PHYSICS
PAPER 1
(THEORY)

Maximum Marks: 70
Time Allotted: Three Hours
Reading Time: Additional Fifteen Minutes

Instructions to Candidates

- You are allowed **an additional 15 minutes** for **only** reading the question paper.
- You must **NOT** start writing during reading time.
- This question paper has **12** printed pages and **20** questions.
- There are **four** sections in the paper: **A, B, C and D**. **Internal choices** have been provided in **two questions** each in **Sections B, C** and **D**.
- **Section A** consists of one question having fourteen sub-parts of **one mark** each.
- **Section B** consists of **seven questions** of **two marks** each.
- **Section C** consists of **nine questions** of three marks each.
- **Section D** consists of **three questions** of **five marks** each.
- Answer ***all*** questions.
- The intended marks for questions are given in brackets [ ].
- A list of useful constants and relations is given at the end of this paper.
- A simple scientific calculator without a programmable memory may be used for calculations.

Instruction to Supervising Examiner

- Kindly read **aloud** the Instructions given above to all the candidates present in the examination hall.

SECTION A– 14 MARKS

Question 1

(A) In questions (i) to (vii) below, choose the correct alternative (a), (b), (c) or (d) for each of the questions given below:

(i) ***Figure 1*** below shows a circuit containing an ammeter A, a galvanometer G and a plug key K. When the key is closed: **[1]**

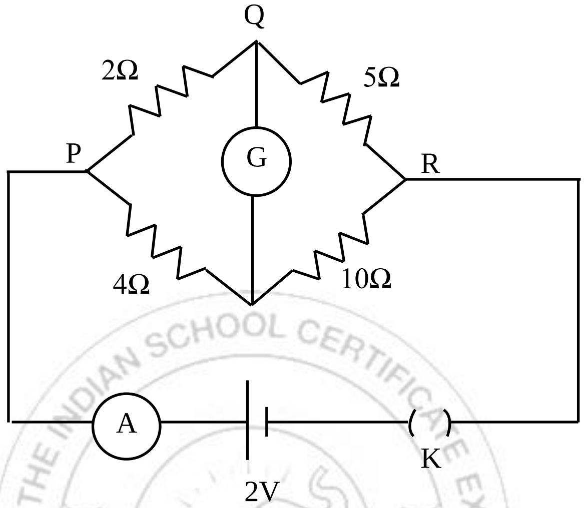


Figure 1

(Analysis)

(a) both G and A show deflections.

(b) neither G nor A shows deflection.

(c) G shows deflection but A does not.

(d) A shows deflection but G does not.

(ii) A circular coil having N turns of radius R carrying a current I is used to produce a magnetic field B at its centre O. **[1]**

If this coil is opened and rewound such that the radius of the newly formed coil is 2R, carrying the same current I, what will be the magnetic field at the centre O? **(Analysis)**

(a) 2B

(b) B

(c) B/2

(d) B/4

(iii) Magnetic susceptibility of a **diamagnetic substance**: **(Recall)** **[1]**

(a) decreases with the increase in its temperature.

(b) is not affected by the change in its temperature.

(c) increases with increase in its temperature.

(d) first increases then decreases with increase in its with temperature.

(iv) The **de Broglie wavelength** of an electron in the first Bohr's orbit of hydrogen atom is equal to: **(Understanding)** **[1]**

(a) diameter of the first orbit.

(b) circumference of the first orbit.

(c) radius of the second orbit.

(d) $h/2\pi$.

(v) An ideal PN junction diode offers: **(Recall)** **[1]**

(a) zero resistance in forward as well as reverse bias.

(b) infinite resistance in forward as well as reverse bias.

(c) zero resistance in forward, but infinite resistance in reverse bias.

(d) infinite resistance in forward, but zero resistance in reverse bias.

(vi) Given below are two statements marked Assertion and Reason. Read the two statements and choose the correct option. **[1]**

Assertion: An astronomical telescope has an objective lens having large focal length.

Reason: Magnifying power of an astronomical telescope varies directly with focal length of the objective lens. **(Understanding)**

(a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.

(c) Assertion is false and Reason is true.

(d) Both Assertion and Reason are false.

(vii) Given below are two statements marked, Assertion and Reason. Read the two statements and choose the correct option. **[1]**

Assertion: If critical angle of glass-air pair ($\mu g = 3/2$) is θ_1 and that of water-air pair ($\mu w = 4/3$) is θ_2, then the critical angle for the water-glass pair will lie between θ_1 and θ_2.

Reason: A medium is optically denser if its refractive index is greater. **(Analysis)**

(a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.

(c) Assertion is false and Reason is true.

(d) Both Assertion and Reason are false.

