PRACTICE QUESTION PAPER 3

CLASS XII

SAMPLE PAPER-2023-24

BLUE PRINT

S.No.	Unit	MCQ (1Mark)	A&R (1Mark)	SA I (2Marks)	SA II (3Marks)	CSB (4Marks)	LA (5marks)	Total	Marks
1	**Electrostatics**	2(2)					5(1)	7(3)	**17(7)**
2	**Current electricity**	2(2)			3(1)		5(1)	10(4)	
3	**Magnetic effects of current and Magnetism**	2(2)		4(2)				6(4)	**14(8)**
4	**Electromagnetic Induction and Alternating currents**	2(2)			6(2)			8(4)	
5	**Electromagnetic Waves**	1(1)		2(1)				3(2)	**19(8)**
6	**Optics**	1(1)	1(1)	2(1)	3(1)	4(1)	5(1)	16(6)	
7	**Dual nature of Radiation and matter**	1(1)	1(1)		3(1)			5(3)	**12(6)**
8	**Atoms & Nuclei**	1(1)			6(2)			7(3)	
9	**Electronic devices**		2(2)	2(1)		4(1)		8(4)	8(4)
		12(12)	**4(4)**	**10(5)**	**21(7)**	**8(2)**	**15(3)**	**70(33)**	**70(33)**

SESSION: 2023-24

PRACTICE QUESTION PAPER 3

SUBJECT: PHYSICS (THEORY)

Maximum Marks: 70 M **Time Allowed: 3 hours.**

General Instructions:

(1) There are 33 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study-based questions of four marks each and Section E contains three long answer questions of five marks each.

(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

(6) Use of calculators is not allowed.

(7) You may use the following values of physical constants where ever necessary

i. $c = 3 \times 10^8$ m/s

ii. $m_e = 9.1 \times 10^{-31}$ kg

iii. $e = 1.6 \times 10^{-19}$ C

iv. $\mu_0 = 4\pi \times 10^{-7}\ TmA^{-1}$

v. $h = 6.63 \times 10^{-34}$ Js

vi. $\varepsilon_0 = 8.854 \times 10^{-12} C^2N^{-1}m^{-2}$

SECTION A

1. Two large vertical and parallel metal plates having a separation of 1 cm are connected to a dc voltage source of potential difference X. A proton is released at rest midway between the two plates. It is found to move at 45^0 to the vertical just after release. Then X is nearly

   (a) 1×10^{-5} V
   (b) 1×10^{-7} V
   (c) 1×10^{-9} V
   (d) 1×10^{-10} V

2. Two capacitors of capacitances C_1 and C_2 are connected in parallel. If a charge q is given to the assembly, the charge gets shared. The ratio of the charge on the capacitor C_1, to the charge that on C_2, is

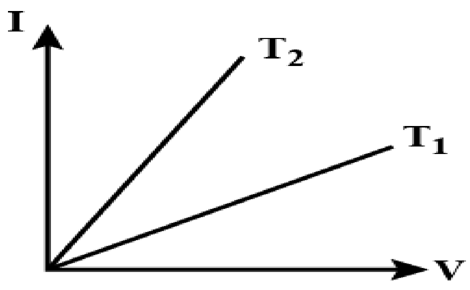
   (a) C_1/C_2

   (b) C_2/C_1

   (c) C_1C_2

   (d) $1/C_1C_2$

3. The current - voltage graph for a given metallic wire at two different temperatures T_1 and T_2 as shown in figure, then



a) Temperature T_2 is greater than T_1

b) Temperature T_1 is greater than T_2

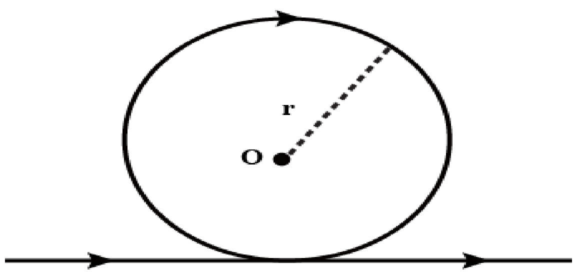
c) Both T_1 and T_2 are equal

d) Resistance of metallic wire is independent of temperature

4. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and radii of the wires are in the ratio of 4/3 and 2/3, then the ratio of the currents passing through the wire will be

