Series HMJ/3 Set 5**5**/3/1 **SET-1**

Candidates must write the Code on the title page of the answer-book.

	NOTE
(I)	Please check that this question paper contains 19 printed pages.
(II)	Code number given on the right hand side of the question paper should be written on the title page of the answer -book by the candidate.
(III)	Please ch eck that this question paper contains 37 questions.
(IV)	Please write down the Serial Number of the question in the answer -book before attempting it.
(V)	15 minute t ime has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer -book during this period.

CBSE Physics Class 12 Question Paper 2020

PHYSICS (Theory)

Time allowed : 3 hours Maximum Marks : 70

General Instructions :

Read the following instructions very carefully and strictly follow them :

(i) This question paper comprises four Sections – A, B, C and D.

(ii) There are 37 questions in the question paper. All questions are compulsory.

(iii) Section A – Questions no. 1 to 20 are very short answer type questions, carrying one mark each.

(iv) Section B – Questions no. 21 to 27 are short answer type questions, carrying two marks each.

(v) Section C – Questions no. 28 to 34 are long answer type questions, carrying three marks each.

(vi) Section D – Questions no. 35 to 37 are also long answer type questions, carrying five marks each.

(vii) There is no overall choice in the question paper. However, an internal choice has been provided in 2 questions of 1 mark, 2 questions of 2 marks, 1 question of three marks and all the 3 questions of five marks. You have to attempt only one of the choices in such questions.

(viii) In addit ion to this, separate instructions are given with each section and question, wherever necessary.

(ix) Use of calculators and log tables is not permitted.

(x) You may use the following values of physical constants wherever necessary.

$c = 3 \quad 10^{8}$ m/s

$h = 6 \cdot 63 \quad 10^{-34}$ Js

$e = 1 \cdot 6 \quad 10^{-19}$ C

$_{0} = 4 \quad 10^{-7}$ T m A^{-1}

$_{0} = 8 \cdot 854 \quad 10^{-12}$ C^{2} N^{-1} m^{-2}

$\frac{1}{4 \quad _{0}} = 9 \quad 10^{9}$ N m^{2} C^{-2}

Mass of electron (m_{e}) = $9 \cdot 1 \quad 10^{-31}$ kg

Mass of neutron = $1 \quad \cdot 675 \quad 10^{-27}$ kg

Mass of proton = $1 \quad \cdot 673 \quad 10^{-27}$ kg

Avogadro' s number = $6 \cdot 023 \quad 10^{23}$ per gram mole

Boltzmann constant = $1 \quad \cdot 38 \quad 10^{-23}$ JK^{-1}

SECTION A

Note : Select the most appropriate option from those given below each question :

1. If a positive charge is displaced against the electric fie ld in which it was situated, then 1

(A) work will be done by the electric field on the charge.

(B) the intensity of the electric field decreases.

(C) energy of the system will decrease.

(D) energy will be provided by external source displacing the charge.

2. The electric flux emerging out from 1 C charge is 1

(A) $\frac{1}{0}$

(B) 4

(C) $\frac{4}{0}$

(D) 0

3. Two capacitors of capacitances C_1 and C_2 are connected in parallel. If a charge Q is given to the combination, the ratio of the charge on the capacitor C_1 to the charge on C_2 will be 1

(A) $\frac{C_1}{C_2}$

(B) $\sqrt{\frac{C_1}{C_2}}$

(C) $\sqrt{\frac{C_2}{C_1}}$

(D) $\frac{C_2}{C_1}$

4. The electrical resi stance of a conductor 1

(A) varies directly proportional to its area of cross -section.

(B) decreases with increase in its temperature.

(C) decreases with increase in its conductivity.

(D) is independent of its shape but depends only on its volume.

5. $m^2V^{-1}s^{-1}$ is the SI unit of which of the following ? 1

(A) Drift velocity

(B) M obility

(C) R esistivity

(D) P otential gradient

6. The element of a heater is rated (P, V). If it is connected across a source of voltage $\frac{V}{2}$, then the power consumed by it will be 1

(A) P

(B) 2P

(C) $\frac{P}{2}$

(D) $\frac{P}{4}$

7. In Bohr's model of hydrogen atom, the total energy of the electron in n^{th} discrete orbit is proportional to 1

(A) n

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

(C) n^2

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

8. A zener diode has 1

(A) heavily doped p -side and lightly doped n -side.

(B) heavily doped n -side and lightly doped p -side.

(C) heavily doped n -sid e as well as p -side.

(D) lightly doped n -side as well as p -side.