(B) Answer the following questions briefly:

(i) Current I flowing through a metallic wire is gradually increased. Show **graphically** how heating power (P) developed in it varies with the current (I). **(Application)** **[1]**

(ii) Explain why core of a transformer is always **laminated**. **(Recall)** **[1]**

(iii) Why does a car driver use a convex mirror as a rear-view mirror? **(Recall)** **[1]**

(iv) Represent diagrammatically how the incident planar wavefronts of wavelength λ pass through an aperture of size d, when d is approximately equal to λ. **(Understanding)** **[1]**

(v) What is meant by "**Dual nature of matter**"? **(Recall)** **[1]**

(vi) What happens when an electron collides with a positron? **(Recall)** **[1]**

(vii) What energy conversion takes place in a **solar cell**? **(Recall)**

SECTION B – 14 MARKS

Question 2 **[2]**

(i) A dielectric slab of dielectric constant K and thickness t is introduced between the two plates of a capacitor of plate-separation d (>t) and common area A. The capacitance of this system is given as:

$$C = \frac{\varepsilon_0 A}{(d-t) + (t/K)}$$

How does the capacitance C modify in each of the following cases? **(Application)**

(a) The dielectric slab covers half the distance of separation between the two plates.

(b) The whole space between the plates is filled with the dielectric.

OR

(ii) In ***Figure 2*** below, the current-voltage graphs for a conductor are given at two different temperatures T_1 and T_2. **(Analysis)**

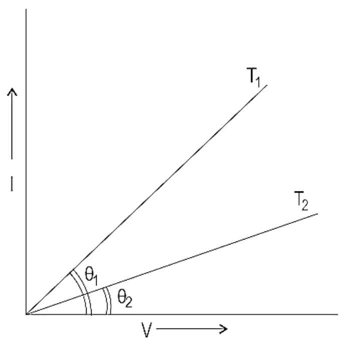


Figure 2

(a) At which temperature T_1 or T_2 is the resistance higher?

(b) Which temperature (T_1 or T_2) is higher?

Question 3 **[2]**

Arrangement of an oxygen ion and two hydrogen ions in a water molecule is shown in ***Figure 3*** below.

Calculate electric dipole moment of water molecule. Express your answer in terms of e (charge on hydrogen ion), l and θ. **(Application)**

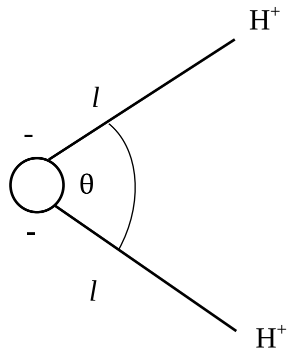


Figure 3

Question 4 **[2]**

(i) ***Figure 4*** below shows a **part** of an electric circuit. **(Application)**

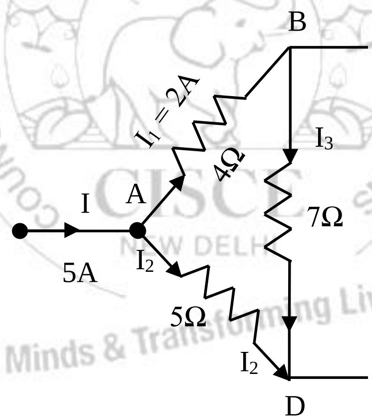


Figure 4

(a) Apply **Kirchhoff's junction rule** to the junction A to find current flowing through the 5Ω resistor.

(b) Apply **Kirchhoff's loop rule** to the loop ABDA to find current flowing through the 7Ω resistor.

OR

(ii) In a potentiometer, a cell is balanced against 110 cm when the circuit is open. A cell is balanced at 100 cm when short-circuited through a resistance of 10 Ω. Find the internal resistance of the cell. **(Application)**

Question 5 **[2]**

Figure 5 below are two long, parallel wires carrying current in the same direction such that $I_1 < I_2$. **(Recall)**

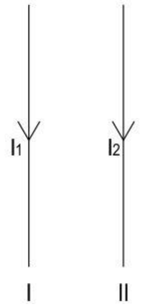


Figure 5

(i) In which direction will wire I_1 move?

(ii) If the direction of the current I_2 is reversed, in which direction will the wire I_1 move now?

