CBSE **Class** 12 Physics Question Paper 2020
Set 55/1/1

Series HMJ/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 23 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 check 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 time 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 = $1 \cdot 675 \quad 10^{-27}$ kg

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

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

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

SECTION A

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

1. If the net electric flux through a closed surface is zero, then we can infer 1

   (A) no net charge is enclosed by the surface.

   (B) uniform electric field exists within the surface.

   (C) electric potential varies from point to point inside the surface.

   (D) charge is present inside the surface.

2. An electric dipole consisting of charges + q and – q separated by a distance L is in stable equilibrium in a uniform electric field E . The electrostatic potential energy of the dipole is 1

   (A) qLE

   (B) zero

   (C) – qLE

   (D) – 2 qEL

3. A potentiometer can measure emf of a cell because 1

   (A) the sensitivity of potentiometer is large.

   (B) no current is drawn from the cell at balance.

   (C) no current flows in the wire of potentiometer at balance.

   (D) internal resistance of cell is neglected.

4. Two resistors R_1 and R_2 of 4 and 6 are connected in parallel across a battery. The ratio of power dissipated in them, $P_1 : P_2$ will be 1

   (A) 4 : 9

   (B) 3 : 2

   (C) 9 : 4

   (D) 2 : 3

5. The magnetic dipole moment of a current carrying coil does **not** depend upon 1

(A) number of turns of the coil.

(B) cross -sectional area of the coil.

(C) current flowing in the coil.

(D) material of the turns of the coil.

6. Larger aperture of objective lens in an astronomical telescope 1

(A) increases the resolving power of telescope.

(B) decreases the brightness of the image.

(C) increases the size of the image.

(D) decreases the length of the telescope.

7. A biconvex lens of glass having refractive index 1·47 is immersed in a liquid. It becomes invisible and behaves as a plane glass plate. The refractive index of the liquid is 1

(A) 1·47

(B) 1·62

(C) 1·33

(D) 1·51

8. For a glass prism, the angle of minimum deviation will be smallest for the light of 1

(A) red colour.

(B) blue colour.

(C) yellow colour.

(D) green colour.

9. Which of the following statements is **not** correct according to Rutherford model ? 1

(A) Most of the space inside an atom is empty.

(B) The electrons revolve around the nucleus under the influence of coulomb force acting on them.

(C) Most part of the mass of the atom and its positive charge are concentrated at its centre.

(D) The stability of atom was established by the model.

10. Photons of energies 1 eV and 2 eV are successively incident on a metallic surface of work function 0·5 eV. The ratio of kinetic energy of most energetic photoelectrons in the two cases will be 1

(A) 1 : 2

(B) 1 : 1

(C) 1 : 3

(D) 1 : 4

Note : Fill in the blanks with appropriate answer :

11. The magnetic field and angle of dip at a place on the earth are 0·3 G and 30 , respectively. The value of vertical component of the earth's magnetic field at the place is ____________ . 1

12. Laminated iron sheets are used to minimize ____________ currents in the core of a transformer. 1

13. The number of turns of a solenoid are doubled without changing its length and area of cross-section. The self-inductance of the solenoid will become ____________ times. 1

14. According to Bohr's atomic model, the circumference of the electron orbit is always an ____________ multiple of de Broglie wavelength. 1

OR

In -decay, the parent and daughter nuclei have the same number of ______________ . 1

15. A ray of light on passing through an equilateral glass prism, suffers a minimum deviation equal to the angle of the prism. The value of refractive index of the material of the prism is ____________ . 1

Note : Answer the following :

16. Write the mathematical form of Ampere-Maxwell circuital law. 1

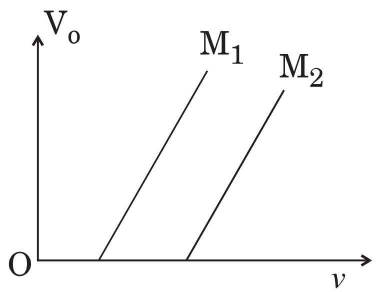
17. How does an increase in doping concentration affect the width of depletion layer of a p-n junction diode ? 1

18. The nuclear radius of $^{27}_{13}Al$ is 3·6 fermi. Find the nuclear radius of $^{64}_{29}Cu$. 1

OR

A proton and an electron have equal speeds. Find the ratio of de Broglie wavelengths associated with them. 1

19. The variation of the stopping potential (V_o) with the frequency (ν) of the light incident on two different photosensitive surfaces M_1 and M_2 is shown in the figure. Identify the surface which has greater value of the work function. 1