(a)3 (b)1/3 (c)8/9 (d)2

5. A current l flows through a long straight conductor which is bent into a circular loop of radius R in the middle as shown in the figure



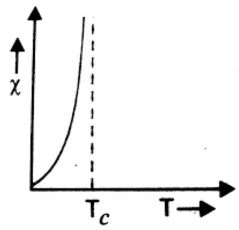
The magnitude of the net magnetic field at point O will be

(a) Zero
(b) $\frac{\mu 0 I}{2R}(1+\pi)$
(c) $\frac{\mu_\circ I}{4\pi R}$
(d) $\frac{\mu_\circ I}{2R}(1-\frac{1}{\pi})$

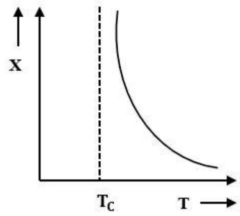
6. **The objective of a telescope must be of large diameter in order to**
(a) remove chromatic aberration
(b) remove spherical aberration and high magnification
(c) gather lighter and for high resolution
(d) increase its range of observation

7. The variation of magnetic susceptibility with the temperature of a ferromagnetic material can be plotted as

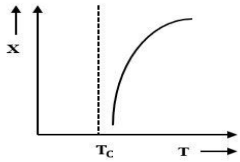
(a)



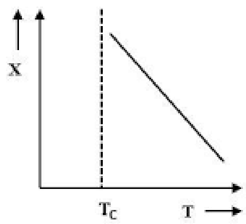
(b)



(c)



(d)



8. A square loop of wire, side length 10 cm is placed at angel of 45° with a magnetic field that changes uniformly form 0.1 T to zero in 0.7s. The induced current in the loop (its resistance is 1Ω is
   (a) 1.0 mA
   (b) 2.5 mA
   (c) 3.5 mA
   (d) 4.0 mA

9. In an LCR circuit, capacitance is changed from C to 2C. For the resonant frequency to remain unchanged, the inductance should be changed from L to

   (a)4L
   (b)2L
   (c)L/2
   (d)L/4

10. An electromagnetic wave of frequency 3 MHz passes from vacuum into a dielectric medium with permittivity ε= 4. Then,

    (a) wavelength and frequency both remain unchanged.

    (b) wavelength is doubled and the frequency remains unchanged.

    (c) wavelength is doubled and the frequency becomes half.

(d) wavelength is halved and the frequency remains unchanged.

11. The threshold frequency for photoelectric effect on sodium corresponds to a wavelength of 5000 Å. Its work function is
(a) 4×10^{-19} J
(b)1 J
(c) 2×10^{-19} J
(d) 3 x 10^{-19} J

12. If the binding energy per nucleon in ${}_3Li^7$ and ${}_2He^4$ nuclei are 5.60 MeV and 7.06 MeV respectively, then in reaction ${}_1H^1 + {}_3Li^7 \rightarrow 2\ {}_2He^4$ energy of proton must be
(a) 28.24 MeV
(b) 17.28 MeV
(c)1.46 MeV
(d) 39.2 MeV

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

A) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
C) If Assertion is true but Reason is false.
D) If both Assertion and Reason are false.

13. **Assertion**: In Young's double slit experiment interference pattern disappears when one of the slits is closed.
Reason: Interference occurs due to superposition of light waves from two coherent sources.

14. **Assertion:** The resistivity of a semiconductor increases with temperature.
Reason: The atoms of a semiconductor vibrate with larger amplitudes at higher temperatures thereby increasing its resistivity.
15. **Assertion:** In photoelectron emission, the velocity of electron ejected from near the surface is larger than that coming from interior of metal.
Reason: The velocity of ejected electron will be zero
16. **Assertion (A):** When a pure semiconductor is doped with a pentavalent impurity, the number of conduction electrons is increased while the number of holes is decreased.
Reason (R): Some of the holes get recombined with the conduction electrons as the concentration of the conduction electrons is increased.

