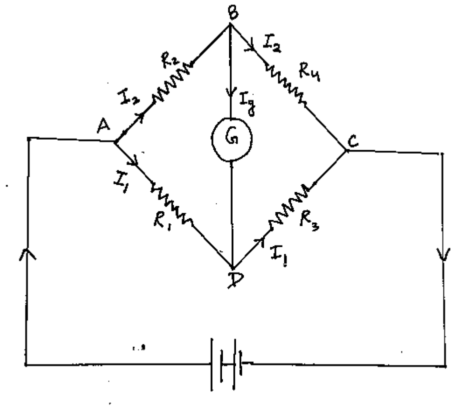
Marking Scheme
Strictly Confidential
(For Internal and Restricted use only)
Senior School Certificate Examination, 2024
SUBJECT PHYSICS (CODE 55/3/2)

General Instructions: -

1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers. These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (**✓**)while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.

9	If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out with a note **“Extra Question”**.
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks 0-70 has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).This is in view of the reduced syllabus and number of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in the past:- ● Leaving answer or part thereof unassessed in an answer book. ● Giving more marks for an answer than assigned to it. ● Wrong totaling of marks awarded on an answer. ● Wrong transfer of marks from the inside pages of the answer book to the title page. ● Wrong question wise totaling on the title page. ● Wrong totaling of marks of the two columns on the title page. ● Wrong grand total. ● Marks in words and figures not tallying/not same. ● Wrong transfer of marks from the answer book to online award list. ● Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.) ● Half or a part of answer marked correct and the rest as wrong, but no marks awarded.
14	While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.
15	Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.
16	The Examiners should acquaint themselves with the guidelines given in the “**Guidelines for Spot Evaluation**” before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once again reminded that they must ensure that evaluation is carried out strictly as per value points for each answer as given in the Marking Scheme.

	MARKING SCHEME : PHYSICS (042)		
	CODE: 55/3/2		
Q.NO.	**VALUE POINT/ EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION A		
1.	(C) –q and Q + q	**1**	**1**
2.	(B) 1.6 x 10^{-18} J	**1**	**1**
3.	(C) –(0.24nT) $\hat{k}$	**1**	**1**
4.	(D) Repel each other with a force $\frac{\mu_o I^2}{2\pi a}$, per unit length	**1**	**1**
5.	(B) 0.3 MB	**1**	**1**
6.	(D) 0.1 C	**1**	**1**
7.	(B) *l* is decreased and A is increased	**1**	**1**
8.	(C) X- rays	**1**	**1**
9.	(B) 2	**1**	**1**
10.	(C) $\phi_3 > \phi_2 > \phi_1$	**1**	**1**
11.	(B) decreases 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.	**(a)** Meaning of relaxation time ½; Derivation of R 1 ½		
	Average time between two successive collisions of electron in presence of electric field.	½	
	Drift velocity of an electron $\upsilon_d = \frac{eE}{m}\tau \quad ---(i)$	½	
	Current flowing through a conductor of length *l* and area of cross section A $I = neA\upsilon_d \quad ---(ii)$		
	$I = \frac{ne^2AE\tau}{m} = \frac{ne^2A\tau V}{ml}$	½	
	$R = \frac{V}{I} = \frac{ml}{ne^2\tau A}$	½	**2**
	OR		
	(b) Circuit diagram of Wheatstone bridge ½; Obtaining the condition when no 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)-

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

From eq (ii)-

$$\frac{I_1}{I_2} = \frac{R_4}{R_3}$$ ½

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.

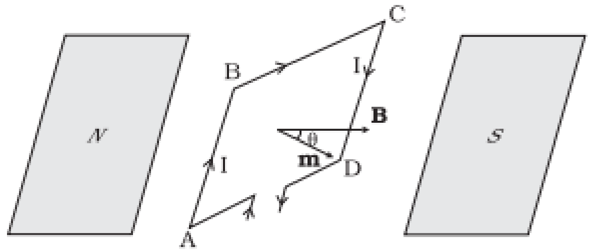
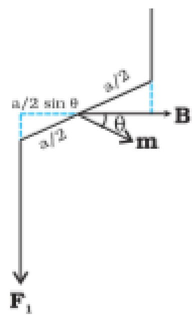
Differences between interference and diffraction of light	1+1

Interference	**Diffraction**
(i) In interference pattern width of each maxima is same. (ii) In interference pattern intensity of all maxima is same.	(i) In diffraction pattern width of central maxima is twice the width of secondary maxima. (ii) In diffraction pattern intensity of maxima goes on decreasing as we move away from central maxima.

