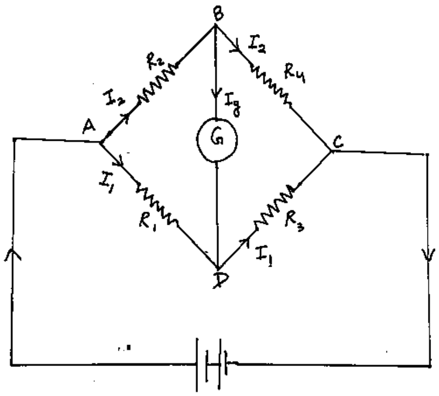
	MARKING SCHEME : PHYSICS (042)		
	CODE: 55/3/3		
Q.NO.	VALUE POINT/ EXPECTED ANSWERS	MARKS	TOTAL MARKS
	SECTION A		
1.	(B) 0.1mC	1	1
2.	(B) 1.6×10^{-18} J	1	1
3.	(C) $-(0.24\text{ nT})\ \hat{k}$	1	1
4.	(D) Sodium Chloride	1	1
5.	(B) 0.3 MB	1	1
6.	(D) 100 V	1	1
7.	(B) l is decreased and A is increased	1	1
8.	(A) +z direction and in phase with $\vec{E}$	1	1
9.	(B) 2	1	1
10.	(A) $\frac{\lambda}{\sqrt{2}}$	1	1
11.	(B) decreased by 87.5%	1	1
12.	(B) 0.05 eV	1	1
13.	(D) Assertion (A) is false and Reason (R) is also false.	1	1
14.	(C) Assertion (A) is true but Reason (R) is false.	1	1
15.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).	1	1
16.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).	1	1
	SECTION B		
17.	Meaning of relaxation time ½ Derivation of R 1½		
	Average time between two successive collisions of electron in presence of electric field.	½	
	Drift velocity of an electron $\upsilon_d = \frac{eE}{m}\tau \qquad ---(i)$	½	
	Current flowing through a conductor of length l and area of cross section A $I = neA\upsilon_d \qquad ---(ii)$		
	$I = \frac{ne^2 AE\tau}{m} = \frac{ne^2 A\tau V}{ml}$	½	
	$R = \frac{V}{I} = \frac{ml}{ne^2\tau A}$	½	
	OR		
	Circuit diagram of Wheatstone bridge ½ Obtaining the condition when current flows through galvanometer 1½		

		½	
	By applying Kirchoff's loop rule to closed loops ADBA and CBDC $-I_1R_1 + 0 + I_2R_2 = 0$ -----(i) $[I_g = 0]$ $I_2R_4 + 0 - I_1R_3 = 0$ -----(ii)	½	
	From eq (i) - $\frac{I_1}{I_2} = \frac{R_2}{R_1}$	½	
	From eq (ii) - $\frac{I_1}{I_2} = \frac{R_4}{R_3}$ Hence, $\frac{R_2}{R_1} = \frac{R_4}{R_3}$	½	**2**
18.	Finding the focal length of objective lens 2 Magnifying power =24 , Distance between lenses =150 cm $\frac{f_o}{f_e} = 24$	½	
	$f_o + f_e = 150\,\text{cm}$	½	
	$f_e = 6\,\text{cm}$	½	
	$f_o = 144\,\text{cm}$	½	**2**
19.	Sustained or stable interference 1 Conditions for sustained interference 1 ❖ When position of maxima and minima is not changing with time, interference pattern is called sustained or stable interference.	**1**	
	❖ Light sources must be coherent	**1**	**2**
20.	Possibility of emission of electron 1 Calculation of longest wavelength of emitted electron 1 $E = \frac{hc}{\lambda}$		