SECTION B

17. Name the parts of the electromagnetic spectrum which is
(i) suitable for radar systems used in aircraft navigation.
(ii) used to kill germs in water purifier.
18. Two similar bars, made from two different materials P and Q, are placed one by one, in a non-uniform magnetic field. It is observed that
a) bar P tends to move from the weak to the strong field region.
b) bar Q tends to move from the strong to the weak field region.
Identify the magnetic material used for making these two bars. Show with the help of diagrams, the behaviour of the field lines, due to an external magnetic field, near each of these two
19. **A straight wire of length L is bent into a semi-circular loop. Use Biot-Savart's law to deduce an expression for the magnetic field at its centre due to the current 7 passing through it.**

20. Use the mirror equation to show that an object placed between F and 2F of a concave mirror produces a real image beyond 2F.
21. Two material bars A and B of equal area of cross-section are connected in series to a dc supply. A is made of usual resistance wire and B of an n-type semiconductor. In which bar is the drift speed of free electrons greater? Why?

OR

Draw the energy band diagram of an n-type semiconductor. How does the energy gap of an intrinsic semiconductor vary with increase in temperature?

SECTION C

22. State Ampere's circuital law. Use this law to obtain the expression for magnetic field at a normal distance 'r' from an infinitely long current carrying straight wire. How will the magnetic field intensity at the centre of a current carrying circular coil change, if the current through the coil is doubled and the radius of the coil is halved?
23. A series LCR circuit with R=20 Ω, L =1.5 H and C = 35 μF is connected to a variable frequency 200V ac supply. When the frequency of the supply equals the natural frequency of the circuit, what is the average power transferred to the circuit in one complete cycle?
24. a) State Faraday's laws of electromagnetic induction.

    b) A metallic rod of 1m length is rotated with a frequency of 50 rev/s, with one end hinged at the centre and the other end at the circumference of a circular metallic ring of radius1m, about an axis passing through the centre and perpendicular to the plane of the ring. A constant uniform magnetic field of 1T parallel to the axis is present everywhere. What is the emf between the centre and the metallic ring?
25. Draw a graph between the frequency of incident radiation (ϒ) and the maximum kinetic energy of the electrons emitted from the surface of a photo sensitive material. State clearly how this graph can be used to find a) Planck's constant and b) work function of the material.

OR

The work function of Caesium metal is 2.14eV. When light of frequency $6\text{x } 10^{14}$Hz is incident on the metal surface, photoemission of electrons occurs. What is

a) maximum kinetic energy of the emitted electron

b) stopping potential and

c)maximum speed of the emitted photoelectrons

26. Draw a schematic arrangement of Geiger- Marsden experiment. Calculate the distance of closest approach when a 7.7MeV α-particle approaches a gold nucleus (Z = 79)
27. Derive an expression for the fringe width of interference pattern obtained in Young's double slit experiment.
28. (a) The mass of a nucleus in its ground state is always less than the total mass of its constituents – neutrons and protons. Explain.

    (b) Plot a graph showing the variation of potential energy of a pair of nucleons as a function of their separation.

SECTION D

29. Case Study: Read the following paragraph and answer the questions.

Two sources of light which continuously emit light waves of same frequency (or wavelength) with a zero or constant phase difference between them, are called coherent sources. Two independent sources of light cannot act as coherent sources, they have to be derived from the same parent source. In Young's double slit experiment, two identical narrow slits S1 and S2 are placed symmetrically with respect to narrow slit S illuminated with monochromatic light. The interference pattern is obtained on an observation screen placed at large distance D from S1 and S2.

a) Mention any 2 conditions for sustained interference.

b) In the Young's double slit experiment using a monochromatic light of wavelength λ, what is the path difference (in terms of an integer n) corresponding to any point having half the peak intensity?

c)Calculate the ratio of the fringe width for bright and dark fringes in YDS experiment.

d)In Young's double slit experiment, while using a source of light of wavelength 4500 Å, the fringe width obtained is 0.4 cm. If the distance between the slits and the screen is reduced to half, calculate the new fringe width.

30. Case Study: Read the following paragraph and answer the questions.

P-N junction diode: P-N junction is a semiconductor diode. It is obtained by bringing p-type semiconductor in close contact with n- type semiconductor. A thin layer is developed at the p- n junction which is devoid of any charge carrier but has immobile ions. It is called depletion layer. At the junction a potential barrier appears, which does not allow the movement of majority charge carriers across the junction in the absence of any biasing of the junction. p-n junction offers low resistance when forward biased and high resistance when reverse biased.

a) Can we take one slab of p-type semiconductor and physically join it to another n-type semiconductor to get p-n junction?

b) Is p-type semiconductor a charged material?

c)Draw the energy level diagram shows the variation of Barrier potential under forward bias and reverse bias.

d)Draw circuit diagram of p-n junction diode under forward bias and reverse bias.