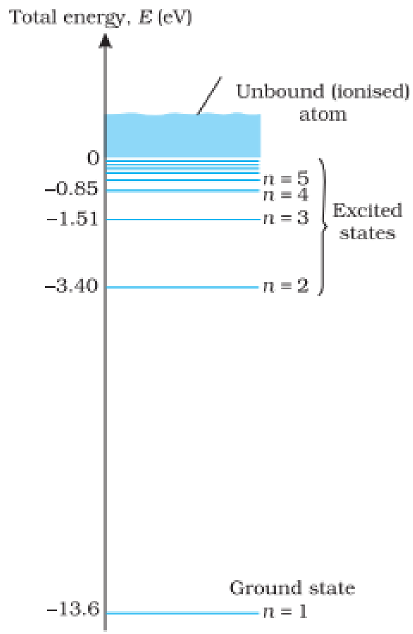
1+1

[Award full credit if students write any other two differences] **2**

20.	(i) Calculation of Kinetic energy (in eV) 1½ (ii) Stopping potential ½		
	Using Einstein Photoelectric equation		
	$\frac{hc}{\lambda} = K.E_{\max} + \phi_0$	½	
	$K.E_{\max} = \frac{hc}{\lambda} - \phi_0$		
	$= \frac{1240 eV nm}{500\,nm} - 2.14\,eV$	½	
	$K.E_{\max} = 0.34\,eV$	½	
	$K.E_{\max} = eV_0$		
	$\therefore V_0 = 0.34V$	½	**2**
21.	Calculation of concentration of holes and electrons 2		
	$n_e n_h = n_i^2$	½	
	$n_h \approx 5\times10^{22}/m^3$		
	$n_e = \frac{n_i^2}{n_h}$		
	$n_e = \frac{(1.5\times10^{16})^2}{5\times10^{22}}$	½	
	$n_e = 4.5\times10^{9}/m^3$	½	
	$n_h > n_e$, it is a p- type crystal	½	**2**
	SECTION C		
22.	Calculation of (a) emf of battery ½ (b) Internal resistance of battery(r) 1½ (c) external resistance (R) 1		
	(a) V= *E*=10 V(When key K is open and I=0 A)	½	
	(b) V=*E*-Ir (When key K is closed and I=2 A)	½	
	6=10-2r	½	
	r = 2Ω	½	
	(c) E=I(r+R)	½	
	10=2(2+R)		
	R= 3 Ω	½	**3**
23.	Derivation of torque in vector form 3		

	 	1	
	Forces on the arms BC and DA are, equal opposite and collinear. Hence they will cancel each other.	½	
	The forces on arms AB and CD are $\vec{F_1}$ and $\vec{F_2}$, equal but not collinear. The magnitude of the torque on the loop is $\tau = F_1 \frac{a}{2} \sin\theta + F_2 \frac{a}{2} \sin\theta$	½	
	$= IabB\sin\theta$ $= mB\sin\theta \quad (m = IA)$	½	
	$\vec{\tau} = \vec{m} \times \vec{B}$	½	3
24.	Differences between reactance and impedance 1 Showing Ideal inductor in an ac circuit does not dissipate any power 2		
	Reactance- It is the measure of opposition to flow of current in ac circuit comprising Inductor or Capacitor.	½	
	Impedance- It is the measure of opposition to flow of current in ac circuit comprising Resistor, Capacitor and Inductor.	½	
	$\varepsilon = \varepsilon_0 \sin\omega t$ $I = I_0 \sin(\omega t - \frac{\pi}{2}) = -I_0 \cos\omega t$	½	
	$P = \varepsilon I$ $= -\varepsilon_0 I_0 \sin\omega t \cos\omega t$ $= -\frac{\varepsilon_0 I_0}{2} 2\sin\omega t \cos\omega t$ $P = \frac{\varepsilon_0 I_0}{2} \sin 2\omega t$	½	