	$= \frac{1240\, eV\, nm}{600\, nm}$ $= 2.06\, eV$ $\because$ Work function $\phi_0 = 2.3 eV$ $\because E < \phi_0$ No emission will take place. $\lambda_{max} = \frac{hc}{\phi}$ $= \frac{1240\, eV\, nm}{2.3\, eV}$ $\lambda_{max} = 539.13 nm$	½ ½ ½ ½	2
21.	Calculation of concentration of holes & electrons 2 $n_e n_h = n_i^2$ $n_h \approx 5 \times 10^{22} / m^3$ $n_e = \frac{n_i^2}{n_h}$ $n_e = \frac{(1.5 \times 10^{16})^2}{5 \times 10^{22}}$ $n_e = 4.5 \times 10^9 / m^3$ $n_h > n_e$, it is a p- type crystal	½ ½ ½ ½	2
	SECTION C		
22.	Calculation of (a) Electric field across the wire 1 (b) Current density 1 (c) Average relaxation time (τ) 1 (a) $E = \frac{V}{l}$ $= \frac{1.0 V}{1.0 m} = 1.0$ V/m (b) $J = I/A$ $J = \frac{1.6 A}{1.0 \times 10^{-7} m^2} = 1.6 \times 10^7$ A/m^2 (c) $\tau = \frac{m}{ne^2} \frac{J}{E}$ $= \frac{9.1 \times 10^{-31} \times 1 \times 1.6}{9 \times 10^{28} \times (1.6 \times 10^{-19})^2}$ $= 6.31 \times 10^{-14}$s	½ ½ ½ ½ ½ ½	3

23.

Derivation of magnetic dipole moment	2 ½
Gyromagnetic ratio	½

Electron revolve around the nucleus constitute a current

$I = e/T$ ½

$T = \dfrac{2\pi r}{v}$

$I = \dfrac{ev}{2\pi r}$ ½

Magnetic moment, M =I.A

$\mu_l = \dfrac{ev.\pi r^2}{2\pi r}$ ½

$\mu_l = \dfrac{evr}{2}$ ½

$(L = mvr)$

Since electron has negative charge, μ_l is opposite in direction of an electron of angular momentum L.

$\overrightarrow{\mu_l} = -\dfrac{e}{2m}\vec{L}$ ½

Gyromagnetic ratio- The ratio of magnetic moment to angular momentum is called gyromagnetic ratio.

That is, $\dfrac{\mu_e}{L} = \dfrac{e}{2m}$ ½ **3**

[Note- give half mark of gyromagnetic ratio to each student, if it is not attempted]]

24.

Proof of induced charge	3

Using Faraday's law of electromagnetic induction

$|\varepsilon| = \dfrac{\triangle\phi}{\triangle t}$ ½

$I = \dfrac{|\varepsilon|}{R}$ ½

$I = \dfrac{1}{R}\left(\dfrac{\triangle\phi}{\triangle t}\right)$ ½

$\dfrac{\triangle Q}{\triangle t} = \dfrac{1}{R}\left(\dfrac{\triangle\phi}{\triangle t}\right)$ ½

$\triangle Q = \dfrac{\triangle\phi}{R}$ ½

Hence induced charge depends on change in magnetic flux, not on the time interval of flux change. ½ **3**

25.

(a) Finding the wavelength and frequency	1+1
(b) Finding the amplitude of magnetic field	½
(c) Writing expression for magnetic field	½

(a) $k = \frac{2\pi}{\lambda}$ ½

$\lambda = \frac{2\pi}{K} = \frac{4\pi}{3}\text{m} = 4.18\text{m}$ ½

$\omega = 2\pi\upsilon$

$\nu = \frac{\omega}{2\pi} = \frac{4.5\times10^8}{2\pi}\text{Hz}$ ½

$\nu = \frac{9}{4\pi}\times10^8\text{ Hz}$ ½

$\nu = 7.16\times10^{-1}\text{ Hz}$

(b) $B_0 = \frac{E_0}{c}$

$B_0 = \frac{6.3}{3\times10^8} = 2.1\times10^{-8}\text{T}$ ½

(c) $\vec{B} = 2.1\times10^{-8}[(\cos 1.5\,\text{rad/m})\,y + (4.5\times10^8\,\text{rad/s})\,t]\hat{k}\,\text{T}$ ½ **3**

26.

