MARKING SCHEME

Q. No.	Expected Answer/ Value Points	Marks	Total Marks
	Section A		
Q1	i. Nichrome	1/2	
	ii. $R_{Ni} > R_{Cu}$ (or Resistivity _{Ni} > Resistivity _{Cu})	1/2	1
Q2	Yes	1	
02		1/	1
Q3	i. Decreases	1/2	
	ii. $n_{\text{Violet}} > n_{\text{Red}}$	1/2	
	(Also accept if the student writes $\lambda_V < \lambda_R$)		1
Q4	Photoelectric Effect (/Raman Effect/ Compton Effect)	1	
		1.0	30
Q5	A is positive and	1/2	1
Q3	B is negative	1/2	1
	(Also accept: A is negative and B is positive)	/2	_
	(Also accept. At is negative and B is positive)		
	SECTION B		
Q6	Interference pattern ½		
	Diffraction pattern ½		
	Two Differences $\frac{1}{2} + \frac{1}{2}$		
	I I _{max} 3λ 2λ 1λ 0 1λ 2λ 3λ → Path Difference	1/2	

Incoming wave	Slit Viewing screen	1/2	
Interference	Diffraction		
All maxima have equal	Maxima have different	-	
intensity	(/rapidly decreasing) intensity		
All fringes have equal	Different (/changing)	100	37
width.	width.	- 12	
Superposition of two	Superposition of wavelets	$\frac{1}{2} + \frac{1}{2}$	
wavefronts	from the same wavefront	2	
	(Any two)		2
	OR		
Expression for intensity	of polarized beam 1		
Plot of intensity variation	on with angle 1		
Interest to in Io 2002 O (if I	i- (1- intermiter of several min- 1 links)		
Intensity is $\frac{1}{2}\cos^2\theta$ (if I_0	is the intensity of unpolarised light.)		
	the intensity of polarized light.) ent writes the expression as $I_0 \cos^2 \theta$)		
(11ward /2 mark if the stade	on writes the expression as 10 cos (b)	1	
I			
		1	
	Y		
<u> </u>	$\longrightarrow \theta$		_
			2

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Q7			
Q'	(a) Identification $\frac{1}{2} + \frac{1}{2}$		
	(b) Uses $\frac{1}{2} + \frac{1}{2}$		
	(a) X – rays	1/2	
	Used for medical purposes.		
	(Also accept UV rays and gamma rays and	1/2	
	Any one use of the e.m. wave named)	1/4	
	(b) Microwaves	1/2	
	Used in radar systems	1/2	
	(Also accept short radio waves and	, -	
	Any one use of the e.m. wave named)		2
Q8			
	Condition		
	i. For directions of \vec{E} , \vec{B} , \vec{v} 1		
	ii. For magnitudes of \vec{E} , \vec{B} , \vec{v}		()
	(i) The velocity \vec{v} , of the charged particles, and the \vec{E} and \vec{B}		-1-
	vectors, should be mutually perpendicular.	1/2	0.1
	Also the forces on q , due to \vec{E} and \vec{B} , must be	100	3.5
	oppositely directed.	1/2	
	(Also accept if the student draws a diagram to show the	3. "	
	directions.)	2	
	↑ 9		
	_{FE} ↑↑E		
	-8		
	/ × ×		
	B ^L / _		
	F _B		
	(ii) $qE = qvB$	17	
	(ii) $qE = qvB$ $or \ v = \frac{E}{R}$	1/ ₂ 1/ ₂	
	V = B	72	
	[Alternatively The student may write:		
	[Alternatively, The student may write: Force due to electric field $= a\vec{F}$	1/2	
	Force due to electric field = $q\vec{E}$	1/2	
	Force due to magnetic field = $q(\overrightarrow{v} \times \overrightarrow{B})$ The required condition is		
	The required condition is $q\vec{E} = -q \ (\vec{v} \times \vec{B})$	17	
	$q\vec{E} = -q(\vec{v} \times \vec{B})$ $[or \vec{E} = -(\vec{v} \times \vec{B}) = (\vec{B} \times \vec{v})]$	1/2	
		1/2	
	(Note: Award 1 mark only if the student just writes: "The forces, on the charged particle, due to the electric and		
	magnetic fields, must be equal and opposite to each other")]		2
	magnetic netaes, must be equal une opposite to each other)]	l	

00			
Q9	i. Writing		
	$E_n \propto \frac{1}{n^2}$		
	ii. Identifying the level to which the ½		
	electron is emitted.		
	iii. Calculating the wavelengths and $\frac{1}{2} + \frac{1}{2}$		
	identifying the series of atleast one of the		
	three possible lines, that can be emitted.		
	1		
	i. We have $E_n \propto \frac{1}{n^2}$	1/2	
	ii. ∴ The energy levels are		
	ii. ∴ The energy levels are -13.6 eV; -3.4 eV; -1.5 eV	1/2	
	∴ The 12.5 eV electron beam can excite the electron up	- 1	
	to n=3 level only.	45	
	iii. Energy values, of the emitted photons, of the three		
	possible lines are	62	
	$3 \rightarrow 1 : (-1.5 + 13.6) \text{eV} = 12.1 \text{ eV}$	A 10	
	$2 \rightarrow 1 : (-3.4 + 13.6) \text{eV} = 10.2 \text{ eV}$ $3 \rightarrow 2 : (-1.5 + 3.4) \text{eV} = 1.9 \text{ eV}$	9	
	$3 \rightarrow 2 \cdot (-1.5 + 3.4)eV - 1.7 eV$		
	The corresponding wavelengths are: 102 nm, 122 nm and	$\frac{1}{2} + \frac{1}{2}$	
	653 nm	,2 . ,2	
	$\left(\lambda = \frac{hc}{F}\right)$		
	(Award this 1 mark if the student draws the energy level diagram		
	and shows (and names the series) the three lines that can be emitted) / (Award these ($\frac{1}{2} + \frac{1}{2}$) marks if the student		
	calculates the energies of the three photons that can be emitted		
	and names their series also.)		
			2
Q10			
	a) Two properties for making permanent $\frac{1}{2} + \frac{1}{2}$		
	magnet		
	b) Two properties for making an $\frac{1}{2} + \frac{1}{2}$ electromagnet		
	Ciccionagnet		

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	a) For making permanent magnet:		
	(i) High retentivity	$\frac{1}{2} + \frac{1}{2}$	
	(ii) High coercitivity		
	(iii) High permeability		
	(Any two)		
	b) For making electromagnet:		
	(i) High permeability	$\frac{1}{2} + \frac{1}{2}$	
	(ii) Low retentivity		
	(iii) Low coercivity		
	(Any two)		2
	SECTION C		<u> </u>
Q11	a) The factor by which the potential		-
	difference changes 1		
	b) Voltmeter reading 1	(5)	
	Ammeter Reading 1	A. T.	
	a) $H = \frac{V^2}{R}$	1/2	
	$\therefore V \text{ increases by a factor of } \sqrt{9} = 3$	1/2	
		1/2	
	b) Ammeter Reading $I = \frac{V}{R+r}$	72	
	12	1/2	
	$=\frac{12}{4+2}A=2A$		
	Voltmeter Reading $V = E - Ir$	1/2	
	$= [12 - (2 \times 2)] V = 8V$ (Alternatively, $V = iR = 2 \times 4V = 8V$)	1/2	
	(Alternatively, $V = IX = 2 \times 4V = 6V$)		3
Q12			
	a) Achieving amplitude Modulation 1		
	b) Stating the formulae $\frac{1}{2}$ Calculation of v_c and v_m $\frac{1}{2} + \frac{1}{2}$		
	Calculation of v_c and v_m $\frac{1}{2} + \frac{1}{2}$ Calculation of bandwidth $\frac{1}{2}$		
	a) Amplitude modulation can be achieved by applying the message signal, and the carrier wave, to a non linear		
	(square law device) followed by a band pass filter.		

	(Alternatively, The student may just draw the block diagram.) $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		
	(Alternatively, Amplitude modulation is achieved by superposing a message signal on a carrier wave in a way that causes the amplitude of the carrier wave to change in accordance with the message signal.)	1	
	b) Frequencies of side bands are: $(\upsilon_c + \upsilon_m) \text{ and } (\upsilon_c - \upsilon_m)$	1/2	
	$: v_c + v_m = 660 \text{ kHz} $		A.
	and $v_c - v_m = 640 \text{ kHz}$		38
	$∴ v_c = 650 \text{ kHz}$	1/2	
	$∴$ $\upsilon_{\rm m} = 10 \rm kHz$	1/2	
		1/2	
	Bandwidth = $(660 - 640)$ kHz = 20 kHz	72	3
Q13	a) The nature of biasing b) Diagram of full wave rectifier Working 1 a) Reverse Biased b) Diagram of full wave rectifier Centre Tap Transformer Diode 1(D) Revolution	1	

	Working: The diode D_1 is forward biased during one half cycle and current flows through the resistor, but diode D_2 is reverse biased and no current flows through it. During the other half of the signal, D_1 gets reverse biased and no current passes through it, D_2 gets forward biased and current flows through it. In both half cycles current, through the resistor, flows in the same direction.	1	
	(Note: If the student just draws the following graphs (but does not draw the circuit diagram), award ½ mark only.		200
014			3
Q14	Photon picture plus Einstein's photoelectric equation $\frac{1}{2} + \frac{1}{2}$ Two features $\frac{1}{2} + \frac{1}{2}$		
	In the photon picture, energy of the light is assumed to be in the form of photons, each carrying an energy <i>hv</i> .	1/2	
	Einstein assumed that photoelectric emission occurs because of a single collision of a photon with a free electron.	1/2	
	The energy of the photon is used to		
	 (i) free the electrons from the metal. [For this, a minimum energy, called the work function (=W) is needed]. And (ii) provide kinetic energy to the emitted electrons. 	1/2	

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	Hence		
	$(K. E.)_{max} = hv - W$ $/\left(\frac{1}{2}mv_{max}^2 = hv - W\right)$ This is Einstein's photoelectric equation Two features (which cannot be explained by wave theory):	1/2	
	 i) 'Instantaneous' emission of photoelectrons ii) Existence of a threshold frequency iii) 'Maximum kinetic energy' of the emitted photoelectrons, is independent of the intensity of incident light (Any two) 	1/2 + 1/2	3
Q15	a. Calculation of wavelength, frequency and speed b. Lens Maker's Formula Calculation of <i>R</i> 1/2 + 1/2 + 1/2 1/2 1/2	3 Pi	5.4
	a) $\lambda = \frac{589 \text{ nm}}{1.33} = 442.8 \text{nm}$	1/2	
	Frequency $v = \frac{3 \times 10^8 \text{ ms}^{-1}}{589 \text{ nm}} = 5.09 \times 10^{12} \text{Hz}$	1/2	
	Speed $v = \frac{3 \times 10^8}{1.33}$ m/s = 2.25 × 10 ⁸ m/s	1/2	
	b) $\frac{1}{f} = \left[\frac{\mu_2}{\mu_1} - 1\right] \left[\frac{1}{R_1} - \frac{1}{R_2}\right]$	1/2	
	$\therefore \frac{1}{20} = \left[\frac{1.55}{1} - 1\right] \frac{2}{R}$	1/2	
	$\therefore R = (20 \times 1.10) \text{cm} = 22 \text{ cm}$	1/2	3
Q16	Definition of mutual inductance 1 Derivation of mutual inductance for two long solenoids 2		