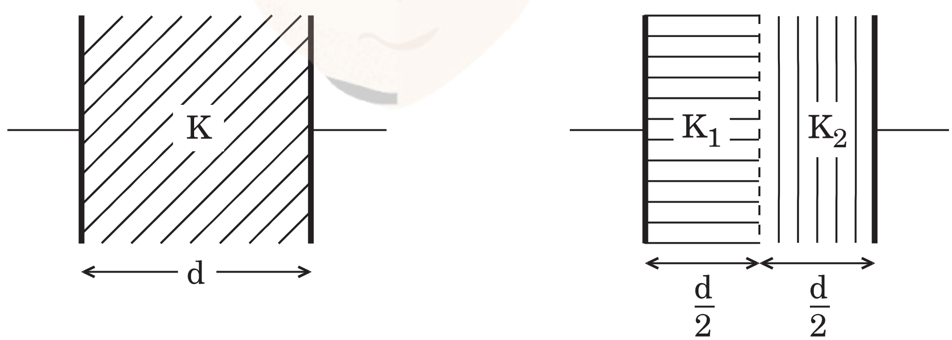


20. Why cannot we use Si and Ge in fabrication of visible LEDs ? 1

SECTION B

21. Explain the principle of working of a meter bridge. Draw the circuit diagram for determination of an unknown resistance using it. 2

22. The space between the plates of a parallel plate capacitor is completely filled in two ways. In the first case, it is filled with a slab of dielectric constant K. In the second case, it is filled with two slabs of equal thickness and dielectric constants K_1 and K_2 respectively as shown in the figure. The capacitance of the capacitor is same in the two cases. Obtain the relationship between K, K_1 and K_2. 2



(Case 1) (Case 2)

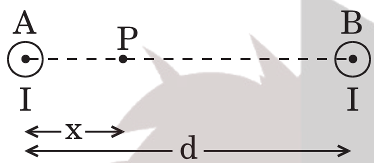
23. Define the term 'Half-life' of a radioactive substance. Two different radioactive substances have half-lives T_1 and T_2 and number of undecayed atoms at an instant, N_1 and N_2, respectively. Find the ratio of their activities at that instant. 2

24. Define wavefront of a travelling wave. Using Huygens principle, obtain the law of refraction at a plane interface when light passes from a denser to rarer medium. 2

OR

Using lens maker's formula, deriv e the thin lens formula $\frac{1}{f} \quad \frac{1}{v} - \frac{1}{u}$ for a biconvex lens. 2

25. Two long straight parallel wires A and B separated by a distance d, carry equal current I flowing in same direction as shown in the figure.



(a) F ind the mag netic field at a point P situated between them at a distance x from one wire.

(b) S how graphically the variation of the magnetic field with distance x for $0 < x < d$. 2

26. Using Bohr's atomic model, derive the expression for the radius of n^{th} orbit of the revolving electron in a hydrogen atom. 2

OR

(a) Write two main observations of photoelectric effect experiment which could only be explained by Einstein's photoelectric equation.

(b) Draw a graph showing variation of photocurrent with the anode potential of a photocell. 2

27. Explain the terms 'depletion layer' and 'potential barrier' in a p-n junction diode. How are the (a) width of depletion layer, and (b) value of potential barrier affected when the p -n junction is forward biased ? 2

SECTION C

28. (a) Two cells of emf E_1 and E_2 have their internal resistances r_1 and r_2, respectively. Deduce an expression for the equivalent emf and internal resistance of their parallel combination when connected across an external resistance R. Assume that the two cells are supporting each other.

(b) In case the two cells are identical, each of emf E = 5 V and internal resistance r = 2 , calculate the voltage across the external resistance R = 10 . 3

29. (a) Write an expression of magnetic moment associated with a current (I) carrying circular coil of radius r having N turns.

(b) Consider the above mentioned coil placed in YZ plane with its centre at the origin. Derive expression for the value of magnetic field due to it at point (x, 0, 0). 3

OR

(a) Define current sensitivity of a galvanometer. Write its expression.

(b) A galvanometer has resistance G and shows full scale deflection for current I_g.

(i) How can it be converted into an ammeter to measure current up to I_0 ($I_0 > I_g$) ?

(ii) What is the effective resistance of this ammeter ? 3

30. A resistance R and a capacitor C are connected in series to a source $V = V_0 \sin\ t$.

Find :

(a) The peak value of the voltage across the (i) resistance and (ii) capacitor.

(b) The phase difference between the applied voltage and current. Which of them is ahead ? 3

31. What is the effect on the interference fringes in Young's double slit experiment due to each of the following operations ? Justify your answers. 3

(a) The screen is moved away from the plane of the slits.

(b) The separation between slits is increased.

(c) The source slit is moved closer to the plane of double slit.

32. (a) Write the expression for the speed of light in a material medium of relative permittivity $_r$ and relative magnetic permeability $_r$.

(b) Write the wavelength range and name of the electromagnetic waves which are used in (i) radar systems for aircraft navigation, and (ii) Earth satellites to observe the growth of the crops. 3

33. The nucleus $^{235}_{92}Y$, initially at rest, decays into $^{231}_{90}X$ by emitting an -particle

$$^{235}_{92}Y \qquad ^{231}_{90}X \quad ^{4}_{2}He + \text{energy.}$$

The binding energies per nucleon of the parent nucleus, the daughter nucleus and -particle are 7·8 MeV, 7·835 MeV and 7·07 MeV, respectively. Assuming the daughter nucleus to be formed in the unexcited state and neglecting its share in the energy of the reaction, find the speed of the emitted -particle. (Mass of -particle = 6·68 10^{-27} kg) 3

34. (a) Draw circuit diagram and explain the working of a zener diode as a dc voltage regulator with the help of its I-V characteristic.