Statement of Bohr's second postulates	½
Derivation of $r_n \alpha n^2$	2½

Bohr's second postulate

Electron revolves around the nucleus only in those orbits for which the angular momentum in some integral multiple of h/2π. ½

Electrostatic force between revolving electron & nucleus provide requisite centripetal force

$$\frac{mv_n^2}{r_n} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_n^2}$$ ½

$$v_n = \frac{e}{\sqrt{4\pi\varepsilon_0 m r_n}} \qquad \text{\_\_\_\_\_\_\_\_\_(i)}$$ ½

$$mv_n r_n = \frac{nh}{2\pi} \qquad \text{\_\_\_\_\_\_\_\_\_(ii)}$$ ½

From eqn. (i) and (ii)

$$r_n = \left(\frac{n^2}{m}\right)\left(\frac{h}{2\pi}\right)^2\frac{4\pi\varepsilon_0}{e^2}$$ ½

$$r_n \propto n^2$$ ½ **3**

27.

(a) Definition of Atomic mass unit (u)	1
(b) Calculation of energy required	2

(a) Atomic mass unit (u) is defined as 1/12th of the mass of the carbon (^{12}C) atom. **1**

(b) $m\left({}_1H^2\right) \rightarrow m\left({}_1H^1\right) + m\left({}_0n^1\right)$ ½

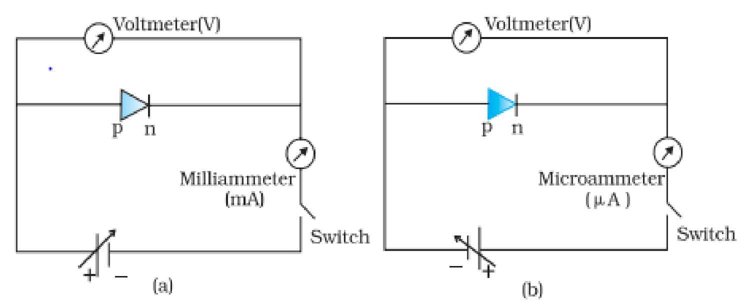
$Q = (m_R - m_P)\times 931.5\,MeV$

	$= (2.014102 - 1.007825 - 1.008665) \times 931.5\, MeV$	½	
	$= -0.002388 \times 931.5\, MeV$	½	
	$= -2.224\, MeV$	½	3
	Hence energy required is 2.224 MeV		

28.

(a)

(a) Drawing of circuit diagram for V-I characteristics	1
Salient features of V-I characteristics in	
(i) Forward biasing	1
(ii) Reverse biasing	1



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[any one circuit diagram]

Salient features

(i) **Forward biasing-** After threshold voltage or cut in voltage diode current increases significantly (exponentially), even for a small increase in the bias voltage. **1**

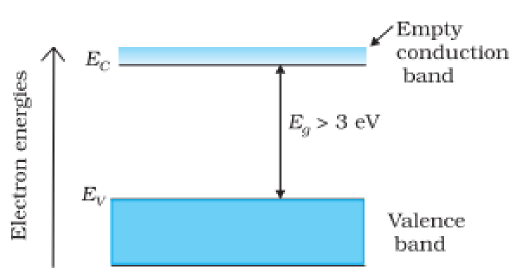
(ii) **Reverse biasing-** Current is very small (~μA) and almost remains constant and it increases rapidly after breakdown voltage. **1**

OR

(b)

Energy band diagrams	
Difference between	
(i) an insulator	
(ii) a semiconductor	
(iii) a metal	1+1+1

(i)



