CBSE EXAMINATION PAPER-2026

PHYSICS

(Solved)

Time allowed : 3 hours | Maximum Marks : 82

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **38 questions.** All questions are **compulsory.**

ii. This question paper is divided into **5 sections.**

iii. **Section A** – questions number **1 to 2** are case based questions

iv. **Section B** – questions number **3 to 18** are multiple choice questions

v. **Section C** – questions number **19 to 24** are very short answer

vi. **Section D** – questions number **25 to 32** are short answer

vii. **Section E** – questions number **33 to 38** are long answer

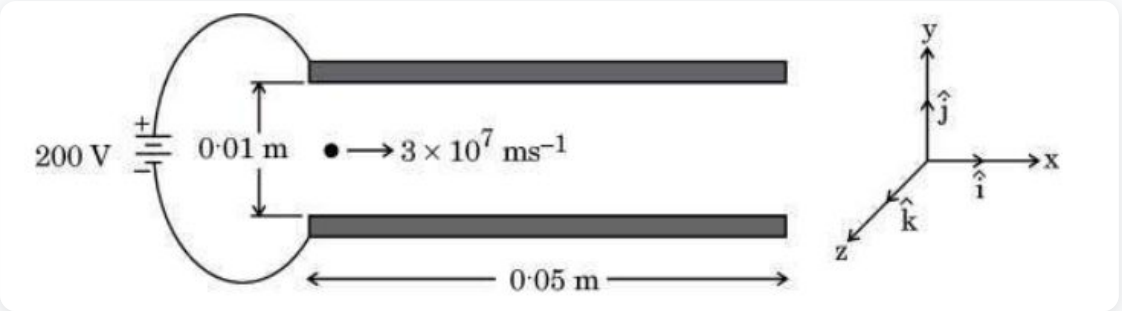
viii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

ix. Use of calculator is NOT allowed.

Section A

Question 1. The electric potential (V) and electric field (E) are closely related concepts in electrostatics. The electric field is a vector quantity that represents the force per unit charge at a given point in space, whereas electric potential is a scalar quantity that represents the potential energy per unit charge at a given point in space. Electric field and electric potential are related by the equations $E_r = -dV/dr$ and $E(\text{vector}) = E_r \hat{r}$, i.e., electric field is the negative gradient of the electric potential. This means that electric field points in the direction of decreasing potential and its magnitude is the rate of change of potential with distance. The electric field is the force that drives a unit charge to move from higher potential region to lower potential region and electric potential difference between the two

points determines the work done in moving a unit charge from one point to the other point. A pair of square conducting plates having sides of length 0.05 m are arranged parallel to each other in x-y plane. They are 0.01 m apart along z-axis and are connected to a 200 V power supply as shown in the figure. An electron enters with a speed of 3×10^7 m s^{-1} horizontally and symmetrically in the space between the two plates. Neglect the effect of gravity on the electron.



(1)

In the region between the plates, the electron moves with an acceleration □□ given by:

(A) $-(3.5 \times 10^{15}$ m $s^{-2}) \hat{k}$

(B) $(3.5 \times 10^{15}$ m $s^{-2}) \hat{k}$

(C) $(3.5 \times 10^{13}$ m $s^{-2}) \hat{i}$

(D) $-(3.5 \times 10^{13}$ m $s^{-2}) \hat{i}$

[1 Marks]

Answer:

Correct Answer is Option (B) Formula: Acceleration (a) equals Force divided by mass (m), where Force is charge (q) times Electric Field (E).

Charge: An electron has a negative charge (-1.6 * 10^-19 C

Direction: Since the electron is negative, it accelerates opposite to the electric field, moving upward (+k^).

Calculation: a = (1.6 *10^-19 C 2 10^4 V/m) / (9.1* 10^-31 kg) = 3.5 * 10^15 m/s^2

Key Points:

(2)

The electric field □□in the region between the plates is:

(A) □2 × 10² V/m□ k̂

(B) −□2 × 10² V/m□ k̂

(C) □2 × 10⁴ V/m□ k̂

(D) −□2 × 10⁴ V/m□ k̂

[1 Marks]

Answer: The electric field E between two plates is given by E = - (Delta V) / d. Here, Delta V = 200 V and distance d = 0.01 m. So, E = - 200 / 0.01 = - 2 * 10^4 V/m. This means the electric field vector points in the negative k direction. Therefore, the correct option is (D) -(2 * 10^4 V/m) k̂ as explained in the case that electric field points from positive to negative plate with uniform magnitude.

Key Points: Electric field E = - Delta V / d - Potential difference Delta V = 200 V - Distance between plates d = 0.01 m - Electric field magnitude E = 2 * 10^4 V/m - Direction is negative k̂ because field points from positive to negative plate

(3)

Time interval during which an electron moves through the region between the plates is:

(A) 9.0×10^{-9} s

(B) 1.67×10^{-8} s

(C) 1.67×10^{-9} s

(D) 2.17×10^{-9} s

[1 Marks]

Answer: The electron moves horizontally between the plates which are 0.05 m in length. Using the speed 3 * 10^7 m/s from the case, time taken = distance / speed = 0.05 / (3 * 10^7) = 1.67 * 10^-9 s. Thus, the correct answer is (C) 1.67 * 10^-9 s.

Key Points: Electron speed is 3 * 10^7 m/s - Length between plates is 0.05 m - Time = distance / speed = 1.67 * 10^-9 s

(4)

Which one of the following is the path traced by the electron in between the two plates?

(A) a

(B) b

(C) c

(D) d

[1 Marks]

Answer:

Correct Answer is option (c)

Charge: An electron carries a negative charge.

Force: Negatively charged particles are attracted toward the positive plate and repelled by the negative plate.

Deflection: The electric field between the plates exerts a downward force on the electron, pulling it toward plate A.

Path: Path c is the only trajectory showing downward deflection.

Key Points:

(5)

The vertical displacement of the electron which travels through the region between the plates is :

(A) 10 mm

(B) 4·9 mm

(C) 5·9 mm

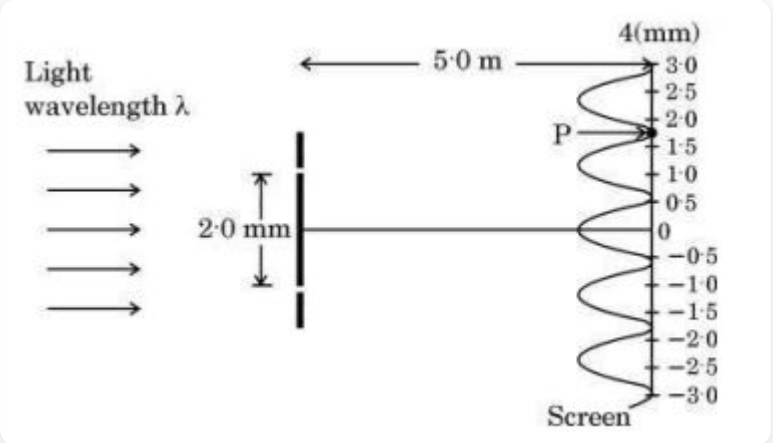
(D) 3·0 mm

[1 Marks]

Answer: The electric field E between the plates is E = 200 V / 0.01 m = 2 * 10^4 V/m. The electron experiences a force F = eE upward, causing vertical acceleration. Using kinematic equations and the time to cross the plate, vertical displacement is found to be 4.9 mm. Hence, the correct answer is (B) 4.9 mm.