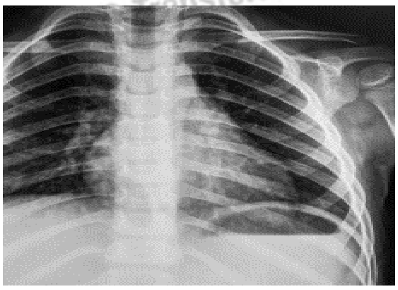
Question 6 **[2]**

(i) The focal length of a double convex lens is equal to the radius of curvature of either surface. What is the refractive index of its material? **(Application)**

(ii) What is meant by a **thin** prism? **(Recall)**

Question 7 **[2]**

(i) Name the electromagnetic radiation that has been used in obtaining the image below. **(Recall)**



(ii) What is the wavelength range of electromagnetic radiation used in radio broadcast? **(Recall)**

Question 8 **[2]**

How does **stopping potential** in photoelectric emission vary if

(i) the intensity of the incident radiation increases? **(Recall)**

(ii) the frequency of incident radiation decreases? **(Understanding)**

SECTION C – 27 MARKS

Question 9 **[3]**

"A uniformly charged conducting spherical shell for the points outside the shell behaves as if the entire charge of the shell is concentrated at its centre". Show this with the help of a proper diagram and verify this statement. **(Recall)**

Question 10 **[3]**

(i) Study the two circuits shown in ***Figure 6*** below. The cells in the two circuits are identical to each other. The resistance of the load resistor R is the same in both circuits.

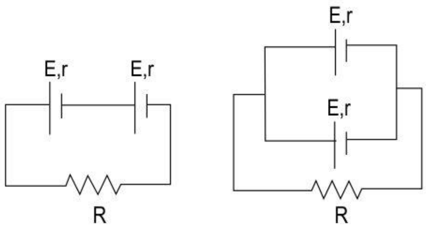


Figure 6

If the same current flows through the resistor R in both circuits, calculate the internal resistance of each cell in terms of the resistance of resistor R. Show your calculations. **(Application)**

OR

(ii) The drift velocity of electrons in a conductor connected to a battery is given by $\boldsymbol{v}_d = -e\boldsymbol{E}\tau/m$. Here, e is the charge of the electron, E is the electric field, τ is the average time between collisions and m is the mass of the electron.

Based on this, answer the following: **(Analysis)**

(a) How does the drift velocity change with a change in the potential difference across the conductor?

(b) A copper wire of length '*l*' is connected to a source. If the copper wire is replaced by another copper wire of the same area of cross-section but of length '4*l*', how will the drift velocity change? Explain your answer.

Question 11 **[3]**

A galvanometer of resistance 100 Ω gives a full-scale deflection for a potential difference of 200 mV. **(Application)**

(i) What must be the resistance connected to convert the galvanometer into an ammeter of the range 0-200 mA?

(ii) Determine resistance of the ammeter.

Question 12 **[3]**

(i) A student records the following data for the magnitudes (B) of the magnetic field at **axial points** at different distances x (See ***Figure 7*** given below) from the centre O of a circular coil of radius a carrying a current I. **Verify** (for any two) that these observations are in good agreement with the expected theoretical **values** of B. **(Application)**

x	$x = 0$	$x = a$	$x = 2a$	$x = 3a$
B	B_0	$\frac{B_0}{2\sqrt{2}}$	$\frac{B_0}{5\sqrt{5}}$	$\frac{B_0}{10\sqrt{10}}$

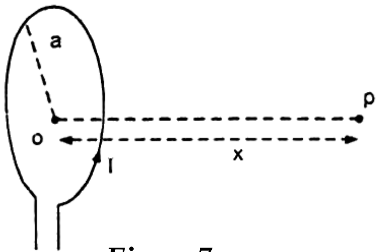


Figure 7

OR

(ii) An electron moving along positive X axis with a velocity of $8 \times 10^7 ms^{-1}$ enters a region having uniform magnetic field $B = 1{\cdot}3 \times 10^{-3}T$ along positive Y axis. **(Application)**

(a) Explain why the electron describes a circular path.

(b) Calculate the radius of the circular path described by the electron.

Question 13 **[3]**

With the help of a neatly drawn labelled diagram, prove the law of reflection on the basis of **Huygen's wave theory**. **(Recall)**

Question 14 **[3]**

A lens of focal length ***f*** is divided into two equal parts and then these parts are put in a combination as shown in ***Figure 8*** below. **(Application)**

(i) What is the focal length of L_1?

(ii) What is the focal length of the final combination?

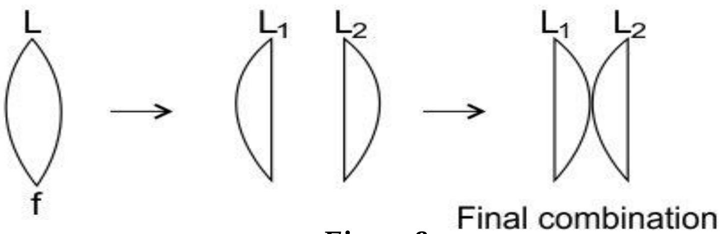


Figure 8

Question 15 **[3]**

In **Young's double slit experiment**, how is interference pattern affected when the following changes are made: **(Understanding)**

(i) Slits are brought closer to each other.

(ii) Screen is moved away from the slits.

(iii) Red coloured light is replaced with blue coloured light.