SECTION E

31. a) Derive an expression for the electric field 'E' due to a dipole of length '2a' at a point, distant 'r', from the centre of the dipole, on the axial line.

b) Draw a graph of E varies 'r' for r>>a.

c) Four equal point charges each 16μC are placed on the four corners of a square of side 0.2m. Calculate the force on any one of the charges

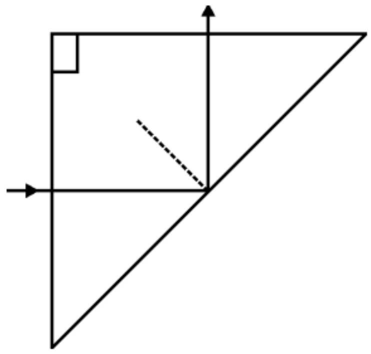
OR

a) Using Gauss' law, deduce the expression for the electric field due to a uniformly charged spherical conducting shell of radius 'R' at a point i) outside and ii) inside the shell.

b) Two charges of magnitude -2Q and +Q are located at point (a,o) and (4a, o) respectively. Find the electric flux due to these charges through a sphere of radius 3a with its centre at the origin.

32. Plot a graph to show variation of the angle of deviation as a function of angle of incidence for light passing through a prism. Derive an expression for refractive index of the prism in terms of angle of minimum deviation and angle of prism.

(i) A ray of light incident normally on one face of a right isosceles prism is totally reflected as shown in fig. What must be the minimum value of refractive index of glass ? Give relevant calculations.



OR

a) Define a wave front.

b) Use Huygen's geometrical construction to show the propagation of plane wavefront from a rarer medium to a denser medium.Hence derive Snell's law of refraction.

c)What is the effect on the interference fringes in Young's double slit experiment, if the separation between the two slits is decreased? Justify your answer.

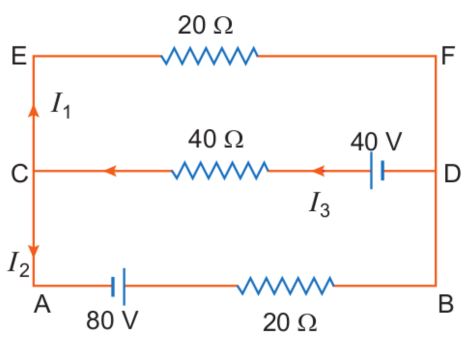
33. (a) Plot a graph showing the variation of resistance of a conducting wire as a function of its radius, keeping the length of the wire and its temperature as constant.

(b) Prove that the current density of a metallic conductor is directly proportional to the drift speed of electrons.

(c) The number density of free electrons in a copper conductor is $8.5\times10^{28}m^{3}$ .How long does an electron take to drift from one end of a wire 3 m long, to its another end? The area of cross section of the wire is 2.0×10^{-6} m^{2} and it is carrying a current of 3.0 A.

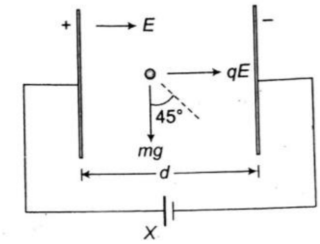
OR

(a) Use Kirchhoff 's laws to determine the value of current I_1 in the given electrical circuit.



(b) Draw a circuit diagram showing balancing of Wheatstone bridge. Use Kirchhoff 's laws to obtain the balance condition in terms of the resistances of four arms of Wheatstone Bridge.

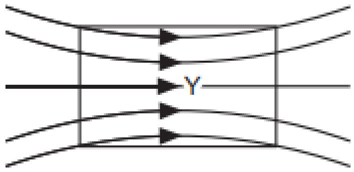
CLASS XII : SESSION : 2023-2024
ANSWER KEY
PRACTICE QUESTION PAPER-3 (THEORY)
SUBJECT: PHYSICS