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T T			
(i)	Mutual inductance is numerically equal to the induced emf in the secondary coil when the current in the primary coil changes by unity. Alternatively: Mutual inductance is numerically equal to the magnetic flux linked with one coil/secondary coil when unit current flows through the other coil/primary	1	
(ii)	coil.		
(ii)	N_1 turns N_2 turns	1/2	
	Let a current, i_2 , flow in the secondary coil $\mu_0 N_2 i_2$	1/2	
	$\therefore B_2 = {l}$		
	∴ Flux linked with the primary coil		
	$= N_1 A_1 B_2 = \frac{\mu_0 N_2 N_1 A_1 i_2}{l} = M_{12} i_2$	1/2	
Не	ence, $M_{12} = \frac{\mu_0 N_2 N_1 A_2}{l} = \mu_0 n_2 n_1 A_1 l \left(n_1 = \frac{N_1}{l}; n_2 = \frac{N_2}{l} \right)$	1/2	3
	OR		
	Definition of self inductance 1		
	Expression for energy stored 2		

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	(i) Self inductance, of a coil, is numerically equal to the emf induced in that coil when the current in it changes		
	at a unit rate.	1	
	(Alternatively: The self inductance of a coil equals the		
	flux linked with it when a unit current flows through		
	it.)		
	(ii) The work done against back /induced emf is stored as		
	magnetic potential energy.	1/2	
	The rate of work done, when a current i is passing		
	through the coil, is	1/2	
	$\frac{dW}{dt} = \varepsilon i = \left(L\frac{di}{dt}\right)i$		
		1/2	0
	$\therefore W = \int dW = \int_0^I Lidi$	1/2	3.5
	$=\frac{1}{2}Li^2$	72	
Q17			3
	a) Principle of meter bridge 1		
	b) Relation between l_1, l_2 , and S		
	a) The principle of working of a meter bridge is same as that of a balanced Wheatstone bridge.		
	(Alternatively:		
	P N Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q	1	
	When $i_g=0$, then $\frac{P}{Q}=\frac{R}{S}$)		

	b) $\frac{R}{S} = \frac{l_1}{100 - l_1}$	1/2	
	When X is connected in parallel: $\frac{R}{\left(\frac{XS}{X+S}\right)} = \frac{l_2}{100 - l_2}$	1/2	
	On solving, we get $X = \frac{l_1 S(100 - l_2)}{100(l_2 - l_1)}$	1	3
Q18	Diagram of generalized communication system 1½ Function of (a) transmitter (b) channel (c) receiver ½+½+½		
	formation Message Transmitter Transmitted Channel Signal Receiver Signal Noise	S Pri	200
	[Also accept the following diagram Information	1 1/2	
	(a) Transmitter: A transmitter processes the incoming message signal so as to make it suitable for transmission through a channel and subsequent reception.	1/2	
	(b) Channel: It carries the message signal from a transmitter to a receiver.	1/2	
	(c) Receiver: A receiver extracts the desired message signals from the received signals at the channel output.	1/2	
			3

Q19	a) Function of each of the three segments \(\frac{1}{2} + \frac{1}{2} + \frac{1}{2} \) b) Diagram of output wave form 1 Truth table \(\frac{1}{2} \)
	a) Emitter: Supplies a large number of majority charge carriers. 1/2
	Base: Controls the flow of majority carriers from the emitter to the collector.
	Collector: It collects the majority carriers from the base / majority of those emitted by the emitter.
	t1 t2 t3 t4 t5 t6 t7 t8
	Truth Table A B Y
Q20	(a) Ray diagram for astronomical telescope in normal adjustment 1½ (b) Identification of lenses for objective and eyepiece 1 Reason ½

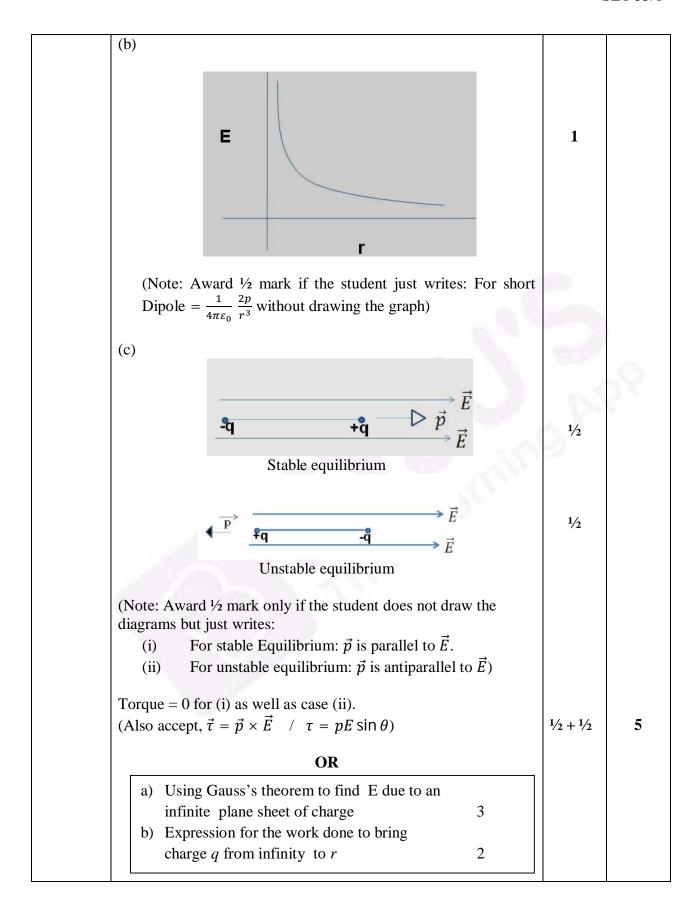
	(a) Ray diagram of astronomical telescope		
	Objective For Eyepiece B' A' B' A'	1 1/2	
	(Note: Deduct ½ mark if the 'arrows' are not marked) (b) Objective Lens: Lens L ₁	1/2	
	Eyepiece Lens: Lens L ₂	1/2	0
	Reason: The objective should have large aperture and large focal length while the eyepiece should have small aperture and small focal length.	1/2	3
Q21	(a) Statement of Biot Savart law 1		
	Expression in vector form ½		
	(b) Magnitude of magnetic field at centre 1		
	Direction of magnetic field ½		
	(a) It states that magnetic field strength, $d\vec{B}$, due to a current element, $Id\vec{l}$, at a point, having a position vector \mathbf{r} relative to the current element, is found to depend (i) directly on the current element, (ii) inversely on the square of the distance $ \mathbf{r} $, (iii) directly on the sine of angle between the current element and the position vector \mathbf{r} .	1	
	In vector notation, $\overrightarrow{d}\overrightarrow{\boldsymbol{B}} = \frac{\mu_0}{4\pi} \frac{I \overrightarrow{d} \overrightarrow{\boldsymbol{l}} \times \overrightarrow{\boldsymbol{r}}}{ \overrightarrow{\boldsymbol{r}} ^3}$ Alternatively, $\left(d\overrightarrow{\boldsymbol{B}} = \frac{\mu_0}{4\pi} \frac{I \overrightarrow{d} \overrightarrow{\boldsymbol{l}} \times \hat{\boldsymbol{r}}}{ \overrightarrow{\boldsymbol{r}} ^2} \right)$	1/2	

		1	,
	(b) $B_p = \frac{\mu_0 \times 1}{2R} = \frac{\mu_0}{2R}$ (along z – direction)	1/2	
	$B_Q = \frac{\mu_0 \times \sqrt{3}}{2R} = \frac{\mu_0 \sqrt{3}}{2R}$ (along x – direction)		
	$\therefore B = \sqrt{B_p^2 + B_Q^2} = \frac{\mu_0}{R}$	1/2	
	This net magnetic field ${\bf B}$, is inclined to the field ${\bf B}_p$, at an angle Θ , where		
	$\tan \theta = \sqrt{3}$ $\left(/\theta = \tan^{-1} \sqrt{3} = 60^{0}\right)$	1/2	
	(in XZ plane)		3
Q22	Formula for energy stored Energy stored before Energy stored after Ratio 1/2 1 1 1/2	Pi	56
	Energy stored = $\frac{1}{2} CV^2 \left(= \frac{1}{2} \frac{Q^2}{C} \right)$	1/2	
	Net capacitance with switch S closed = $C + C = 2C$	1/2	
	$\therefore \text{ Energy stored} = \frac{1}{2} \times 2C \times V^2 = CV^2$	1/2	
	After the switch S is opened, capacitance of each capacitor= KC		
	$\therefore \text{ Energy stored in capacitor A} = \frac{1}{2}KCV^2$		
	For capacitor B,	1/2	
	Energy stored = $\frac{1}{2} \frac{Q^2}{KC} = \frac{1}{2} \frac{C^2 V^2}{KC} = \frac{1}{2} \frac{CV^2}{K}$		
	$\therefore \text{ Total Energy stored} = \frac{1}{2}KCV^2 + \frac{1}{2}\frac{CV^2}{K} = \frac{1}{2}CV^2\left(K + \frac{1}{K}\right)$		
	$=\frac{1}{2}CV^2\left(\frac{K^2+1}{K}\right)$	1/2	

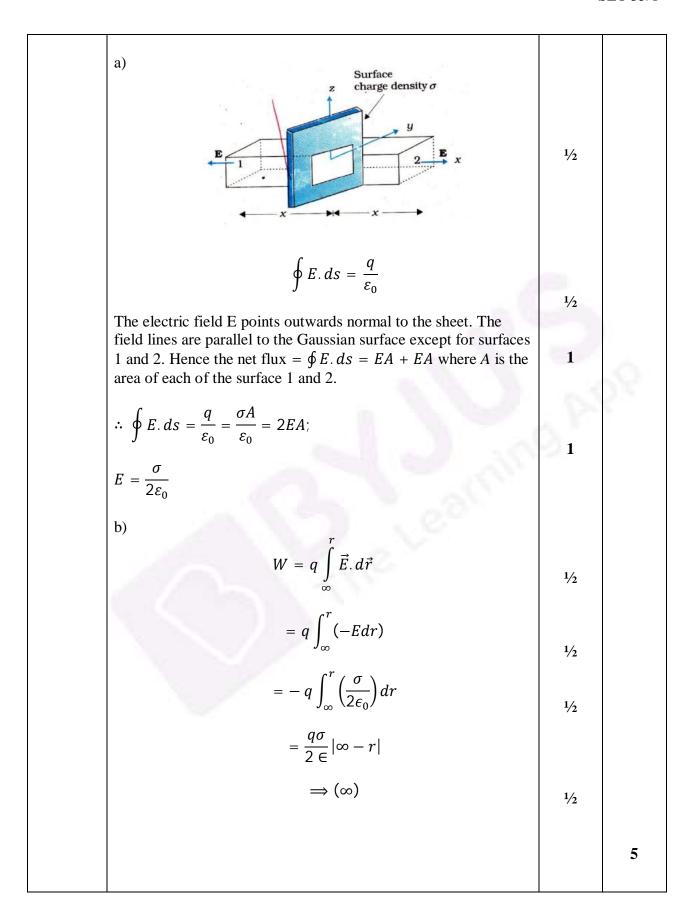
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	2CV ² .K 2K		
	$\therefore \text{ Required ratio} = \frac{2CV^2.K}{CV^2(K^2+1)} = \frac{2K}{(K^2+1)}$	1/2	3
	SECTION D	I	
Q23	a) Name of the installation, the cause of disaster ½ + ½ b) Energy release process 1 c) Values shown by Asha and mother 1+1 a) (i) Nuclear Power Plant:/'Set-up' for releasing Nuclear Energy/Energy Plant (Also accept any other such term) (ii)Leakage in the cooling unit/ Some defect in the set up. b) Nuclear Fission/Nuclear Energy Break up (/ Fission) of Uranium nucleus into fragments c) Asha: Helpful, Considerate, Keen to Learn, Modest Mother: Curious, Sensitive, Eager to Learn, Has no airs (Any one such value in each case)	1/2 1/2 1 1 1	4
	SECTION E		
Q24	(a) Derivation of E along the axial line of dipole (b) Graph between E vs r (c) (i) Diagrams for stable and unstable equilibrium of dipole (ii) Torque on the dipole in the two cases (a) E+q E-q P P	3 Pi	SA
	Electric field at P due to charge $(+q)=E_1=\frac{1}{4\pi\varepsilon_0}\frac{q}{(r-a)^2}$ Electric field at P due to charge $(-q)=E_2=\frac{1}{4\pi\varepsilon_0}\frac{q}{(r+a)^2}$	1/2	
	Net electric Field at P= $E_1 - E_2 = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r-a)^2} - \frac{1}{4\pi\varepsilon_0} \frac{q}{(r+a)^2}$	1/2	
	$=\frac{1}{4\pi\varepsilon_0}\frac{2pr}{(r^2-a^2)^2}\qquad (p=q.2a)$		
	Its direction is parallel to \vec{p} .	1/2	