Question 16 **[3]**

(i) A virologist studies details of a virus with the help of an instrument. Name the instrument used by him. **(Recall)**

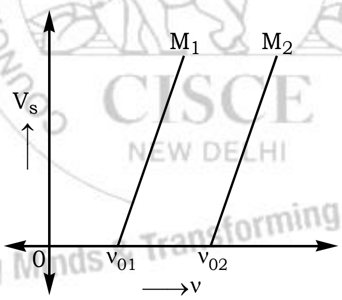
(ii) Draw a labelled ray diagram of an image formed by this instrument, assuming **(Recall)**

(a) a small upright object.

(b) image lies at least distance of distinct vision.

Question 17 **[3]**

The graphs below show the variation of the stopping potential V_S with the frequency (ν) of the incident radiations for two different photosensitive materials M_1 and M_2.



Express work function for M_1 and M_2 in terms of Planck's constant(h) and Threshold frequency and charge of the electron (e).

If the values of stopping potential for M_1 and M_2 are $\boldsymbol{V1}$ and $\boldsymbol{V2}$ respectively then show that the slope of the lines equals to $\frac{V_1 - V_2}{\nu_{01} - \nu_{02}}$ for a frequency,

$$\nu > \nu_{02} \text{ and also } \nu > \nu_{01}$$ **(Analysis)**

SECTION D – 15 MARKS

Question 18 **[5]**

(i) The magnetic field through a single loop of wire, 12 cm in radius and 8·5 Ω resistance, changes with time as shown in graph below ***(Figure 9).*** The magnetic field is perpendicular to the plane of the loop.

(a) Find the induced emf for the time intervals 0 to 2·0 s, 2·0 to 4·0 s, and 4·0 to 6·0 s. **(Application)**

(b) Hence, plot induced current as a function of time. **(Application)**

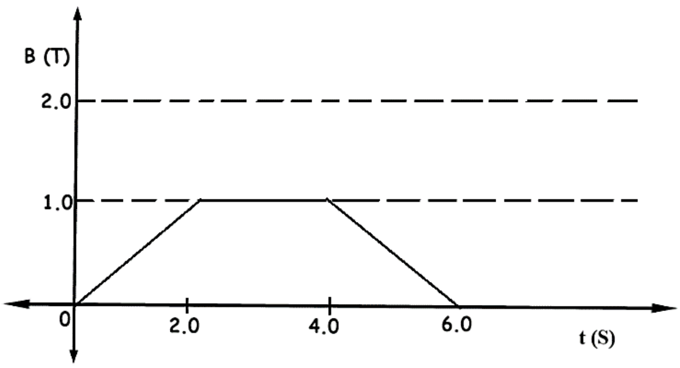
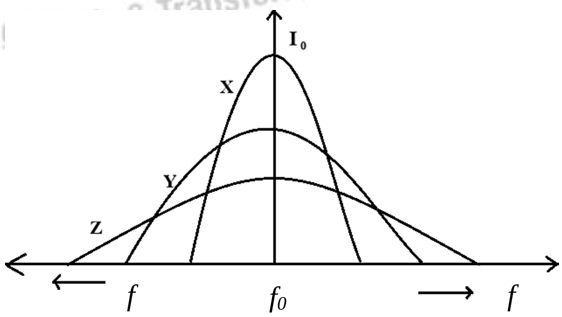


Figure 9

OR

(ii) Three students, X, Y and Z performed an experiment for studying the variation of a.c. with frequency in a **series LCR circuit** and obtained the graphs as shown below. They all used

- an AC source of the same emf and
- inductance of the same value.



(a) Who used minimum resistance? **(Analysis)**

(b) In which case will the quality Q factor be **maximum**? **(Analysis)**

(c) What did the students conclude about the nature of impedance at resonant frequency (f_0)? **(Analysis)**

(d) An ideal capacitor is connected across 220V, 50Hz, and 220V, 100Hz supplies. Find the ratio of current flowing through it in the two cases. **(Application)**

Question 19 **[5]**

(i)

(a) Find the **binding energy per nucleon** of ^{235}U based on the information given below.

	Mass(u)
mass of neutral $^{235}_{92}U$	235·0439
mass of a proton	1·0073
mass of a neutron	1·0087

(Application)

(b) Find the energy released during the following fission reaction.

$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{236}_{92}U \rightarrow ^{90}_{36}Kr + ^{143}_{56}Ba + 3\ ^{1}_{0}n$

	Mass(u)
^{235}U	235·0439
^{90}Kr	89·9195
^{143}Ba	142·9206
^{1}n	1·0087

(Application)

(c) During **Rutherford's gold foil experiment**, it was observed that most of the α-particles did not deflect. However, some showed a deflection of 180°.