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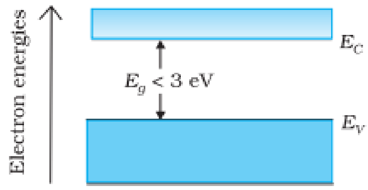
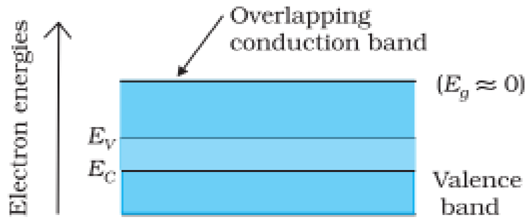
	(ii) 	1	
	(iii) 	1	3
	SECTION D		
29.	(i) (D) IV (ii) (D) accelerate along $-\hat{i}$ (iii) (A) $V = V_0 + \alpha x$ (iv) (a) (C) $E_4 > E_3 > E_2 > E_1$ OR (b) (B) 2.6×10^6 m/s	1 1 1 1	4
30.	(i) (D) 6 (ii) (C) 3 (iii) (a) (C)6 OR (b) (B) $\sin^{-1}(0.225)$ (iv) (D) 10	1 1 1 1	4
	SECTION E		
31.	**(a)** (i) Obtaining expression for the capacitance — 3 (ii) Finding the electric potential — 2 (i) at the surface (ii) at the centre		
	When a dielectric slab is inserted between the plates of capacitance there is induced charge density σ_P which opposes the original charge density (σ) on the plate of capacitance.	½	
	Electric field with dielectric medium is $E = \frac{(\sigma - \sigma_P)}{\varepsilon_0}$	½	
	$V = E \times d = \frac{(\sigma - \sigma_P)}{\varepsilon_0} d$	½	
	$(\sigma - \sigma_P) = \frac{\sigma}{K}$	½	
	$V = \frac{\sigma d}{\varepsilon_0 K} = \frac{Qd}{A\varepsilon_0 K}$	½	
	$C = \frac{Q}{V} = \frac{K\varepsilon_0 A}{d}$	½	

(ii) Electric potential due to a point charge

$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ ½

(i) At the surface

$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} = \frac{9\times10^{9}\times6\times10^{-6}}{0.2}$ ½

$V = 2.7 \times 10^5$ V ½

(ii) Since electric field inside the hollow sphere is zero, hence V remains constant throughout the volume.

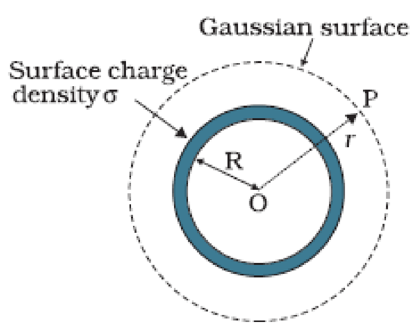
$V = 2.7 \times 10^5$ V ½

OR

(b)

(i) Expression for electric field at appoint lying	
(i) inside	1
(ii) outside	2
(ii) Explanation	2

(i) <u>Field inside the shell</u>



The Flux through the Gaussian surface is

$= E \times 4\pi R^2$ ½

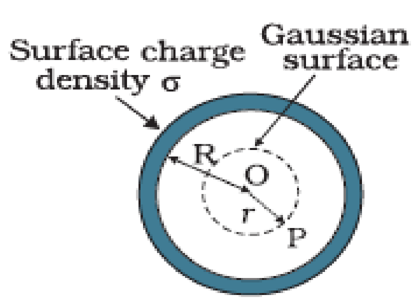
In this case Gaussian surface enclosed no charge.

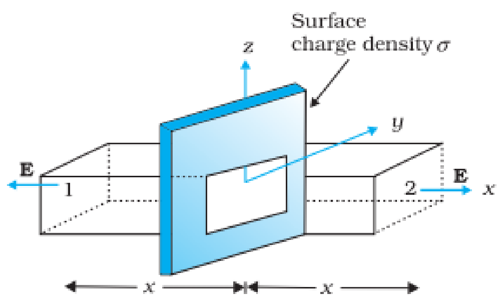
Hence $E \times 4\pi R^2 = 0$

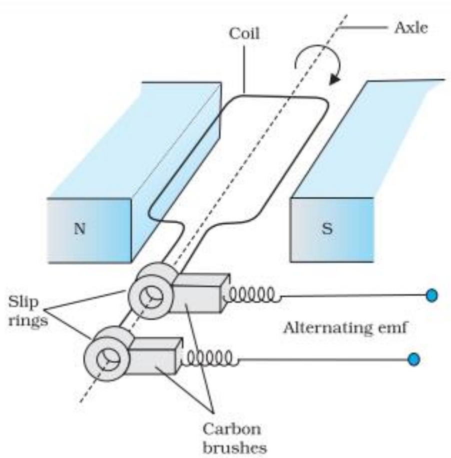
E =0 ½

(Note: Award full credit of this part if a student writes directly E=0, mentioning as there is no charge enclosed by Gaussian surface)