9. A region has a uniform magnetic field in it. A proton enters into the region with velocity making an angle of 45 with the direction of the magnetic field. In this region the proton will m ove on a path having the shape of a 1

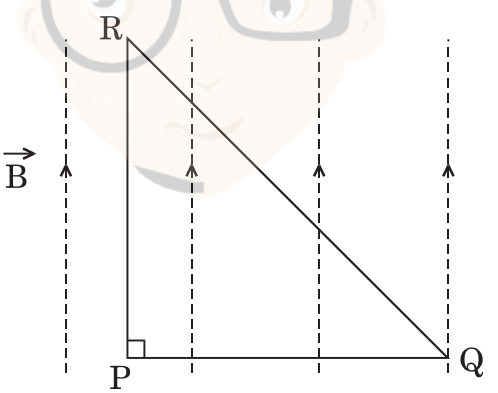
(A) straight line

(B) circle

(C) spiral

(D) helix

10. An isosceles right angled current carrying loop PQR is placed in a uniform magnetic field B pointing along PR. If the magnetic force acting on the arm PQ is F, then the magnetic force which acts on the arm QR will be 1



(A) F

(B) $\frac{F}{\sqrt{2}}$

(C) $\sqrt{2}$ F

(D) – F

Note : Fill in the blanks with appropriate answer :

11. The shape of the wavefront originating from a line source is __ _____ . 1

12. The refractive index of the material of a converging lens is 1·5. If air is replaced by a medium of refractive index 1·6, then the lens will now behave as a _____ lens. 1

13. In Young's double slit experiment, the separation between the two slits is halved. The new fringe width will be _____ times its initial value. 1

14. The value of Brewster's angle for air-glass interface is $\frac{}{3}$, hence the refractive index of glass is _____ . 1

15. In photoelectric effect, the number of emitted photoelectrons is proportional to _____ of incident light. 1

OR

Light of frequency v is incident on a photosensitive surface of threshold frequency v_0 $(v > v_0)$. The value of kinetic energy of the emitted photoelectrons will be _____ . 1

Note : Answer the following :

16. An ac is passed through a series LCR circuit. What is the impedance of the circuit at resonance ? 1

17. Two identical coils, one of copper and the other of aluminium are rotated with the same angular speed in an external magnetic field. In which of the two coils will the induced current be more ? 1

18. In an ac circuit, the applied voltage and flowing current are $E = E_0 \sin t$ and $I = I_0 \sin (t + \frac{}{2})$ respectively. What is the average power consumed in one cycle in this circuit ? 1

OR

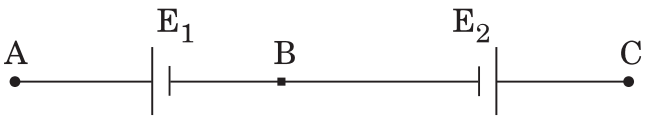
What happens when a block of metal is kept in a varying magnetic field ? 1

19. Mention the contribution of Indian physicist J.C. Bose in the production of electromagnetic waves. 1

20. Write one use of the electromagnetic waves of frequency range from 10^{16} Hz to 10^{20} Hz. 1

SECTION B

21. Two cells of emf E_1 and E_2 ($E_1 > E_2$) are connected as shown in the figure below. When a potentiometer is used to measure potential difference between the points A and B, the balancing length of the potentiometer wire is 300 cm. But the same potentiometer for the potential difference between points A and C, gives the balancing length 100 cm. Find $\frac{E_1}{E_2}$. 2



22. Two identical bars, one of paramagnetic material and other of diamagnetic material are kept in a uniform external magnetic field parallel to it. Draw diagrammatically the modifications in the magnetic field pattern in each case. 2

23. Two coplanar and concentric coils 1 and 2 have respectively the number of turns N_1 and N_2 and radii r_1 and r_2 ($r_2 >> r_1$). Deduce the expression for mutual inductance of this system. 2

24. How does an oscillating charge radiate an electromagnetic wave ? Give the relation between the frequency of radiated wave and the frequency of oscillating charge. 2

OR

(a) Explain briefly the fact that electromagnetic waves carry energy.

(b) Why do we not feel the pressure due to sunshine ? 2

25. A converging lens of focal length f_1 is placed coaxially in contact with a diverging lens of focal length f_2 ($f_1 > f_2$). Determine the power and nature of the combination in terms of f_1 and f_2. 2

OR

How is the resolving power of a compound microscope affected if (a) wavelength of light used is decreased, and (b) the diameter of its objective lens is increased ? Justify your answers. 2

26. Define the terms (a) threshold frequency, and (b) stopping potential. How were these terms incorporated in Einstein's photoelectric equation ? 2

27. A hydrogen atom is in its third excited state.

(a) How many spectral lines can be emitted by it before coming to the ground state ? Show these transitions in the energy level diagram.

(b) In which of the above transitions will the spectral line of shortest wavelength be emitted ? 2

SECTION C

28. (a) Differentiate between the random velocity and the drift velocity of electrons in an electrical conductor. Give their order of magnitudes.

(b) A conductor of uniform cross -sectional area is connected across a dc source of variable voltage. Draw a graph showing variation of drift velocity of electrons (v_d) as a function of current density (J) in it. 3

29. A series LCR ac circuit has L = 2·0 H, C = 32 F and R = 10 .

(a) At w hat angular frequency of ac will it resonate ?