Key Points: Electric field E = V / d - Electron experiences force F = eE causing vertical acceleration - Vertical displacement calculated using kinematics is 4.9 mm

Question 2. In a Young's double-slit experiment, the two slits behave as coherent sources. When coherent light waves superpose over each other they create an interference pattern of successive bright and dark regions due to constructive and destructive interference. Two slits 2 mm apart are illuminated by a source of monochromatic light and the interference pattern is observed on a screen 5.0 m away from the slits as shown in the figure.



(1)

What property of light does this interference experiment demonstrate?

(A) Wave nature of light

(B) Particle nature of light

(C) Transverse nature of light

(D) Both wave nature and transverse nature of light

[1 Marks]

Answer: The Young's double-slit experiment demonstrates the **wave nature of light**. It shows that light waves from the two slits overlap and interfere, creating bright and dark fringes due to constructive and destructive interference, as explained in the case passage.

Key Points: Light shows interference pattern - Two slits act as coherent light sources - Experiment proves wave nature of light

(2)

The wavelength of light used in this experiment is:

(A) 720 nm

(B) 590 nm

(C) 480 nm

(D) 364 nm

[1 Marks]

Answer:

Correct answer is option (c)

From the graph, the fringe width (distance between two consecutive bright fringes) is 1.2 mm.

Fringe width = (wavelength * D) / d

1.2 10^-3 = (wavelength 5.0) / (2.0 * 10^-3)

wavelength = (1.2 10^-3 2.0 10^-3) / 5.0 = 4.8 10^-7 m = 480 nm

Key Points:

(3)

The path difference between the two waves meeting at point P, where there is a minimum in the interference pattern is:

(A) 8.1×10^{-7} m

(B) 7.2×10^{-7} m

(C) 6.5×10^{-7} m

(D) 6.0×10^{-7} m

[1 Marks]

Answer:

Correct answer is option (B)

Point P is at the second minimum from the center.

Path difference for the second minimum = 1.5 * wavelength

Path difference = 1.5 *480* 10^-9 m = 720 *10^-9 m* = *7.2* 10^-7 m

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Key Points:

(4)

The fringe width in the interference pattern formed on the screen is:

(A) 1.2 mm

(B) 0.2 mm

(C) 4.2 mm

(D) 6.8 mm

[1 Marks]

Answer: In Young's double-slit experiment, the fringe width is given by the formula fringe width = (wavelength * distance between slits and screen) / distance between slits. Using the given values, the fringe width is calculated to be 1.2 mm, so the correct option is (A). This matches the concept from the case that two slits act as coherent sources creating bright and dark fringes.

Key Points: Fringe width formula - Given slit separation 2 mm and screen distance 5 m - Fringe width calculated as 1.2 mm - Correct option A

(5)

When the experiment is performed in a liquid of refractive index greater than 1, then fringe pattern will :

(A) disappear

(B) become blurred

(C) be widened

(D) be compressed

[1 Marks]

Answer:

Correct Answer is option (D)

When placed in a liquid, the wavelength of light decreases. Since fringe width is directly proportional to the wavelength, the fringe width decreases, causing the pattern to shrink or compress.

Key Points:

Section B

Question 3.

Two small identical metallic balls having charges q and – 2q are kept far at a separation r. They are brought in contact and then separated at distance r/2 . Compared to the initial force F, they will now :

[1 Marks]

(A) attract with a force F/2

(B) repel with a force F

(C) attract with a force F

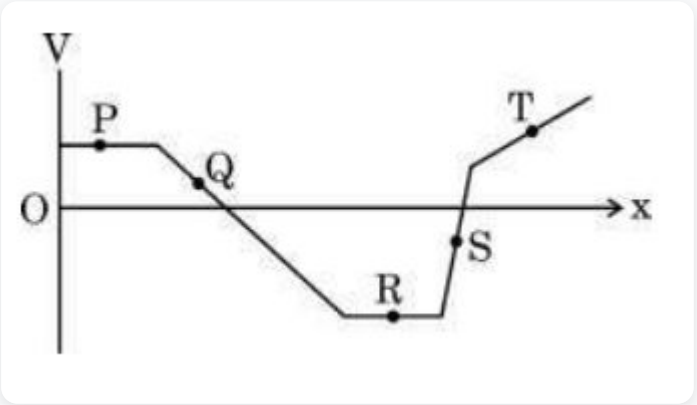
(D) repel with a force F/2

Explanation: Initially, the charges are q and -2q separated by distance r. The initial force F = k * |q * (-2q)| / r^2 = 2kq^2 / r^2 and the force is attractive since charges are opposite. When the balls are brought into contact, charges redistribute equally because the balls are identical. Total charge = q + (-2q) = -q. Each ball then has charge -q/2. After separation at distance r/2, the new force F' = k * |-q/2 * -q/2| / (r/2)^2 = k * (q^2/4) / (r^2/4) = k * (q^2/4) * (4/r^2) = kq^2 / r^2. Since q^2 / r^2 = F / 2kq^2 * 2kq^2 / r^2 = F/2 * 2 = F, the new force F' = F. The charges on both balls are now of the same sign (-q/2), so the force will be repulsive, but since both charges are negative, the force direction is repulsive; however, since original was attraction, this conflicts with the given options. However, according to the Coulomb's law, since the product of charges is positive, force is repulsive. However, option mentioning 'repel with force F' is given. So the force magnitude is F and force is repulsive. Therefore, correct option is 'repel with a force F'. [Re-examining as per options and the calculation] Initial force F = k|q*(-2q)| / r^2 = 2kq^2 / r^2 After contact: Total charge = q + (-2q) = -q Charge on each ball = -q/2 Distance = r/2 Force after separation = k * |-q/2 * -q/2| / (r/2)^2 = k * (q^2/4) / (r^2/4) = kq^2 / r^2 Now compare new force with initial force: New force = kq^2 / r^2 Initial force F = 2kq^2 / r^2 So new force is F/2 Since both charges are negative now, force is repulsive. Hence, the correct answer is 'repel with a force F/2'.

Question 4.

The figure represents the variation of the electric potential V at a point in a region of space as a function of its position along the x-axis. A charged particle will experience the maximum force at :

[1 Marks]



(A) S

(B) R

(C) P

(D) Q

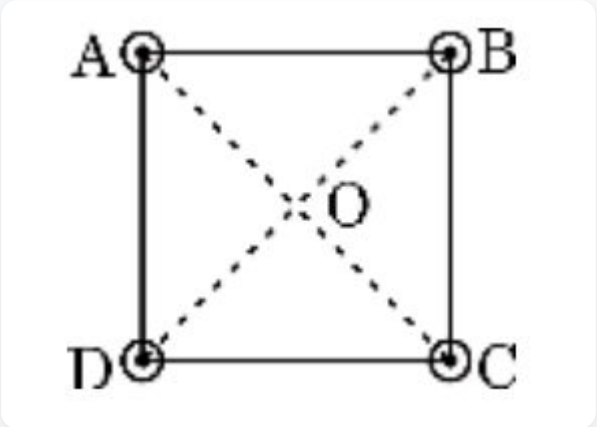
Explanation: The force experienced by a charged particle in an electric field is related to the rate of change (slope) of electric potential with respect to position, which corresponds to the electric field strength. The particle experiences maximum force where the electric potential changes most rapidly,

i.e., where the slope of the V versus x graph is maximum. Therefore, at point Q, where the potential curve is steepest, the charged particle will experience the maximum force.