(b) What is the purpose of heavy doping of p- and n-sides of a zener diode ? 3

SECTION D

35. (a) Using Gauss law, derive expression for electric field due to a spherical shell of uniform charge distribution and radius R at a point lying at a distance x from the centre of shell, such that

(i) $0 < x < R$, and

(ii) $x > R$.

(b) An electric field is uniform and acts along + x direction in the region of positive x. It is also uniform with the same magnitude but acts in – x direction in the region of negative x. The value of the field is $E = 200$ N/C for $x > 0$ and $E = -200$ N/C for $x < 0$. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x -axis so that one flat face is at $x = +10$ cm and the other is at $x = -10$ cm.

Find :

(i) The net outward flux through the cylinder.

(ii) The net charge present inside the cylinder. 5

OR

(a) Find the expression for the potential energy of a system of two point charges q_1 and q_2 located at r_1 and r_2, respectively in an external electric field E .

(b) Draw equipotential surfaces due to an isolated point charge (– q) and depict the electric field lines.

(c) Three point charges + 1 C, – 1 C and + 2 C are initially infinite distance apart. Calculate the work done in assembling these charges at the vertices of an equilateral triangle of side 10 cm. 5

36. (a) Derive the expression for the torque acting on the rectangular current carrying coil of a galvanometer. Why is the magnetic field made radial ?

(b) An -particle is accelerated through a potential difference of 10 kV and moves along x -axis. It enters in a region of uniform magnetic field $B = 2 \quad 10^{-3}$ T acting along y -axis. Find the radius of its path. (Take mass of -particle = $6{\cdot}4 \quad 10^{-27}$ kg) 5

OR

(a) With the help of a labelled diagram, explain the working of a step-up transformer. Give reasons to explain the following :

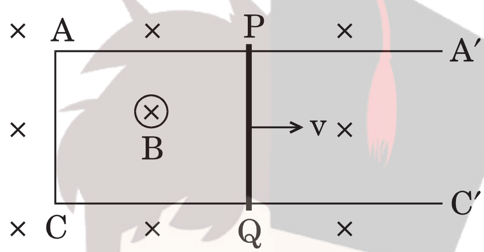
(i) The core of the transformer is laminated.

(ii) Thick copper wire is used in windings.

(b) A conducting rod PQ of len gth 20 cm and resistance 0·1 rests on two smooth parallel rails of negligible resistance AA and CC . It can slide on the rails and the arrangement is positioned between the poles of a permanent magnet producing uniform magnetic field B = 0·4 T. The rai ls, the rod and the magnetic field are in three mutually perpendicular directions as shown in the figure. If the ends A and C of the rails are short circuited, find the

(i) external force required to move the rod with uniform velocity v = 10 cm/s, and

(ii) power required to do so. 5



37. (a) Draw the ray diagram of an astronomical telescope when the final image is formed at infinity. Write the expression for the resolving power of the telescope.

(b) An astronomical telescope has an o bjective lens of focal length 20 m and eyepiece of focal length 1 cm.

(i) Find the angular magnification of the telescope .

(ii) If this telescope is used to view the Moon, find the diameter of the image formed by the objective lens. Given the diameter of the M oon is 3·5 10^6 m and radius of lunar orbit is 3·8 10^8 m. 5

OR

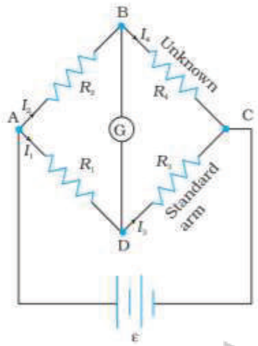
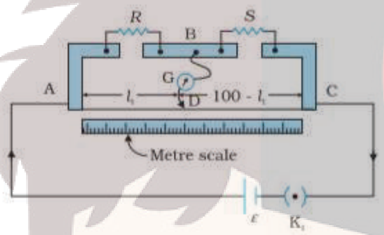
(a) An object is placed in front of a concave mirror. It is observed that a virtual image is formed. Draw the ray diagram to show the image formation and hence derive the mirror equation $\frac{1}{f} \quad \frac{1}{u} \quad \frac{1}{v}$.