(b) Calculate the Q value of the circuit. 3

OR

An ideal inductor of $\frac{5}{}$ H inductance is connected to a 200 V, 50 Hz ac supply.

(a) Calculate the rms and peak value of current in the indu ctor.

(b) What is the phase difference between current through the inductor and the applied voltage ? How will it change if a small resistance is connected in series with this inductor in the circuit ? 3

30. (a) Using the necessary ray diagram, derive the mirror formula for a concave mirror.

(b) In the magnified image of a measuring scale (with equidistant markings) lying along the principal axis of a concave mirror, the markings are not equidistant. Explain. 3

31. (a) The density of the nuclear matter is t remendously larger than the physical density of the material. Explain.

(b) The nuclear forces are not coulomb forces between nucleons. Explain.

(c) Draw a plot of the potential energy between a pair of nucleons as a function of distance between them inside a nucleus. 3

32. What do you mean by wave nature of an electron ? How wa s quantisation of angular momentum of the orbiting electron in Bohr's model of hydrogen atom explained by de Broglie hypothesis ? 3

33. Name the diode which can act as a voltage regulator. Explain its working with the help of its labelled circuit diagram . Draw its V – I characteristic. 3

34. (a) Why is an intrinsic semiconductor deliberately converted into an extrinsic semiconductor by adding impurity atoms ?

(b) Explain briefly the two processes that occur in p -n junction region to create a potential ba rrier. 3

SECTION D

35. (a) An electric dipole of dipole moment p is placed in a uniform electric field E at an angle with it. Derive the expression for torque ( ) acting on it. Find the orientation of the dipole relative to the electric field for which torque on it is (i) maximum, and (ii) half of maximum.

(b) Two point charges $q_1 = + 1$ C and $q_2 = + 4$ C are placed 2 m apart in air. At what distance from q_1 along the line joining the two charges, will the net electric field be zero ? 5

OR

(a) Derive an expression for the energy stored in a parallel plate capacitor of capacitance C when charged up to voltage V. How is this energy stored in the capacitor ?

(b) A capacitor of capacitance 1 F is charged by connecting a battery of negligible internal resistance and emf 10 V across it. Calculate the amount of charge supplied by the battery in charging the capacitor fully. 5

36. (a) Derive the expression for the force acti ng per unit length between two long straight parallel current carrying conductors. Hence define one ampere.

(b) Two long parallel straight condu ctors are placed 12 cm apart in air. They carry equal currents of 3 A each. Find the magnitude and direction of the magnetic field at a point midway between them (drawing a figure) when the currents in them flow in opposite directions. 5

OR

(a) Draw the schematic sketch of a cyclotron. Explain the shape of the path on which charged particle moves when the p article is accelerated by it.

(b) To convert a give n galvanometer into a voltmeter of ranges 2 V, V and $\frac{V}{2}$ volt, resistances R_1, R_2 and R_3 ohm respectively, are required to be connected in series with the galvanometer. Obtain the relationship between R_1, R_2 and R_3. 5

37. (a) What is meant by plane polarised light ? An unpolarised light is incident at an angle on the surface of glass of refractive index . If the refl ected and refracted rays are perpendicular to each other, then obtai n the relationship between and .

(b) Two polaroids P_1 and P_2 are placed in a crossed position. Unpolarised light of intensity I_0 is incident on P_1. If P_2 is rotated through an angle about the direction of propagation of light , keeping P_1 fixed, plot the graph of intensity of light for $0 < < 360$ which is (i) transmitted by P_1, and (ii) transmitted by P_2. 5

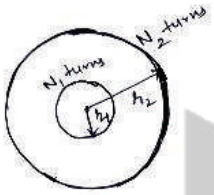
OR

(a) Briefly describe the Y oung's double slit experiment of interference of light . Drive the expression for fringe width in the pa ttern.

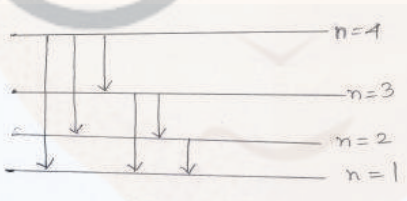
(b) Monochromatic light of wavelength 588 n m is incident fr om air to water interface. Find the wavelength and speed of the refracted light. The refractive index of water is $\frac{4}{3}$. 5

MARKING SCHEME: PHYSICS			
QUESTION PAPER CODE: 55/3/1			
Q.No.	**Value Points/Expected Answer**	**Marks**	**Total Marks**
	SECTION A		
1	(D) energy will be provided by external source displacing the charge.	1	1
2	(A) $\frac{1}{o}$	1	1
3	(A) $\frac{C_1}{C_2}$	1	1
4	(C) Decreases with increase in its conductivity	1	1
5	(B) Mobility	1	1
6	(D) $\frac{P}{4}$	1	1
7	(D) $\frac{1}{n^2}$	1	1
8	(C) heavily doped n-side as well as p-side	1	1
9	(D) Helix	1	1
10	(D) -F	1	1
11	Cylindrical	1	1
12	Divergent lens/ Concave lens	1	1
13	Two	1	1
14	$\sqrt{3}$	1	1
15	Intensity OR $(v - v_o)$	1	1
16	Z=R Alternatively, Impedance=Resistance	1	1
17	Copper	1	1