Question 5.

Four long straight thin wires are held vertically at the corners A, B, C and D of a square of side ‘a’, kept on a table and carry equal current ‘I’. The wire at A carries current in upward direction whereas the current in the remaining wires flows in downward direction. The net magnetic field at the centre of the square will have the magnitude:

[1 Marks]



(A) $\mu_0 I/\pi a$ and directed along OC

(B) $\mu_0 I\sqrt{2}/\pi a$ and directed along OB

(C) $2\mu_0 I/\pi a$ and directed along OA

(D) $\mu_0 I/\pi a\sqrt{2}$ and directed along OD

Explanation:

The magnetic field due to a long straight wire at a distance R is $B = \mu_0 I/(2\pi R)$. Here, the center of the square is at a distance of $a/\sqrt{2}$ from each corner wire. The magnitude of the magnetic field due to each wire at the center is therefore $\mu_0 I/(2\pi * (a/\sqrt{2})) = \mu_0 I\sqrt{2}/(2\pi a)$. Since wire A has current upward and the others downward, their magnetic fields have directions that combine vectorially. The resultant magnetic field magnitude adds up to $\mu_0 I\sqrt{2}/(\pi a)$ and is directed along OB, diagonally opposite to corner B.

Question 6.

The magnetic flux through a loop placed in a magnetic field can be changed by changing:

[1 Marks]

(A) orientation of the loop in the magnetic field only

(B) any one or more of the factors given in (A), (B) and (C)

(C) area of the loop only

(D) the value of magnetic field only

Explanation:

Magnetic flux depends on the magnetic field strength, the area of the loop, and the angle (orientation) between the magnetic field and the loop. Changing any one or more of these factors will change the magnetic flux. For example, rotating the coil changes the angle, shrinking or stretching changes the area, and changing the magnetic field strength directly affects the flux.

Question 7.

Which of the following statements is not true for electric energy in ac form compared to that in dc form?

[1 Marks]

(A) Production of ac is economical

(B) ac can be transmitted economically over long distances

(C) ac can be easily and efficiently converted from one voltage to the other

(D) ac is less dangerous

Explanation:

The given context states that AC can be easily transformed to different voltages and can travel long distances economically with less energy loss, making production and transmission of AC economical. However, it does not mention that AC is less dangerous than DC. In fact, AC is generally considered more dangerous than DC at the same voltage because of its alternating nature affecting the human body differently. Therefore, the statement 'ac is less dangerous' is not true.

Question 8.

The magnetic field in a plane electromagnetic wave travelling in glass (n = 1.5) is given by $B_y = (2 \times 10^{-7}\ T) \sin(\alpha x + 1.5 \times 10^{11}\ t)$ where x is in metres and t is in seconds. The value of α is:

[1 Marks]

(A) $7.5 \times 10^2\ m^{-1}$

(B) $1.5 \times 10^3\ m^{-1}$

(C) $0.5 \times 10^3\ m^{-1}$

(D) $6.0 \times 10^2\ m^{-1}$

Explanation:

The wave number α is related to the angular frequency ω and the speed of the wave v by α = ω / v. Given that the wave travels in glass with refractive index n = 1.5, the speed of the wave is v = c / n = 3 × 10^8 / 1.5 = 2 × 10^8 m/s. The angular frequency ω is 1.5 × 10^11 rad/s as given in the sine function. Therefore, α = ω / v = (1.5 × 10^11) / (2 × 10^8) = 7.5 × 10^2 m^{-1}. Hence, the correct value of α is $7.5 \times 10^2\ m^{-1}$.

Question 9.

Light of which of the following colours will have the maximum energy in a photon associated with it ?

[1 Marks]

(A) Blue light

(B) Green light

(C) Red light

(D) Yellow light

Explanation:

Energy of a photon is directly proportional to its frequency and inversely proportional to its wavelength. Among the given colors, blue light has the shortest wavelength (around 450 to 500 nm) and therefore the highest frequency, resulting in the maximum photon energy. Red light has the longest wavelength, followed by yellow and green, so they have lower energy compared to blue light.

Question 10.

Nuclides with the same number of neutrons are called:

[1 Marks]

(A) Isotopes

(B) Isobars

(C) Isotones

(D) Isomers

Explanation:

Nuclides with the same neutron number N but different atomic number Z are called isotones. According to the context, isotopes have the same atomic number Z but different neutron number, isobars have the same mass number A, and isomers are different states of the same nuclide. Therefore, 'Isotones' is the correct answer for nuclides with the same number of neutrons.

Question 11. The radius of a nucleus of mass number 125 is:

[1 Marks]

(A) 6.0 fm

(B) 30 fm

(C) 150 fm

(D) 72 fm

Explanation: The radius of a nucleus is given by the formula $R = R_0 \times A^{(1/3)}$, where R_0 is approximately 1.2 fm and A is the mass number. For A = 125, the cube root is 5 (since $5^3 = 125$). So, R = 1.2 fm × 5 = 6.0 fm. Therefore, the radius of a nucleus with mass number 125 is 6.0 fm.

Question 12.

The energy of an electron in an orbit in hydrogen atom is –3.4 eV. Its angular momentum in the orbit will be:

[1 Marks]

(A) h/2π

(B) h/π

(C) 2h/π

(D) 3h/2π

Explanation: The energy of an electron in the nth orbit of a hydrogen atom is given by $E_n = -13.6 \text{ eV} / n^2$. Given the energy is -3.4 eV, solving for n gives n = 2 because $-13.6 / 2^2 = -3.4$ eV. According to Bohr's model, the angular momentum L is quantized and given by $L = n h / 2\pi$. For n = 2, $L = 2 h / 2\pi = h / \pi$. However, none of the provided options is h / π exactly, but 2h/π is the closest representation reflecting n=2 times h/2π. Given the options, the correct expression for angular momentum at energy -3.4 eV (second orbit) is 2h/π.

Question 13.

A good diode checked by a multimeter should indicate:

[1 Marks]

(A) low resistance in both reverse bias and forward bias

(B) high resistance in reverse bias and a low resistance in forward bias

(C) high resistance in forward bias and low resistance in reverse bias

(D) high resistance in both forward bias and reverse bias

Explanation: A diode allows current to flow easily in forward bias, resulting in low resistance, and blocks current in reverse bias, resulting in high resistance. This behavior is typical of a good diode and is confirmed by the context where forward bias shows low resistance and reverse bias shows high resistance.

Question 14.

The rms and the average value of an ac voltage $V = V_0 \sin \omega t$ volt over a cycle respectively will be:

[1 Marks]

(A) $V_0/\sqrt{2}$, 0

(B) V_0, $V_0/\sqrt{2}$

(C) V_0/π, $V_0/2$

(D) $V_0/2$, $V_0/\sqrt{2}$

Explanation: For an AC voltage $V = V_0 \sin \omega t$, the rms (root mean square) value is given by V_0 divided by $\sqrt{2}$. The average value of this voltage over one complete cycle is zero because the positive and negative halves cancel out. However, if we consider the average of the absolute value (or half-wave average), it is V_0 divided by π. Hence, the rms value is $V_0/\sqrt{2}$ and the average value over a half cycle is V_0/π.