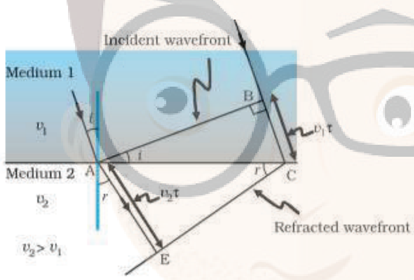
(b) An object is placed 30 cm in front of a plano-convex lens with its spherical surface of radius of curvature 20 cm. If the refractive index of the material of the lens is 1·5, find the position and nature of the image formed. 5

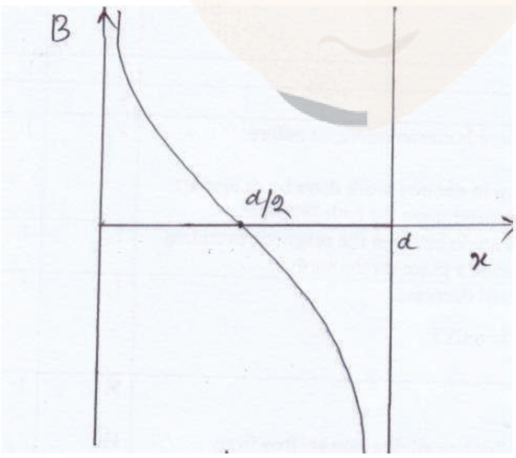
MARKING SCHEME: PHYSICS

QUESTION PAPER CODE: 55/1/1

Q.No.	Value Points/Expected Answer	Marks	Total Marks
	SECTION A		
1	(A) no net charge is enclosed by the surface	1	1
2	(C) $-qLE$	1	1
3	(C) No current flows in the potentiometer wire at balance	1	1
4	(B) 3:2	1	1
5	(D) material of the turns of the coil	1	1
6	(A) increases the resolving power of telescope	1	1
7	(A) 1.47	1	1
8	(A) red colour	1	1
9	(D) The stability of atom was established by the model	1	1
10	(C) 1:3	1	1
11	0.15G	1	1
12	Eddy	1	1
13	Four times	1	1
14	Integral OR Nucleons	1	1
15	$\sqrt{3}$	1	1
16	$\oint B.dl = \mu_0(i_c + i_d)$	1	1
17	Decreases or reduce	1	1
18	4.8 fermi OR $\frac{1}{1836}$	1	1
19	M_2	1	1
20	Si & Ge cannot be used for fabrication of visible LED because their energy gap is less 1.8eV	1	1

<table>
<tr><th colspan="4">SECTION B</th></tr>
<tr><td>21</td><td>(a) Principle 1 mark
(b) Circuit diagram for determining unknown resistance of meter bridge 1 mark</td><td></td><td></td></tr>
<tr><td></td><td>
</td><td>½</td><td></td></tr>
<tr><td></td><td>Meter bridge works on the principle of a balanced wheatstone bridge.
$\frac{R_1}{R_2} = \frac{R_3}{R_4}$ at null point when Ig=0</td><td>½</td><td></td></tr>
<tr><td></td><td>(unknown)

</td><td>1</td><td>2</td></tr>
<tr><td>22</td><td>Formula for parallel plate ½ mark
Calculation of effective capacitance of the combination 1 mark
Relation K, K_1 and K_2 ½ mark</td><td></td><td></td></tr>
<tr><td></td><td>$$C_1 = \frac{k\epsilon_0 A}{d}$$</td><td>½</td><td></td></tr>
<tr><td></td><td>Capacitor are connected in series
$$C_2 = \frac{C'C''}{C' + C''} = \left(\frac{2K_1K_2}{K_1 + K_2}\right)\frac{\epsilon_0 A}{d}$$</td><td>1</td><td></td></tr>
<tr><td></td><td>$C_1 = C_2$
$$K = \frac{2K_1K_2}{K_1 + K_2}$$</td><td>½</td><td>2</td></tr>
</table>

23	Definition of half life — 1 mark Determination of ratio R_1 and R_2 — 1 mark		
	The time interval in which the number of radioactive nuclei reduced / disintegrated to half of initial value	1	
	Let R_1 and R_2 be their activities then $R_1 = \lambda_1 N_1$ $R_2 = \lambda_2 N_2$	½	
	$\frac{R_1}{R_2} = \frac{\lambda_1 N_1}{\lambda_2 N_2} = \frac{\frac{N_1}{T_1}}{\frac{N_2}{T_2}} = \frac{N_1 T_2}{N_2 T_1}$	½	2
24	Definition of wavefront — ½ mark Figure — ½ mark Derivation of law of refraction — 1 mark		
	Wavefront is defined as the surface of constant phase; Alternatively It is a locus of all the points in the same phase of disturbance	½	
		½	
	$\sin i = \frac{BC}{AC} = \frac{v_1 t}{AC}$	½	
	$\sin r = \frac{AE}{AC} = \frac{v_2 t}{AC}$ $\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$	½	2
	OR		

	Lens Maker's formula — 1 mark Derivation of focal length of three lenses — 1 mark		
	$\because \frac{1}{v} - \frac{1}{u} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) - - - - - - - 1$	1	
	When u=∞ and $v = f$ $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) - - - - - - - - - - - 2$ $[n = \frac{n_2}{n_1}]$	½	
	From Eq 1 and 2 $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ *then lens formula* [Even if the student derives $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ for biconvex lens, award 1 ½ marks]	½	2
25	Magnetic field at point P — 1 ½ mark Curve — ½ mark		
	a) $B = \frac{\mu_o I}{2\pi x}$	½	
	$B_P = B_1 - B_2 = \frac{\mu_o I}{2\pi x} - \frac{\mu_0 I}{2\pi(d-x)} = \frac{\mu_o I(d-2x)}{2\pi(d-x)x}$	1	
	b) 	½	2