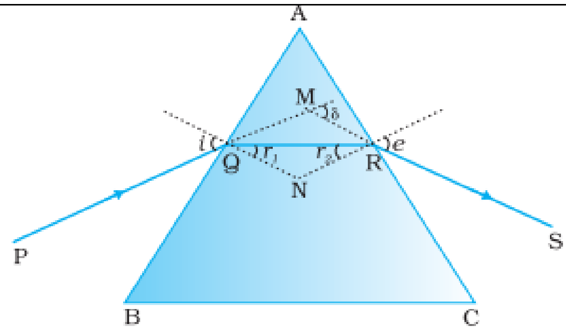
(ii) <u>Field outside the shell</u>-

 ½

	Electric flux through Gaussian surface		
	$E \times 4\pi r^2 = \frac{(\sigma\, 4\pi R^2)}{\varepsilon_0}$	½	
	Charge enclosed by the Gaussian surface		
	$E \times 4\pi r^2 = \frac{(\sigma\, 4\pi R^2)}{\varepsilon_0}$		
	Using Gauss's law:		
	$\int \vec{E}.\vec{ds} = \frac{Q}{\varepsilon_0}$	½	
	$E \times 4\pi r^2 = \frac{(\sigma\, 4\pi R^2)}{\varepsilon_0}$		
	$E = \frac{\sigma}{\varepsilon_0}\frac{R^2}{r^2} = \frac{q}{4\pi\varepsilon_0 r^2}$	½	
	(ii) For conducting sheet,		
	Electric field due to a conducting sheet		
	$E_c = \frac{\sigma}{\varepsilon_0}$	½	
			
	For non-conducting sheet		
	$E_{nc} = \frac{\sigma}{2\varepsilon_0}$	½	
	Since surface charge density is same.	½	
	$2E_{nc} = E_c$	½	**5**
32.			
	(a) (i)(1) Meaning of current sensitivity, mentioning factors 2 (2) Finding the required resistance 1½ (ii) Finding the induced current 1½		
	(i) (1) Current sensitivity of galvanometer is defined as the deflection per unit current.	**1**	
	Alternatively,		
	$\frac{\phi}{I} = \frac{NBA}{K}$		
	Factors		
	Number of turns in coil, Magnetic field intensity, Area of coil, Torsional Constant **(Any two)**	½+½	
	(2) $R = \frac{V}{I} - G$ for (0-V) Range	½	
	$R_1 = \frac{V}{2I} - G$ for (0-$\frac{V}{2}$) Range	½	
	$\frac{V}{I} = R + G$		
	$R_1 = \left(\frac{R+G}{2}\right) - G$		

	$R_1 = \frac{R-G}{2}$	½	
	(ii) $\phi = (2.0t^3 + 5.0t^2 + 6.0t)$ mWb		
	$\lvert\varepsilon\rvert = \frac{d\phi}{dt} = 50 \times 10^{-3}$ V	½	
	$I = \frac{\lvert\varepsilon\rvert}{R}$	½	
	$I = \frac{50\times10^{-3}}{5}$ A = 10 mA	½	
	OR		
	(b) (i) Obtaining the expression of emf induced — 3 (ii) Calculation of mutual inductance — 2		
		1	
	(i) The flux at any instant t is		
	$\phi = NBA\cos\theta = NBA\cos\omega t$	½	
	From Faraday's law $\boldsymbol{\varepsilon} = -\frac{d\phi_B}{dt}$	½	
	$= -NBA\frac{d}{dt}(\cos\omega t)$	½	
	$\boldsymbol{\varepsilon} = -NBA\,\omega\sin\omega t$	½	
	(ii) $M = \frac{\mu_0\pi r_1^2}{2r_2} = \frac{4\pi\times10^{-7}\times\pi r_1^2}{2r_2}$	½+½	
	$= \frac{2\times10\times10^{-7}\times(10^{-2})^2}{100\times10^{-7}}$	½	
	$= 2\times10^{-10}$H	½	5
33.	**(a)** (i) Tracing the path of Ray — ½ Obtaining an expression for angle deviation — 1½ Drawing Graph — 1 (ii) Finding the refractive index — 2		