	$\langle P\rangle=\frac{\int_0^T Pdt}{\int_0^T dt}$	½	
	$\langle P\rangle=\frac{\int_0^T \frac{\varepsilon_0 I_0}{2}\sin 2\omega t dt}{T}$ $=\frac{\varepsilon_0 I_0}{2T}\int_0^T \sin 2\omega t dt$ $=-\frac{\varepsilon_0 I_0}{2T}\left(\cos\omega t\right)_0^T=\frac{\varepsilon_0 I_0}{2T}(1-1)$		
	$\langle P\rangle=0$ Hence average power associated with inductor is zero.	½	
	Alternatively $P=\varepsilon_{rms}I_{rms}\cos\phi$ For inductive circuit $\phi=\pi/2$	**1**	
	$P=\varepsilon_{rms}I_{rms}\cos\frac{\pi}{2}$	½	
	$P=0$	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) $\vec{B}=2.1\times10^{-8}[(\cos 1.5\text{ rad/ m})\text{ y}+(4.5\times10^8\text{ rad/ s})\text{ t}]\hat{k}\text{ T}$	½	**3**

26.	Explanation of origin of spectral lines of hydrogen atom 1 Energy level diagram showing various spectral series of hydrogen atom 2 When an electron makes a transition from higher energy level to a lower energy orbit, a photon is emitted having energy equal to energy difference between these two orbits.  **[Do not deduct marks for not showing transition in diagram]**	**1** **2**	**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. (b) $m\left({}_1H^2\right) \rightarrow m\left({}_1H^1\right) + m\left({}_0n^1\right)$ $Q = (m_R - m_P) \times 931.5\,MeV$ $= (2.014102 - 1.007825 - 1.008665) \times 931.5\,MeV$ $= -0.002388 \times 931.5\,MeV$ $= -2.224\,MeV$ Hence energy required is 2.224 MeV	**1** ½ ½ ½ ½	**3**
28.	(a) (a) Drawing the 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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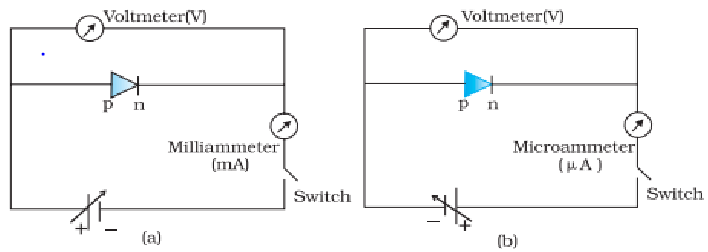
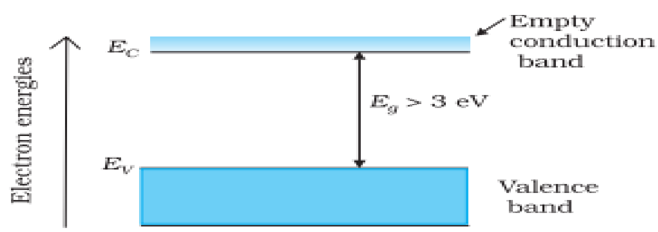
<tr><td></td><td>

