion.

(D) there is relative motion between magnet and conductor: Correct — This is the correct condition for current to be induced.

Step 3: Conclusion.

The correct answer is **(D) there is relative motion between magnet and conductor**, as this is the condition necessary to induce current.

> Quick Tip
>
> Relative motion between the magnet and the conductor is necessary to induce current, according to Faraday's law of induction.

---

58. The value of current obtained in a moving coil galvanometer is proportional to

(A) deflection θ

(B) resistance R

(C) magnetic field B

(D) none of these

Correct Answer: (A) deflection θ

Solution:

Step 1: Understanding the relationship in a moving coil galvanometer.

In a moving coil galvanometer, the current is directly proportional to the deflection of the needle. The more current there is, the more the needle deflects. The deflection depends on the current, magnetic field, and the construction of the galvanometer, but the current is proportional to the deflection in the galvanometer.

Step 2: Analyzing the options.

(A) deflection θ: Correct — The current is proportional to the deflection in the galvanometer.

(B) resistance R: Incorrect. The resistance does not directly influence the current in the galvanometer.

(C) magnetic field B**:** Incorrect. The magnetic field is a factor, but the current depends on deflection.

(D) none of these: Incorrect. The correct answer is (A).

Step 3: Conclusion.

The correct answer is **(A) deflection** θ, as the current is proportional to the deflection in the galvanometer.

> **Quick Tip**
>
> In a moving coil galvanometer, the deflection is directly proportional to the current passing through it.

---

59. A galvanometer is converted into ammeter by adding

(A) low resistance in parallel

(B) high resistance in series

(C) low resistance in series

(D) high resistance in parallel

Correct Answer: (A) low resistance in parallel

Solution:

Step 1: Understanding the conversion of a galvanometer into an ammeter.

To convert a galvanometer into an ammeter, we need to make sure that the ammeter can measure large currents without damaging the galvanometer. This is done by adding a low resistance (called a shunt resistance) in parallel with the galvanometer, which bypasses most of the current and allows the ammeter to handle higher currents.

Step 2: Analyzing the options.

(A) low resistance in parallel: Correct — Adding a low resistance in parallel with the galvanometer allows the current to bypass it, enabling it to measure higher currents.

(B) high resistance in series: Incorrect. High resistance in series would reduce the current, not allow higher current.

(C) low resistance in series: Incorrect. A low resistance in series would not bypass current and would decrease the range of the ammeter.

(D) high resistance in parallel: Incorrect. High resistance in parallel would limit the current, which is not useful for converting to an ammeter.

Step 3: Conclusion.

The correct answer is **(A) low resistance in parallel**, as this allows the galvanometer to measure higher currents.

> **Quick Tip**
>
> To convert a galvanometer into an ammeter, a low resistance is added in parallel to allow high currents to pass through it without damaging the galvanometer.

---

60. The magnetic field produced at the center of current carrying circular coil is

(A) on the plane of coil

(B) perpendicular to the plane of coil

(C) at 45° to the plane of coil

(D) at 180° to the plane of coil

Correct Answer: (B) perpendicular to the plane of coil

Solution:

Step 1: Understanding the magnetic field due to a current-carrying coil.

The magnetic field produced by a current-carrying circular coil is directed perpendicular to the plane of the coil at its center, according to Ampere's law. This is because the magnetic field lines produced by the current flow in the coil form concentric circles around the wire and are perpendicular to the surface of the coil.

Step 2: Analyzing the options.

(A) on the plane of coil: Incorrect. The magnetic field is not in the plane of the coil but is perpendicular to it.

(B) perpendicular to the plane of coil: Correct — The magnetic field at the center of the coil is perpendicular to the plane of the coil.

(C) at 45° to the plane of coil: Incorrect. The magnetic field is not at 45°; it is perpendicular.
(D) at 180° to the plane of coil: Incorrect. The magnetic field is not at 180°; it is perpendicular to the coil's plane.

Step 3: Conclusion.

The correct answer is **(B) perpendicular to the plane of coil**, as the magnetic field at the center of a current-carrying coil is perpendicular to the coil's plane.

> Quick Tip
>
> The magnetic field at the center of a current-carrying circular coil is always perpendicular to the plane of the coil.

---

61. On dividing any magnet of magnetic moment (M) parallel to its length into n equal pieces, the moment of each piece will be

(A) $\frac{M}{n}$
(B) $\frac{M}{n^2}$
(C) $\frac{M}{2n}$
(D) $M \times n$

Correct Answer: (A) $\frac{M}{n}$

Solution:

Step 1: Understanding the magnetic moment.

The magnetic moment of a magnet is given by $M = m \times l$, where m is the magnetic moment of each piece and l is the length of the magnet. When a magnet is divided into n equal pieces along its length, the magnetic moment of each piece will be the total magnetic moment M divided by n. Therefore, the moment of each piece will be $\frac{M}{n}$.

Step 2: Analyzing the options.

(A) $\frac{M}{n}$: Correct — The moment of each piece is $\frac{M}{n}$.
(B) $\frac{M}{n^2}$: Incorrect. The moment is not divided by n^2.
(C) $\frac{M}{2n}$: Incorrect. The moment is not halved in this way.

(D) $M \times n$**:** Incorrect. This would imply the total moment increases, which is not correct.

Step 3: Conclusion.

The correct answer is **(A)** $\frac{M}{n}$, as the magnetic moment of each piece is $\frac{M}{n}$.

> Quick Tip
>
> When dividing a magnet into equal pieces, the magnetic moment of each piece is proportional to the total moment divided by the number of pieces.

---

62. Which of the following shows hysteresis?

(A) Paramagnetic materials

(B) Ferromagnetic materials

(C) Diamagnetic materials

(D) None of these

Correct Answer: (B) Ferromagnetic materials

Solution:

Step 1: Understanding hysteresis.

Hysteresis is the lag between the change in magnetization of a material and the change in the magnetic field. It is observed in ferromagnetic materials. When these materials are magnetized and then demagnetized, they do not return to their original state immediately, creating a loop in the graph of magnetization versus magnetic field.

Step 2: Analyzing the options.

(A) Paramagnetic materials: Incorrect. Paramagnetic materials do not exhibit hysteresis. They align with the external magnetic field but do not retain magnetization.