(i)



½

For quadrilateral AQNR,

$\angle A + \angle QNR = 180^o$ --- (i)

For triangle QNR

$r_1 + r_2 + \angle QNR = 180^o$ ---- (ii) ½

comparing equation (i) and (ii)

$r_1 + r_2 = A$ ------ (iii) ½

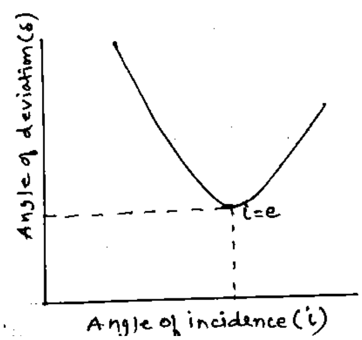
The angle of deviation

$\delta = (i - r_1) + (e - r_2)$ ------ (iv)

from equation (iii) and (iv)

$\delta = i + e - A$ ½

Graph



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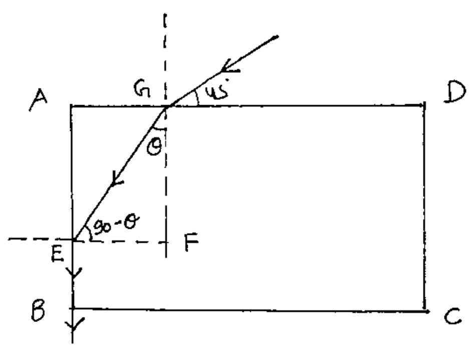
(ii)



$$\frac{\sin 45^0}{\sin\theta} = \mu$$

$$\frac{1}{\sqrt{2}} = \mu\sin\theta$$ ½

For second surface,

$$\frac{1}{\sqrt{2}}\frac{\cos\theta}{\sin\theta} = 1$$ ½

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$tan\,\theta = \frac{1}{\sqrt{2}}$

From the triangle GEF

$sin\,\theta = \frac{1}{\sqrt{3}}$

$\mu = \sqrt{\frac{3}{2}}$

OR

(b)

(i) Expression for resultant intensity	3
(ii) Ratio of intensities	2

(i) $y_1 = a\,cos\,\omega\,t$

$y_2 = a\,cos(\,\omega\,t + \phi)$

According to the principle of superposition

$y = y_1 + y_2$

$y = a\,cos\,\omega\,t + a\,cos(\,\omega\,t + \phi)$

$y = a\,cos\,\omega\,t + acos\,\omega\,tcos\,\phi - a\,sin\,\omega\,tsin\,\phi$

$y = a\,cos\,\omega\,t(\,1 + cos\,\phi) - a\,sin\,\phi\,sin\,\omega\,t$

Let,

$a(1 + cos\,\phi) = Acos\,\theta$ ------- (i)

$a\,sin\,\phi = A\;\;sin\,\theta$ --------(ii)

Squaring and adding equation (i) and (ii)

$A^2 = a^2(1+cos\phi)^2 + a^2 sin^2\phi$

$= a^2(1 + cos^2\,\phi + 2\,cos\,\phi) + a^2\,sin^2\,\phi$

$= 2a^2(1 + cos\,\phi)$

$= 4a^2\,cos^2\,\phi\,/2$

$I \alpha A^2$

$I = kA^2$

where k is constant

$I = 4ka^2\,cos^2\,\phi\,/2$

[Award full credit for this part for any other alternative methods]

(ii) $\phi_1 = \frac{2\pi}{\lambda} \times \frac{\lambda}{6} = \pi/3$

$I_1 = 4I_0\,cos^2\,\phi\,/2$

$= 4I_0\,cos^2(\,\pi/6)$

$I_1 = 3I_0$

$\phi_2 = \frac{2\pi}{\lambda} \times \frac{\lambda}{12} = \pi/6$

$I_2 = 4I_0\,cos^2(\,\pi/12)$

$I_2 = 4I_0\,cos^2\,15^0$

$\frac{I_1}{I_2} = \frac{3}{4\,cos^2\,15^0}$

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