26

Electrostatic force= centripetal force	½ mark
Angular momentum=$\frac{nh}{2\pi}$	½ mark
Formula for radius of nth orbit	1 mark

$$F_c = F_E$$

$$\frac{m_e v_n^2}{r_n} = \frac{Kze^2}{r_n^2}$$ ½

$$m_e v_n^2 r_n = Kze^2$$

By Bohr's second postulate

$$L = m_e v_n r_n = \frac{nh}{2\pi}$$ ½

$$r_n = \frac{n^2h^2}{4\pi^2 m_e k e^2 Z}$$

$$r_n = \frac{n^2h^2}{4\pi^2 m_e k e^2} \quad (\because Z = 1)$$ 1 | 2

OR

Two observations	1 mark
Diagram	1 mark

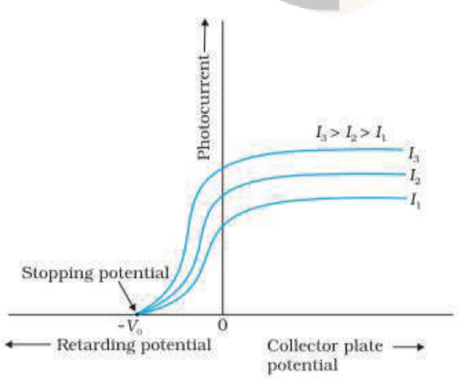
a) ½

(i) There exists a threshold frequency below which no photoelectron is ejected.

(ii) KE of electron depends linearly on frequency and is independent of intensity of radiation. ½

[or any other correct observation]

b)



1 | 2

[only curve is essential to draw]

27

Explanation of depletion layer and potential barrier	½ + ½ mark
Effect on depletion layer	½ mark
Effect on Potential barrier	½ mark

The small region in the vicinity of the junction which is depleted of free charge carrier and has only immobile ions is called depletion region/ layer. ½

The accumulation of negative charges in p - region and positive charges in n- region set up a potential difference across the junction, which acts as a barrier and is called barrier potential. ½

In forward bias (a) width of depletion layer decreases ½

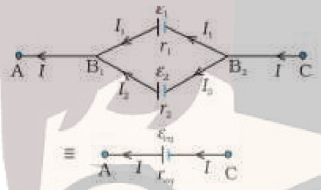
(b) value of potential decreases ½ 2

SECTION C

28

a) Internal resistance	1 ½ mark
b) Voltage across R	1 ½ mark

(a)



Current drawn from cell -1

$$I_1 = \frac{E_1 - V}{r_1}$$ ½

Current drawn from cell -2

$$I_2 = \frac{E_2 - V}{r_2}$$

Resultant current $I = I_1 + I_2$

On solving

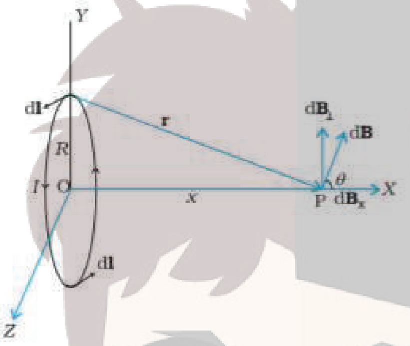
$$\therefore I = \frac{E_1 r_2 + E_2 r_1}{r_1 r_2} - V\left(\frac{r_2 + r_1}{r_1 r_2}\right)$$

$$\therefore V = \frac{E_1 r_2 + E_2 r_1}{r_1 r_2} - I\left(\frac{r_1 r_2}{r_2 + r_1}\right)$$

$$V = E_{eq} - I r_{eq}$$

$$E_{eq} = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$$ ½

$$r_{eq} = \frac{r_1 r_2}{r_2 + r_1}$$ ½

	$$r_{eff} = \frac{r_1 r_2}{r_1 + r_2} = \frac{2 \times 2}{2 + 2} = 1\Omega$$	½	
	Current through R $$I = \frac{E_{effect}}{R + r_{eff}} = \frac{5}{10 + 1} = \frac{5}{11} A$$	½	
	P.D across R $$= \frac{5}{11} \times 10 = 4.54\ volt$$	½	3
29	a) Writing expression for magnetic moment ½ mark b) Figure ½ mark Magnetic field and calculation 2 mark		
	(a) magnetic moment = M= NIA $$M = NI\pi r^2$$	½	
		½	
	According to Biot-sevart law $$\vec{dB} = \frac{\mu_0 I}{4\pi} \frac{\lvert \vec{dl} \times r \rvert}{r^3}$$ $$dB = \frac{\mu_0 I}{4\pi} \frac{dl}{r^2}$$	½	
	$dB_{\perp}$ components due to diametrically opposite components cancel out. Only dB_x components refrain $$dB_x = \frac{\mu_0 I dl}{4\pi r^2} . cos\theta$$	½	
	$$B = \int dB_x$$ $$B = \frac{\mu_0 I R^2}{2(R^2 + x^2)^{3/2}}\ (along\ x\ axis)$$	1	3