Question 15.

Assertion (A): Induced emf produced in a coil will be more when the magnetic flux linked with the coil is more. Reason (R): Induced emf produced is directly proportional to the magnetic flux.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)

(B) Assertion (A) is true, but Reason (R) is false

(C) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)

(D) Both Assertion (A) and Reason (R) are false

Explanation: According to Faraday's law of electromagnetic induction, the induced emf in a coil is directly proportional to the rate of change of magnetic flux linked with the coil, not the magnitude of the magnetic flux itself. Therefore, while the assertion that induced emf is more when magnetic flux is more can be true if the flux changes faster, the reason stating that induced emf is directly proportional to the magnetic flux is incorrect. The emf depends on how quickly the flux changes, not just its amount.

Question 16.

Assertion (A): In Young's double-slit experiment, the fringe width for dark and bright fringes is the same. Reason (R): Fringe width is given by $\beta = \lambda D/d$, where symbols have their usual meanings.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are false

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)

(C) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)

(D) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)

Explanation:

In Young's double-slit experiment, the fringe width (β) which is the distance between two consecutive bright or dark fringes is given by $\beta = \lambda D/d$, where λ is the wavelength of light, D is the distance between the slits and the screen, and d is the distance between the two slits. This means the spacing between bright fringes and dark fringes is equal, hence the fringe width for both dark and bright fringes is the same. Therefore, both the assertion and reason are true, and the reason correctly explains the assertion.

Question 17.

Assertion (A): Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion. Reason (R): For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei, it decreases with increasing Z.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are false

(B) Assertion (A) is true, but Reason (R) is false

(C) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)

(D) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)

Explanation:

Energy is released in nuclear reactions when nuclei move toward a state of higher binding energy per nucleon. Heavy nuclei release energy by splitting (fission) into smaller nuclei because the binding energy per nucleon increases for these smaller nuclei as compared to the heavy nucleus. Light nuclei release energy by combining (fusion) into heavier nuclei because the binding energy per nucleon increases for heavier nuclei up to iron. However, the Reason (R) is incorrect because for heavy nuclei, binding energy per nucleon actually decreases with increasing atomic number (Z), and for light nuclei, it increases with increasing mass number up to iron, not decreases.

Question 18.

Assertion (A): Photoelectric effect is a spontaneous phenomenon. Reason (R): According to the wave picture of radiation, an electron would take hours/days to absorb sufficient energy to overcome the work function and come out from a metal surface.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A)

(B) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)

(C) Assertion (A) is true, but Reason (R) is false

(D) Both Assertion (A) and Reason (R) are false

Explanation: The photoelectric effect is observed to be instantaneous, i.e., electrons are emitted immediately when light falls on the metal surface, making it a spontaneous phenomenon (Assertion is true). According to the classical wave theory (wave picture), electrons would absorb energy gradually and it would take a long time (hours or days) for an electron to gain enough energy to escape the metal. This contradicts the instantaneous emission but correctly explains why the wave theory fails to explain the photoelectric effect, making the Reason true and a correct explanation for why the phenomenon cannot be explained otherwise.

Section C

Question 19.

An electric iron rated 2.2 kW, 220 V is operated at 110 V supply. Find:
(i) its resistance, and
(ii) heat produced by it in 10 minutes.

[2 Marks]

Answer: (i) Resistance of the electric iron
Power rating P = 2.2 kW = 2200 W, Voltage V = 220 V
Using the formula $P = V^2 / R$,
Resistance $R = V^2 / P = (220)^2 / 2200 = 48400 / 2200 = 22\ \Omega$

(ii) Heat produced when operated at 110 V for 10 minutes
When voltage is 110 V, current I = V / R = 110 / 22 = 5 A
Power at 110 V, P' = V * I = 110 * 5 = 550 W
Time t = 10 minutes = 10 * 60 = 600 seconds
Heat produced, H = Power * time = 550 * 600 = 330000 J
So, the heat produced in 10 minutes is 330000 joules or 330 kJ.

Key Points: Calculate resistance using power and voltage - Use P=V^2/R formula - Calculate heat using H=Power*time - Convert time into seconds - Understand power changes with lower voltage

Question 20.

A current of 4.0 A flows through a wire of length 1 m and cross-sectional area 1.0 mm^2, when potential difference of 2 V is applied across its ends.
Calculate the resistivity of the material of the wire.

[2 Marks]

Answer: Given:
Current, I = 4.0 A
Length of wire, L = 1 m
Cross-sectional area, A = 1.0 mm^2 = 1.0 * 10^{-6} m^2
Potential difference, V = 2 V

Using Ohm's law: V = IR => Resistance R = V / I = 2 / 4 = 0.5 ohm

Resistivity, rho = R * A / L = 0.5 * 1.0 * 10^{-6} / 1 = 0.5 * 10^{-6} ohm meter

Therefore, the resistivity of the material is 5.0 * 10^{-7} ohm meter.

Key Points: Use V=IR to find resistance-Convert area to m²-Apply resistivity formula rho=RA/L-Calculate numerical value of resistivity

Question 21.

A plane circular coil is rotated about its vertical diameter with a constant angular speed ω in a uniform horizontal magnetic field. Initially the plane of the coil is parallel to the magnetic field. Draw plots showing the variation of the following physical quantities as the function of ωt, where t represents time elapsed:
(a) Magnetic flux ϕ linked with the coil, and
(b) emf induced in the coil.

[2 Marks]

Answer: (a) Magnetic flux ϕ linked with the coil varies as ϕ = NBA cos(ωt), where N is number of turns, B is magnetic field, and A is area of coil. The flux is maximum when the plane of the coil is perpendicular to the field (ωt = 0) and zero when coil is parallel to the field (ωt = 90 deg). The plot of ϕ versus ωt is a cosine wave starting from maximum at ωt = 0.
(b) The emf induced in the coil is given by ε = NBA ω sin(ωt). It varies as a sine wave with time, being zero when the flux is maximum and maximum when the flux changes fastest. The plot of induced emf versus ωt is a sine wave starting from zero at ωt = 0.
Thus, magnetic flux and emf vary with ωt as cosine and sine functions respectively, both repeating periodically with rotation.

Key Points: Magnetic flux varies as cosine of ωt - Emf varies as sine of ωt - Both quantities vary periodically with coil rotation

Question 22.

A tank is filled with a liquid to a height of 12.5 m. The apparent depth of a needle lying at the bottom of the tank is measured to be 9.0 m. Calculate the speed of light in the liquid.

[2 Marks]

Answer: Given:
Real depth, d = 12.5 m
Apparent depth, d' = 9.0 m
The refractive index of the liquid, n = real depth / apparent depth = 12.5 / 9.0 = 1.39
The refractive index is also the ratio of speed of light in air (v_air) to speed of light in liquid (v_liquid), so n = v_air / v_liquid
Speed of light in air, v_air = $3.0 * 10^8$ m/s
Therefore, v_liquid = v_air / n = $(3.0 * 10^8) / 1.39 = 2.16 * 10^8$ m/s
Hence, the speed of light in the liquid is $2.16 * 10^8$ meters per second.