	SECTION A	Marks
1	(c) When the proton moves at 45° with vertical, qE=mg  q.(X/d) = mg $1.6 \times 10^{-9} \times (X/0.01) = 1.6 X 10^{-27} X 10$ $X = 1\times 10^{-9}$ V	1
2	(a) For the two capacitors connected in parallel, V_1 = V2 $C_1/q_1 = C_2/q_2$ or $q_1/q_2 = C_1/C_2$	1
3	b) Temperature T_1 is greater than T_2 Slope of the graph is inverse proportional resistance and resistance increases with the temperature.	1
4	(b) $R_1/R_2 = (l_1/ l_2). (A_2/A_1) = (l_1/l_2) .(\pi r_2^2/ \pi r_1^2) = (l_1/l_2) . (r_2/r_1)=(4/3).(3/2)^2 = 3$ For wires connected in parallel, $V_1 = V_2$ OR $I_1R_1 = I_2R_2$ $I_1/I_1 = R_1/R_2 = ⅓$	1
5	d). $\frac{\mu_\circ I}{2r}(1-\frac{1}{\pi})$	1
6	(c) gather lighter and for high resolution	1

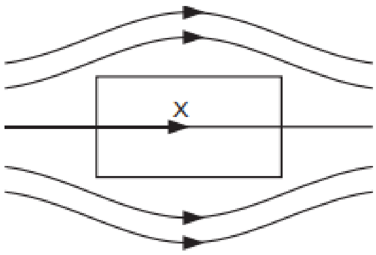
7	(b) Susceptibility of a ferromagnetic material decreases with the increase in temperature and above the Curie temperature T_C, it becomes paramagnetic	1
8	a). 1.0 mA	1
9	(c) Resonance frequency, f_r=1 / [2π√(LC)] when C is changed to 2C, L should be changed to L/2 so that f, remains unchanged	1
10	(d) The frequency of the e.m. wave remains same when it passes from one medium to another. Refractive index of the medium, $n = \sqrt{(\varepsilon/\varepsilon_0)}=\sqrt{(4/1)}= 2$ Wavelength of the electromagnetic wave in the medium. $\lambda_{med} = \lambda/n = \lambda/2$.	1
11	(a) $W_o= hc/ \lambda_0 = (6.63\times10^{-34}\times3\times10^8) / (5000 \times 10^{-10})$J $= 4 \times 10^{-19}$ J.	1
12	(b) Energy released, $=2B.E(_2He^4)-B.E(_1H^1+ {_3Li^7})$ =2x4x7.06-[0+7x 5.60] =56.48-39.20=17.28 MeV.	1
13	a) Both A and R are true and R is the correct explanation of A	1
14	d) Both the assertion and reason are false. Resistivity of a semiconductor decreases with temperature. Larger amplitudes of atoms at higher temperatures increase conductivity of a semiconductor.	1
15	(c) For an incident photon of given energy, velocity of photoelectron ejected from near the surface is larger than that coming from the interior of the metal because less energy is required to eject an electron from the surface than from the interior. The velocity of ejected electron may not be zero.	1
16	(A) Both are correct and reason is correct explanation of assertion	
	SECTION B	
17	(i) microwaves	2

<table>
<tr><td></td><td>(ii) Ultra violet rays</td><td></td></tr>
<tr><td>18</td><td>

a. Paramagnetic



b. Diamagnetic



</td><td>2</td></tr>
<tr><td>19</td><td>$B = \mu_0 \Pi i/4L$</td><td>2</td></tr>
<tr><td>20</td><td>

From mirror formula, $1/v = 1/f - 1/u$, Now for a concave mirror, $f < 0$ and for an object at $u < 0$, $2f<u<f$ or $1/2f> 1/u >1/f$

$1/2f < 1/v < 0$

This implies that $v < 0$ so that image is formed on left.

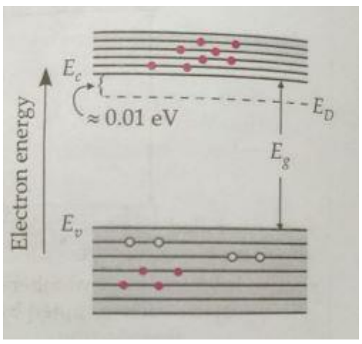
Also the above inequality implies $2f>v$ OR $|2f| <|v|$ [2 f and v are negative] i.e., the real image is formed beyond 2f.

</td><td></td></tr>
<tr><td>21</td><td>

Drift speed in B is higher. Since the two bars are connected in series, the current through both same.