What hypothesis was made to justify the deflection of α-particle by 180°? **(Recall)**

OR

(ii)

(a) Define **unified atomic mass** unit. **(Recall)**

(b) Calculate its energy equivalent. **(Application)**

(c) In an atom X, electrons absorb the energy from an external source. This energy "excites" the electrons from a lower-energy level to a higher-energy level around the nucleus of the atom. When electrons return to the ground state, they emit photons.

Figure 10 below is the energy level diagram of atom X with three energy levels, $E_1 = 0{\cdot}00$eV, $E_2 = 1{\cdot}78$eV and $E_3 = 2{\cdot}95$eV. **The ground state is considered 0 eV for reference**. The transition of electrons takes place between levels E_1 and E_2.

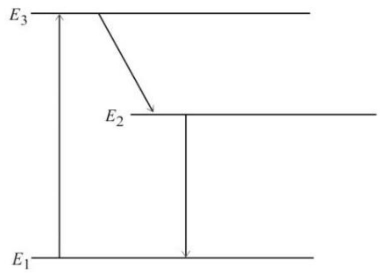


Figure 10

(1) What wavelength of radiation is needed to excite the atom to energy level E_2 from E_1? **(Application)**

(2) Suppose the external source has a power of 100 W. What would be the rate of photon emission? **(Application)**

Question 20 **[5]**

Sanya performed an experiment of obtaining characteristic curves of a junction diode. When she forward biased it, she found that beyond forward voltage V = V_k, the conductivity is very high. When she reverse biased the diode she found that a very small current (of about a few microamperes) flows in the diode. It remained constant even though she varied the voltage.

(i) In ***Figure 11***, which one of the diodes is forward biased? **(Recall)**

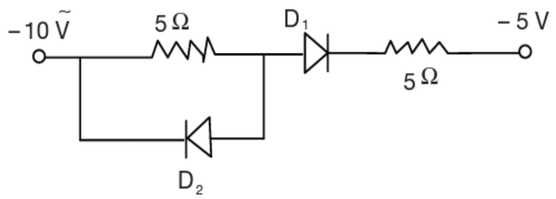


Figure 11

(ii) What is meant by a **saturation** current? **(Application)**

(iii) When applied voltage during forward bias is small, why does no current flow in the diode? **(Recall)**

(iv) The circuit shown in the ***Figure 12*** below contains two diodes, each with a forward resistance of 50 Ω and with infinite resistance during reverse bias. If the battery voltage is 6V, then calculate the current through the 100 Ω resistance. **(Application)**

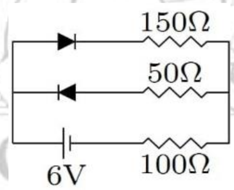


Figure 12

USEFUL CONSTANTS AND RELATIONS

1.	Planck's constant	h	=	$6{\cdot}6 \times 10^{-34}$ Js
2.	Speed of light in vacuum	c	=	3×10^{8} ms^{-1}
3.	Charge of a proton = Charge of an electron	e	=	$\pm 1{\cdot}6 \times 10^{-19}$ C
4.	Mass of an electron	m	=	$9{\cdot}1 \times 10^{-31}$ Kg
5.	One electron volt	1 eV	=	$1{\cdot}6 \times 10^{-19}$ J
6.	Unified atomic mass unit	1 u	=	931·5 MeV

PHYSICS

PAPER 1
(THEORY)
ANSWER KEY

SECTION A– 14 MARKS

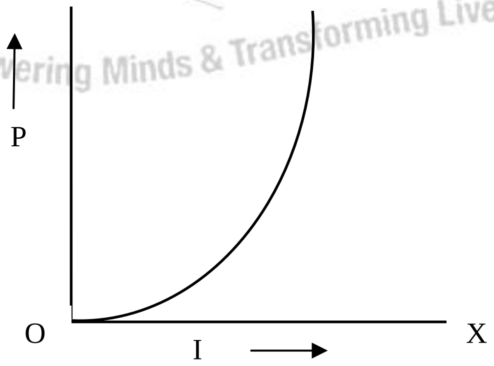
Question 1

(A) **In answering Multiple Choice Questions, candidates have to write either the correct option number or the explanation against it. Please note that only ONE correct answer should be written.**

(i)	(d) A shows deflection but G does not.	**[1]**
(ii)	(d) B/4	**[1]**
(iii)	(b) is not affected by the change in its temperature.	**[1]**
(iv)	(b) circumference of the first orbit.	**[1]**
(v)	(c) zero resistance in forward, but infinite resistance in reverse bias.	**[1]**
(vi)	(a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion.	**[1]**
(vii)	(c) Assertion is false and Reason is true.	**[1]**

(B) Answer the following questions briefly:

(i) **[1]**



(ii)	to reduce the loss of power/energy due to **eddy currents**	**[1]**
(iii)	since it forms diminished images of objects behind and hence provides a wide field of view.	**[1]**
(iv)	diagram showing **diverging spherical wavefront**	**[1]**
(v)	Matter exhibits both particle and wave nature.	**[1]**
(vi)	They annihilate each other producing gamma ray photons.	**[1]**
(vii)	Solar/ light energy to electrical energy	

SECTION B – 14 MARKS

Question 2 **[2]**

(i) (a) Using t = d/2 **[1]**

Substituting in the given formula and calculating,

$C = \frac{\epsilon_o A}{\left[\left(d - \frac{d}{2}\right) + \frac{d}{2K}\right]}$

$C = \frac{2\epsilon_o AK}{[d(K+1)]}$

(b) The whole space between the plates is filled with the dielectric implies, t = d, so, **[1]**

$$C = \frac{K\epsilon_o A}{d}$$

OR

(ii) (a) For the I-V graph, the slope of the I-V graph gives the conductance **[1]**

$R = \frac{V}{I} = \frac{1}{\tan\theta}$

Since $\theta_1 > \theta_2$

$\tan\theta_1 > \tan\theta_2$

So Resistance at T_1 < Resistance at T_2.

(b) Since the resistance of a conductor rises with temperature and 'R' at T_2 is higher than 'R' at T_1, so $T_2 > T_1$. **[1]**

Question 3 **[2]**

$P_1 = P_2 = e \times l$

$P = 2p \cos\alpha = 2\, e \times l \cos(\theta/2)$

Question 4 **[2]**

(i) (a) $I_1 + I_2 = I$

$2 + I_2 = 5$

$I_2 = 5 - 2 = 3A$

(b) $I_1 \times 4 + I_3 \times 7 = I_2 \times 5$

$2 \times 4 + I_3 \times 7 = 3 \times 5$

$7I_3 = 15 - 8 = 7$

So, $I_3 = 1A$

OR

(ii) $r = R\,(\mathbf{l_1} / \mathbf{l_2} - 1)$

$= 10\,(110 / 100 - 1)$

$= 1\ \Omega$

Question 5 **[2]**

(i) It will move towards I_1.
(Two linear parallel conductors carrying currents in the same direction attract each other.)

(ii) It will move away from I_1.
(Two linear parallel conductors carrying currents in the opposite direction repel each other.)

Question 6 **[2]**

(i) $1/f = (n-1)\,(1/r_1 + 1/r_2)$

$1/f = (n-1)\,(1/f + 1/f)$

$(n-1) = ½$

So, $n = 1{\cdot}5$

(ii) It is that prism whose refracting angle is small i.e., less than 4°

Question 7 **[2]**

(i) X rays

(ii) Greater than 1m.

Question 8 **[2]**

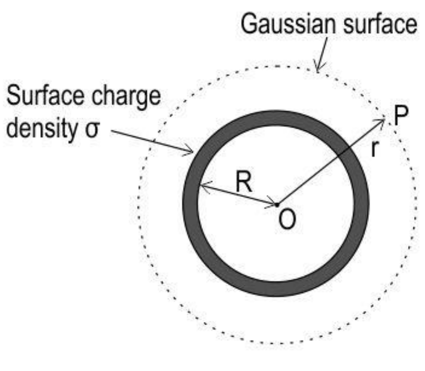
(i) The stopping potential is independent of the intensity of the incident photon.

(ii) The stopping potential will change with the frequency of the incident photon.

SECTION C – 27 MARKS

Question 9 **[3]**

A shell of radius R is carrying uniformly distributed charge of charge density σ.



Electric field E at point P at a distance r from the centre of a uniformly charged spherical shell:

Consider a Gaussian surface to be a sphere of radius r >R and with centre O, passing through P.
Using the principles of spherical symmetry, E and area vector ΔS at every point are parallel, flux through each of the area element.
$\Delta\Phi = E\cdot\Delta S$

Summing over all ΔS,
$\Phi = E \times 4\pi R^2$.

The charge enclosed is $\sigma \times 4\pi R^2$.

By Gauss' law,

$$E \times 4\pi r^2 = \frac{q}{\varepsilon_0} = \frac{\sigma \times 4\pi R^2}{\varepsilon_0}$$

$$E = \frac{\sigma R^2}{\varepsilon_0 r^2} = \frac{q}{4\pi\varepsilon_0 r^2}$$

This formula is exactly similar to the field produced by a point charge q placed at the centre O, that is, as per Coulomb's law.

Question 10 **[3]**

(i) Current I in load resistance R is given by the formula I = E/(R+r); where E is the emf of the cell, r is the internal resistance of the cell

In circuit 1, the cells are in series.