18	Zero Eddy currents are produced in metal block / block gets heated	1	1
19	J.C Bose observed / produced electromagnetic waves of short wavelength/ did very significant work in production of e.m waves.	1	1
20	X rays are used as diagnostic tool in medicine / Gamma rays are used to destroy cancer cells.	1	1
	SECTION B		
21	Writing formula $E_1 \quad l_1$ ½ mark $E_1 - E_2 \quad l_2$ ½ mark Calculating $\frac{E_1}{E_2}$ 1 mark $E_1 \quad l_1$ $E_1 - E_2 \quad l_2$ $\frac{E_1 - E_2}{E_1} = \frac{l_2}{l_1}$ $1 - \frac{E_2}{E_1} = \frac{l_2}{l_1}$ $\frac{E_2}{E_1} = 1 - \frac{l_2}{l_1} = 1 - \frac{1}{3} = \frac{2}{3}$ $\frac{E_1}{E_2} = \frac{3}{2}$	½ ½ ½ ½	2
22	Modification in magnetic field pattern by paramagnetic material 1 mark Modification in magnetic field pattern by diamagnetic material 1 mark  (a) diamagnetic (b) paramagnetic	1+1	2

23	Deducing the expression for Mutual Inductance: 2 marks The given system has the shape shown here Let a current I flow through the larger coil.  Magnetic field, due to the current at the centre of coil is $$B_C = \frac{\mu_o I N_2}{2r_2}$$ We can consider this to be the value of the magnetic field over the whole area of the smaller coil(as $r_1 << r_2$) Magnetic flux through the smaller coil $$= B_c(\pi r_1^2) N_1 = \frac{\mu_o I N_2}{2r_2} \pi r_1^2 N_1$$ $$= \left(\frac{\mu_o \pi r_1^2}{2r_2} N_1 N_2\right) I$$ But Magnetic flux=MI Where M= mutual Inductance of the system $$MI = \frac{\mu_o \pi r_1^2 N_1 N_2}{2r_2} I$$ $$M = \frac{\mu_o \pi r_1^2 N_1 N_2}{2r_2}$$	½ ½ ½ ½	2
24	Radiation of electromagnetic wave by an oscillating charge 1 mark Relation between the frequency of radiated wave and the frequency of oscillating charge 1 mark An oscillating charge produces an oscillating electric field in space, which produces an oscillating magnetic field, which in turn, is a source of oscillating electric field, and so on. The oscillating electric and magnetic fields thus regenerate each other, as the wave propagates through the space. The frequency of the electromagnetic wave equals the frequency of oscillation of the charge.	1 1	2

	OR a) Explaining the fact that e.m waves carry energy 1 mark b) Correct Explanation 1 mark a) Consider a plane perpendicular to the direction of propagation of the electromagnetic wave. If there are, on this plane, electric charges, they will be set and sustained in motion by the electric and magnetic fields of the electromagnetic wave. The charges thus acquire energy and momentum from the waves. b) When the sun shines on your hand, you feel the energy being absorbed from the electromagnetic waves (your hands get warm). Electromagnetic waves also transfer momentum to your hand but because c is very large, the amount of momentum transferred is extremely small and you do not feel the pressure. [For any other alternative correct explanation also, award full 2 marks]	1 1	2
25	Determining power of the combination 1 ½ mark Nature of combination ½ mark $\frac{1}{f} = \frac{1}{f_1} - \frac{1}{f_2}$ $\frac{1}{f} = \frac{f_2 - f_1}{f_1 f_2}$ $P = \frac{f_2 - f_1}{f_1 f_2}$ Because $f_2 < f_1$ P is negative nature is diverging lens OR Writing the formula 1 mark (a) effect of wavelength on Resolving power ½ mark (b) effect of diameter of lens on Resolving power ½ mark Resolving power of compound microscope is $Resolving\ Power = \frac{2\mu\ sin\theta}{1.22\lambda}$	½ ½ ½ ½ 1	2