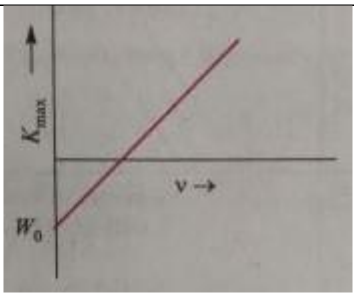
$I = neAv_d$, $v_d \propto 1/n$. Since n is much lower in semiconductors, drift velocity will be more.

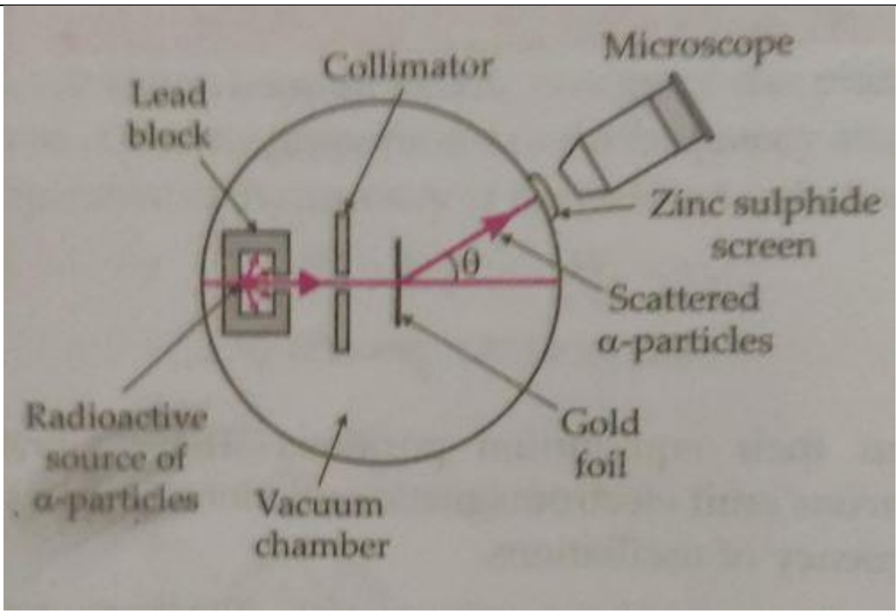
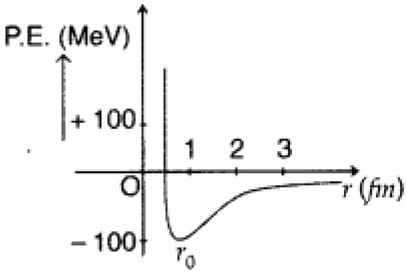
OR

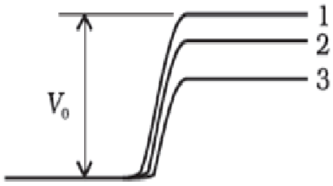
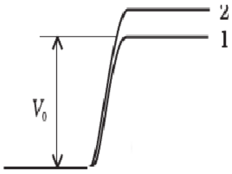
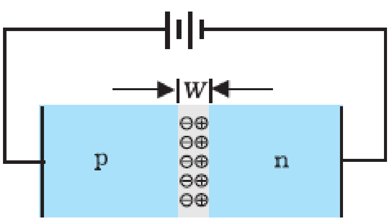
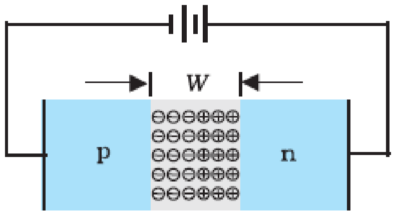


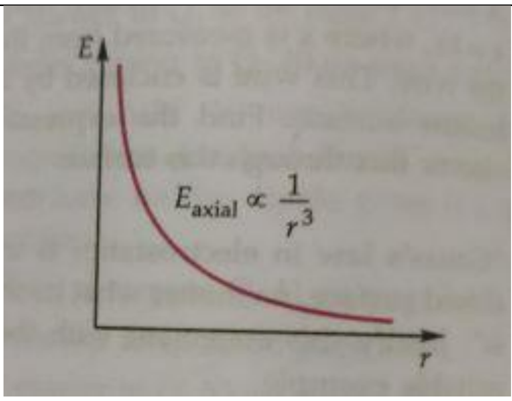
The energy gap does not change with temperature