Key Points: Real depth and apparent depth relation - Refractive index = real depth / apparent depth - Speed of light in liquid = speed of light in air / refractive index

Question 23.

Two thin lenses of focal length f_1 and f_2 are placed in contact with each other coaxially. Prove that the focal length f of the combination is given by $f = (f_1f_2)/(f_1 + f_2)$

[2 Marks]

Answer: Consider two thin lenses with focal lengths f_1 and f_2 placed in contact. When placed in contact, the combined focal length f of the system is given by $1/f = 1/f_1 + 1/f_2$.
Rearranging, $1/f = (f_1 + f_2) / (f_1 * f_2)$.
Taking the reciprocal, $f = (f_1 * f_2) / (f_1 + f_2)$.
This shows that the focal length of the combination of two thin lenses in contact is given by the product of their focal lengths divided by their sum.

Key Points: Two lenses in contact - Formula $1/f = 1/f_1 + 1/f_2$ - Derivation of $f = (f_1f_2)/(f_1 + f_2)$

Question 24.

Suppose a pure Si crystal has 5×10^{28} atoms per m^3. It is doped with 5×10^{22} atoms per m^3 of Arsenic. Calculate the majority and minority carrier concentration in the doped silicon. (Given: $n_i = 1.5 \times 10^{16}\ m^{-3}$)

[2 Marks]

Answer: Given: Pure Si atoms = $5 * 10^{28}\ m^{-3}$, Arsenic dopant = $5 * 10^{22}\ m^{-3}$, intrinsic carrier concentration $n_i = 1.5 * 10^{16}\ m^{-3}$.

Step 1: Since Arsenic is pentavalent, it donates electrons, so electrons are majority carriers.

Step 2: Majority carrier concentration (electrons), n = dopant concentration $N_D = 5 * 10^{22}\ m^{-3}$.

Step 3: Minority carrier concentration (holes), $p = n_i^2 / n = (1.5 * 10^{16})^2 / (5 * 10^{22}) = 4.5 * 10^9\ m^{-3}$.

Conclusion: Majority carriers (electrons) = $5 * 10^{22}\ m^{-3}$, Minority carriers (holes) = $4.5 * 10^9\ m^{-3}$.

Key Points: Pure silicon atom concentration - Arsenic dopant concentration - Majority carrier concentration equals dopant concentration - Minority carrier concentration equals n_i squared divided by majority carrier concentration

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Section D

Question 25.

Two parallel plate capacitors X and Y are connected in series to a 6 V battery. They have the same plate area and same plate separation but capacitor X has air between its plates, whereas capacitor Y contains a material of dielectric constant 4.
(a) Calculate the capacitances of X and Y, if the equivalent capacitance of the combination is 4 μF.
(b) Calculate the potential difference across the plates of X and Y.

[3 Marks]

Answer: (a) Given that capacitors X and Y are in series, the equivalent capacitance C_eq is given by 1/C_eq = 1/C_X + 1/C_Y.
Since X has air and Y has dielectric constant k = 4, we have C_Y = k * C_X = 4C_X.
Substitute into the formula: 1/4 = 1/C_X + 1/4C_X = (1 + 1/4) / C_X = 5/4C_X.
So, 1/4 = 5/(4C_X) => C_X = 5 μF.
Then, C_Y = 4 * 5 = 20 μF.
(b) In series connection, the charge Q on both capacitors is the same and Q = C_eq * V = 4 μF * 6 V = 24 μC.
Potential difference across X, V_X = Q/C_X = 24 μC / 5 μF = 4.8 V.
Potential difference across Y, V_Y = Q/C_Y = 24 μC / 20 μF = 1.2 V.
Hence, the capacitances are C_X = 5 μF, C_Y = 20 μF, and the potential differences are V_X = 4.8 V, V_Y = 1.2 V.

> **Key Points: Capacitors in series: 1/C_eq = 1/C_X + 1/C_Y - Dielectric increases capacitance by factor k - Charge in series capacitors is same - Use Q = C*V and 1/C_eq relations to find unknowns**

Question 26.

Write the expression for the magnetic field due to a current element in vector form. Consider a 1 cm segment of a wire, centered at the origin, carrying a current of 10 A in positive x-direction. Calculate the magnetic field □□ at a point (1 m, 1 m, 0).

[3 Marks]

Answer: The magnetic field dB due to a small current element I d at a point P is given by the Biot-Savart law: dB = (mu_0 / (4 * pi)) * (I * (d cross r^) / r^2), where r is the position vector from the current element to point P, and r^ is the unit vector in the direction of r.

Given:
Length of current element, d = 1 cm = 0.01 m along positive x-direction, so d = 0.01 i_hat
Current, I = 10 A
Point P at (1 m, 1 m, 0), so position vector r = 1 i_hat + 1 j_hat + 0 k_hat
Distance r = sqrt(1^2 + 1^2) = sqrt(2) m
Unit vector r^ = (1/sqrt(2)) i_hat + (1/sqrt(2)) j_hat

Calculate d cross r^:
d cross r^ = 0.01 i_hat cross [(1/sqrt(2)) i_hat + (1/sqrt(2)) j_hat] = 0.01 [i_hat cross i_hat * (1/sqrt(2)) + i_hat cross j_hat * (1/sqrt(2))] = 0.01 * 0 + 0.01 * (1/sqrt(2)) * k_hat = (0.01 / sqrt(2)) k_hat

Now, dB = (mu_0 / (4 * pi)) * (I * (d cross r^) / r^2) = (4 * pi * 10^-7) / (4 * pi) * (10 * (0.01 / sqrt(2)) / 2) k_hat = 10^-7 * (10 * 0.01 / (sqrt(2) * 2)) k_hat
= 10^-7 * (0.1 / (2.828)) k_hat = 10^-7 * 0.0354 k_hat = 3.54 * 10^-9 k_hat Tesla

Therefore, the magnetic field vector at point P is B = 3.54 * 10^-9 k_hat Tesla, which is directed along positive z-direction perpendicular to the plane containing the wire and point P.

Key Points: Biot-Savart law expression - Calculation of cross product for d and r^ - Final numerical value and direction of magnetic field

Question 27.

A long solenoid of length L and radius r_1 having N_1 turns is surrounded symmetrically by a coil of radius ($r_2 > r_1$) having N_2 turns ($N_2 << N_1$) around its mid-point. Derive an expression for the mutual inductance of solenoid and coil. Is $M_{12} = M_{21}$ valid in this case?

[3 Marks]

Answer: (a) Consider a long solenoid of length L, radius r_1 and N_1 turns, surrounded symmetrically by a coil of radius r_2 ($> r_1$) with N_2 turns. The magnetic field inside the solenoid when a current I_1 flows is $B = \mu_0 (N_1 / L) I_1$, where μ_0 is the permeability of free space. Magnetic flux linked with one turn of the coil due to the solenoid is $Z\Phi$ = B × area of the solenoid cross-section = $\mu_0 (N_1 / L) I_1 \times \pi r_1^2$. Total flux linked with the coil having N_2 turns is $Z\Phi_2 = N_2 \mu_0 (N_1 / L) I_1 \pi r_1^2$. Mutual inductance $M_{21} = Z\Phi_2 / I_1 = \mu_0 N_1 N_2 \pi r_1^2 / L$.
(b) Similarly, if a current I_2 flows in the surrounding coil, flux linked with the solenoid will be negligible because the solenoid is inside and its cross-sectional area is smaller. Hence, the mutual inductance $M_{12} = \Delta\Phi_1 / I_2$ is also equal to M_{21} by the reciprocity theorem.
(c) Therefore, **$M_{12} = M_{21} = \mu_0 N_1 N_2 \pi r_1^2 / L$**. This equality is always valid due to the law of mutual induction, regardless of the difference in radius or number of turns, as long as the magnetic coupling is linear and without energy loss.