	Justification of the following is based on the above formula: a) If λ decreases, Resolving Power increases. b) If diameter of objective lens is increased, $sin\theta$ increases, Resolving Power increases	½ ½	2
26	a) definition of threshold frequency ½ mark b) definition of stopping potential ½ mark incorporating these terms in Einstein's photoelectric equation 1 mark (a) Threshold Frequency: The minimum cut off frequency υ_o below which no photoelectric emission is possible, even if the intensity is large (b) Stopping Potential: The minimum negative (retarding) potential V_o given to the plate for which the photocurrent stops or becomes zero is called the cut off or stopping potential. $$\nu = \phi_0 + \frac{1}{2}mV_{max}^2$$ $$\nu = \nu_o + eV_o$$	½ ½ ½ ½	2
27	a) Stating the number of spectral lines ½ mark Showing the transitions in energy level diagram 1 mark b) Stating the transition for the shortest wave length emission ½ mark a) number of spectral lines =6 energy level diagram  b) n=4 to n=1	½ 1 ½	2
	SECTION C		
28	a) differentiating between random velocity and drift velocity 1mark Order of magnitude 1 mark b) drawing the graph showing the variation of drift velocity as a function of Current density 1 mark		

	a) Write any one difference 	Random Velocity v	Drift Velocity v_d
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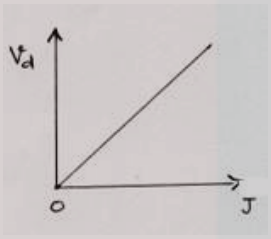
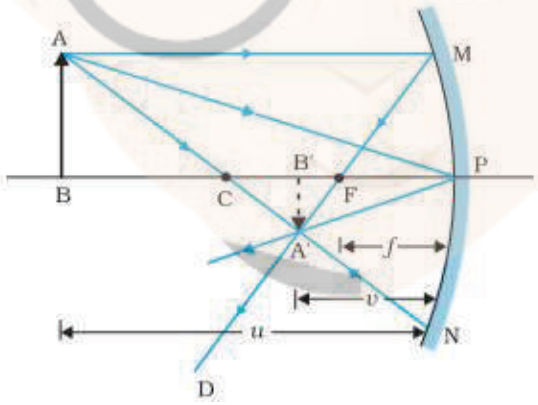
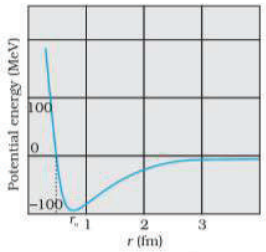
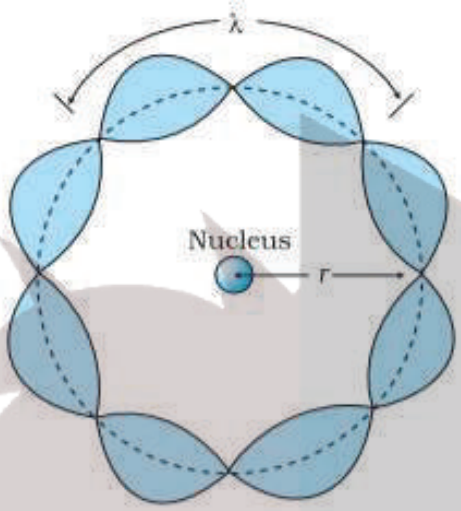
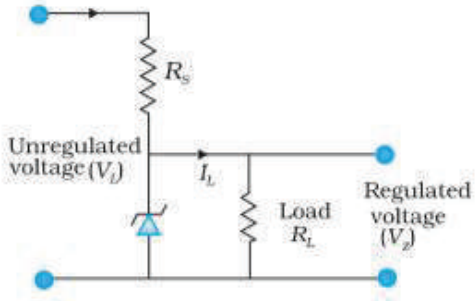
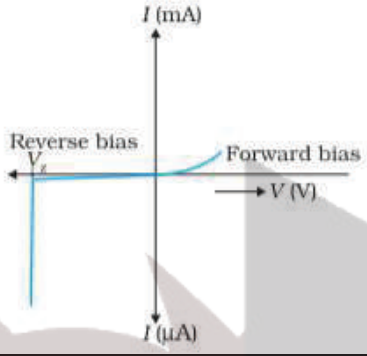
1. The velocity acquired by the free electrons in the absence of electric field.	1. The average velocity acquired by the free electrons in presence of electric field.
2. The average random velocity is zero.	2. The average drift velocity is not zero.
3. Has quite a large value	3. Has a very small value | Order of magnitude of random velocity is 10^2m/s. Order of magnitude of drift velocity is 10^{-3}m/s. [Note: If the student writes drift speed is nearly 10^{-5} times smaller than random velocity ,award the last 1 mark]  [if a student writes $J = \frac{I}{A} = \frac{n\,e\,A\,v_d}{A} = nev_d$ but does not draw the graph award ½ mark only]	1 ½ ½ 1	3
29	a) writing the formula for resonant angular frequency ½ mark calculating this angular frequency 1 mark b) writing the formula for Q value ½ mark calculating Q value 1 mark a) $\omega_o = \frac{1}{\sqrt{LC}}$ $= \frac{1}{\sqrt{2 \times 32 \times 10^{-6}}}$ =125 rad/s b) $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$ or $Q = \frac{L\omega}{R}$ $Q = \frac{1}{10}\sqrt{\frac{2}{32\times10^{-6}}} =$ 25 Alternatively Q=$\frac{2}{10}\frac{125}{}$ 25	½ ½ ½ ½ 1	3