OR

a) Definition and expression	1 mark
b) Conversion of Galvanometer	
(i) into ammeter	1 mark
(ii) Effective resistance	1 mark

a) Deflection per unit current — ½

$$I_s = \frac{\theta}{I} = \frac{BNA}{K}$$ ½

b) (i) By connecting a low resistance (R_s) in parallel to galvanometer such that — ½

$(I_0 - I_g)R_s = I_g G$ — ½

(ii) effective resistance

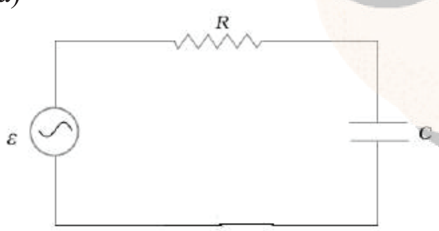
$$\frac{1}{R_A} = \frac{1}{R_s} + \frac{1}{G} = \frac{G + R_s}{R_s G}$$

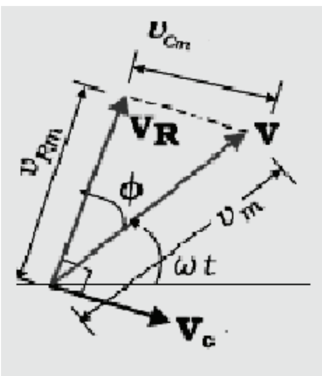
$$\therefore R_A = \frac{R_s G}{G+R_s}$$ 1 — 3

30

(a) Peak value of current and phasor	1 mark
Potential across R	½ mark
Potential across C	½ mark
(b) Phase difference	½ mark
Identification	½ mark

(a)





½

	Peak value of current $I_0 = \frac{V_0}{Z} = \frac{V_0}{\sqrt{X_c^2 + R^2}}$ $X_c = \frac{1}{\omega C}$ (i) $V_R = I_0 R = \frac{V_0 R}{\sqrt{X_c^2 + R^2}}$ (ii) $V_c = I_0 X_c = (\frac{V_0}{\sqrt{X_C^2 + R^3}})\ X_c$ (b) From phasor $tan\phi = \frac{X_c}{R}$ Current leads the applied voltage by phase ϕ	½ ½ ½ ½ ½	3
31	a) Dependence on distance D from slit 1 mark b) Dependence on slit separation d 1 mark c) Dependence on distance between source and slit 1 mark (a) Fringe width increases, $\beta \propto D$ (b) Fringe width decreases, $\beta \propto \frac{1}{d}$ (c) Fringes disappear because $\frac{s}{S} < \frac{\lambda}{d}$ not satisfied	½ + ½ ½ + ½ ½ + ½	3
32	(a) Speed of light in material medium 1 mark (b) (i) Identification and Range ½ + ½ mark (ii) Identification and Range ½ + ½ mark (a) Speed of light in medium $\upsilon = \frac{1}{\sqrt{\mu\epsilon}} = \frac{1}{\sqrt{\mu_0\mu_r\epsilon_0\epsilon_r}}$ (b) (i) Microwave range 0.1mt – 1mm (10^{-3}m – 10^{-1}m) (ii) Infrared waves range $1\ mm - 700nm$	1 ½ +½ ½ + ½	3
33	KE of α particle 1 mark Calculation 2 marks KE of α particle $E_{k\alpha} = (m_y - m_x - m_\alpha)c^2$ $= m_y c^2 - m_x c^2 - m_\alpha c^2$ = (235 × 7.8 – 231 × 7.835 – 4 × 7.07) MeV = 1833 – 1809.885 – 28.28 = 1833 – 1838.165 = -5.165 MeV	½ ½ ½ ½ 1	3

<table>
<tr><td></td><td>$E_k < 0$ wrong information
[Award full marks till this step]</td><td></td><td></td></tr>
<tr><td>34</td><td>

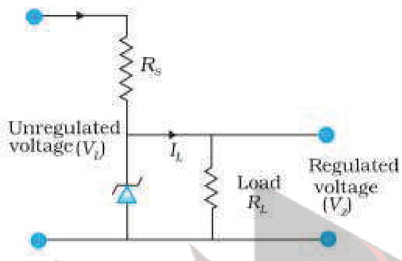
(a) Circuit diagram 1 mark

Working of Zener diode as DC voltage regulator 1 mark

V-I graph ½ mark

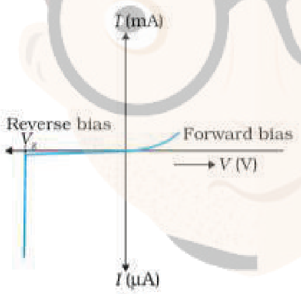
(b) Reason of heavy doping ½ mark

(a)



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 changes in the voltage across the Zener diode. This is because in the breakdown region, Zener voltage remains constant even though the current through that Zener diode changes.