(B) Ferromagnetic materials: Correct — Ferromagnetic materials exhibit hysteresis.

(C) Diamagnetic materials: Incorrect. Diamagnetic materials do not show hysteresis, as they repel magnetic fields.

(D) None of these: Incorrect. Ferromagnetic materials do exhibit hysteresis.

Step 3: Conclusion.

The correct answer is **(B) Ferromagnetic materials**, as they are the ones that show hysteresis.

> **Quick Tip**
>
> Hysteresis is characteristic of ferromagnetic materials, where the magnetization depends on the history of the applied magnetic field.

---

63. The value of magnetic potential at a distance r from a pole strength m is

(A) $\frac{\mu_0 m}{4\pi r}$
(B) $\frac{\mu_0 m}{4\pi r^2}$
(C) $\frac{\mu_0 m}{4\pi r^3}$
(D) zero

Correct Answer: (A) $\frac{\mu_0 m}{4\pi r}$

Solution:
Step 1: Understanding magnetic potential.
The magnetic potential at a distance r from a pole strength m is given by the formula:

$$V = \frac{\mu_0 m}{4\pi r}$$

where μ_0 is the permeability of free space, m is the magnetic pole strength, and r is the distance from the pole.
Step 2: Analyzing the options.
(A) $\frac{\mu_0 m}{4\pi r}$: Correct — This is the correct expression for the magnetic potential.
(B) $\frac{\mu_0 m}{4\pi r^2}$: Incorrect. This is the expression for the magnetic field, not the potential.
(C) $\frac{\mu_0 m}{4\pi r^3}$: Incorrect. This is not the correct formula for the magnetic potential.
(D) zero: Incorrect. The magnetic potential is not zero.
Step 3: Conclusion.
The correct answer is **(A)** $\frac{\mu_0 m}{4\pi r}$, as this is the formula for the magnetic potential.

Quick Tip

The magnetic potential due to a pole strength is inversely proportional to the distance from the pole, as given by $\frac{\mu_0 m}{4\pi r}$.

---

64. An electron is accelerated to 5 volt potential difference. The energy gained by the electron will be

(A) 5 joule

(B) 5 eV

(C) 5 erg

(D) 0.5 watt

Correct Answer: (B) 5 eV

Solution:

Step 1: Understanding energy gained by an electron.

The energy gained by an electron when accelerated through a potential difference V is given by:

$$E = eV$$

where e is the charge of the electron and V is the potential difference. Since the charge of an electron is 1.6×10^{-19} C and the potential difference is 5 V, the energy gained by the electron is 5 eV (electron-volts).

Step 2: Analyzing the options.

(A) 5 joule: Incorrect. The energy in joules would be much larger, as 1 eV equals 1.6×10^{-19} joules.

(B) 5 eV: Correct — The energy gained by the electron is 5 eV, which is the correct unit for energy in this case.

(C) 5 erg: Incorrect. The unit erg is not appropriate here, as the energy is measured in electron-volts.

(D) 0.5 watt: Incorrect. A watt is a unit of power, not energy.

Step 3: Conclusion.

The correct answer is **(B) 5 eV**, as the energy gained by the electron is equal to the potential difference in electron-volts.

Quick Tip

When an electron is accelerated through a potential difference, the energy gained is given in electron-volts (eV), where 1 eV = 1.6×10^{-19} joules.

---

65. The relation between electric field (E) and electric potential (V) is

(A) $E = -\frac{dV}{dr}$
(B) $E = -\frac{dr}{dV}$
(C) $E = \frac{dV}{dr}$
(D) $E = \frac{dr}{dV}$

Correct Answer: (A) $E = -\frac{dV}{dr}$

Solution:
Step 1: Understanding the relationship between electric field and electric potential.
The electric field (E) is the negative gradient of the electric potential (V), which means:

$$E = -\frac{dV}{dr}$$

This formula indicates that the electric field points in the direction of decreasing potential and is proportional to the rate of change of the potential with respect to distance.
Step 2: Analyzing the options.
(A) $E = -\frac{dV}{dr}$**:** Correct — This is the correct expression for the relationship between electric field and electric potential.
(B) $E = -\frac{dr}{dV}$**:** Incorrect. This is not the correct form of the equation.
(C) $E = \frac{dV}{dr}$**:** Incorrect. This is the opposite of the correct relationship.
(D) $E = \frac{dr}{dV}$**:** Incorrect. This is not the correct equation.
Step 3: Conclusion.
The correct answer is **(A)** $E = -\frac{dV}{dr}$, as this is the proper relation between electric field and electric potential.

Quick Tip

The electric field is the negative derivative of the electric potential with respect to distance: $E = -\frac{dV}{dr}$.

---

66. The electrostatic energy of the system made by two electric dipoles kept at a distance r is proportional to

(A) r^2

(B) r^{-3}

(C) r^4

(D) none of these

Correct Answer: (B) r^{-3}

Solution:

Step 1: Understanding electrostatic energy.

The electrostatic potential energy between two electric dipoles is inversely proportional to the cube of the distance between them. The formula is given by:

$$U \propto \frac{1}{r^3}$$

where r is the distance between the dipoles.

Step 2: Analyzing the options.

(A) r^2**:** Incorrect. The energy is not proportional to r^2.

(B) r^{-3}**:** Correct — This is the correct relationship for the electrostatic energy between two dipoles.

(C) r^4**:** Incorrect. This is not the correct exponent for the energy relationship.

(D) none of these: Incorrect. Option (B) is the correct answer.

Step 3: Conclusion.

The correct answer is **(B)** r^{-3}, as the electrostatic energy is inversely proportional to r^3.

Quick Tip

The electrostatic energy between two dipoles is inversely proportional to the cube of the distance between them: $U \propto \frac{1}{r^3}$.

---

67. Picofarad is the unit of

(A) electric charge

(B) intensity of electric field

(C) electric capacity

(D) electric flux

Correct Answer: (C) electric capacity

Solution:

Step 1: Understanding the unit picofarad.

Picofarad (pF) is a unit of capacitance, which measures the ability of a component (like a capacitor) to store charge. One picofarad is equal to 10^{-12} farads.

Step 2: Analyzing the options.

(A) electric charge: Incorrect. Picofarad is not a unit of charge. It is a unit of capacitance.