[any one circuit diagram]</td><td>1</td><td></td></tr>
<tr><td></td><td>Salient features
(i) Forward biasing- After threshold voltage or cut in voltage diode current increase significantly (exponentially), even for a small increase in the diode bias voltage.</td><td>1</td><td></td></tr>
<tr><td></td><td>(ii) Reverse biasing- Current is very small (~μA) and almost remains constant and it increases rapidly after breakdown voltage.
OR</td><td>1</td><td></td></tr>
<tr><td></td><td>(b) Energy band diagrams
Difference between
(i) an insulator
(ii) a semiconductor
(iii) a metal 1+1+1</td><td></td><td></td></tr>
<tr><td></td><td>(i) 
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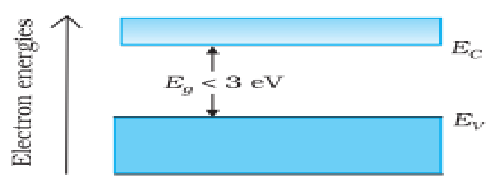
<tr><td></td><td>(ii) 
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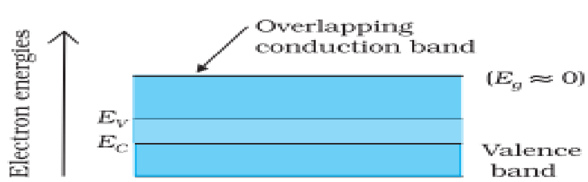
<tr><td></td><td>(iii) 
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<tr><td></td><td>SECTION D</td><td></td><td></td></tr>
<tr><td>29.</td><td>(i) (D) IV</td><td>1</td><td></td></tr>
<tr><td></td><td>(ii) (D) accelerate along $-\hat{i}$</td><td>1</td><td></td></tr>
<tr><td></td><td>(iii) (A) V= $V_0+\alpha x$</td><td>1</td><td></td></tr>
<tr><td></td><td>(iv) (a) (C) $E_4 > E_3 > E_2 > E_1$
OR
(b) (B) 2.6×10^6 m/s</td><td>1</td><td>4</td></tr>
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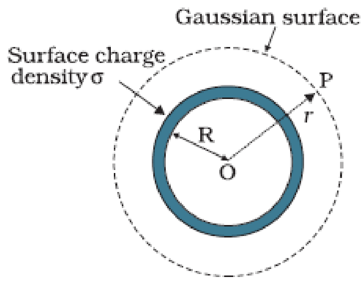
30.	(i) (D) 6 (ii) (C) 3 (iii) (a) (C) 6 **OR** (b) (B) $\sin^{-1}(0.225)$ (iv) (D) 10	**1** **1** **1** **1**	 **4**
	SECTION E		
31.	**(a)** (i) Obtaining expression for the capacitance 3 (ii) Finding the electric potential 2 (i) at the surface (ii) at the centre (i) When a dielectric slab is inserted between the plates of capacitance, there is induced charge density σ_P which opposes the original charge density (σ) on the plate of capacitance. Electric field with dielectric medium is $E = \frac{(\sigma - \sigma_P)}{\varepsilon_0}$ $V = E \times d = \frac{(\sigma - \sigma_P)}{\varepsilon_0} d$ $(\sigma - \sigma_P) = \frac{\sigma}{K}$ $V = \frac{\sigma d}{\varepsilon_0 K} = \frac{Qd}{A\varepsilon_0 K}$ $C = \frac{Q}{V} = \frac{K\varepsilon_0 A}{d}$ (ii) Electric potential due to a point charge $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ (i) At the surface $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} = \frac{9\times10^9\times6\times10^{-6}}{0.2}$ $V = 2.7 \times 10^5$ V (ii) Since electric field inside the hollow sphere is zero, hence V is same as that of the surface and remains constant throughout the volume.. $V = 2.7 \times 10^5$ V **OR** **(b)** (i) Expression for electric field at appoint lying (i) inside 1 (ii) outside 2 (ii) Explanation 2	 ½ ½ ½ ½ ½ ½ ½ ½ ½ ½	

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



The Flux through the Gaussian surface is

$= E \times 4\pi R^2$ ½

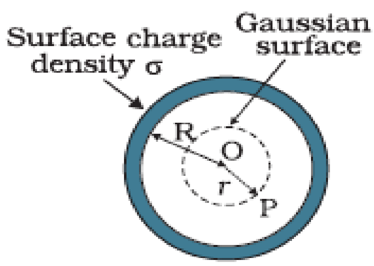
In this case Gaussian surface enclosed no charge.

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

$E \times 4\pi r^2 = \frac{(\sigma\, 4\pi R^2)}{\varepsilon_0}$ ½

Using Gauss's law:

$\int \vec{E}.\overrightarrow{ds} = \frac{Q}{\varepsilon_0}$ ½

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

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

(ii) For conducting sheet,

Electric field due to a conducting sheet ½

$E_c = \frac{\sigma}{\varepsilon_0}$

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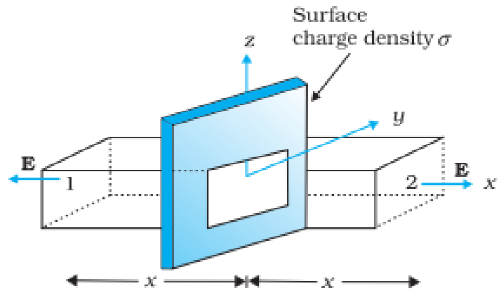

For non-conducting sheet

$E_{nc} = \frac{\sigma}{2\varepsilon_0}$

Since surface charge density is same.

$2E_{nc} = E_c$
</td>
<td>½

½
½</td>
<td>5</td>
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<td>
(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.