Therefore, $E_{eq} = 2E$ and $r_{eq} = 2r$
Current through R in circuit 1, I = 2E/ (R+2r)

In circuit 2, the cells are in parallel.
Therefore, $E_{eq} = E$ and $r_{eq} = r/2$
Current through R in circuit 2, I = E/(R+r/2)
Since the current is the same in both circuits,
2E/ (R+2r) = E/(R+r/2)
Solving, we get r = R

OR

(ii)

(a) As the potential difference across the conductor is increased, the electric field set-up inside the conductor increases. Since $v_d \propto E$, drift velocity also increases with an increase in potential difference.

(b) Given $\boldsymbol{v_d} \propto \boldsymbol{E}$
but E = V/l
Therefore $\boldsymbol{v_d} \propto (1/l)$
As length increases to 4l, drift velocity becomes (1/4)th of the original value.

Question 11 **[3]**

(i) Given G = 100 Ω; I = 200 mA;
V_g=200 mV;
Resistance to be connected to the galvanometer to convert to an ammeter:
$S = I_gG/(I-I_g)$
Here $I_g = V_g/G$ = 200 mV/100 Ω= 2 mA
$S = 2 \times 10^{-3} \times 100 /(0{\cdot}2-0{\cdot}002)$
S = 1·01 Ω

(ii) 1/R = 1/100 + 1/1.01
R = 0.999Ω

Question 12 **[3]**

(i) The expression for B at an axial point of a circular coil carrying current is,

$B = \frac{\mu_0}{4\pi}\frac{2NI(\pi a^2)}{r^3}$, for N turns

$B = \frac{\mu_0}{4\pi}\frac{2I(\pi a^2)}{r^3}$, for N= 1 turn

At the center, x = 0: $= \frac{\mu_0}{2}\frac{I}{a}$

At $x = a$: $= \frac{B_0}{2\sqrt{2}}$

At $x = 2a$: $= \frac{B_0}{5\sqrt{5}}$

At $x = 3a$: $= \frac{B_0}{10\sqrt{10}}$

OR

(ii)

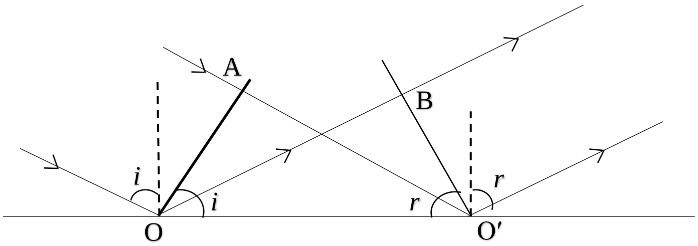
(a) Because force exerted by the magnetic field is always perpendicular to its velocity. So, it provides the necessary centripetal force to the electron.

(b) $\frac{e}{m} = \frac{v}{Br}$

$$\frac{1{\cdot}6 \times 10^{-19}}{9{\cdot}1 \times 10^{-31}} = \frac{8 \times 10 \times 7}{1{\cdot}3 \times 10^{-3} \times r}$$

So, r = 0·35m

Question 13 **[3]**



Correct diagram [$\angle$i and $\angle$r at one place, atleast one arrow marked

and wavefront nearly perpendicular or shown with arc drawn

In triangles AOO' & BOO'

OO' is common.

$AO' = O'B$ = ct or vt

$\angle OAO' = \angle OBO' = 90$

Hence, the two triangles are equal/ congruent in all respects

$\angle AOO' = \angle BO'O$

$\therefore$ ($\angle i = \angle r$) only accepted if shown correctly in the diagram.

(Any other equivalent derivation may be accepted)

Question 14 **[3]**

(i) $1/f = (\eta-1)(2/R)$

(ii) $1/f_1 = (\eta-1)(1/R)$

$F_1 = 2f$

$1/f_2 = (\eta-1)(2/R)$

$F_2 = f$

Question 15 **[3]**

(i) Fringe width (separation) increases.

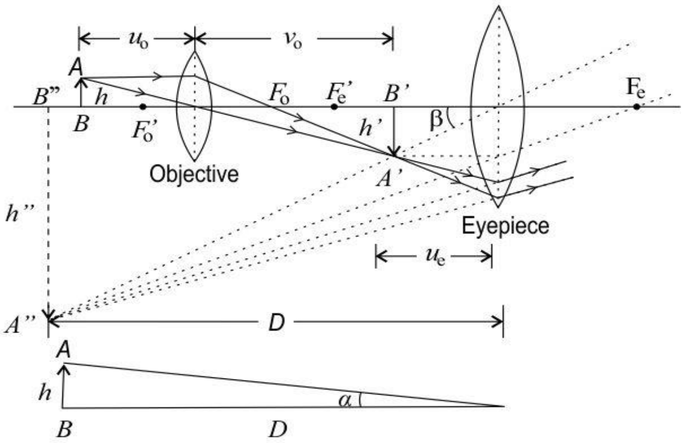
(ii) Fringe width (separation) decreases.