(B) intensity of electric field: Incorrect. Picofarad is not used to measure the intensity of the electric field.

(C) electric capacity: Correct — Picofarad is the unit of electric capacitance (capacity to store charge).

(D) electric flux: Incorrect. Picofarad is not used for electric flux.

Step 3: Conclusion.

The correct answer is **(C) electric capacity**, as picofarad is the unit of capacitance.

Quick Tip

Picofarad (pF) is a unit of capacitance, used to measure the ability of a capacitor to store charge.

68. Capacity of any condenser does not depend upon

(A) shape of plates

(B) size of plates

(C) charges on plates

(D) distance between plates

Correct Answer: (C) charges on plates

Solution:

Step 1: Understanding the capacity of a condenser.

The capacitance of a capacitor or condenser is given by:

$$C = \frac{\varepsilon_0 A}{d}$$

where C is the capacitance, ε_0 is the permittivity of free space, A is the area of the plates, and d is the distance between the plates. The capacitance does not depend on the charges on the plates, but rather on the physical characteristics of the plates (size, shape) and the distance between them.

Step 2: Analyzing the options.

(A) shape of plates: Incorrect. The shape of plates can affect the capacitance.

(B) size of plates: Incorrect. The size of the plates also affects the capacitance.

(C) charges on plates: Correct — The capacitance is independent of the charges on the plates. It depends on the physical parameters of the condenser.

(D) distance between plates: Incorrect. The distance between the plates affects the capacitance.

Step 3: Conclusion.

The correct answer is **(C) charges on plates**, as the capacitance does not depend on the amount of charge on the plates.

Quick Tip

Capacitance depends on the physical characteristics of the plates and the distance between them, but not on the charges on the plates.

69. The capacity of a spherical conductor is $1.0\mu F$. Its radius will be

(A) 1.11 meter

(B) 10 meter

(C) 9 km

(D) 1.11 cm

Correct Answer: (A) 1.11 meter

Solution:

Step 1: Formula for the capacitance of a spherical conductor.

The capacitance C of a spherical conductor is given by:

$$C = \frac{4\pi\varepsilon_0 r}{1}$$

where r is the radius of the sphere, ε_0 is the permittivity of free space, and C is the capacitance. Given that the capacitance is $1.0\mu F$, we can solve for r.

Step 2: Analyzing the options.

Using the formula for capacitance of a sphere, we find the radius of the sphere to be approximately 1.11 meters.

Step 3: Conclusion.

The correct answer is **(A) 1.11 meter**, as the radius of the sphere for a $1.0\mu F$ conductor is 1.11 meters.

Quick Tip

The capacitance of a spherical conductor is directly proportional to its radius. Use the formula $C = \frac{4\pi\varepsilon_0 r}{1}$ to find the radius when the capacitance is known.

---

70. The dielectric constant of a metal is

(A) 1

(B) 0

(C) ∞

(D) none of these

Correct Answer: (B) 0

Solution:

Step 1: Understanding dielectric constant.

The dielectric constant (also known as relative permittivity) of a material is a measure of its ability to store electrical energy in an electric field. For metals, the dielectric constant is zero because metals are conductors, and they do not support an electric field inside them. In contrast, non-conducting materials like air or glass have a dielectric constant greater than 1.

Step 2: Analyzing the options.

(A) 1: Incorrect. The dielectric constant of metals is not 1.

(B) 0: Correct — Metals have a dielectric constant of 0.

(C) ∞: Incorrect. Metals do not have an infinite dielectric constant.

(D) none of these: Incorrect. The correct answer is (B).

Step 3: Conclusion.

The correct answer is **(B) 0**, as the dielectric constant of metals is 0.

> **Quick Tip**
>
> The dielectric constant of a metal is 0, because metals are conductors and do not support an electric field inside.

Section B

1. What is electromagnetic wave? On which factors does its velocity in vacuum depend?

Solution:

Step 1: Understanding electromagnetic waves.

Electromagnetic waves are waves that propagate through space with the help of oscillating electric and magnetic fields. They travel at the speed of light (c) in a vacuum and include light, radio waves, microwaves, X-rays, and others. Electromagnetic waves do not require any medium to propagate and can travel through a vacuum.

Step 2: Factors affecting the velocity of electromagnetic waves in a vacuum.

The velocity of electromagnetic waves in a vacuum is constant and is denoted by the speed of light c. This speed is approximately 3×10^8 m/s. The speed of electromagnetic waves in a vacuum depends on the permeability μ_0 and the permittivity ε_0 of free space, and is given by the formula:

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

where μ_0 is the permeability of free space and ε_0 is the permittivity of free space. In a vacuum, both μ_0 and ε_0 are constants, and thus the velocity of electromagnetic waves remains constant at c in a vacuum.

Step 3: Conclusion.

The velocity of electromagnetic waves in a vacuum is constant and depends on the constants μ_0 and ε_0, which are properties of free space.

Quick Tip

The speed of electromagnetic waves in a vacuum is constant and given by $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$, which is approximately 3×10^8 m/s.

---

2. What is cyclotron? State its two limitations.

Solution:

Step 1: Understanding a cyclotron.

A cyclotron is a type of particle accelerator that uses a magnetic field and an electric field to accelerate charged particles to high speeds. It works by applying a perpendicular magnetic field to the charged particle's path, which causes the particle to move in a circular path. At the same time, an oscillating electric field is applied to the particle as it moves between two "dees" (electrodes shaped like D's), which accelerates the particle. The particle's velocity increases with each pass through the electric field.

Step 2: Limitations of a cyclotron.

1. **Relativistic Limitation:** As the speed of the particle increases, its relativistic mass increases, which results in a decrease in the frequency of the oscillating electric field. This

means the cyclotron can no longer accelerate the particle effectively once its speed approaches the speed of light. This limits the cyclotron's ability to accelerate particles to very high energies.

2. **Size Limitation:** Cyclotrons are limited by their physical size. The radius of the circular path of the particles increases as the particle's energy increases. For higher energies, the cyclotron needs to be very large, which is not practical.

Step 3: Conclusion.

The cyclotron is an important device for accelerating particles, but it has limitations related to relativistic effects and its physical size.