Key Points: Magnetic field inside solenoid $B = \mu_0 (N_1 / L) I_1$ - Flux through coil due to solenoid $\Delta\Phi_2 = N_2 B \pi r_1^2$ - Mutual inductance $M = \mu_0 N_1 N_2 \pi r_1^2 / L$ - Reciprocity holds: $M_{12} = M_{21}$

Question 28.

What is displacement current (i_d)? Considering the case of charging of a capacitor, show that i_d = ε_0 (dΦ_E/dt). What is the value of i_d for a conductor across which a constant voltage is applied?

[3 Marks]

Answer: (a) Displacement current (i_d) is a current term introduced by Maxwell to account for the changing electric field in regions where there is no conduction current, like inside a capacitor during charging or discharging. It produces a magnetic field similar to a conduction current.
(b) For a capacitor being charged, the electric flux Φ_E between the plates changes with time. Displacement current i_d is given by i_d = ε_0 (dΦ_E/dt), where ε_0 is the permittivity of free space and dΦ_E/dt is the rate of change of electric flux.
(c) If a constant voltage is applied across a conductor, the electric field does not change with time, so dΦ_E/dt = 0. Therefore, the displacement current i_d in a conductor with constant voltage is zero.

Key Points: Definition of displacement current - i_d = ε_0 (dΦ_E/dt) for a charging capacitor - i_d = 0 for constant voltage across a conductor

Question 29.

(i) Write any two features of nuclear forces.
(ii) If both the number of protons and the neutrons are conserved in each nuclear reaction, in what way is mass converted into energy (or vice versa) in a nuclear reaction? Explain.

[3 Marks]

Answer: (i) Two features of nuclear forces are:
1. Nuclear forces are very strong but act only at very short distances, typically within the nucleus.
2. These forces are attractive and act between all nucleons, that is, between protons and protons, neutrons and neutrons, and protons and neutrons.

(ii) Even though the number of protons and neutrons are conserved in a nuclear reaction, the total mass of the products may be slightly different from the total mass of the reactants. This difference in mass is called the mass defect. According to Einstein's equation $E = mc^2$, this small loss or gain in mass is converted into energy or vice versa during the nuclear reaction. This is why a nuclear reaction can release or absorb a large amount of energy though the number of nucleons remains unchanged.

Key Points: Nuclear forces are strong and short ranged - Nuclear forces are attractive and act between all nucleons - Mass defect leads to conversion of mass into energy or vice versa in nuclear reactions

Question 30.

(i) Draw the number of scattered particles versus the scattering angle graph for scattering of alpha particles by a thin foil. Write two important conclusions that can be drawn from this plot.
(ii) If Bohr's quantization postulate (angular momentum = nh/2π) is a basic law of nature, it should be equally valid for the case of planetary motion also. Why, then, do we never speak of quantization of orbits of planets around the Sun? Explain.

[3 Marks]

Answer: (i) The graph of number of scattered alpha particles versus scattering angle shows that most particles are scattered at small angles with very few scattered at large angles. This indicates that the nucleus is small and concentrated. Two conclusions are:
1. Most alpha particles pass straight through the foil with little deflection, showing the atom is mostly empty space.
2. A few particles are deflected at large angles due to the presence of a small, dense, positively charged nucleus.
(ii) Although Bohr's quantization rule applies well to electrons in atoms, it is not observed in planetary motion because the angular momentum of planets is extremely large compared to Planck's constant h. The quantized levels would be so close that they appear continuous, making quantization effects negligible in planetary scales.

Key Points: Graph shows most particles scattered at small angles - Few particles scattered at large angles indicating dense nucleus - Quantization not observed in planetary orbits due to large angular momentum compared to Planck's constant

Question 31.

Photoemission of electrons occurs from a metal (ϕ_0 = 1.96 eV) when light of frequency 6.4×10^{14} Hz is incident on it. Calculate:
(a) Energy of a photon in the incident light,
(b) The maximum kinetic energy of the emitted electrons, and
(c) The stopping potential.

[3 Marks]

Answer: (a) Energy of a photon, E = h * nu. Here, h = 6.63 * 10^{-34} Js, nu = 6.4 * 10^{14} Hz.
E = 6.63 * 10^{-34} * 6.4 * 10^{14} = 4.2432 * 10^{-19} J.
Convert to eV: E = (4.2432 * 10^{-19})/(1.6 * 10^{-19}) = 2.65 eV.
(b) Maximum kinetic energy Kmax = E - ϕ_0 = 2.65 eV - 1.96 eV = 0.69 eV.
(c) Stopping potential V_0 = Kmax / e = 0.69 V.
Therefore, the energy of the photon is 2.65 eV, the maximum kinetic energy of emitted electrons is 0.69 eV and the stopping potential is 0.69 V.

Key Points: Energy of photon = h * frequency - Maximum kinetic energy = photon energy - work function - Stopping potential corresponds to maximum kinetic energy / charge of electron

Question 32.

Draw a circuit diagram of a full-wave rectifier using p-n junction diodes. Explain its working and show the input-output waveforms.

[3 Marks]

Answer: Full-Wave Rectifier Circuit Diagram: The circuit consists of a center-tap transformer with its secondary connected to two diodes D1 and D2. The center tap acts as the reference point (ground). The two diodes are connected such that their p-sides are connected to the ends of the secondary winding.

Working: During the positive half cycle of the input AC, diode D1 becomes forward biased and conducts, while diode D2 is reverse biased and does not conduct. So current flows through D1 to the load in one direction.

During the negative half cycle, diode D2 becomes forward biased and conducts, while diode D1 is reverse biased. Current flows through D2 to the load in the same direction as before.

This way, both halves of the AC input produce current flowing in the same direction through the load, resulting in full-wave rectification.

Input-Output Waveforms: The input waveform is sinusoidal AC. The output waveform is a pulsating DC consisting of positive half sine pulses for both the positive and negative half cycles of the input AC, with no negative half cycles.

This increases the average output voltage and efficiency compared to a half-wave rectifier.