(iii) Fringe width (separation) decreases.

Question 16 **[3]**

(i) Compound microscope.

(ii)



Question 17 **[3]**

$W_{01} = \dfrac{h\nu_{01}}{e}$ and $W_{02} = \dfrac{h\nu_{02}}{e}$

$V_1 = \left[\frac{h}{e}\right] \upsilon - \left[\frac{h}{e}\right] V_{01}$

$V_2 = \left[\frac{h}{e}\right] \upsilon - \left[\frac{h}{e}\right] V_{02}$

$\therefore$ V1 – V2 = $\left[\frac{h}{e}\right] (V_{01} - V_{02})$

$\left[\frac{h}{e}\right] = \dfrac{V1 - V2}{V_{01} - V_{02}}$

SECTION D – 15 MARKS

Question 18 **[5]**

(i) (a) $e = -\dfrac{d\phi}{dt} = = -\dfrac{dNAB\cos\theta}{dt}$

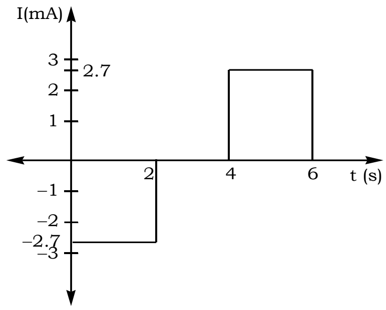
e = - 0.023 volt

$i = \dfrac{e}{R} = -\dfrac{0.023}{8.5} = -2.7 \times 10^{-3}$ A

t : 0 – 2.0 sec : i = -2.7×10^{-3} A

t : 2.0 sec – 4.0 sec : i = 0

t : 4.0 sec – 6.0 sec : i = $+2.7 \times 10^{-3}$ A

(b) 

OR

(ii) (a) Resistance used by X is the least and resistance used by Z is the maximum.

(b) Q maximum for X

(c) at resonance impedance is equal to ohmic resistance.

(d) In a capacitor the current is dependent directly on frequency

$\frac{I_1}{I_2} = \frac{1}{2}$

Question 19 **[5]**

(i) (a) mass of protons (m_p) = 92 × 1·0073 u = 92·6716 u

mass of neutrons (m_n) = 143 × 1·0087 u = 144·2441 u

Total mass ($m_p + m_n$) = 236·9157 u

mass defect = Δm = 236·9157u – 235·0439u =1·8718 u

Binding energy = Δm × 931·5 MeV = 1·8718 × 931·5 MeV = 1743·6 MeV

Binding energy per nucleon = 1743·6 MeV / 235 = 7·42 MeV

(b) Mass of reactants = 235·0439 + 1·0087 = 236·0526 u

Mass of products = 89·9195 + 142·9206 + 3 (1·0087) =235·8662 u

change in mass = $\Delta m =$ 236·0526 − 235·8662 = 0·1864u

Q = Δm × 931·5 MeV = 0·1864 × 931·5 MeV =173·63

(c) entire +ve charge in the atom is concentrated at its centre, which he called as nucleus

OR

(ii) (a) 1/12th of the mass of an atom of $_6C^{12}$ isotope.

(b) The value of E to be calculated in MeV using

$$\Delta m \times c^2 = E = 931 \cdot 5 MeV$$

(c) (1) To start the laser, the molecule will have to be excited from E_1 to E_3. The wavelength required is

$\lambda = hc/\Delta E$
$= 1{\cdot}24 \times 10^{-6}/2{\cdot}95$
$= 420{\cdot}3$ nm

Laser transition takes place between E_1 and E_2. So the wavelength of the beam of laser-produced will be

$\lambda = hc / \Delta E$
$= 1{\cdot}24 \times 10^{-6}/ 1{\cdot}78$
$= 696{\cdot}6$ nm

(2) energy of photon = $1{\cdot}78$ eV
$= 1{\cdot}78 \times 1{\cdot}602 \times 10^{-19}$ J $= 2{\cdot}8516 \times 10^{-19}$ J
photons emitted per second = power (energy emitted per second) / energy of each photon = 100 W / $2{\cdot}8516 \times 10^{-19}$ J
$= 3{\cdot}506 \times 10^{20}$

Question 20 **[5]**

(i) D_2 is forward biased.

(ii) It is that current which remains constant even on increasing the p.d.

(iii) Due to potential barrier or barrier p.d.

(iv) Ignoring D_2 as it is reverse biased and offers infinite resistance,

By Ohm' law,

$$I = \frac{E}{(R_* + R_*)} = 6/(50+150+100) = 6/300 = 0{\cdot}02 \text{ A}$$