> Quick Tip
>
> Cyclotrons can accelerate particles to high speeds, but they have limitations due to relativistic effects and the increasing size needed for higher energies.

---

3. Define two magnetic elements of the earth.

Solution:

Step 1: Understanding magnetic elements of the Earth.

The Earth's magnetic field is similar to that of a bar magnet, but it is more complex. There are two main magnetic elements that describe the Earth's magnetic field:

1. **Declination (D):** Declination is the angle between the magnetic meridian (the direction of the magnetic field) and the geographic meridian (true north). It is measured in degrees east or west of true north. The declination varies depending on the location on Earth.

2. **Inclination (I):** Inclination, also called magnetic dip, is the angle between the Earth's magnetic field and the horizontal plane. At the magnetic poles, the inclination is $90°$, meaning the field lines are vertical, while at the equator, the inclination is $0°$, meaning the field lines are horizontal.

Step 2: Conclusion.

The two main magnetic elements of the Earth are declination, which measures the angular difference between the magnetic and geographic meridians, and inclination, which measures the angle between the Earth's magnetic field and the horizontal plane.

Quick Tip

Magnetic declination and inclination describe the orientation of the Earth's magnetic field relative to the surface.

---

4. What is eddy current? Write down its utilities.

Solution:

Step 1: Understanding eddy current.

Eddy currents are circulating currents induced in a conductor when it is exposed to a changing magnetic field. According to Faraday's law of electromagnetic induction, a time-varying magnetic field produces an electric field, which in turn induces currents in the conductor. These circulating currents are called eddy currents. The direction of the induced current is given by Lenz's law, which opposes the change in magnetic flux.

Step 2: Utility of eddy currents.

Eddy currents are widely used in various applications, such as:

- **Induction heating:** Eddy currents are used to heat materials in induction furnaces for melting metals.
- **Eddy current brakes:** Eddy currents are used in braking systems, where they generate opposing magnetic fields that slow down a moving object without physical contact.
- **Metal detectors:** Eddy currents help in detecting metals by measuring the opposing currents they generate when subjected to a magnetic field.
- **Electric meters:** Eddy currents are used in electric meters to measure the energy consumption based on the heat generated due to resistance.

Step 3: Conclusion.

Eddy currents are induced currents that are widely used in industrial applications such as induction heating, braking systems, and metal detection.

Quick Tip

Eddy currents are generated when a conductor is exposed to a changing magnetic field and can be used for heating, braking, and metal detection.

---

5. Write down energy losses in transformer.

Solution:

Step 1: Energy losses in a transformer.

Transformers, though efficient, experience several types of energy losses during operation. The major energy losses in transformers are:

1. **Core loss (Iron loss):** The core of a transformer is subjected to alternating magnetic flux, which induces eddy currents in the iron core. These eddy currents and hysteresis (caused by the magnetization and demagnetization of the core) lead to energy loss. This is also called iron loss and is made up of hysteresis loss and eddy current loss.

2. **Copper loss (Winding loss):** The resistance of the transformer windings causes energy loss in the form of heat when current flows through the windings. This loss is proportional to the square of the current. The copper loss can be calculated as I^2R, where I is the current and R is the resistance of the windings.

3. **Leakage flux loss:** Some magnetic flux does not contribute to energy transfer between the primary and secondary windings of the transformer. This leakage flux can cause losses in the form of heat in the windings.

4. **Dielectric loss:** The insulation used in the transformer also leads to some energy loss due to its resistance to the flow of electric current. This is a relatively small loss but still contributes to the total energy loss.

Step 2: Conclusion.

Energy losses in transformers are primarily due to core losses (iron loss), copper losses (winding losses), leakage flux losses, and dielectric losses.

Quick Tip

Transformer losses are due to core losses (eddy currents and hysteresis), copper losses (resistance of windings), and leakage flux.

---

6. Explain polarization of light.

Solution:

Step 1: Understanding light polarization.

Polarization of light refers to the phenomenon where the oscillations of light waves are restricted to a specific direction. In unpolarized light, the electric field oscillates in multiple directions perpendicular to the direction of propagation. When light is polarized, its electric field vibrates in a single plane.

Step 2: Methods of polarization.

Light can be polarized in the following ways:

- **Polarization by reflection:** When light reflects off a surface at a certain angle (Brewster's angle), it gets polarized. The reflected light oscillates in a plane parallel to the surface.
- **Polarization by absorption:** Polarizing filters, such as Polaroid sheets, allow only light vibrating in a certain direction to pass through, blocking other vibrations.
- **Polarization by scattering:** Light can be polarized by scattering off particles or molecules in the atmosphere. This is why the sky appears blue, as sunlight scatters and gets partially polarized.

Step 3: Conclusion.

Polarization of light is the process of restricting light to oscillate in one direction. This is achieved through various methods such as reflection, absorption, and scattering.

Quick Tip

Polarization occurs when light's oscillations are restricted to a single plane, and it can be achieved through reflection, absorption, or scattering.

---

7. Convert binary number $(1101)_2$ into decimal system.

Solution:

Step 1: Understanding binary to decimal conversion.

To convert a binary number to a decimal, multiply each digit of the binary number by 2 raised to the power of its position (starting from 0 from the right). Then sum the results.

For $(1101)_2$, we perform the following:

$$(1101)_2 = 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$

$$= 1 \times 8 + 1 \times 4 + 0 \times 2 + 1 \times 1$$

$$= 8 + 4 + 0 + 1 = 13$$

Step 2: Conclusion.

The decimal equivalent of $(1101)_2$ is 13.

Quick Tip

To convert binary to decimal, multiply each binary digit by $2^{position}$, then sum the results.

---

8. Explain www and Fax.

Solution:

Step 1: Understanding WWW.

WWW (World Wide Web) is a system of interlinked hypertext documents that are accessed through the internet. It allows users to view and interact with text, images, and other multimedia through web browsers. It uses the HTTP protocol to transfer data and is a vast collection of websites and webpages that provide information, entertainment, services, and more.

Step 2: Understanding Fax.

Fax (short for facsimile) is a method of transmitting scanned printed material, such as text or images, over a telephone line or the internet. A fax machine scans the document, converts it into a digital signal, and transmits it to a receiving fax machine, which then prints the document. Fax technology is widely used in offices for transmitting official documents.