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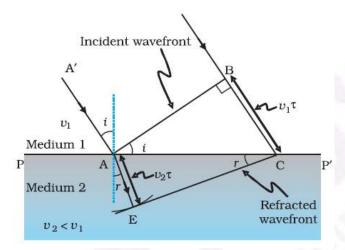
Q25	a) Identification ½		
	b) Identifying the curves 1		
	Justification ½		
	c) Variation of Impedance		
	with frequency ½		
	Graph ½		
	d) Expression for current 1½		
	Phase relation ½		
	a) The device X is a capacitor	1/2	
	a) The device II is a capacitor	, 2	
	b) Curve B voltage		
	Curve C → current	1/2	
	Curve A power	1/2	
	Reason: The current leads the voltage in phase, by $\pi/2$,	1/2	
	for a capacitor.		0
			3.5
	c) $X_c = \frac{1}{\omega c} \left(/ X_c \propto \frac{1}{\omega} \right)$		
	$C/\Lambda_c = \omega c (\Lambda_c \propto \omega)$	1/2	
	X _c \uparrow	1/2	
	d) $V = V_0 \sin \omega t$		
	$u = v_0 \sin \omega t$		
	$Q = CV = CV_O \sin \omega t$	1/2	
	, dq ,,		
	$I = \frac{dq}{dt} = \omega c V_o \cos \omega t$	1/2	
	$= I_0 \sin(\omega t + \frac{\pi}{2})$ V=V _o sinwt	1/2	
	, _	, 2	
	Current leads the voltage, in phase, by $\pi/2$	1/2	
	(Note: If the student identifies the device X as an Inductor but writes correct answers to parts (c) and (d) (in terms of an inductor), the student be given full marks for (only) these two parts)		5

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OR		
a) Labelled diagram of ac generator 1 Expression for emf 2 b) Formula for emf ½ Substitution ½ Calculation of emf 1		
a)		
Slip rings Carbon brushes Let ω be the angular speed of rotation of the coil. We then have		
$\phi(t) = NBA\cos\omega t$ $\therefore E = -\frac{d\phi}{dt}$	1/2	
$= NBA\omega \sin \omega t$	1/2	
$= E_0 \sin \omega t \qquad (E_0 = NBAw)$	1	
b) Induced emf = BlV	1/2	
$\therefore E = 0.3 \times 10^{-4} \times 10 \times 5 \text{ volt}$	1/2	
$E = 1.5 \times 10^{-3} \text{V} \ (= 1.5 \text{mV})$	1	5

Q26

- a) Definition of wavefront
 Verifying laws of refraction by Huygen's
 principle
 b) Polarisation by scattering
 Calculation of Brewster's angle
 1
- a) The wavefront is the common locus of all points which are in phase(/surface of constant phase)



1

1/2

Let a plane wavefront be incident on a surface separating two media as shown. Let v_1 and v_2 be the velocities of light in the rarer medium and denser medium respectively. From the diagram

$$BC = v_1 t \text{ and } AD = v_2 t$$

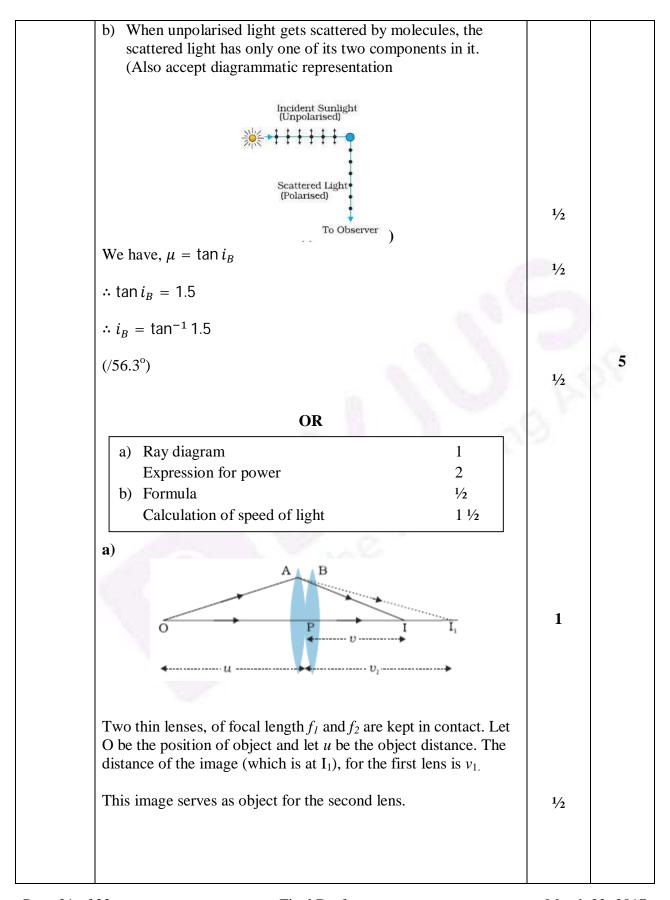
$$\sin i = \frac{BC}{AC} \text{ and } \sin r = \frac{AD}{AC}$$

$$\therefore \frac{\sin i}{\sin r} = \frac{BC}{AD} = \frac{v_1 t}{v_2 t}$$

$$= \frac{v_1}{v_2} = a \text{ constant}$$

$$\frac{1}{2}$$

This proves Snell's law of refraction.



Let the final image be at I. We then have		
$\frac{1}{f_1} = \frac{1}{v_1} - \frac{1}{u}$ $\frac{1}{f_2} = \frac{1}{v} - \frac{1}{v_1}$	1/2	
Adding, we get $\frac{1}{f_{1}} + \frac{1}{f_{2}} = \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$	1/2	
$\therefore \frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$		
b) At minimum deviation $r = \frac{A}{2} = 30^{\circ}$	1/2	
We are given that $i = \frac{3}{4}A = 45^{\circ}$	1/2	30
$\therefore \mu = \frac{\sin 45^{\circ}}{\sin 30^{\circ}} = \sqrt{2}$	1/2	
∴ Speed of light in the prism = $\frac{c}{\sqrt{2}}$ ($\approx 2.1 \times 10^8 \text{ ms}^{-1}$)	1/2	
[Award ½ mark if the student writes the formula: $\mu = \frac{\sin(A + D_m)/2}{\sin(A/2)}$		
but does not do any calculations.]		
		5

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MARKING SCHEME

Q. No.	Expected Answer/ Value Points	Marks	Total Marks
	Section A		
Q1	Q to P through ammeter and D to C through ammeter (Alternatively: Anticlockwise as seen from left in coil PQ clockwise as seen from left in coil CD)	1/2 1/2	1
Q2	Speed of electromagnetic wave, $c = \frac{E_0}{B_0}$.	1	1
Q3	$ \label{eq:cutoff} \begin{array}{ll} i. & Nichrome \\ \\ ii. & R_{Ni}\!>R_{Cu} \; (or \; Resistivity_{Ni} > Resistivity_{Cu}) \end{array} $	1/2	1
Q4	i. Decreases ii. $n_{\text{Violet}} > n_{\text{Red}}$ (Also accept if the student writes $\lambda_V < \lambda_R$)	1/2	20
Q5	Photoelectric Effect (/Raman Effect/ Compton Effect) SECTION B	1	1
Q6	Condition i. For directions of \vec{E} , \vec{B} , \vec{v} 1 ii. For magnitudes of \vec{E} , \vec{B} , \vec{v} 1 i. The velocity \vec{v} , of the charged particles, and the \vec{E} and \vec{B} vectors, should be mutually perpendicular. Also the forces on q , due to \vec{E} and \vec{B} , must be oppositely directed. (Also accept if the student draws a diagram to show the directions.)	1/2	

	ii. $qE = qvB$	1/2	
		1/2	
	$or v = \frac{E}{B}$		
	[Alternatively The student may remite.	1/	
	[Alternatively, The student may write:	1/ ₂ 1/ ₂	
	Force due to electric field = $q\vec{E}$	72	
	Force due to magnetic field = $q(\vec{v} \times \vec{B})$ The required condition is		
	$q\vec{E} = -q \ (\vec{v} \times \vec{B})$	1/2	
	$[or \vec{E} = -(\vec{v} \times \vec{B}) = (\vec{B} \times \vec{v})]$	1/2	
	[Of $E = (V \wedge B) = (B \wedge V)$] (Note: Award 1 mark only if the student just writes:		
	"The forces, on the charged particle, due to the electric and		2
	magnetic fields, must be equal and opposite to each other")]		
Q7			
	(a) Identification $\frac{1}{2} + \frac{1}{2}$		
	(b) One use each $\frac{1}{2} + \frac{1}{2}$		
	a) X-rays/ Gamma rays	1/2	100
	One use of the name given	1/ ₂ 1/ ₂ 1/ ₂	37
	b) Infrared/Visible/Microwave	1/2	
	One use of the name given	1/2	
	(Note: Award ½ mark for each correct use (relevant to	10	
	the name chosen) even if the names chosen are		
	incorrect.)		
			2
Q8	Interference pattern ½		
	Diffraction pattern ½		
	Diffraction pattern ½		
	Two Differences $\frac{1}{2} + \frac{1}{2}$		
	I I		
		1/2	
	Imax O	, -	
	/\ /\ /\ /\ /\ /\ /\		
	3λ 2λ 1λ Ο 1λ 2λ 3λ		
	—▶ Path Difference		

Intensity is $I \cos^2 \theta$ (if <i>I</i> is the intensity of polarized light.)	All maxima have equal intensity (/rapidly decreasing) intensity All fringes have equal pointerent (/changing) width. Superposition of two superposition of wavelets from the same wavefront (Any two) OR Expression for intensity of polarized beam 1 Plot of intensity variation with angle 1 Intensity is ½ cos² θ (if Ia is the intensity of unpolarised light)	Differences	Viewing screen	1/2	
All maxima have equal intensity (/rapidly decreasing) intensity All fringes have equal intensity (/rapidly decreasing) intensity All fringes have equal width. Superposition of two superposition of wavelets from the same wavefront (Any two) OR Expression for intensity of polarized beam 1 Plot of intensity variation with angle 1 Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)	All maxima have equal intensity (/rapidly decreasing) intensity All fringes have equal intensity (/rapidly decreasing) intensity All fringes have equal width. Superposition of two superposition of wavelets from the same wavefront (Any two) OR Expression for intensity of polarized beam 1 Plot of intensity variation with angle 1 Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)	Interference	Diffraction		, a
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width. Superposition of two wavefronts Superposition of wavelets from the same wavefront (Any two) OR Expression for intensity of polarized beam 1 Plot of intensity variation with angle 1 Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)	width. Superposition of two wavefronts Superposition of wavelets from the same wavefront (Any two) OR Expression for intensity of polarized beam 1 Plot of intensity variation with angle 1 Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)				~
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wavefronts from the same wavefront (Any two) OR Expression for intensity of polarized beam 1 Plot of intensity variation with angle 1 Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)	wavefronts from the same wavefront (Any two) OR Expression for intensity of polarized beam 1 Plot of intensity variation with angle 1 Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)				
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Expression for intensity of polarized beam 1 Plot of intensity variation with angle 1 Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)	Expression for intensity of polarized beam 1 Plot of intensity variation with angle 1 Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)		(Any two)		4
Plot of intensity variation with angle 1 Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)	Plot of intensity variation with angle 1 Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)		OR		
Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)	Intensity is $\frac{I_0}{2} \cos^2 \theta$ (if I_0 is the intensity of unpolarised light.) Intensity is $I \cos^2 \theta$ (if I is the intensity of polarized light.)	Expression for intensity	of polarized beam 1		
Intensity is $I \cos^2 \theta$ (if <i>I</i> is the intensity of polarized light.)	Intensity is $I \cos^2 \theta$ (if <i>I</i> is the intensity of polarized light.)	Plot of intensity variation	on with angle 1		
Intensity is $I \cos^2 \theta$ (if <i>I</i> is the intensity of polarized light.)	Intensity is $I \cos^2 \theta$ (if <i>I</i> is the intensity of polarized light.)	Intensity is $\frac{I_0}{I_0} \cos^2 \theta$ (if I_0	is the intensity of unpolarised light)		
		Intensity is $\frac{1}{2}\cos^2\theta$ (if Lie	the intensity of polarized light)	1	
	(Award 72 mark if the student writes the expression as $I_0 \cos \theta$)				
		1		1	
1	1	↑			
1	I ↑				
1	1				
1	1		γ		
1	1		$\longrightarrow \theta$		2
1	1		27 (74		2