(a)



(b)

(b) To decrease the width of depletion region which increases electric field at the junction.

</td><td>1

1

½

½</td><td>3</td></tr>
<tr><td colspan="4">SECTION D</td></tr>
<tr><td>35</td><td>

(a) (i) Electric Field inside hollow sphere 1½ mark

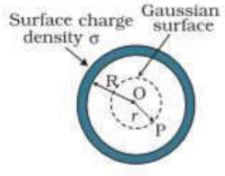
(ii) Electric Field outside hollow sphere 1½ mark

(b) (i) The net outward flux through cylinder 1 mark

(ii) The net charge present inside the cylinder 1 mark

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

(a)
(i)



½

According to Gauss's Law

$$\oint \vec{E}.\vec{dA} = \frac{q_{in}}{\epsilon_0}$$ ½

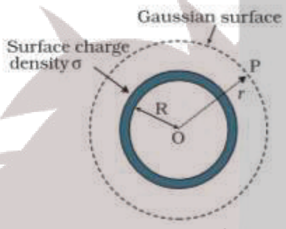
$$\because \textit{ inside hollow sphere}$$

$q_{in} = 0$

$$\therefore \oint \vec{E}\,.\vec{dA} = 0$$

E = 0 ½

(ii)



½

$$q = \sigma 4\pi R^2$$ ½

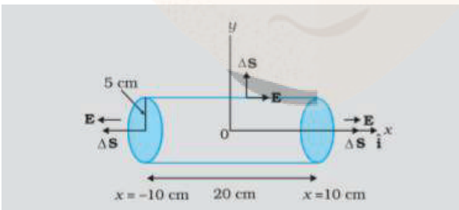
$$\oint \vec{E}.\vec{dA} = \frac{q}{\epsilon_0}$$

$$E \oint dA = \frac{q}{\epsilon_0}$$

$$E.4\pi x^2 = \frac{\sigma 4\pi R^2}{\epsilon_0}$$

$$E = \frac{\sigma R^2}{\epsilon_0 x}$$ ½

b)



(i) The net outward flux through cylinder

$$\phi = EA + EA = 2EA \qquad A = \pi r^2$$ ½

= 2 ×200 × 3.14 × 0.05 × 0.05

$$= 3.14 \frac{N}{C} m^2$$ ½

(ii) The net charge present inside the cylinder

$$q = \epsilon_0 \phi$$ ½

q= 8.854 × 3.14 × 10^{-12}

= 2.78×10^{-11} C ½ 5

OR

a) Expression for potential energy	3 marks
b) Equipotential surface due to isolated -ve charge	1 mark
c) Work done in assembling the charge	1 mark

(a) Work done in bringing q from infinity against the field

$$E = q_1 V|\vec{r}_1|$$ 1

Work done on q_2 against the field E= $q_2 V|\vec{r}_2|$

Work done on q_2 against the field due to q_1

$$= \frac{q_1 q_2}{4\pi\epsilon_0 (r_{12})}$$ 1

Potential energy of the system= Total work done in assembling the system ½

$$= q_1 V(\vec{r}_1) + q_2 V(\vec{r}_2) + \frac{q_1 q_2}{4\pi\epsilon_0 r_{12}}$$ ½

b)

1

c) Work done= charge in potential energy

$$= \frac{kq_1 q_2}{r_{12}} + \frac{kq_1 q_3}{r_{13}} + \frac{kq_2 q_{31}}{r_{23}}$$ ½

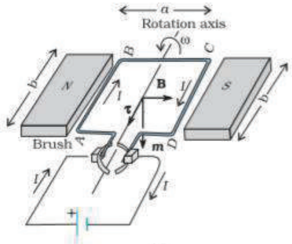
$$= \frac{9 \times 10^9 \times 10^{-12}}{0.1} [1 \times -1 + -1 \times 2 + 1 \times 2]$$

$$= 9 \times 10^{-2} [-1 - 2 + 2]$$

$$= -9 \times 10^{-2} J$$ ½ 5

36

a) Labelled diagram	1 mark
Derivation for torque	1 mark
Justification of radial magnetic field	1 marks
(b) Calculation of radius of the path	2 marks



(a)

1

Magnetic forces of AB and CD are equal and opposite and have different line of action so constitute torque

Force acting on current carrying arms AB and CD

$$F_1 = F_2 = BIl = F\ (say)$$

$$\therefore \tau = F\ \times perpendiclar\ distance\ between\ two\ force\ arm$$ ½

$$\therefore \tau = BIlbsin\theta$$

$$lb = A$$

$$\tau = BIA\ sin\theta$$

For N turn

$$\tau = BINA\ sin\theta$$ ½

Radial fields always produce maximum torque and removes the dependence of torque on θ 1