Step 3: Conclusion.

WWW is the system of accessing and interacting with information on the internet, while Fax is a method of transmitting scanned documents over a telephone or internet line.

> **Quick Tip**
>
> WWW allows users to access and interact with information on the internet, while Fax transmits documents over a telephone or internet line.

---

9. What is critical angle? Write down its necessary conditions.

Solution:

Step 1: Understanding critical angle.

The critical angle is the angle of incidence above which total internal reflection occurs when light passes from a denser medium to a rarer medium. It is the minimum angle of incidence for which the refracted ray becomes parallel to the boundary between the two media. At this angle, the refracted ray travels along the boundary, and the angle of refraction is $90°$.

The formula for the critical angle (θ_c) is given by:

$$\sin\theta_c = \frac{n_2}{n_1}$$

where n_1 is the refractive index of the denser medium and n_2 is the refractive index of the rarer medium.

Step 2: Necessary conditions for total internal reflection.

1. The light must travel from a denser medium to a rarer medium (for example, from glass to air).

2. The angle of incidence must be greater than the critical angle for total internal reflection to occur.

Step 3: Conclusion.

The critical angle is the minimum angle of incidence above which total internal reflection occurs, and it depends on the refractive indices of the two media involved.

Quick Tip

Total internal reflection occurs only when light moves from a denser to a rarer medium, and the angle of incidence exceeds the critical angle.

---

10. $\mathbf{10}^{19} electronsareplacedonanunchargedbody.Calculatethechargeproducedonthebody.$

Solution:

Step 1: Understanding the charge of an electron.

The charge on a single electron is approximately $e = 1.6 \times 10^{-19}$ Coulombs.

Step 2: Calculating the total charge.

If 10^{19} electrons are placed on the body, the total charge Q is given by:

$$Q = \text{number of electrons} \times \text{charge of one electron}$$

$$Q = 10^{19} \times 1.6 \times 10^{-19}\,\text{C}$$

$$Q = 1.6\,\text{C}$$

Step 3: Conclusion.

The total charge produced on the body is $1.6\,\text{C}$.

Quick Tip

To calculate the charge produced by a number of electrons, multiply the number of electrons by the charge of one electron: $Q = \text{number of electrons} \times e$.

---

11. Explain the difference between nuclear fission and nuclear fusion.

Solution:

Step 1: Understanding nuclear fission.

Nuclear fission is a process in which a heavy atomic nucleus splits into two smaller nuclei along with the release of a large amount of energy. This process typically occurs when an atomic nucleus, such as uranium-235, absorbs a neutron and becomes unstable. The nucleus then splits into smaller fragments, releasing more neutrons and energy in the form of heat. This reaction is used in nuclear reactors and atomic bombs.

Step 2: Understanding nuclear fusion.

Nuclear fusion is the process in which two light atomic nuclei combine to form a heavier nucleus, releasing a tremendous amount of energy. The most common fusion reaction occurs between hydrogen isotopes (deuterium and tritium) to form helium and energy. Fusion is the process that powers stars, including the sun, and has the potential for use in future clean energy production.

Step 3: Comparing fission and fusion.

- Nuclear Fission: Splitting of a heavy nucleus into smaller nuclei, releases energy. It is used in nuclear reactors and bombs.
- Nuclear Fusion: Combining of two light nuclei into a heavier nucleus, releases more energy than fission. It powers stars and has potential for clean energy.

Step 4: Conclusion.

Nuclear fission involves the splitting of heavy nuclei, while nuclear fusion involves the combining of light nuclei. Fusion releases much more energy than fission.

> Quick Tip
>
> Fusion releases significantly more energy than fission and is the process that powers stars, while fission is used in nuclear reactors.

---

12. What is Rydberg constant? Write down its unit.

Solution:

Step 1: Understanding Rydberg constant.

The Rydberg constant R_H is a physical constant that appears in the Rydberg formula for the spectral lines of hydrogen. It is used to calculate the wavelengths of the lines in the hydrogen spectrum. The value of the Rydberg constant for hydrogen is:

$$R_H = 1.097 \times 10^7 \, \text{m}^{-1}$$

Step 2: Unit of Rydberg constant.

The unit of the Rydberg constant is inverse meters (m^{-1}) because it represents the reciprocal of the wavelength of light in the hydrogen spectrum.

Step 3: Conclusion.

The Rydberg constant is used in spectroscopy and has a value of $1.097 \times 10^7\,m^{-1}$. Its unit is m^{-1}.

> **Quick Tip**
>
> The Rydberg constant is used to calculate the wavelengths of spectral lines in hydrogen and has a unit of m^{-1}.

---

13. What is wattless current?

Solution:

Step 1: Understanding wattless current.

Wattless current is the current that flows in an AC circuit but does not contribute to the power consumed by the circuit. It does not do any real work because it is out of phase with the voltage. The wattless current, also known as reactive current, is associated with inductive or capacitive elements in the circuit (such as inductors or capacitors) and contributes only to the reactive power, not the active power.

Step 2: Conclusion.

Wattless current is the current that flows in an AC circuit but does not contribute to the real power. It is associated with reactive components.

> **Quick Tip**
>
> Wattless current does not contribute to real power in the circuit. It is out of phase with voltage and is associated with reactive components like inductors and capacitors.

---

14. What is light-emitting diode (LED)? Write down its one application.

Solution:

Step 1: Understanding LED.

A Light Emitting Diode (LED) is a semiconductor device that emits light when an electric current flows through it. Unlike traditional light sources such as incandescent bulbs, LEDs use electroluminescence to produce light. The color of the emitted light depends on the material used to make the LED. LEDs are energy-efficient, have a long life, and produce very little heat.

Step 2: One application of LED.

One common application of LEDs is in **display screens** (such as TV screens, computer monitors, and smartphones). LEDs are used in the backlighting of these displays because of their efficiency and ability to produce bright, clear images.

Step 3: Conclusion.

An LED is a semiconductor device that emits light, and one of its common applications is in display screens.

> **Quick Tip**
>
> LEDs are widely used in display screens due to their energy efficiency and long lifespan.

---

15. p-type and n-type semiconductors: Mention the difference between them.

Solution:

Step 1: Understanding p-type and n-type semiconductors.