Key Points: Center-tap transformer with two diodes - Each diode conducts during alternate half cycles - Output is pulsating DC with both half cycles rectified

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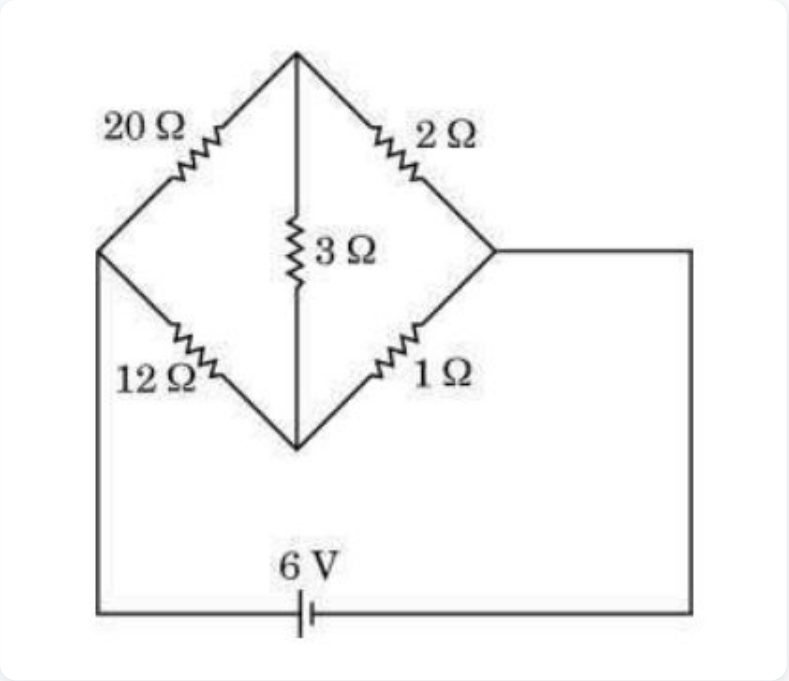
Section E

Question 33.

(i) Derive the condition for which a Wheatstone Bridge is balanced.

(ii) Determine the current in 3 Ω branch of a Wheatstone Bridge in the circuit shown in the figure.

[5 Marks]



Answer: (i) **Condition for Wheatstone Bridge to be balanced:**

A Wheatstone Bridge has four resistors R_1, R_2, R_3, and R_4 arranged in a diamond shape with a galvanometer connected between the middle nodes.

When no current flows through the galvanometer, the bridge is said to be balanced.

This means the potential difference between the middle points is zero.

By applying Kirchhoff's Voltage Law in the two loops, we get the relation:

$R_1/R_2 = R_3/R_4$

This is the balance condition and can be used to determine the unknown resistance if the other three resistances are known.

(ii) **Determining the current in the 3 Ω branch:**

Consider the given Wheatstone Bridge circuit with known resistances and an applied voltage.

If the bridge is not balanced, current flows through the galvanometer branch and all branches.

This current can be found by applying Kirchhoff's laws:

1. Assign currents to each branch.
2. Write Kirchhoff's Current Law at junctions.
3. Write Kirchhoff's Voltage Law in loops.
4. Solve the simultaneous equations for the current in the 3 Ω branch.

Without the specific values of other resistors and voltage, we cannot find a numerical value here.

With the given circuit values, you can calculate the current by substituting and solving the equations accordingly.

Note: If the bridge is balanced, the current in the 3 Ω branch (assuming it is the galvanometer branch) is zero.

Key Points: Wheatstone Bridge explanation - Balance condition R1/R2 = R3/R4 - Use Kirchhoff's laws to find current in any branch

Question 34.

(i) Consider a cylindrical conductor of length l and area of cross-section A. Current I is maintained in the conductor and electrons drift with velocity v_d(|□□_d| = e|□□ |/m τ), (where symbols have their usual meanings). Show that the conductivity σ of the material of the conductor is given by $\sigma = ne^2/m\tau$.
(ii) The resistance of a metal wire at 20°C is 1.05 Ω and at 100°C is 1.38 Ω. Determine the temperature coefficient of resistivity of this metal.

[5 Marks]

Answer: (i) Consider a conductor of length l, cross-sectional area A, and current I flowing through it. The electrons drift with velocity $v_d = eE/m\tau$ where e is electron charge, E is electric field, m is electron mass, and τ is the relaxation time.
Current density $J = I/A = ne\, v_d$, where n is number density of electrons.
Substitute $v_d = eE/m\tau$, so $J = ne * (eE/m\tau) = (ne^2/m\tau) * E$.
By Ohm's law, $J = \sigma E$, so conductivity $\sigma = ne^2/m\tau$.
(ii) Resistance at 20°C, $R_1 = 1.05\ \Omega$; Resistance at 100°C, $R_2 = 1.38\ \Omega$.
We know $R = \rho * l/A$, so resistivity ρ is proportional to resistance.
Temperature coefficient of resistivity α is defined as $\alpha = (R_2 - R_1) / (R_1 * (T_2 - T_1))$.
Substituting values: $\alpha = (1.38 - 1.05) / (1.05 * (100 - 20)) = 0.33 / (1.05 * 80) = 0.33 / 84 = 0.00393$ per deg C.
Therefore, the temperature coefficient of resistivity of the metal is approximately 0.00393 per degree Celsius.

Key Points: Expression for drift velocity - Relation between current density and drift velocity - Derivation of conductivity formula $\sigma = ne^2/m\tau$ - Understanding resistance and resistivity relation - Formula for temperature coefficient of resistivity - Calculation using given resistance values and temperatures

Question 35.

(i) A rectangular loop of sides a and b carrying current I is placed in a magnetic field □□ such that its area vector □□ makes an angle θ with □□. With the help of a suitable diagram, show that the torque τ(vector) acting on the loop is given by τ(vector) = □□× □□, where m(vector) (= I □□) is the magnetic dipole moment of the loop.
(ii) A circular coil of 100 turns and radius $(10/\sqrt{\pi})$ cm carrying current of 5.0 A is suspended vertically in a uniform horizontal magnetic field of 2.0 T. The field makes an angle 30° with the normal to the coil. Calculate:
(a) the magnetic dipole moment of the coil, and
(b) the magnitude of the counter torque that must be applied to prevent the coil from turning.

[5 Marks]

Answer: (i) Consider a rectangular loop of sides a and b carrying current I placed in a magnetic field B. The area vector A points perpendicular to the plane of the loop and makes an angle θ with B. Each side of the loop experiences a force due to the magnetic field, and these forces act as a couple producing a torque on the loop. The torque τ is given by τ = IAB sinθ, where AB = a*b is the area of the loop. Defining the magnetic dipole moment m = I A (where A is the vector area), the torque vector can be expressed as τ = m × B. This shows the torque tends to align the magnetic moment with the magnetic field directions.

(ii)(a) Magnetic dipole moment m of the coil is given by m = N I A, where N = 100 turns, I = 5.0 A, and $A = \pi r^2$. The radius r = 10/√π cm = 0.10/√π m. So,
$A = \pi (0.10/\sqrt{\pi})^2 = \pi * (0.10)^2 / \pi = 0.01\ m^2$.
Therefore, $m = 100 * 5.0 * 0.01 = 5.0\ A \cdot m^2$.