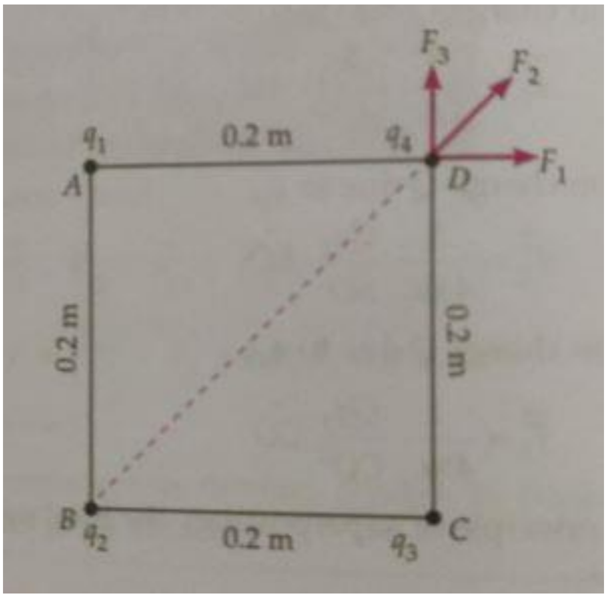
</td><td>2</td></tr>
</table>

	SECTION C	
22	Statement of Ampere’s law Expression for magnetic field Magnetic field at the centre $B = \mu_0 I/2a$ If I = 2I and a= a/2, B’ = 4B	3
23	When frequency of supply is equal to natural frequency, then $X_L = X_C$. $Z = \sqrt{R^2 + (X_L - X_C)^2} = R$ $P_{av} = VI\cos\phi = V.\frac{V}{R} \times 1 = \frac{V^2}{R} = \frac{200 \times 200}{20}$ $P_{av} = 2000 \text{ watt} = 2kW$	3
24	Statement of Faraday’s law Emf induced = ½ $BR^2\omega$ B = 1T, R = L = 1m, ω = 2πν = 2π x 50 = 100π Emf = ½ x 1x 1^2x 2π x 50 = 50π = 157V	3
25	 **$K_{max} = h\nu - \Phi_0$** Slope of the graph gives the value of Planck’s constant Intercept on the negative Y axis gives the value of work function **OR** **Φ_0 = 2.14eV, ν = 6 x 10^{14}Hz** 1.$K_{max} = h\nu - \Phi_0$ = 0.34eV 2.$K_{max} = eV0$ V_0 = 0.34V 3.K_{max} = ½ m v^2_{max} v^2_{max} = 345.8 x 10^3 m/s	3

26	 $K = 7.7 MeV = 7.7 \times 10^{6} \times 1.6 \times 10^{-19}$ $K = Ze \times 2e / 4\pi\epsilon_0 r_0$ Substituting, r_0 = 30fm	3
27	Derivation of the expression $\beta = D\lambda/d$	3
28	(a) When nucleons approach each other to form a nucleus, they strongly attract each other. Their potential energy decreases and becomes negative. It is this potential energy which holds the nucleons together in the nucleus. The decrease in' potential energy results in the decrease in the mass of the nucleons inside the nucleus. (b) 	
	SECTION D	
29	(i) No! Any slab, howsoever flat, will have roughness much larger than the inter-atomic crystal spacing (~2 to 3 Å) and hence continuous contact at the atomic level will not be possible. (ii) No. P semiconductor material didn't lose or gains electrons. Hence it is neutral material. (iii)	4

30	 Forward Bias  Reverse bias OR  Forward bias  Reverse bias = $\lambda/4\ (2n+1)$ a.Ratio = 1:1 $\beta = \lambda D/d$ Taking the ratio new fringe width is half the first one = 0.2cm a. This is because the energy gap for Ge (E=0.7 eV) is smaller than the energy gap for Si (E=1.1 eV). b. Reverse Bias, figure c. if the reverse bias decreases the width of the depletion region decreases OR c.Drift and Diffusion.	4
	SECTION E	
31	a.Derivation of expression for electric field	5