- **p-type semiconductor:** A p-type semiconductor is a semiconductor that is doped with an element that has fewer valence electrons than the semiconductor material. For example, silicon (which has four valence electrons) can be doped with boron (which has three valence electrons). This creates 'holes' (positive charge carriers) in the material. In a p-type semiconductor, the majority charge carriers are holes.

- **n-type semiconductor:** An n-type semiconductor is doped with an element that has more valence electrons than the semiconductor material. For example, silicon can be doped with phosphorus (which has five valence electrons). This creates extra electrons (negative charge carriers) in the material. In an n-type semiconductor, the majority charge carriers are electrons.

Step 2: Key differences.

1. Charge carriers: - p-type: Majority charge carriers are holes (positive charge). - n-type: Majority charge carriers are electrons (negative charge).

2. Doping elements: - p-type: Doped with elements having fewer valence electrons than the semiconductor (e.g., boron for silicon). - n-type: Doped with elements having more valence electrons than the semiconductor (e.g., phosphorus for silicon).

Step 3: Conclusion.

The key difference between p-type and n-type semiconductors is the type of charge carrier (holes vs. electrons) and the doping element used to create those charge carriers.

> **Quick Tip**
>
> In p-type semiconductors, the majority charge carriers are holes, while in n-type semiconductors, the majority charge carriers are electrons.

---

16. Write down two uses of shunt.

Solution:

Step 1: Understanding the shunt.

A shunt is a low-resistance resistor used in parallel with a measuring instrument to divert a portion of the current around the instrument. This is done to protect the instrument from high currents or to measure higher currents than the instrument's rated capacity.

Step 2: Uses of shunt.

1. **Current measurement:** A shunt is used to measure large currents by diverting a small known fraction of the current through a voltmeter. The voltage drop across the shunt can be used to calculate the total current.

2. **Protecting instruments:** A shunt is used to protect sensitive instruments like ammeters from damage due to excessive current. By providing an alternate path for excess current, it prevents the instrument from burning out.

Step 3: Conclusion.

Shunts are used for current measurement and protecting instruments from excessive currents.

Quick Tip

A shunt is used in parallel with an instrument to measure large currents and protect the instrument from excessive currents.

---

17. Define intensity of electric field at any point. Write down its S.I. unit.

Solution:

Step 1: Understanding electric field intensity.

The intensity of an electric field at any point is defined as the force experienced by a unit positive charge placed at that point. Mathematically, it is given by:

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

where E is the electric field intensity, F is the force acting on the charge, and q is the magnitude of the charge.

Step 2: SI unit of electric field intensity.

The SI unit of electric field intensity is Newton per Coulomb (N/C), since the electric field is defined as the force per unit charge. The unit can also be expressed as volts per meter (V/m) because 1 V/m $= 1$ N/C.

Step 3: Conclusion.

The electric field intensity at a point is the force experienced by a unit charge, and its SI unit is Newton per Coulomb (N/C) or volts per meter (V/m).

Quick Tip

Electric field intensity is the force per unit charge and its SI unit is N/C or V/m.

---

18. An electric dipole of dipole moment 2×10^{-6} Cm is kept inside a closed surface. What will be the net flux coming out from the surface?

Solution:

Step 1: Understanding Gauss's law.

Gauss's law states that the net electric flux through a closed surface is proportional to the total charge enclosed within the surface. Mathematically, Gauss's law is given by:

$$\Phi = \frac{Q_{\text{enc}}}{\varepsilon_0}$$

where Φ is the electric flux, Q_{enc} is the enclosed charge, and ε_0 is the permittivity of free space.

Step 2: Electric flux for a dipole.

In the case of an electric dipole, even though it has a dipole moment, the net charge enclosed by the surface is zero (since the positive and negative charges of the dipole cancel each other out). According to Gauss's law, if the net charge enclosed by the surface is zero, the net electric flux through the surface will also be zero.

Step 3: Conclusion.

Since the dipole does not contribute any net charge inside the closed surface, the net flux through the surface will be zero.

Quick Tip

The net flux through a closed surface is zero when the enclosed charge is zero, as in the case of an electric dipole.

---

19. Find the increase in energy of a condenser of capacity 6 μF on changing potential difference from 10 V to 20 V.

Solution:

Step 1: Formula for energy stored in a capacitor.

The energy stored in a capacitor is given by the formula:

$$E = \frac{1}{2}CV^2$$

where E is the energy, C is the capacitance, and V is the potential difference across the capacitor.

Step 2: Energy before the potential difference change.

Initially, the potential difference is 10 V, so the energy stored in the capacitor is:

$$E_1 = \frac{1}{2} \times 6 \times 10^{-6} \times 10^2$$

$$E_1 = \frac{1}{2} \times 6 \times 10^{-6} \times 100 = 3 \times 10^{-4}\,\text{J}$$

Step 3: Energy after the potential difference change.

After the potential difference is changed to 20 V, the energy stored in the capacitor becomes:

$$E_2 = \frac{1}{2} \times 6 \times 10^{-6} \times 20^2$$

$$E_2 = \frac{1}{2} \times 6 \times 10^{-6} \times 400 = 1.2 \times 10^{-3}\,\text{J}$$

Step 4: Increase in energy.

The increase in energy is the difference between the final and initial energies:

$$\Delta E = E_2 - E_1 = 1.2 \times 10^{-3} - 3 \times 10^{-4}$$

$$\Delta E = 9 \times 10^{-4}\,\text{J}$$

Step 5: Conclusion.

The increase in energy of the capacitor is 9×10^{-4} J.

> **Quick Tip**
>
> The energy stored in a capacitor is proportional to the square of the potential difference. The change in energy can be found by calculating the difference in energy at the two potential differences.

---

20. What are ohmic and non-ohmic resistances? Write down one example of both.

Solution:

Step 1: Understanding ohmic resistance.

Ohmic resistance refers to the resistance of materials that obey Ohm's law, which states that the current passing through a conductor is directly proportional to the voltage across it and inversely proportional to the resistance. This is expressed as:

$$V = IR$$

where V is the voltage, I is the current, and R is the resistance. In ohmic resistors, the resistance remains constant over a wide range of voltages.

Example of ohmic resistance:

- Resistor: A simple metallic wire or resistor made of materials like copper or tungsten exhibits ohmic behavior.