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Q9	Formula Calculation	1½ 1½		
	$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$		1/2	
	$\therefore \text{ For Balmer Series: } (\lambda_B)_{short} = \frac{4}{R}$		1/2	
	and For Lyman Series: $(\lambda_L)_{short} = \frac{1}{R}$		1/2	
	$\therefore \lambda_B = 913.4 \times 4 A^0 = 3653.6$	6 A ⁰	1/2	2
Q10	a) Two properties for making permanent magnet	1/2 + 1/2)
	b) Two properties for making an electromagnet	1/2 + 1/2		
	a) For making permanent magnet:		O. V.	
	(i) High retentivity		$\frac{1}{2} + \frac{1}{2}$	
	(ii) High coercitivity			
	(iii) High permeability			
	(Any two)			
	b) For making electromagnet:			
	(i) High permeability		$\frac{1}{2} + \frac{1}{2}$	
	(ii) Low retentivity			
	(iii) Low coercivity			
	(Any two)			
				2
	SECTION C			
Q11	a. Calculation of wavelength, frequency and speed	1/2 + 1/2 + 1/2		
	b. Lens Maker's Formula	1/2		
	Calculation of R	1		

		T	
	a) $\lambda = \frac{589 \text{ nm}}{1.33} = 442.8 \text{nm}$	1/2	
	Frequency $v = \frac{3 \times 10^8 \text{ ms}^{-1}}{589 \text{ nm}} = 5.09 \times 10^{12} \text{Hz}$	1/2	
	Speed $v = \frac{3 \times 10^8}{1.33}$ m/s = 2.25 × 10 ⁸ m/s	1/2	
	b) $\frac{1}{f} = \left[\frac{\mu_2}{\mu_1} - 1\right] \left[\frac{1}{R_1} - \frac{1}{R_2}\right]$	1/2	
	$\therefore \frac{1}{20} = \left[\frac{1.55}{1} - 1 \right] \frac{2}{R}$	1/2	
	$\therefore R = (20 \times 1.10) \text{cm} = 22 \text{ cm}$	1/2	3
Q12	(a) Ray Diagram for reflecting Telescope 2 (b) Two advantages of it over refracting type of ½ + ½ telescope	P	99
	(a) Ray Diagram Arrow marking Labelling	1 1/2 1/2	
	Secondary mirror Eyepiece		
	(b) Advantages		
	 (i) Spherical aberration is absent (ii) Chromatic aberration is absent (iii) Mounting is easier (iv) Polishing is done on only one side (v) Light gathering power is more 		
	(Any two)	$\frac{1}{2} + \frac{1}{2}$	3

Q13	a) Principle of meter bridge 1		
	b) Relation between l_1, l_2 , and S		
	a) The principle of working of a meter bridge is same as that of a balanced Wheatstone bridge.		
	(Alternatively:		
	P TT Q R TT S	1	
			96
	When $i_g=0$, then $\frac{P}{Q}=\frac{R}{S}$)	χY^{α}	
	b) $\frac{R}{S} = \frac{l_1}{100 - l_1}$	1/2	
	When X is connected in parallel: $\frac{R}{\left(\frac{XS}{X+S}\right)} = \frac{l_2}{100 - l_2}$	1/2	
	On solving, we get $X = \frac{l_1 S(100 - l_2)}{100(l_2 - l_1)}$	1	3
Q14	Definition of mutual inductance 1 Derivation of mutual inductance for two long solenoids 2		
	(i) Mutual inductance is numerically equal to the induced emf in the secondary coil when the current in the primary coil changes by unity.		
	Alternatively: Mutual inductance is numerically equal to the magnetic flux linked with one coil/secondary coil		

when unit current flows through the other coil /primary	1	
coil.		
(ii)		
r_1 N_1 turns S_2	1/2	
N_2 turns	~	3Y
Let a current, i_2 , flow in the secondary coil	V.	
$\therefore B_2 = \frac{\mu_0 N_2 i_2}{I}$	1/2	
∴ Flux linked with the primary coil		
$= N_1 A_1 B_2 = \frac{\mu_0 N_2 N_1 A_1 i_2}{l} = M_{12} i_2$	1/2	
Hence, $M_{12} = \frac{\mu_0 N_2 N_1 A_2}{l} = \mu_0 n_2 n_1 A_1 l \left(n_1 = \frac{N_1}{l}; n_2 = \frac{N_2}{l} \right)$	1/2	3
OR		
Definition of self inductance 1		
Expression for energy stored 2		
(i) Self inductance, of a coil, is numerically equal to the		
emf induced in that coil when the current in it changes at a unit rate.	1	
(Alternatively: The self inductance of a coil equals the		
flux linked with it when a unit current flows through it.)		
	(ii) Let a current, i_2 , flow in the secondary coil $\therefore B_2 = \frac{\mu_0 N_2 i_2}{l}$ $\therefore \text{ Flux linked with the primary coil}$ $= N_1 A_1 B_2 = \frac{\mu_0 N_2 N_1 A_1 i_2}{l} = M_{12} i_2$ Hence, $M_{12} = \frac{\mu_0 N_2 N_1 A_2}{l} = \mu_0 n_2 n_1 A_1 l \left(n_1 = \frac{N_1}{l}; n_2 = \frac{N_2}{l}\right)$ OR Definition of self inductance Expression for energy stored 2 (i) Self inductance, of a coil, is numerically equal to the emf induced in that coil when the current in it changes at a unit rate. (Alternatively: The self inductance of a coil equals the	coil. (ii) Let a current, i_2 , flow in the secondary coil $\therefore B_2 = \frac{\mu_0 N_2 i_2}{l}$ $\therefore \text{ Flux linked with the primary coil}$ $= N_1 A_1 B_2 = \frac{\mu_0 N_2 N_1 A_1 i_2}{l} = M_{12} i_2$ Hence, $M_{12} = \frac{\mu_0 N_2 N_1 A_2}{l} = \mu_0 n_2 n_1 A_1 l \left(n_1 = \frac{N_1}{l}; n_2 = \frac{N_2}{l}\right)$ OR Definition of self inductance 1 Expression for energy stored 2 (i) Self inductance, of a coil, is numerically equal to the emf induced in that coil when the current in it changes at a unit rate. (Alternatively: The self inductance of a coil equals the flux linked with it when a unit current flows through

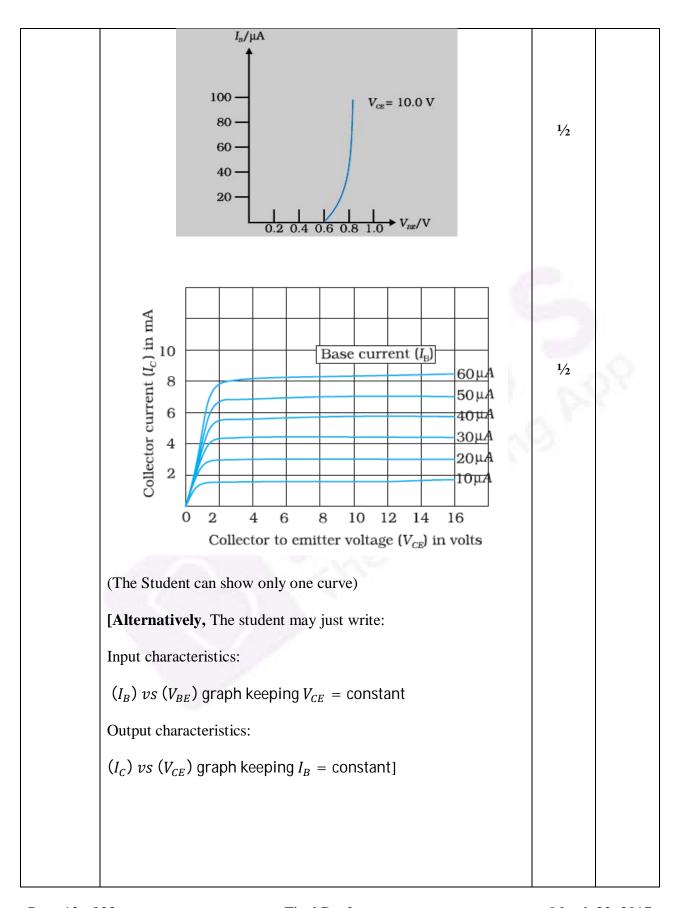
	(ii) The work done against back /induced emf is stored as magnetic potential energy.		
	The rate of work done, when a current i is passing through the coil, is	1/2	
	$\frac{dW}{dt} = \varepsilon i = \left(L\frac{di}{dt}\right)i$	1/2	
	$\therefore W = \int dW = \int_0^I Lidi$	1/2	
	$=\frac{1}{2}Li^2$	1/2	3
Q15	 (a) Variation of photocurrent with intensity of radiation (b) Stopping potential versus frequency for different materials (c) Independence of maximum kinetic energy of the emitted photoelectrons (a) The collision of a photon can cause emission of a photoelectron (above the threshold frequency). As intensity increases, number of photons increases. Hence the current increases. (b) We have, eV_s = h(v - v₀) 	1	5.5
	$\therefore v_s = \frac{h}{e}(v) + \left(-\frac{hv_0}{e}\right)$	1/2	
	\therefore Graph of v_s with v is a straight line and slope $\left(=h/e\right)$ is a constant.	1/2	
	(c) Maximum for different surfaces $K.E = h(v - v_0)$	1/2	
	Hence, it depends on the frequency and not on the intensity of the incident radiation.	1/2	
			3

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Q16	(a) Identification of the bulb and reason 1/2 + 1/2 (b) Diagram of solar cell 1/2 (c) Names of the processes 1/2 + 1/2 + 1/2 (a) Bulb B ₁ glows Diode D ₁ is forward biased.	1/2	
	(c) Generation: Incident light generates electron-hole pairs. Separation: Electric field of the depletion layer separates the electrons and holes. Collection: Electrons and holes are collected at the n and p side contacts.	1/2 1/2 1/2	
			3
Q17	Formula for energy stored Energy stored before Energy stored after Ratio 1/2 1 1 1/2		