$F = \quad q_1 q_2 / 4\pi\epsilon_0 r^2$

F_1 = 57.6N along AD produced $\qquad$ F_2 = 28.8N along BD produced

F_3 = 57.6N along CD produced

Resultant of F_1 and F_3 is 81.5N

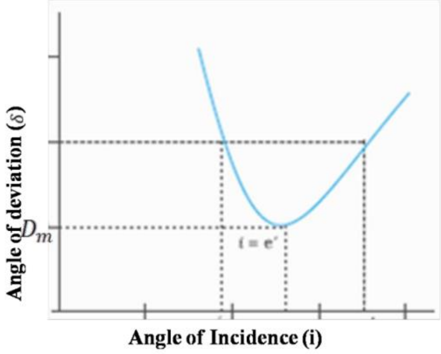
Total force on q_4 = 28.8 + 81.5 =110.3 N along BD produced

OR

a.Expression for electric field

b.Φ_E = Net charge enclosed / ϵ_0 = $-2Q/\epsilon_0$

32	i) a Plot showing the variation of the angle of deviation as a function of angle of incidence (1)	5

ii) 

Derivation of expression of refractive index 2

i= (A+D)/ 2

μ = sin i/ sin r = sin [(A+D)/2] / sin(A/2)

ii) Calculation of minimum value of refractive index 2

For total internal reflection I = c

⟹ 45 ≥ c

Sin (45) ≥ sin c

⟹ 1/ √2 ≥ 1/ n

i.e. n ≥ √2

Hence minimum value of refractive index must be √2

OR

a. Defenition of wavefront

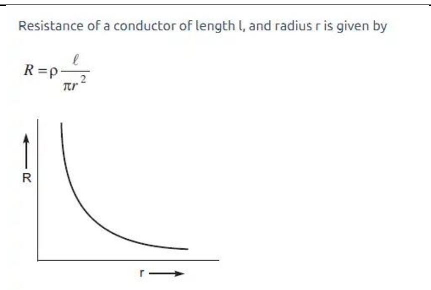
b.Geometrical construction

c.Derivation of Snell's rule

d.Fringe width = λD/d

As d decreases, fringe width increases

33



(a)

5

(b) Derivation.

(c)

Current in wire, $I = neAv_d$

Given $n = 8.5 \times 10^{28}\ m^{-3}$, $e = 1.6\times10^{-19}$ C, $I = 3.0$ A, $A = 2.0 \times 10^{-6}\ m^2$, $l = 3.0$ m

$$\therefore \text{ Drift velocity } v_d = \frac{I}{neA} = \frac{3.0}{8.5\times10^{28}\times1.6\times10^{-19}\times2.0\times10^{-6}} = 1.1\times10^{-4}\ \text{m/s}$$

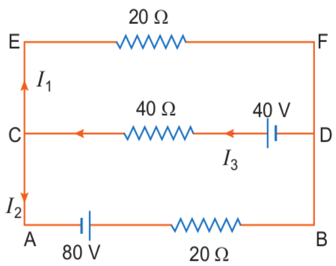
$$\therefore \quad \text{Time, } t = \frac{l}{v_d} = \frac{3.0}{1.1\times10^{-4}} = 2.72\times10^{4}\,\text{s} = \mathbf{7\ h\ 33\ min}$$

OR

(a)

From Kirchhoff's first law at junction C

$$I_3 = I_1 + I_2 \qquad \ldots(i)$$



Applying Kirchhoff's second law in mesh *CDFEC*

$$40I_3 - 40 + 20I_1 = 0 \text{ or } 20\,(2I_3 + I_1) = 40$$

$$\Rightarrow \qquad I_1 + 2I_3 = 2 \qquad \ldots(ii)$$

Applying Kirchhoff's second law to mesh *ABFEA*

$$80 - 20I_2 + 20I_1 = 0$$

$$\Rightarrow \qquad 20\,(I_1 - I_2) = -80$$

$$\Rightarrow \qquad I_2 - I_1 = 4 \qquad \ldots(iii)$$

Substituting value of I_3 from (*i*) in (*ii*), we get

$$I_1 + 2(I_1 + I_2) = 2 \quad \Rightarrow \quad 3I_1 + 2I_2 = 2 \qquad \ldots(iv)$$

Multiplying equation (*iii*) by 2, we get

$$2I_2 - 2I_1 = 8 \qquad \ldots(v)$$

Subtracting (*v*) from (*iv*), we get

$$5I_1 = -6 \;\Rightarrow\; I_1 = -\frac{6}{5}\text{A} = \mathbf{-1.2\ A}$$

(b) Diagram, Derivation.