(b) Radius of circular path $= \frac{mv}{Bq} = \frac{\sqrt{2mE_k}}{Bq}$ 1

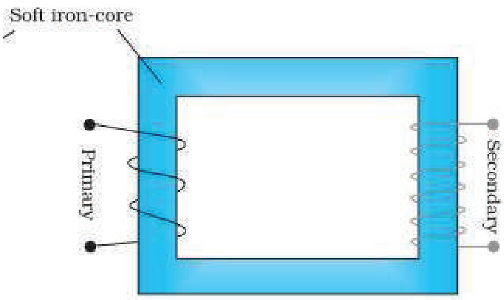
$$= \frac{1}{B}\sqrt{\frac{2mqV}{q^2}}$$

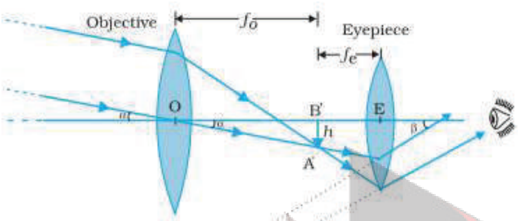
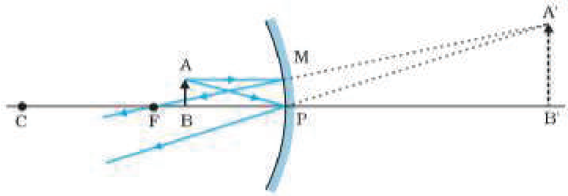
$$= \frac{1}{B}\sqrt{\frac{2mV}{q}} = \frac{1}{2 \times 10^{-3}}$$

r = 10m 1 5

OR

(a) Labelled diagram	1 mark
Working	1 mark
(i) & (ii) Reason/justification	½ + ½ mark
(b) (i) External force required	1 mark
(ii) Power required	1 mark

		1	
	[Note: Diagram with different windings can also be drawn] When an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf		
	Induced emf across primary coil		
	$$e_P = -N_p \frac{d\emptyset}{dt}$$	½	
	Induced emf across secondary coil		
	$$e_s = -N_s \frac{d\emptyset}{dt}$$		
	$$\frac{e_s}{e_p} = \frac{N_s}{N_p} = r$$	½	
	(i) to minimise the eddy currents	½	
	(ii) To reduce the heat loss	½	
	(b) (i)		
	F=BIl $I = \frac{E}{R} = \frac{Bvl}{R}$ $F = \frac{B^2vl^2}{R}$	½	
	$= \frac{0.4 \times 0.4 \times 0.1 \times 0.2 \times 0.2}{0.1}$ $= 6.4 \times 10^{-3}$ N	½	
	$P = F.v = 6.4 \times 10^{-3} \times 0.1$	½	
	$= .64 \times 10^{-3} W$	½	5

37	a) Labelled diagram — 2 marks Figure Expression for resolving power — 1 mark b) Calculation of angular magnification — 1 mark Diameter of image formed by objective lens — 1 mark		
	a)		
	 	2	
	Resolving power of telescope $= \frac{D}{1.22\lambda}$	1	
	b) (i) Angular magnification $m = \frac{\beta}{\alpha} = \frac{f_o}{f_e} = \frac{20m}{10^{-2}m} = 2000$	1	
	(ii) $\frac{D}{d} = \frac{x}{f_o}$	½	
	$d = \frac{Df_0}{x} = \frac{3.5 \times 10^6 \times 20}{3.8 \times 10^8} = .18\text{m}$	½	5
	OR		
	(a) Labelled diagram — 1 mark Derivation of mirror relation — 2 marks (b) Position of image — 1 ½ marks Nature of image — 1 ½ marks		
	 (a)	1	
	$\Delta ABP \sim A'B'P$ $\frac{A'B'}{AB} = \frac{PB'}{PB}$ - - - - - - - - - - 1	½	
	Also $\Delta A'B'F \sim MNP$ (for small curvature)		

	$\therefore \frac{A'B'}{MP} = \frac{B'F}{PF}$		
	$\frac{A'B'}{AB} = \frac{B'F}{PF} - - - - - - - - - - - - - 2$		
	From 1 and 2		
	$\frac{PB'}{PB} = \frac{B'F}{PF} - - - - - - - - - - - - - - 3$	½	
	$\frac{PB'}{PB} = \frac{B'P + PF}{PF} - - - - - - - - - -4$	½	
	$PB = -u \qquad PB' = v \qquad PF = -f$		
	$\frac{v}{-u} = \frac{v - f}{-f}$		
	$-vf = -vu + uf$		
	$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$	½	
	(b) According to lens maker's formula		
	$\frac{1}{f} = (\mu - 1)\,(\frac{1}{R_1} - \frac{1}{R_2})$	½	
	for plano convex lens R_1 R and R_2 ∞		
	$\frac{1}{f} = \frac{(\mu - 1)}{R} = \frac{1.5 - 1}{20}$	½	
	$\therefore$f=40 cm		
	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$		
	$\frac{1}{40} = \frac{1}{v} - \frac{1}{-30}$		
	$v = -12\ cm$	½	
	Nature: virtual	½	5