	Energy stored = $\frac{1}{2} CV^2 \left(= \frac{1}{2} \frac{Q^2}{C} \right)$	1/2	
	Net capacitance with switch S closed = $C + C = 2C$	1/2	
	∴ Energy stored = $\frac{1}{2} \times 2C \times V^2 = CV^2$	1/2	
	After the switch S is opened, capacitance of each capacitor= KC		
	$\therefore \text{ Energy stored in capacitor A} = \frac{1}{2}KCV^2$		
	For capacitor B,	1/	
	Energy stored = $\frac{1}{2} \frac{Q^2}{KC} = \frac{1}{2} \frac{C^2 V^2}{KC} = \frac{1}{2} \frac{CV^2}{K}$	1/2	
	$\therefore \text{ Total Energy stored} = \frac{1}{2}KCV^2 + \frac{1}{2}\frac{CV^2}{K} = \frac{1}{2}CV^2\left(K + \frac{1}{K}\right)$	9	0
	$=\frac{1}{2}CV^2\left(\frac{K^2+1}{K}\right)$	1/2	5.4
	$\therefore \text{ Required ratio} = \frac{2CV^2.K}{CV^2(K^2+1)} = \frac{2K}{(K^2+1)}$	1/2	3
Q18	a) Achieving amplitude Modulation b) Stating the formulae Calculation of v_c and v_m Calculation of bandwidth 1/2 a) Amplitude modulation can be achieved by applying the message signal, and the carrier wave, to a non linear (square law device) followed by a band pass filter. (Alternatively, The student may just draw the block diagram.) The square law device of the square law device		

	(Alternatively, Amplitude modulation is achieved by superposing a message signal on a carrier wave in a way that causes the amplitude of the carrier wave to change in accorda with the message signal.)	
	b) Frequencies of side bands are: $ (\upsilon_c + \upsilon_m) \text{ and } (\upsilon_c - \upsilon_m) $	1/2
	$:: v_c + v_m = 660 \text{ kHz} $	
	and $\upsilon_c - \upsilon_m = 640 \text{kHz}$	
	$∴$ $\upsilon_{c} = 650 \text{ kHz}$	1/2
	$∴ v_{m} = 10 \text{ kHz}$	1/2
	Bandwidth = $(660 - 640) \text{ kHz} = 20 \text{ kHz}$	1/2
Q19	a) Circuit diagram 1	1000
	Input characteristics ½	A 100
	Output characteristics ½	20
	b) Output pulse wave form ½	
	Truth table/Logic symbol ½	
	I_{B} I_{B} I_{B} I_{B} I_{B} I_{B} I_{C} I_{C	1



	Output waveform:						
						1/2	
	Truth Table:						
		In	put	Output			
		A	В	Y		-	
		0	0	0	40.7		2
		0	1	1	0 10		
		1	0	1	100	0 6	33.4
		1	1	1	11/2	- A 1	
	and/or Logic symbol:					Una	
	A B				Y	1/2	3
Q20	Formula				1/2	$\neg \mid$	
	Field due to each coil				$\frac{1}{2} + \frac{1}{2}$		
	Magnitude of resultant field 1						
	Direction of resultant field ½						

	1	4 /	
	Field at the centre of a circular coil = $\frac{\mu_0 I}{2R}$	1/2	
	Field due to coil $P = \frac{\mu_0 \times 3}{2 \times 5 \times 10^{-2}}$ tesla		
	$= 12\pi \times 10^{-6} \text{tesla}$	1/2	
	Field due to coil $Q = \frac{\mu_0 \times 4}{2 \times 5 \times 10^{-2}}$ tesla		
	$= 16\pi \times 10^{-6} \text{ tesla}$	1/2	
	∴ Resultant Field = $(\pi\sqrt{12^2 + 16^2})\mu$ T		
	$= (20 \pi) \mu T$	1	()
	Let the field make an angle θ with the vertical		0
	$\tan\theta = \frac{12\pi \times 10^{-6}}{16\pi \times 10^{-6}} = \frac{3}{4}$	P	3.4
	$\theta = \tan^{-1}\frac{3}{4}$	1/2	3
	(Alternatively: $\theta' = \tan^{-1} \frac{4}{3}$, $\theta' = \text{angle with the horizontal}$)		
	[Note1: Award 2 marks if the student directly calculates B without calculating B_P and B_Q separately.]		
	[Note 2: Some students may calculate the field B_Q and state that it also represents the resultant magnetic field (as coil P has been shown 'broken' and , therefore, cannot produce a magnetic field); They may be given 2 ½ marks for their (correct) calculation of B_Q]		
Q21	Diagram of generalized communication system 1½ Function of (a) transmitter (b) channel (c) receiver ½+½+½		

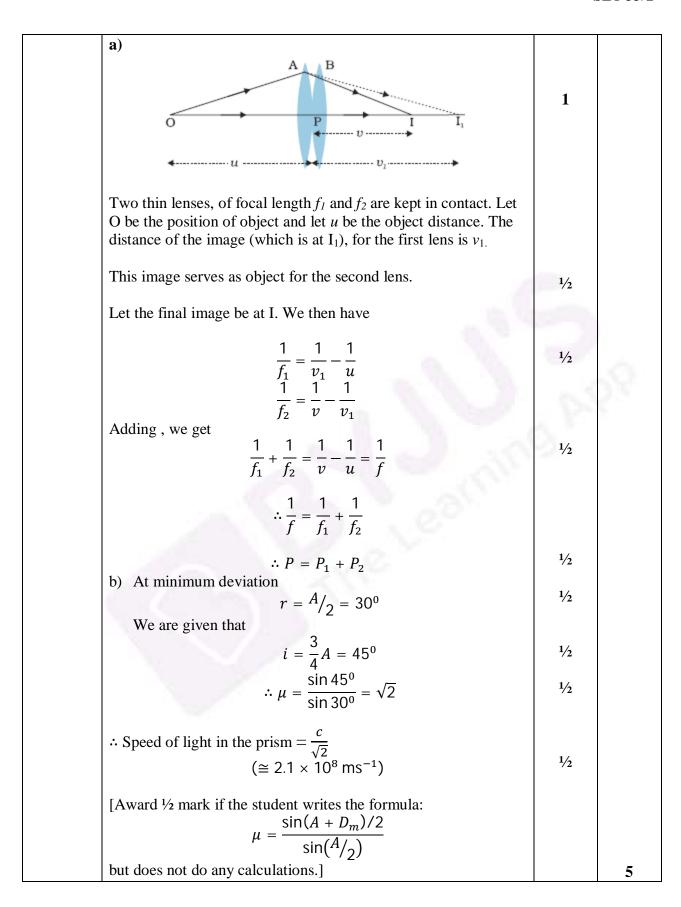
	Communication System		
	formation Message Signal Transmitter Signal Channel Signal Received Signal Receiver Signal Noise		
	[Also accept the following diagram		
	Information Communication Receiver of Information	1 ½	
	(a) Transmitter: A transmitter processes the incoming message signal so as to make it suitable for transmission through a	1/2	
	channel and subsequent reception. (b) Channel: It carries the message signal from a transmitter to a	1/2	56
	receiver. (c) Receiver: A receiver extracts the desired message signals	1/2	
	from the received signals at the channel output.		3
Q22	a) The factor by which the potential difference changes 1 b) Voltmeter reading 1 Ammeter Reading 1		
	a) $H = \frac{V^2}{R}$	1/2	
	∴ V increases by a factor of $\sqrt{9} = 3$	1/2	
	b) Ammeter Reading $I = \frac{V}{R+r}$	1/2	
	$R+r$ $=\frac{12}{4+2}A=2A$	1/2	
	Voltmeter Reading $V = E - Ir$	1/2	
	= $[12 - (2 \times 2)] V = 8V$ (Alternatively, $V = iR = 2 \times 4V = 8V$)	1/2	3

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	SECTION D		
Q23	a) Name of the installation, the cause of disaster ½ + ½ b) Energy release process 1 c) Values shown by Asha and mother 1+1 a) (i) Nuclear Power Plant:/'Set-up' for releasing Nuclear Energy/Energy Plant (Also accept any other such term) (ii)Leakage in the cooling unit/ Some defect in the set up. b) Nuclear Fission/Nuclear Energy Break up (/ Fission) of Uranium nucleus into fragments c) Asha: Helpful, Considerate, Keen to Learn, Modest Mother: Curious, Sensitive, Eager to Learn, Has no airs	1/ ₂ 1/ ₂ 1 1 1 1	
	(Any one such value in each case) SECTION E		4
Q24	a) Definition of wavefront Verifying laws of refraction by Huygen's 3 principle b) Polarisation by scattering Calculation of Brewster's angle 1 a) The wavefront is the common locus of all points which are in phase(/surface of constant phase) Incident wavefront A' Medium 1 P Medium 2 Refracted wavefront	1/2	200
	Let a plane wavefront be incident on a surface separating two media as shown. Let v_1 and v_2 be the velocities of light in the rarer medium and denser medium respectively. From the diagram $BC = v_1 t \text{ and } AD = v_2 t$	1/2	

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	$\sin i = \frac{BC}{AC}$ and $\sin r = \frac{AD}{AC}$	1/2	
	$\therefore \frac{\sin i}{\sin r} = \frac{BC}{AD} = \frac{v_1 t}{v_2 t}$	1/2	
	$=\frac{v_1}{v_2}=a\ constant$	1/2	
T	his proves Snell's law of refraction.		
b)	When unpolarised light gets scattered by molecules, the scattered light has only one of its two components in it. (Also accept diagrammatic representation Incident Sunlight (Unpolarised) Scattered Light (Polarised)	1/2	0
l w	We have, $\mu = an i_B$		
	$tan i_B = 1.5$	1/2	
	$i_B = \tan^{-1} 1.5$		
	(56.3°)	1/2	5
	OR		
	a) Ray diagram Expression for power b) Formula Calculation of speed of light 1 2 1/2 1/2		



Q25

- (a) Derivation of E along the axial line of dipole 2
- (b) Graph between E vs r
- (c) (i) Diagrams for stable and unstable $\frac{1}{2} + \frac{1}{2}$ equilibrium of dipole
 - (ii) Torque on the dipole in the two cases $\frac{1}{2} + \frac{1}{2}$

(a)



Electric field at P due to charge $(+q) = E_1 = \frac{1}{4\pi\epsilon_0} \frac{q}{(r-a)^2}$

Electric field at P due to charge $(-q) = E_2 = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r+a)^2}$

Net electric Field at P= $E_1 - E_2 = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r-a)^2} - \frac{1}{4\pi\varepsilon_0} \frac{q}{(r+a)^2}$

$$= \frac{1}{4\pi\varepsilon_0} \frac{2pr}{(r^2 - a^2)^2} \qquad (p = q.2a)$$

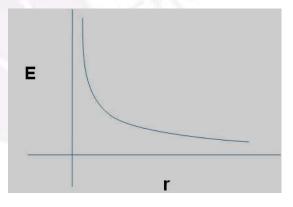
Its direction is parallel to \vec{p} .