Step 2: Understanding non-ohmic resistance.

Non-ohmic resistance refers to the resistance of materials that do not follow Ohm's law. In these materials, the current is not directly proportional to the voltage, and the resistance can vary depending on factors such as temperature, voltage, or current. Non-ohmic resistors show a non-linear relationship between current and voltage.

Example of non-ohmic resistance:

- Diodes: A semiconductor diode is a non-ohmic device because its current-voltage (I-V) characteristic is not linear, and it allows current to flow in one direction but not the other.

Step 3: Conclusion.

Ohmic resistance follows Ohm's law and maintains a constant resistance, while non-ohmic resistance does not follow Ohm's law and exhibits varying resistance under different conditions.

> **Quick Tip**
>
> Ohmic resistors obey Ohm's law, with a linear relationship between current and voltage, while non-ohmic resistors do not obey this law and have non-linear characteristics.

---

21. What is an electric dipole? Find an expression for electric potential at any point due to an electric dipole.

Solution:

Step 1: Understanding electric dipole.

An electric dipole consists of two equal and opposite charges separated by a small distance. It is represented as $+q$ and $-q$, with a separation distance $2a$ between the charges. The dipole moment $\vec{p}$ is given by:

$$\vec{p} = q \cdot 2a$$

where q is the charge and $2a$ is the separation distance between the charges.

Step 2: Electric potential due to an electric dipole.

The electric potential V at a point P due to a dipole is given by the formula:

$$V = \frac{1}{4\pi\varepsilon_0} \left(\frac{\vec{p} \cdot \hat{r}}{r^2} \right)$$

where $\vec{p}$ is the dipole moment, $\hat{r}$ is the unit vector in the direction of the point, and r is the distance from the dipole.

Step 3: Conclusion.

The potential at any point due to an electric dipole is a function of the dipole moment and the distance from the dipole.

> **Quick Tip**
>
> The electric potential due to an electric dipole falls off as $\frac{1}{r^2}$ with distance from the dipole, and it depends on the direction relative to the dipole moment.

---

22. What is interference of light? Find an expression for fringe width in Young's double slit experiment.

Solution:

Step 1: Understanding interference of light.

Interference of light occurs when two or more light waves overlap and combine. The resultant intensity at any point is the sum of the intensities of the individual waves. Interference can be constructive (when the waves are in phase) or destructive (when the waves are out of phase).

Step 2: Fringe width in Young's double slit experiment.

In Young's double slit experiment, the fringe width (distance between two consecutive maxima or minima) is given by the formula:

$$\beta = \frac{\lambda D}{d}$$

where: - λ is the wavelength of light, - D is the distance between the screen and the slits, - d is the separation between the slits.

Step 3: Conclusion.

The fringe width depends on the wavelength of light, the distance from the slits to the screen, and the slit separation.

Quick Tip

The fringe width in Young's double slit experiment increases with the wavelength of light and the distance between the slits and the screen, and decreases with the slit separation.

---

23. Mention the defects of human vision and describe the method to remove them.

Solution:

Step 1: Understanding defects of human vision.

There are several common defects in human vision: 1. Myopia (nearsightedness): A condition where distant objects appear blurry because the eye focuses the image in front of the retina. 2. Hyperopia (farsightedness): A condition where close objects appear blurry because the eye focuses the image behind the retina. 3. Astigmatism: A defect caused by an irregularly shaped cornea, leading to distorted vision. 4. Presbyopia: Age-related difficulty in focusing on nearby objects due to the loss of elasticity in the eye's lens.

Step 2: Methods to remove defects.

1. For Myopia: Myopia is corrected with concave lenses, which diverge light rays before they enter the eye, moving the focal point back onto the retina.

2. For Hyperopia: Hyperopia is corrected with convex lenses, which converge light rays to focus the image on the retina.

3. For Astigmatism: This is corrected with cylindrical lenses that compensate for the uneven curvature of the cornea.

4. For Presbyopia: This condition is typically corrected with bifocal or multifocal lenses, which help focus on both near and distant objects.

Step 3: Conclusion.

Human vision defects can be corrected using appropriate lenses like concave, convex, or cylindrical lenses depending on the nature of the defect.

> **Quick Tip**
>
> Lenses of different shapes are used to correct common vision defects, depending on the focal point and shape of the eye.

---

24. Write the properties of diamagnetic, paramagnetic, and ferromagnetic materials.

Solution:

Step 1: Diamagnetic materials.

Diamagnetic materials are those that are repelled by a magnetic field. The magnetic permeability of these materials is less than that of free space, i.e., $\mu_r < 1$. These materials do not retain magnetization after the external magnetic field is removed. Examples include copper, silver, and bismuth. Their properties are: - Weakly repelled by magnetic fields. - Do not retain magnetization. - χ_m (magnetic susceptibility) is negative.

Step 2: Paramagnetic materials.

Paramagnetic materials are weakly attracted to a magnetic field. They have a positive but small magnetic susceptibility, i.e., $\chi_m > 0$. These materials are not strongly magnetized and lose their magnetization once the external magnetic field is removed. Examples include aluminum, platinum, and oxygen. Their properties are: - Weakly attracted to magnetic fields. - Have a small positive magnetic susceptibility. - χ_m is positive but less than 1.

Step 3: Ferromagnetic materials.

Ferromagnetic materials are strongly attracted to a magnetic field and can retain magnetization even after the external magnetic field is removed. These materials have a large positive magnetic susceptibility and are the strongest type of magnetic material. Examples include iron, cobalt, and nickel. Their properties are: - Strongly attracted to magnetic fields. - Can retain their magnetization after the external magnetic field is removed. - χ_m is much greater than 1.

Step 4: Conclusion.

The properties of diamagnetic, paramagnetic, and ferromagnetic materials differ in their interaction with magnetic fields, with ferromagnetic materials being the strongest in terms of magnetization.

Quick Tip

Ferromagnetic materials can retain their magnetization, while paramagnetic and diamagnetic materials lose it once the external field is removed.

---

25. Define self-inductance and write its S.I. unit. Find the self-inductance for a solenoid of N turns, length l, and radius r.

Solution:

Step 1: Understanding self-inductance.