	OR a) Calculating rms value of current 1 mark calculating peak value of current 1 mark b) Phase difference between current through inductor and applied voltage ½ mark change in phase difference ½ mark a) $X_L = \omega L = 2\pi\nu L$ $X_L = 2\pi \times 50 \times \frac{5}{\pi} = 500\ \Omega$ $I_{rms} = \frac{200}{500} = \frac{2}{5} = 0.4A$ $I_0 = \sqrt{2}\, I_{rms}$ $= \sqrt{2} \times 0.4$ $= 0.56\ A$ [Even if student expresses the answer as $(0.4\sqrt{2})\ A$ give the last ½ marks] b) $\frac{\pi}{2}\ or\ 90^0$ decreases	½ ½ ½ ½ ½ ½	3
30	a) Ray diagram for concave mirror ½ mark derivation of mirror formula 2 marks b) Correct explanation ½ mark a) Ray diagrams for concave mirror  Derivation of Mirror Formula From the diagram, $\Delta A\ B\ F$ & ΔMPF are similar $\frac{B\ A}{PM} = \frac{B\ F}{FP}$	½	

	$\frac{B\ A}{BA} = \frac{B\ F}{FP}$ ($PM = AB$) $- - - - - - - - eq1$ Since $APB = A\ PB$ $\Delta A\ B\ P$ & ΔABP are also similar $\frac{B\ A}{BA} = \frac{B\ P}{BP}$ $- - - - - - - - - - eq\ 2$ Comparing eq. 1 and eq. 2 $\frac{B\ P}{BP} = \frac{B\ P - FP}{FP}$ As per the sign convention $B\ P = -v,$ $FP = -f,$ BP = -u $\frac{-v + f}{-f} = \frac{-v}{-u} = \frac{v}{u}$ $-vu + uf = -vf$ Dividing by uvf $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ b) Magnification is different for different object distances	½ ½ 1 ½	3
31	a) Explaining the high nuclear density 1 mark b) Explaining the non-Colombian nature 1 mark c) Drawing the graph 1 mark a) Volume of Nucleus is very small but its mass is almost the total mass of the atom $Now \quad density = \frac{Mass}{Volume}$ That is why density of nucleus is very high. **Alternatively**, the matter consisting of atoms, has a very large amount of empty space. b) Nuclear forces are very strong, attractive and independent of charge and are short ranged. Whereas Colombian Force are charge dependent and long range. (Accept any one point of difference)  	 1 1 1	3

32	Meaning of wave nature of electron 1 mark Explaining the quantisation of angular momentum using de Broglie hypothesis 2 marks Moving electron can show wave characteristics.  From the diagram $2\pi r = n\lambda$ (Note: Award one mark here even if the student just writes this equation without drawing the diagram) According to de Broglie $\lambda = \frac{}{p}$ $2\pi r = n\lambda = \frac{n}{p}$ $2\pi r = \frac{n}{mv}$ $mvr = \frac{n}{2\pi}$ $w\ \ ere\ n = 1,2,3,\ldots..$ This explains the quantisation of angular momentum of the orbiting electron.	1 ½ ½ ½ ½	3
33	Naming the diode ½ mark Labelled circuit diagram 1 mark Working 1 mark V-I characteristics ½ mark Zener diode  	½ 1	

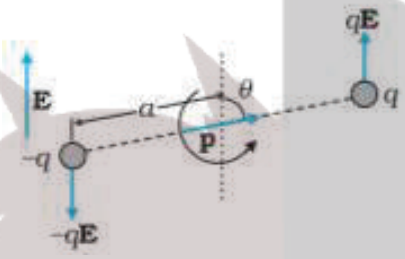
	If the input voltage increases, the current through R_s and Zener diode also increases. This increases the voltage drop across R_s without any change in the voltage across the Zener diode. This is because in the breakdown region, Zener voltage remains constant even though the current through the Zener diode changes.  	1 ½	3
34	a) Stating the reason for adding impurity atoms ½ mark b) Naming the two processes 1 mark Explaining the two processes 1 mark Creation of potential barrier ½ mark a) To increase the electrical conductivity / to increase the number density of charge carriers b) Diffusion and Drift Explanation Diffusion: During the formation of p-n junction, due to the concentration gradient across the p and n sides, the motion of majority charge carriers give rise to diffusion current. Drift: Due to the electric field developed at the junction, the motion of the minority charge carriers due to electric field is called drift. With the passage of time, diffusion current decreases whereas drift current increases and balance each other. This, creates a potential barrier.	½ ½ + ½ ½ ½ ½	3

SECTION D

35

a) Diagram	½ mark
Derivation	1 ½ mark
Orientation for maximum and half of the maximum torque	½ + ½ mark
b) Formula	½ mark
Calculation	1 mark
Result	½ mark

a)