1/2

1/2

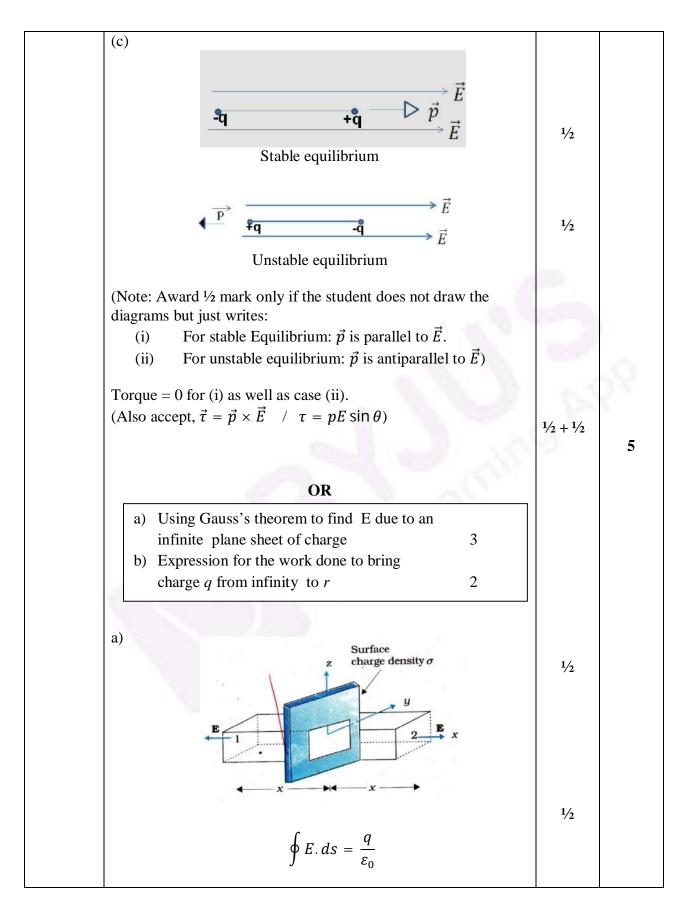
1/2

(b)



(Note: Award ½ mark if the student just writes: For short Dipole = $\frac{1}{4\pi\varepsilon_0} \frac{2p}{r^3}$ without drawing the graph)

1



$E = \frac{\sigma}{2\varepsilon_0}$ b) $W = q \int_{-\infty}^{r} \vec{E} . d\vec{r}$ $= q \int_{-\infty}^{r} (-E dr)$ $= -q \int_{-\infty}^{r} (-E dr)$ $= -q \int_{-\infty}^{r} (-E dr)$ $= \frac{q\sigma}{2\varepsilon} \infty - r $ $\Rightarrow (\infty)$ $Q26$ a) Identification $\frac{1}{2}$ $\Rightarrow (\infty)$ $\frac{1}{2}$ $\Rightarrow (\infty)$ $Q26$ a) Identifying the curves $\frac{1}{2}$		The electric field E points outwards normal to the sheet. The field lines are parallel to the Gaussian surface except for surfaces 1 and 2. Hence the net flux = $\oint E \cdot ds = EA + EA$ where A is the area of each of the surface 1 and 2.	1	
b) $W = q \int_{\infty}^{r} \vec{E} . d\vec{r}$ $= q \int_{\infty}^{r} (-E dr)$ $= -q \int_{\infty}^{r} \left(\frac{\sigma}{2\epsilon_{0}}\right) dr$ $= \frac{q\sigma}{2\epsilon} \infty - r $ $\Rightarrow (\infty)$ $Q26$ a) Identification $\Rightarrow (\infty)$ $1/2$ $\Rightarrow (\infty)$ $Q3$ a) Identification $\Rightarrow (\infty)$ $\Rightarrow (\infty)$ $1/2$			1	
$W = q \int_{\infty}^{r} \vec{E} . d\vec{r}$ $= q \int_{\infty}^{r} (-E dr)$ $= -q \int_{\infty}^{r} \left(\frac{\sigma}{2\epsilon_{0}}\right) dr$ $= \frac{q\sigma}{2\epsilon} \infty - r $ $\Rightarrow (\infty)$ $\frac{1}{2}$ $\Rightarrow (\infty)$ $\frac{1}{2}$		$L=2\varepsilon_0$		
$W = q \int_{\infty}^{\vec{E}} \vec{E} \cdot d\vec{r}$ $= q \int_{\infty}^{r} (-Edr)$ $= -q \int_{\infty}^{r} \left(\frac{\sigma}{2\epsilon_{0}}\right) dr$ $= \frac{q\sigma}{2\epsilon} \infty - r $ $\Rightarrow (\infty)$ $\Rightarrow (\infty)$ $Q26$ a) Identification		b)		
$= q \int_{\infty} (-Edr)$ $= -q \int_{\infty}^{r} \left(\frac{\sigma}{2\epsilon_{0}}\right) dr$ $= \frac{q\sigma}{2\epsilon} \infty - r $ $\Rightarrow (\infty)$ 0 0 0 0 0 0 0 0 0 0		$W = q \int_{\infty}^{r} \vec{E} \cdot d\vec{r}$	1/2	
$= -q \int_{\infty} \left(\frac{\delta}{2\epsilon_0}\right) dr$ $= \frac{q\sigma}{2\epsilon} \infty - r $ $\Rightarrow (\infty)$ $\begin{vmatrix} a & \text{Identification} & \frac{1}{2} \\ b & \text{Identifying the curves} & 1 \\ & \text{Justification} & \frac{1}{2} \\ c & \text{Variation of Impedance} \\ & \text{with frequency} & \frac{1}{2} \\ & \text{Graph} & \frac{1}{2} \\ d & \text{Expression for current} & \frac{11}{2} \\ & \text{Phase relation} & \frac{1}{2} \end{vmatrix}$ a) The device X is a capacitor b) Curve B \rightarrow voltage		$=q\int_{\infty}^{r}(-Edr)$	1/2	
Q26 a) Identification b) Identifying the curves Justification c) Variation of Impedance with frequency Graph d) Expression for current Phase relation b) Curve B voltage voltage		$= -q \int_{\infty}^{r} \left(\frac{\sigma}{2\epsilon_0}\right) dr$	1/2	34
b) Identifying the curves Justification c) Variation of Impedance with frequency Graph d) Expression for current Phase relation 1/2 a) The device X is a capacitor b) Curve B voltage		$= \frac{q\sigma}{2 \in } \infty - r $ $\Rightarrow (\infty)$	1/2	5
b) Identifying the curves Justification v) Variation of Impedance with frequency Graph d) Expression for current Phase relation 1/2 a) The device X is a capacitor b) Curve B voltage	026	a) Identification ½		
c) Variation of Impedance with frequency Graph 1/2 d) Expression for current Phase relation 1/2 a) The device X is a capacitor b) Curve B voltage 1/2 1/2 1/2 1/2	Q20	b) Identifying the curves 1		
with frequency Graph d) Expression for current Phase relation 1½ a) The device X is a capacitor b) Curve B voltage				
Graph d) Expression for current Phase relation 1½ a) The device X is a capacitor b) Curve B voltage				
d) Expression for current Phase relation 1½ 2 a) The device X is a capacitor b) Curve B voltage 1½ 1½				
Phase relation 1/2 a) The device X is a capacitor b) Curve B → voltage 1/2 1/2 1/2		1		
a) The device X is a capacitor b) Curve B voltage				
a) The device X is a capacitor b) Curve B → voltage 1/2 1/4		Filase relation 7/2	1/	
b) Curve B · voltage		a) The device X is a capacitor	72	
1/2		b) Curve B voltage	1/2	
Curve C current		Curve C → current	1/2	
Curve A power				

		T	
	eason: The current leads the voltage in phase, by $\pi/2$,	1/2	
for	r a capacitor.		
		1/2	
$c) X_c$	$x = \frac{1}{\omega C} \left(/ X_C \propto \frac{1}{\omega} \right)$		
	× .	1/2	
	× _c ↑ \	/ 2	
	$\overline{\omega}$		
d) V	$=V_o\sin\omega t$		
	$= CV = CV_0 \sin \omega t$	1/2	
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	$= cv = cv_0 \sin \omega t$	1/2	
<i>I</i> =	$=\frac{dq}{dt}=\omega cV_o\cos\omega t$	/ 2	
		1/2	
=	$I_0 \sin(\omega t + \frac{\pi}{2})$ V=V _o sinwt	17	
	arrent leads the voltage, in phase, by $\pi/2$	1/2	
	arrent leads the voltage, in phase 757		
	Note: If the student identifies the device X as an		
	ductor but writes correct answers to parts (c) and (d)		
	n terms of an inductor), the student be given full marks		
	r (only) these two parts)		5
0.007			
16.00	OR		
- X			
a) Lal	belled diagram of ac generator 1		
	pression for emf 2		
	rmula for emf ½		
	bstitution ½		
Cal	lculation of emf 1		

Let ω be the angular speed of rotation of the coil. We then have $\phi(t) = NBA\cos \omega t$ $\therefore E = -\frac{d\phi}{dt}$ $= NBA\omega \sin \omega t$ $= E_0 \sin \omega t \qquad (E_0 = NE)$ b) Induced emf = BIV $\therefore E = 0.3 \times 10^{-4} \times 10 \times 5 \text{ volt}$ $E = 1.5 \times 10^{-3} \text{V} (= 1.5 \text{mV})$	1/2	
		5

MARKING SCHEME

Q. No.	Expected Answer/ Value Points	Marks	Total Marks
	Section A		
Q1	i. Decreases	1/2	
	ii. $n_{\text{Violet}} > n_{\text{Red}}$	1/2	
	(Also accept if the student writes $\lambda_V < \lambda_R$)	72	
			1
Q2	Photoelectric Effect (/Raman Effect/ Compton Effect)	1	
			1
Q3	Clockwise in loop 1	1/2	
	Anticlockwise in loop 2	1/2	
		72	
			1
Q4			4.5
	\vec{E} along y- axis and \vec{B} along z-axis	$\frac{1}{2} + \frac{1}{2}$	(·
	(Alternatively : \vec{E} along z-axis and \vec{B} along y-axis)	.45.	1
Q5	i. Nichrome	1/2	
Q3		/2	
	ii. $R_{Ni} > R_{Cu}$ (or Resistivity _{Ni} > Resistivity _{Cu})	1/2	1
	SECTION B		
Q6			
	a) Two properties for making permanent $\frac{1}{2} + \frac{1}{2}$		
	magnet b) Two proporties for molying an		
	b) Two properties for making an $\frac{1}{2} + \frac{1}{2}$ electromagnet		
	a) For making permanent magnet:		
	(i) High retentivity	$\frac{1}{2} + \frac{1}{2}$	
	(ii) High coercitivity		
	(iii) High permeability		
	(Any two)		

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	b) For making electromagnet:		
	(i) High permeability	1/2 + 1/2	
	(ii) Low retentivity		
	(iii) Low coercivity		
	(Any two)		2
Q7	Interference pattern ½		
	Diffraction pattern ½		
	Two Differences $\frac{1}{2} + \frac{1}{2}$		
	Inax 3λ 2λ 1λ 0 1λ 2λ 3λ → Path Difference Incoming wave Viewing screen Viewing	1/2	

	Interference	Diffraction			
	All maxima have equal	Maxima have different			
	intensity	(/rapidly decreasing)			
		intensity		$\frac{1}{2} + \frac{1}{2}$	
	All fringes have equal	Different (/changing)			
	width.	width.			
	Superposition of two	Superposition of wavelets			
	wavefronts	from the same wavefront			•
		(Any two)			2
		OR			
	Expression for intensity	of polarized beam	1		
	Plot of intensity variation	on with angle	1		
	Intensity is $\frac{I_0}{I_0} \cos^2 \theta$ (if I_0	is the intensity of unpolarise	od light)		
	<u> </u>	the intensity of polarized light		100.5	
	(Award 1/2 mark if the ctude				
	(Award 72 mark if the stude	ent writes the expression as I	$I_0 \cos^2 \theta$	3	
	I T	ent writes the expression as R	$T_0 \cos^2 \theta$	1	2
	1		$\frac{I_0 \cos^2 \theta}{1}$	1	2
Q8	a) Reason for 1	$ \begin{array}{c} $	riin'	1	2
Q8	a) Reason for 1	$\stackrel{\frown}{\longrightarrow} \theta$	1	1	2
Q8	a) Reason for 1	$ \begin{array}{c} $	1	1	2
Q8	a) Reason for the by Reason fo	no flow of current momentary current	1 1	1	2
Q8	a) Reason for the by Reason for the steady state, the disp	no flow of current momentary current	1 1		2
Q8	a) Reason for the by Reason for the steady state, the disp	no flow of current momentary current	1 1	1	2
Q8	a) Reason for the by Reason for the steady state, the disp	no flow of current momentary current	1 1		2
Z8	a) Reason for the by Reason for the steady state, the displacement, is zero constant.	no flow of current momentary current and hence as $ \vec{E} $, between the plates, if	1 1 the		2
98	a) Reason for the by Reason for the steady state, the disput conduction current, is zero constant. During charging / discharg	no flow of current momentary current	1 1 the is		2