Alternatively,

$\frac{\phi}{I} = \frac{NBA}{K}$

Factors

No. of turns in coil, Magnetic field intensity, Area of coil, Torsional Constant (Any two)

(2) $R = \frac{V}{I} - G$ for (0-V) Range

$R_1 = \frac{V}{2I} - G$ for (0-V/2) Range

$\frac{V}{I} = R + G$

$R_1 = \left(\frac{R+G}{2}\right) - G$

$R_1 = \frac{R-G}{2}$

(ii) $\phi = (2.0t^3 + 5.0t^2 + 6.0t)$ mWb

$|\varepsilon| = \frac{d\phi}{dt} = 50 \times 10^{-3}$ V

$I = \frac{|\varepsilon|}{R}$

$I = \frac{50\times10^{-3}}{5}$ A=10 mA

OR

(b)

(i) Obtaining the expression of emf induced	3
(ii) Calculation of mutual inductance	2
</td>
<td>1

½+½

½
½

½

½
½
½</td>
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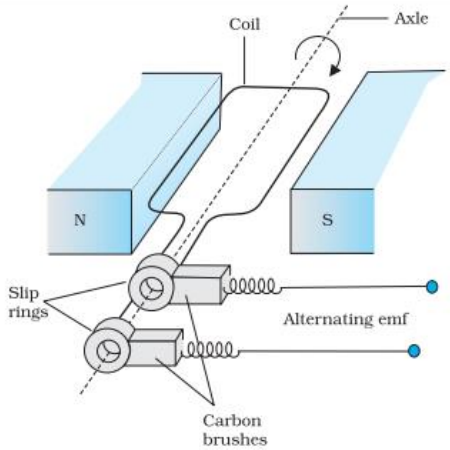


1

(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

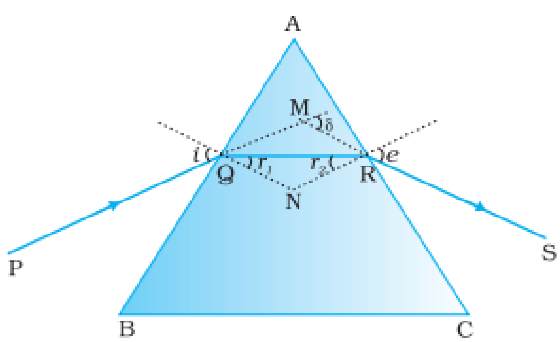
$= 2\times10^{-10}$H — ½ — **5**

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,

∠A + ∠QNR = 180° --- (i) — ½

For triangle QNR

$r_1 + r_2$ + ∠QNR = 180° ---- (ii)

comparing equation (i) and (ii)

$r_1 + r_2 = A$ ------ (iii) ½

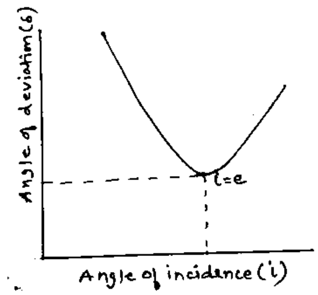
The angle of deviation

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

from equation (iii) and (iv)

$$\delta = i + e - A$$ ½

Graph



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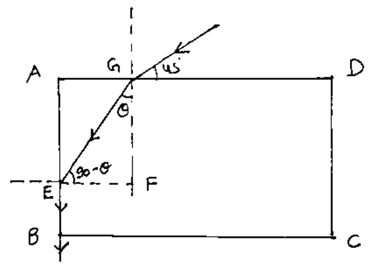
(ii)



$$\frac{\sin 45^0}{\sin\theta} = \mu$$ ½

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

For second surface,

$$\frac{\sin(90^0 - \theta)}{\sin 90^0} = \frac{1}{\mu}$$ ½

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

$$\tan\theta = \frac{1}{\sqrt{2}}$$ ½

From the triangle GEF

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

$$\mu = \sqrt{\frac{3}{2}}$$ ½

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

$$y = y_1 + y_2$$

$$y = a\cos\omega t + a\cos(\omega t + \phi)$$ ½

	$y = a\cos\omega t + a\cos\omega t\cos\phi - a\sin\omega t\sin\phi$ $y = a\cos\omega t(1+\cos\phi) - a\sin\phi\sin\omega t$ Let, $a(1+\cos\phi) = A\cos\theta$ ------- (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 $I = 4ka^2\cos^2\phi/2$ (ii) $\phi_1 = \frac{2\pi}{\lambda} \times \frac{\lambda}{6} = \pi/3$ $I_1 = 4I_0\cos^2\phi/2$ $= 4I_0\cos^2(\pi/6)$ $I_1 = 3I_0$ $\phi_2 = \frac{2\pi}{\lambda} \times \frac{\lambda}{12} = \pi/6$ $I_2 = 4I_0\cos^2(\pi/12)$ $I_2 = 4I_0\cos^2 15^0$ $\frac{I_1}{I_2} = \frac{3}{4\cos^2 15^0}$	½ ½ ½ ½ ½ ½ ½ ½ ½	 **5**