½

From diagram

½

Magnitude of Torque= $(qE)(2a\ sin\theta)$

$= (2qa)(E\ sin\theta)$

$= pEsin\theta$ ½

For direction

$\tau = p \times E$ ½

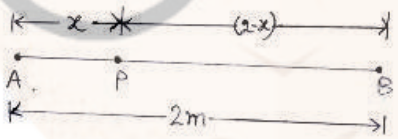
i) for maximum Torque, dipole should be placed perpendicular to the direction of electric field

$\theta = 90^0 = \frac{\pi}{2}$ ½

ii) For the torque to be half the maximum,

$\theta = 30^0 = \frac{\pi}{6}$ ½

(b)

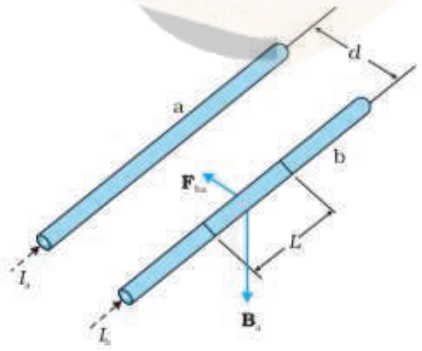


$E_{PA} = E_{PB}$; $E = \frac{kq}{r^2}$

$\frac{kq_A}{x^2} = \frac{kq_B}{(2-x)^2}$ ½

$\frac{1}{x^2} = \frac{4}{2-x)^2}$ ½

$\frac{1}{x} = \frac{2}{2-x}$ ½

	$x = \frac{2}{3}\ m$ OR	½	5
	a) Derivation of expression for energy stored 2 ½ marks Form of energy stored ½ mark b) formula 1 mark calculation ½ mark result ½ mark		
	a) Work done in adding a charge dq $= dW$ $= Vdq$ $= \frac{q}{c}dq$	½ ½	
	Total Amount of work(W)in charging a capacitor $W = \int dW = \frac{1}{C}\int_0^Q qdq$	½	
	$W = \frac{Q^2}{2C}$	½	
	$= \frac{(CV)^2}{2C} = \frac{1}{2}CV^2$	½	
	The electrostatic Energy/ potential energy is stored in the electric field between the plates.	½	
	b) $C = 1\mu F = 1 \times 10^{-6}F;\quad V = 10\ volt$ $Q = CV$ $= 1 \times 10^{-6} \times 10$ $= 10^{-5} coulomb$	1 ½ ½	5
36	a) Diagram showing direction ½ mark Derivation of expression 1 ½ marks Definition of 1 ampere 1 mark b) Magnetic fields of the wires ½ mark Net magnetic field and its direction 1 + ½ mark		
	a)  	½	

$$B_1 = \frac{\mu_o I_1}{2\pi d}$$ ½

$$F = I(l \times B)$$

$$F_{21} = I_2 l_2 B_1 sin90^o$$

$$= I_2 l_2 \frac{\mu_o I_1}{2\pi d}$$ ½

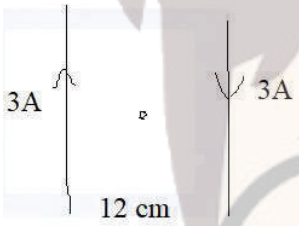
Force per unit length

$$f_{21} = \frac{F_{21}}{l_2} = \frac{\mu_o I_1 I_2}{2\pi d}$$ ½

<u>Definition of 1 ampere</u> – One ampere is defied as that steady current which, when maintained in each of the two very long, straight parallel conductors of negligible cross section, and placed at a distance 1 meter apart in vacuum, will produce on each of the conductors a force equal to $2 \times 10^{-7} N$ per metre of length. 1

Alternatively, $I_1 = I_2 = IA,\ d = 1m, \frac{F}{l} = 2 \times 10^{-7} N/m$

b)



$$B = B_1 + B_2$$ ½

$$B = \frac{\mu_o I_1}{2\pi r_1} + \frac{\mu_o I_2}{2\pi r_2}$$

$$= \frac{\mu_o}{2\pi}\left(\frac{3}{6 \times 10^{-2}} + \frac{3}{6 \times 10^{-2}}\right)$$

$$= \frac{4\pi \times 10^{-7} \times 3}{\pi \times 6 \times 10^{-2}}$$

$$= 2 \times 10^{-5}\ tesla$$ 1

Direction of B at midpoint is perpendicular to the plane containing the two conductors and pointing downwards. ½

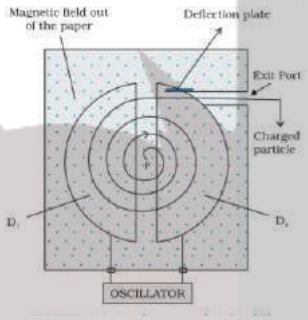
(Note: give full credit of this direction if student takes direction opposite to the shown in fig and answer accordingly)