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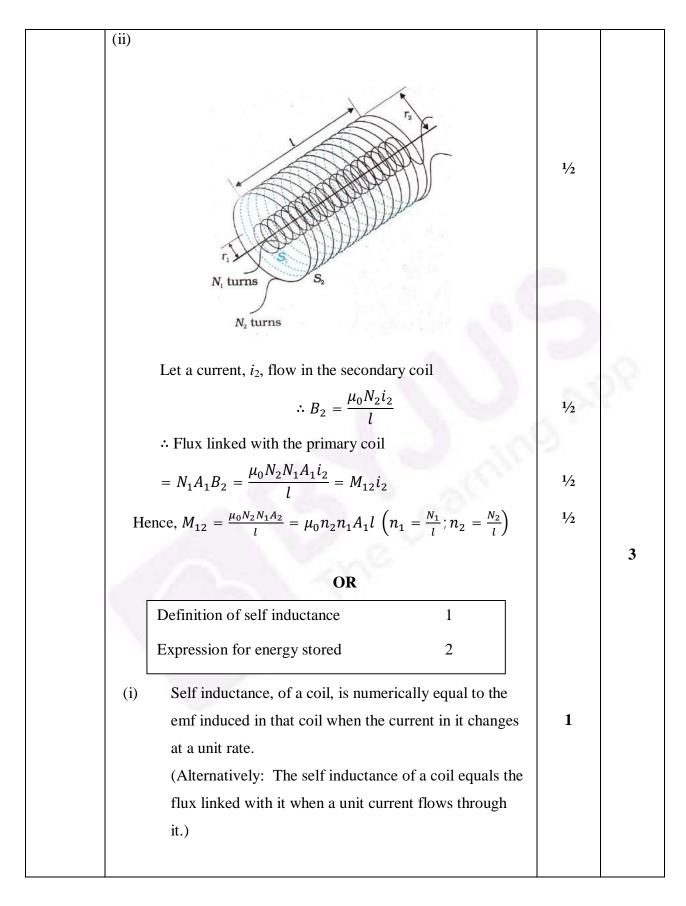
	 i) In the steady state no current flows because, we have two sources (battery and fully charged capacitor) of 'equal potential' connected in opposition. 	1	
	ii) During charging /discharging there is a momentary flow of current as the 'potentials' of the two 'sources' are not equal to each other.	1	
	+ -	5	
	Alternatively,	3	
	Capacitative impedence $=\frac{1}{\omega C}$ iii) During steady state: $\omega = 0$ $\therefore X_c \to \infty$ Hence current is zero.	1/2	
	iv) During charging /discharging : $\omega \neq 0$ $\therefore X_c \text{ is finite.}$ Hence current can flow.	1/2	2
Q9	a) Calculation of energy difference ½ b) Formula ½ c) Calculation of wavelength ½ d) Name of the series of spectral lines ½		

Energy = $\frac{hc}{\lambda}$ = 3.024×10 ⁻¹⁹ J Wavelength = 6.57x10 ⁻⁷ m Series is Balmer series //2 Q10 Condition i. For directions of \vec{E} , \vec{B} , \vec{v} 1 ii. For magnitudes of \vec{E} , \vec{B} , \vec{v} 1 ii. For magnitudes of \vec{E} , \vec{B} , \vec{v} 1 (i) The velocity \vec{v} , of the charged particles, and the \vec{E} and \vec{B} vectors, should be mutually perpendicular. Also the forces on q , due to \vec{E} and \vec{B} , must be oppositely directed. (Also accept if the student draws a diagram to show the directions.) (ii) $qE = qvB$ or $v = \frac{E}{B}$ [Alternatively, The student may write: Force due to electric field = $q\vec{E}$ Force due to magnetic field = $q\vec{E}$ $q\vec{E} = -q(\vec{v} \times \vec{B})$		Energy difference = $3.4 \text{ eV} - 1.51 \text{ eV} = 1.89 \text{ eV} = 3.024 \times 10^{-19} \text{ J}$	1/2	
Series is Balmer series Q10 Condition i. For directions of \vec{E} , \vec{B} , \vec{v} 1 ii. For magnitudes of \vec{E} , \vec{B} , \vec{v} 1 (i) The velocity \vec{v} , of the charged particles, and the \vec{E} and \vec{B} vectors, should be mutually perpendicular. Also the forces on q , due to \vec{E} and \vec{B} , must be oppositely directed. (Also accept if the student draws a diagram to show the directions.) (ii) $q\vec{E} = qv\vec{B}$ $q\vec{v} = v\vec{b}$ $r =$		Energy = $\frac{hc}{\lambda}$ =3.024×10 ⁻¹⁹ J	1/2	
Q10 Condition i. For directions of \vec{E} , \vec{B} , \vec{v} ii. For magnitudes of \vec{E} , \vec{B} , \vec{v} 1 (i) The velocity \vec{v} , of the charged particles, and the \vec{E} and \vec{B} vectors, should be mutually perpendicular. Also the forces on q , due to \vec{E} and \vec{B} , must be oppositely directed. (Also accept if the student draws a diagram to show the directions.) (ii) $q\vec{E} = qv\vec{B}$ $or \ v = \frac{E}{B}$ [Alternatively, The student may write: Force due to electric field = $q\vec{E}$ Force due to magnetic field = $q(\vec{v} \times \vec{B})$ The required condition is $q\vec{E} = -q(\vec{v} \times \vec{B}) = (\vec{B} \times \vec{v})$ $ \vec{A} $		Wavelength = 6.57×10^{-7} m	1/2	
i. For directions of \vec{E} , \vec{B} , \vec{v} 1 ii. For magnitudes of \vec{E} , \vec{B} , \vec{v} 1 (i) The velocity \vec{v} , of the charged particles, and the \vec{E} and \vec{B} vectors, should be mutually perpendicular. Also the forces on q , due to \vec{E} and \vec{B} , must be oppositely directed. (Also accept if the student draws a diagram to show the directions.) (ii) $q\vec{E} = qv\vec{B}$ rv rv rv rv rv rv rv rv		Series is Balmer series	1/2	2
(Note: Award 1 mark only if the student just writes: "The forces, on the charged particle, due to the electric and magnetic fields, must be equal and opposite to each other")]	Q10	i. For directions of \vec{E} , \vec{B} , \vec{v} 1 ii. For magnitudes of \vec{E} , \vec{B} , \vec{v} 1 (i) The velocity \vec{v} , of the charged particles, and the \vec{E} and \vec{B} vectors, should be mutually perpendicular. Also the forces on q , due to \vec{E} and \vec{B} , must be oppositely directed. (Also accept if the student draws a diagram to show the directions.) (ii) $qE = qvB$ $or \ v = \frac{E}{B}$ [Alternatively, The student may write: Force due to electric field $= q\vec{E}$ Force due to magnetic field $= q(\vec{v} \times \vec{B})$ The required condition is $q\vec{E} = -q(\vec{v} \times \vec{B}) = (\vec{B} \times \vec{v})$ (Note: Award 1 mark only if the student just writes: "The forces, on the charged particle, due to the electric and	1/ ₂ 1/ ₂ 1/ ₂ 1/ ₂ 1/ ₂ 1/ ₂	2

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	SECTION C		
Q11	a. Calculation of wavelength, frequency and speed b. Lens Maker's Formula Calculation of R 1/2 + 1/2 + 1/2 Lens Maker's Formula		
	a) $\lambda = \frac{589 \text{ nm}}{1.33} = 442.8 \text{nm}$	1/2	
	Frequency $v = \frac{3 \times 10^8 \text{ ms}^{-1}}{589 \text{ nm}} = 5.09 \times 10^{12} \text{Hz}$	1/2	
	Speed $v = \frac{3 \times 10^8}{1.33}$ m/s = 2.25 × 10 ⁸ m/s	1/2	
	b) $\frac{1}{f} = \left[\frac{\mu_2}{\mu_1} - 1\right] \left[\frac{1}{R_1} - \frac{1}{R_2}\right]$	1/2	.0.
	$\therefore \frac{1}{20} = \left[\frac{1.55}{1} - 1 \right] \frac{2}{R}$ $\therefore R = (20 \times 1.10) \text{ cm} = 22 \text{ cm}$	1/2	
	$\therefore R = (20 \times 1.10) \text{cm} = 22 \text{ cm}$		3
Q12	Definition of mutual inductance 1 Derivation of mutual inductance for two long solenoids 2 (i) Mutual inductance is numerically equal to the induced emf in the secondary coil when the current in the primary coil changes by unity. Alternatively: Mutual inductance is numerically equal to the magnetic flux linked with one coil/secondary coil when unit current flows through the other coil/primary coil.	1	

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	(ii) The work done against back /induced emf is stored as	1/-	1
		1/2	
	magnetic potential energy.		
	The rate of work done, when a current i is passing	1/2	
	through the coil, is		
	$\frac{dW}{dt} = \varepsilon i = \left(L\frac{di}{dt}\right)i$	1/2	
	$\therefore W = \int dW = \int_0^I Lidi$	1/2	
	$=\frac{1}{2}Li^2$		3
Q13	 a) Principle of meter bridge 1 b) Relation between l₁, l₂, and S 2 a) The principle of working of a meter bridge is same as that of a balanced Wheatstone bridge. 		200
	(Alternatively:	3	
	When $i_g=0$, then $\frac{P}{Q}=\frac{R}{S}$)	1	
	b) $\frac{R}{S} = \frac{l_1}{100 - l_1}$	1/2	
	When X is connected in parallel: $\frac{R}{\left(\frac{XS}{X+S}\right)} = \frac{l_2}{100 - l_2}$	1/2	
	On solving, we get $X = \frac{l_1 S(100 - l_2)}{100(l_2 - l_1)}$	1	3

Q14	Transistor amplifier circuit diagram 1		
	Derivation of voltage gain 1 ½		
	Explanation of phase reversal ½		
	$V_{i} \cap V_{BB}$ $V_{i} \cap V_{BB}$ $V_{i} \cap V_{CC}$	1	
	<u>_</u>		0
	Change in the input voltage: $\Delta V_{BE} = I_B r_i$	1/2	2.
	Change in the output voltage: $\Delta V_{CE} = I_C R_C$	1/2	
	Voltage gain= Output voltage/Input voltage $A_V = -\frac{\beta R_C}{r_i}$	1/2	
	Negative sign indicates, phase difference is 180°	1/2	
	(Alternatively, There is a phase reversal)		
			3
Q15	a) The factor by which the potential difference changes 1 b) Voltmeter reading 1 Ammeter Reading 1		
	a) $H = \frac{V^2}{R}$	1/2	
	$\therefore V \text{ increases by a factor of } \sqrt{9} = 3$	1/2	
	b) Ammeter Reading $I = \frac{V}{R+r}$	1/2	
	$=\frac{12}{4+2}A=2A$	1/2	

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	Voltmeter Reading $V = E - Ir$	1/2	
	= $[12 - (2 \times 2)] V = 8V$ (Alternatively, $V = iR = 2 \times 4V = 8V$)	1/2	3
Q16	Diagram of generalized communication system 1½ Function of (a) transmitter (b) channel (c) receiver ½+½+½		
	formation Message Signal Transmitter Signal Channel Signal Received Receiver Message Information Signal Noise	0	30
	[Also accept the following diagram Information Communication Receiver of Information	1 1/2	
	(a) Transmitter: A transmitter processes the incoming message		
	signal so as to make it suitable for transmission through a channel and subsequent reception.	1/2	
	(b) Channel: It carries the message signal from a transmitter to a receiver.	1/2	
	(c) Receiver: A receiver extracts the desired message signals from the received signals at the channel output.	1/2	
			3