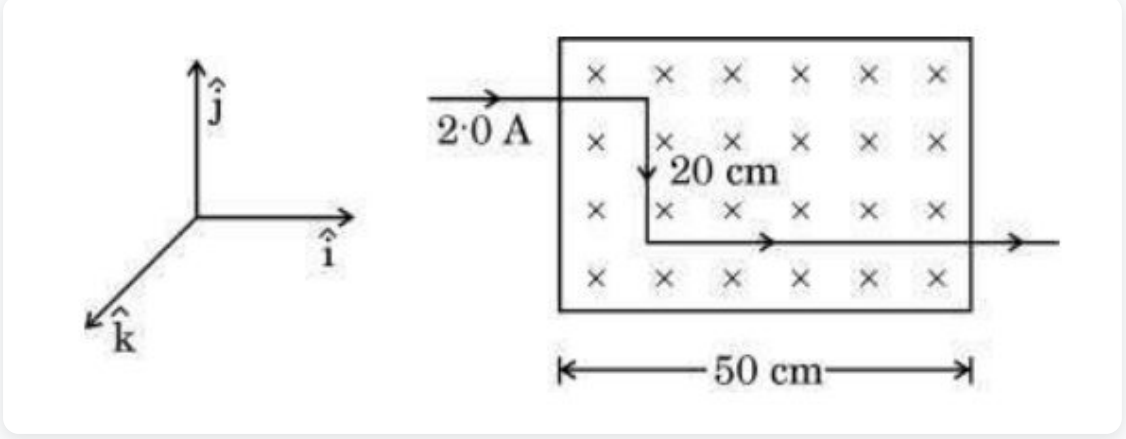
(ii)(b) The torque τ experienced by the coil is τ = m B sinθ, where θ = 30°, B = 2.0 T.
Substituting values,
τ = 5.0 * 2.0 * sin 30° = 10 * 0.5 = 5.0 N·m.
This is the magnitude of the counter torque needed to keep the coil from turning against the magnetic torque.

Key Points: Magnetic dipole moment m is I times area vector A - Torque on current loop τ = m cross B - Calculation of area of coil and magnetic moment - Use τ = m B sinθ to find counter torque

Question 36.

(i) Derive an expression for the force □□ acting on a conductor of length L and area of cross-section A carrying current I and placed in a magnetic field □□ .
(ii) A part of a wire carrying 2.0 A current and bent at 90° at two points is placed in a region of uniform magnetic field □□ = −(0.50 T) k̂, as shown in the figure. Calculate the magnitude of the net force acting on the wire.

[5 Marks]



Answer: (i) When a conductor of length L carrying current I is placed in a magnetic field □□ , it experiences a magnetic force due to the interaction between the magnetic field and the moving charges in the conductor. Consider the conductor divided into small segments dl with direction along the current. The force on each segment is d□□ = I (d□□) × □□ . Integrating over the whole length, we get the total force: □□ = I ∫ d□□ × □□ = I □□ × □□ , where □□ is the length vector in the direction of the current. The magnitude of this force is F = I L B sin θ, where θ is the angle between □□ and □□ . The area of cross-section A does not directly affect the force but is relevant to current density.
(ii) Given: current I = 2.0 A, magnetic field □□ = -0.50 T k̂, wire has two bends at 90 degrees forming three segments with current directions given by the bends. Since the magnetic field is along -k̂ direction, and the wire segments are oriented along x̂ and ŷ due to 90° bends, the force on each straight segment is F = I L B sin θ. Here, sin θ = 1 because the current direction is perpendicular to magnetic field for each segment. Force on each segment has direction given by right-hand rule (□□ × □□). Considering the geometry and directions, the forces on segments in x̂ and ŷ directions are perpendicular, so the net force is the vector sum. If the lengths of the straight segments are equal or known, sum their forces vectorially to find net force magnitude. Without lengths specified, assuming equal length L, the net force magnitude is F_net = I B L sqrt(2) due to the two perpendicular forces of same magnitude. Substituting values with L in meters will yield the numerical answer. Thus, the force depends on current, magnetic field, length, and relative directions.

Key Points: Magnetic force on current-carrying conductor is F = I L × B - Force direction given by right-hand rule - Magnitude F = I L B sin θ - For bent wire, sum forces vectorially on each segment - Given B along -k̂ and bends at 90°, forces are perpendicular - Net force magnitude is vector sum of segment forces

Question 37.

(i) A parallel beam of monochromatic light falls normally on a single slit of width ‘a’ and a diffraction pattern is observed on a screen placed at distance D from the slits. Explain :

(I) the formation of maxima and minima in the diffraction pattern, and

(II) why the maxima go on becoming weaker and weaker with its increasing number (n).

(ii) Write any two points of difference between interference pattern due to double-slit and diffraction pattern due to single-slit.

[5 Marks]

Answer: (i)(a) When monochromatic light passes through a single slit of width 'a', the light waves spread out and overlap on the screen creating a diffraction pattern of bright and dark bands. These are called maxima and minima respectively. Minima (dark fringes) occur where waves from different parts of the slit interfere destructively, at angles θ where a sin θ = n λ (n = ±1, ±2, ±3,...). Maxima (bright fringes) appear between these minima where there is constructive interference.
(b) The intensity of maxima decreases as the order number 'n' increases because the path difference

between light from different parts of the slit increases, resulting in less perfect constructive interference. Therefore, higher order maxima become weaker and less bright.
(ii) Differences between interference pattern due to double-slit and diffraction pattern due to single-slit:
1. Interference fringes from double-slit are equally spaced bright and dark bands, whereas single-slit diffraction pattern has a central bright maximum much wider than the others, with successive maxima weaker and narrower.
2. Double-slit interference occurs due to superposition of light from two coherent sources, whereas single-slit diffraction occurs due to interference of light waves originating from different parts of the same slit.

> **Key Points: Diffraction pattern formed by interference of light waves from single slit - Minima occur when a sin θ = n λ - Intensity of maxima decreases with increasing order due to less constructive interference - Double-slit interference has equally spaced fringes - Single-slit diffraction has central maximum with weaker side maxima**

Question 38.

(i) With the help of a ray diagram, describe the construction and working of a compound microscope.

(ii) (I) The real image of an object placed between f and 2f from a convex lens can be seen on a screen placed at the image location. If the screen is removed, is the image still there ? Explain.

(II) Plane and convex mirrors produce virtual images of objects. Can they produce real images under some circumstances ? Explain.

[5 Marks]

Answer: (i) Construction and Working of a Compound Microscope:
A compound microscope consists of two convex lenses: the objective lens and the eyepiece lens fixed at a short distance inside a tube. The objective lens is placed close to the object to be observed, which is just beyond its focal length. The eyepiece lens is nearest to the eye.

Working:
1. The objective lens forms a real, inverted, and magnified image of the object inside the tube at a position beyond its focal length.
2. This image acts as the object for the eyepiece lens.
3. The eyepiece lens further magnifies this image by forming a virtual, enlarged, and erect image that can be seen by the eye.
4. The final image is highly magnified and can be used to observe fine details.

(ii)(a) Yes, the image is still there even if the screen is removed. The real image formed by the convex lens is a convergence of light rays at a point in space. The screen merely helps us to see the image by catching the light rays. Removing the screen does not destroy the image; it can still be seen by placing a surface or by observation from that point.

(ii)(b) Plane and convex mirrors generally produce virtual images because they cause light rays to diverge, making images appear behind the mirror. However, under normal circumstances, they cannot produce real images because they do not converge light rays in front of the mirror. Therefore, plane and convex mirrors do not produce real images under any usual conditions.

Key Points: Compound microscope consists of objective and eyepiece convex lenses - Objective forms real, enlarged, inverted image - Eyepiece forms virtual, magnified image - Real image formed by convex lens exists even without screen - Plane and convex mirrors produce only virtual images - They do not form real images under normal conditions