5

OR

a) Diagram	1 mark
explaining the shape of the path	2 marks
b) formula	½ mark
calculation	1 mark
result	½ mark

a)



1

Inside the dee, the magnetic field makes the charged particle to move in semi-circular path. ½

Electric field between the dees accelerates the charged particle. ½

The sign of Electric field is changed in tune with the circular motion of the particle. ½

Each time, the acceleration increases the energy of the particle.
As the energy increases, radius of circular path increases.
So, the path is spiral. ½

b)

$$R = \frac{V}{i_g} - G \quad \text{½}$$

$$R_1 = \frac{2V}{i_g} - G = R_o - G$$

$$R_1 + G = 2R_o \quad \text{½}$$

$$[W\ ere\ R_o = \frac{V}{i_g}]$$

Similarily

$$R_2 + G = R_o$$

$$R_3 + G = R_o/2 \quad \text{½}$$

From the above equations,

$$R_1 - R_2 = 2(R_2 - R_3$$

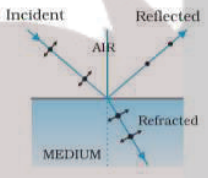
$$R_1 - 3R_2 + 2R_3 = 0 \quad \text{½}$$

5

37

a) Meaning of plane polarised light	1 mark
Diagram	½ mark
Derivation of the relationship between μ *and* θ	1 ½ marks
b) Each graph	1+1 marks

a) A light whose electric vector direction does not change with time is a plane polarised light.
Alternatively, if electric vector is confined to one particular plane, containing direction of propagation it is referred to as plane polarized light. — 1



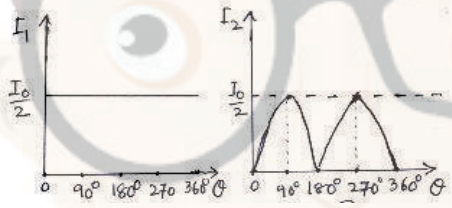
— ½

$$\mu = \frac{\sin i}{\sin r}$$ — ½

$$= \frac{sin\theta}{\sin(\frac{\pi}{2} - \theta)} = \quad if\ i = \theta$$ — ½

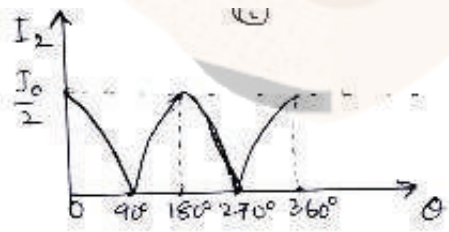
$$= \frac{sin\theta}{cos\theta} = \tan\theta$$ — ½

b) (i) (ii)



— 1+1 — 5

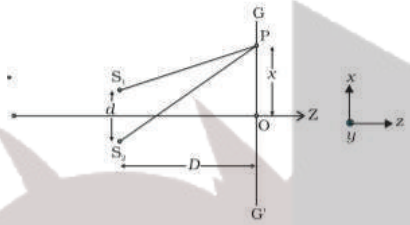
[Note: also accept if a student plots (ii) graph as follows]



OR

a) description of experiment with diagram	1 mark
derivation of the expression for fringe width	2 marks
b) finding the wavelength of refracted light	1 mark
finding the speed of refracted light	1 mark

a)



½

S is a monochromatic source of light. S_1 and S_2 are two pinholes separated by a distance d. GG' is the screen placed at the distance D from the pinholes. ½

P is a general point on the screen.

Derivation

$$(S_2P)^2 - (S_1P)^2 = \left[D^2 + \left(x + \frac{d}{2}\right)^2\right] - \left[D^2 + \left(x - \frac{d}{2}\right)^2\right]$$ ½

$$= D^2 + x^2 + \frac{d^2}{4} + xd - D^2 - x^2 - \frac{d^2}{4} + xd$$

$$= 2xd$$

$$pat\ \ difference = S_2P - S_1P = \frac{2xd}{S_2P + S_1P} \approx \frac{2xd}{2D}$$ ½

$$Pat\ \ difference = \frac{xd}{D}$$

For maxima

$$\frac{xd}{D} = n\lambda, \qquad n = 0,1,2\ldots$$ ½

$$or\ \ x_n = \frac{n\lambda D}{d}$$

$$x_{n+1} = \frac{(n+1)\lambda D}{d}$$

$$\beta = x_{n+1} - x_n$$

$$\beta = \frac{\lambda D}{d}$$ ½

b)

$$\mu_w = \frac{c_0}{c_w} = \frac{\upsilon\lambda_0}{\upsilon\lambda_w} = \frac{\lambda_0}{\lambda_w}$$ ½

$$\lambda_w = \frac{\lambda_0}{\mu_w} = \frac{588 \times 3}{4} = 441\ nm$$ ½

$$c_w = \frac{c_0}{\mu_w} = \frac{3 \times 10^8 \times 3}{4} = 2.25 \times 10^8\ m/s$$ ½ + ½

5