Self-inductance is a property of a coil (or solenoid) that quantifies its ability to oppose changes in current. It is defined as the ratio of the induced electromotive force (emf) in the coil to the rate of change of current producing the emf:

$$L = \frac{N\Phi}{I}$$

where: - L is the self-inductance, - N is the number of turns in the coil, - Φ is the magnetic flux linked with the coil, and - I is the current passing through the coil.

Step 2: S.I. unit of self-inductance.

The S.I. unit of self-inductance is Henry (H). One Henry is defined as the self-inductance when an emf of 1 volt is induced in the coil by a current that changes at the rate of 1 ampere per second.

Step 3: Self-inductance of a solenoid.

For a solenoid with N turns, length l, and radius r, the self-inductance is given by the formula:

$$L = \frac{\mu_0 N^2 A}{l}$$

where: - μ_0 is the permeability of free space ($4\pi \times 10^{-7}$ H/m), - A is the cross-sectional area of the solenoid ($A = \pi r^2$), - l is the length of the solenoid.

Step 4: Conclusion.

The self-inductance of a solenoid depends on the number of turns, the length of the solenoid, and the cross-sectional area.

Quick Tip

The self-inductance of a solenoid is directly proportional to the square of the number of turns and the permeability of free space, and inversely proportional to its length.

---

26. Describe with diagram the working method of p-n-p and n-p-n transistors.

Solution:

Step 1: Understanding p-n-p and n-p-n transistors.

A transistor is a semiconductor device used for amplification or switching. It consists of three layers: the emitter, base, and collector. There are two types of transistors based on the arrangement of p-type and n-type materials: p-n-p and n-p-n transistors.

Step 2: p-n-p transistor.

In a p-n-p transistor, the emitter is p-type, the base is n-type, and the collector is p-type. In this type of transistor, when a small current flows from the base to the emitter, a larger current flows from the collector to the emitter. The current in the base controls the larger current flowing from the collector to the emitter, making the transistor act as an amplifier.

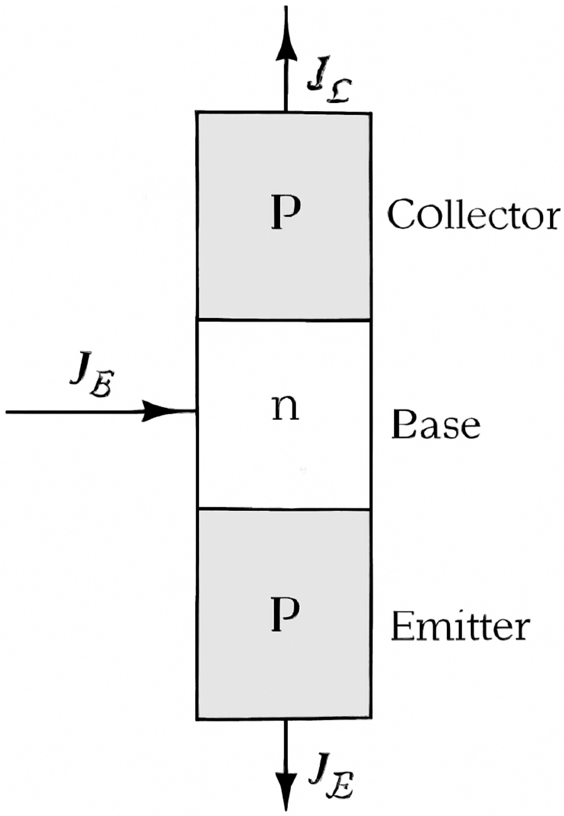
Step 3: n-p-n transistor.

In an n-p-n transistor, the emitter is n-type, the base is p-type, and the collector is n-type. The operation of this transistor is similar to the p-n-p transistor but with current flowing in the opposite direction.

Step 4: Working of p-n-p and n-p-n transistors.

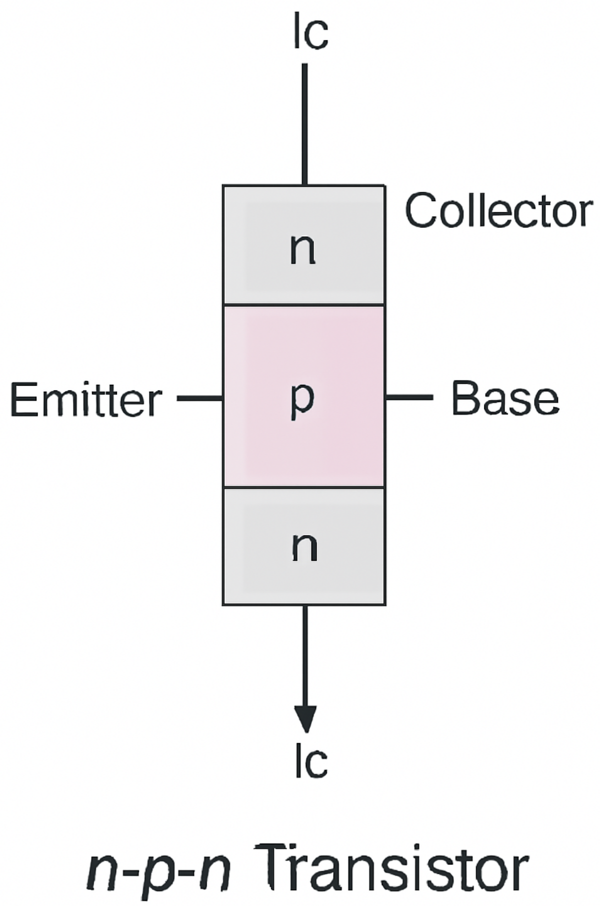
In both types of transistors: - When a small current is applied to the base-emitter junction, it controls the larger current flowing between the collector and emitter. - The transistor can amplify a small input signal into a larger output signal.

Step 5: Diagram of p-n-p and n-p-n transistors.



p-n-p Transistor

p-n-p Transistor



n-p-n Transistor

Step 6: Conclusion.

Both p-n-p and n-p-n transistors work based on the principle of current control between the collector and emitter by the small current at the base. Their primary difference is the direction of current flow and the arrangement of the layers.

> **Quick Tip**
>
> Transistors work by using a small current at the base to control a larger current between the collector and emitter, acting as either an amplifier or a switch.