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Q17	a) Ray diagram for compound microscope 1		
	b) Identification of objective and eye piece 1		
	c) Resolving power of microscope ½		
	d) One factor affecting the resolving power ½		
	a) Ray Diagram for compound microscope		
	B' B Objective A Eyepiece	1	56
	b) Objective: Lens L ₃ Eye Piece: Lens L ₂	1/ ₂ 1/ ₂	
	Eye Tiece. Lens L_2 $2\mu \sin \beta$	1/2	
	c) $R_p = \frac{2\mu \sin \beta}{1.22\lambda}$	72	
	d) Any one factor	1/2	
	 It depends on the wavelength of the light used. Semi angle of cone of incident light. Aperture of the objective Refractive index of the medium. 		
			3

Q18	(a) Identification of X ½	
	(b) Identification of point A ½	
	(c) Graph for three different frequencies 1	
	(d) Graph for three different intensities. 1	
	a) X is collector plate potential.	
	b) A is stopping potential. 1/2	
	c) Graph for different frequencies	
	Photoelectric current 1	
	$V_3 > V_2 > V_1$ Saturation current $V_3 = V_{02} - V_{01} = 0$ Collector plate potential \longrightarrow Retarding potential	
	d) Graph for three different Intensities	
	$\begin{array}{c c} & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & \\ & & & \\ & &$	
	Stopping potential -V ₀ 0	
	Retarding potential Collector plate → potential	
	3	

0.10	Formula for energy stored ½		
Q19	Energy stored before		
	Energy stored after 1		
	Ratio ½		
	Energy stored = $\frac{1}{2} CV^2 \left(= \frac{1}{2} \frac{Q^2}{C} \right)$	1/2	
	2 2 0	1./	
	Net capacitance with switch S closed = $C + C = 2C$	1/2	
	$\therefore \text{ Energy stored} = \frac{1}{2} \times 2C \times V^2 = CV^2$	1/2	
	After the switch S is opened, capacitance of each capacitor= KC		
	$\therefore \text{ Energy stored in capacitor A} = \frac{1}{2}KCV^2$		
	For capacitor B,	1/2	9
	Energy stored = $\frac{1}{2} \frac{Q^2}{KC} = \frac{1}{2} \frac{C^2 V^2}{KC} = \frac{1}{2} \frac{CV^2}{K}$	72	
	$\therefore \text{ Total Energy stored} = \frac{1}{2}KCV^2 + \frac{1}{2}\frac{CV^2}{K} = \frac{1}{2}CV^2\left(K + \frac{1}{K}\right)$	2	
	$=\frac{1}{2}CV^2\left(\frac{K^2+1}{K}\right)$	1/2	
	$\therefore \text{ Required ratio} = \frac{2CV^2.K}{CV^2(K^2+1)} = \frac{2K}{(K^2+1)}$	1/2	3
	Formula for energy stored ½		
Q20	Energy stored before		
	Energy stored after 1		
	Ratio 1/2		
	72		
	Energy stored = $\frac{1}{2} CV^2 \left(= \frac{1}{2} \frac{Q^2}{C} \right)$	1/2	
	Net capacitance with switch S closed = $C + C = 2C$	1/2	
	$\therefore \text{ Energy stored} = \frac{1}{2} \times 2C \times V^2 = CV^2$	1/2	
	After the switch S is opened, capacitance of each capacitor= KC		

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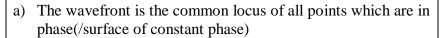
	1		
	$\therefore \text{ Energy stored in capacitor A} = \frac{1}{2}KCV^2$		
	For capacitor B,		
	Energy stored = $\frac{1}{2} \frac{Q^2}{KC} = \frac{1}{2} \frac{C^2 V^2}{KC} = \frac{1}{2} \frac{CV^2}{K}$	1/2	
	$\therefore \text{ Total Energy stored} = \frac{1}{2}KCV^2 + \frac{1}{2}\frac{CV^2}{K} = \frac{1}{2}CV^2\left(K + \frac{1}{K}\right)$		
	$=\frac{1}{2}CV^2\left(\frac{K^2+1}{K}\right)$	1/2	
	$\therefore \text{ Required ratio} = \frac{2CV^2.K}{CV^2(K^2+1)} = \frac{2K}{(K^2+1)}$	1/2	
Q21	a) Correct Choice of R ½	3	3
	Reason ½ b) Circuit Diagram 1		
	Working ½	9	
	<i>I-V</i> characteristics ½		
	a) R would be increased.	1/2	
	Resistance of S (a semi conductor) decreases on heating.	1/2	
	b) Photodiode diagram		
	p-side n-side	1	
	When the photodiode is illuminated with light (photons) (with		
	energy (hv) greater than the energy gap (E_g) of the		
	semiconductor), then electron-hole pairs are generated due to the		

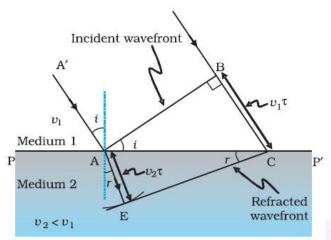
	absorption of photons. Due to junction field, electrons and holes		
	are separated before they recombine. Electrons are collected on		
	n-side and holes are collected on p-side giving rise to an emf.	1/2	
	When an external load is connected, current flows.		
	V-I Characteristics of the diode		
	↑ mA		
	Reverse bias		
	I_1 volts I_2 I_3	1/2	.0
	I_4 μ A	- 6×	2.5
	$I_4 > I_3 > I_2 > I_1$	3	3
Q22	(a) Statement of Biot Savart law 1		
222	Expression in vector form ½		
	(b) Magnitude of magnetic field at centre 1		
	Direction of magnetic field ½		
	(a) It states that magnetic field strength, $d\vec{B}$, due to a current element, $Id\vec{l}$, at a point, having a position vector \mathbf{r} relative to the current element, is found to depend (i) directly on the current element, (ii) inversely on the square of the distance $ \mathbf{r} $, (iii) directly on the sine of angle between the current element and the position vector \mathbf{r} .	1	
	In vector notation, $\overrightarrow{dB} = \frac{\mu_0}{4\pi} \frac{I \overrightarrow{dl} \times \overrightarrow{r}}{ \overrightarrow{r} ^3}$	1/2	
	Alternatively, $\left(d\vec{B} = \frac{\mu_0}{4\pi} \frac{I \vec{dl} \times \hat{r}}{ \vec{r} ^2}\right)$		

	(b) $B_p = \frac{\mu_0 \times 1}{2R} = \frac{\mu_0}{2R}$ (along z – direction)	1/2	
	$B_Q = \frac{\mu_0 \times \sqrt{3}}{2R} = \frac{\mu_0 \sqrt{3}}{2R}$ (along x – direction)		
	$\therefore B = \sqrt{B_p^2 + B_Q^2} = \frac{\mu_0}{R}$	1/2	
	This net magnetic field \mathbf{B} , is inclined to the field \mathbf{B}_p , at an angle Θ , where	,-	
	$\tan \theta = \sqrt{3}$ $\left(/\theta = \tan^{-1} \sqrt{3} = 60^{0}\right)$	1/2	
	(in XZ plane)		2
	SECTION D		3
Q23	a) Name of the installation, the cause of disaster 1/2 + 1/2 b) Energy release process 1		9
	c) Values shown by Asha and mother 1+1 a) (i) Nuclear Power Plant:/'Set-up' for releasing Nuclear Energy/Energy Plant	1/2	
	(Also accept any other such term)(ii)Leakage in the cooling unit/ Some defect in the set up.b) Nuclear Fission/Nuclear Energy	1/ ₂ 1	
	Break up (/ Fission) of Uranium nucleus into fragments c) Asha: Helpful, Considerate, Keen to Learn, Modest Mother: Curious, Sensitive, Eager to Learn, Has no airs (Any one such value in each case)	1 1	
			4
	SECTION E		
Q24	a) Identification ½ b) Identifying the curves 1		
	Justification ½		
	c) Variation of Impedance		
	with frequency ½		
	Graph ½		
	d) Expression for current 1½ Phase relation ½		
	a) The device X is a capacitor	1/2	

Curve C \longrightarrow current Curve A \longrightarrow power Reason: The current leads the voltage in phase, by $\pi/2$, for a capacitor. c) $X_c = \frac{1}{\omega c} (/X_c \propto \frac{1}{\omega})$ $X_c = \frac{1}{\omega c} (/$	b)	Curve B voltage		
Curve A power Reason: The current leads the voltage in phase, by $\pi/2$, for a capacitor. c) $X_c = \frac{1}{\omega c} (/X_c \propto \frac{1}{\omega})$ $X_c = $			1/2	
Reason: The current leads the voltage in phase, by $\pi/2$, for a capacitor. c) $X_c = \frac{1}{\omega c} \left(/ X_c \propto \frac{1}{\omega} \right)$ $X_c \triangle$ $X_c $				
for a capacitor. c) $X_c = \frac{1}{\omega c} (/X_c \propto \frac{1}{\omega})$ $X_c \wedge A$ $V = V_o \sin \omega t$ $Q = CV = CV_o \sin \omega t$ $I = \frac{dq}{dt} = \omega c V_o \cos \omega t$ $= I_o \sin(\omega t + \frac{\pi}{2})$ $V = V_o \sin \omega t$		curve 71 power		
for a capacitor. c) $X_c = \frac{1}{\omega c} (/X_c \propto \frac{1}{\omega})$ $X_c \wedge A$ $V = V_o \sin \omega t$ $Q = CV = CV_o \sin \omega t$ $I = \frac{dq}{dt} = \omega c V_o \cos \omega t$ $= I_o \sin(\omega t + \frac{\pi}{2})$ $V = V_o \sin \omega t$		Reason: The current leads the voltage in phase, by $\pi/2$,	1/2	
c) $X_c = \frac{1}{\omega c} (/X_c \propto \frac{1}{\omega})$ $X_c \wedge \frac{1}{\omega}$ d) $V = V_0 \sin \omega t$ $Q = CV = CV_0 \sin \omega t$ $I = \frac{dq}{dt} = \omega c V_0 \cos \omega t$ $= I_0 \sin(\omega t + \frac{\pi}{2})$ $V = V_0 \sin \omega t$ $V = V_0 \cos \omega t$		· —		
$X_{c} \triangle$ $Q = CV = CV_{0} \sin \omega t$ $I = \frac{dq}{dt} = \omega cV_{0} \cos \omega t$ $I = I_{0} \sin(\omega t + \frac{\pi}{2})$ $V=V_{o} \sin \omega t$		•		
d) $V = V_0 \sin \omega t$ $Q = CV = CV_0 \sin \omega t$ $I = \frac{dq}{dt} = \omega c V_0 \cos \omega t$ $= I_0 \sin(\omega t + \frac{\pi}{2})$ $V = V_0 \sin \omega t$ V_2 V_2 V_2 V_2 V_3 V_4	c)	$X_c = \frac{1}{\omega C} (/X_c \propto \frac{1}{\omega})$	1/2	
d) $V = V_0 \sin \omega t$ $Q = CV = CV_0 \sin \omega t$ $I = \frac{dq}{dt} = \omega c V_0 \cos \omega t$ $= I_0 \sin(\omega t + \frac{\pi}{2})$ $V = V_0 \sin \omega t$ V_2 V_2 V_2 V_2 V_3 V_4				
d) $V = V_0 \sin \omega t$ $Q = CV = CV_0 \sin \omega t$ $I = \frac{dq}{dt} = \omega c V_0 \cos \omega t$ $= I_0 \sin(\omega t + \frac{\pi}{2})$ $V = V_0 \sin \omega t$ V_2 V_2 V_2 V_2 V_3 V_4				
d) $V = V_0 \sin \omega t$ $Q = CV = CV_0 \sin \omega t$ $I = \frac{dq}{dt} = \omega c V_0 \cos \omega t$ $= I_0 \sin(\omega t + \frac{\pi}{2})$ $V = V_0 \sin \omega t$ $V_2 = V_0 \sin \omega t$ $V_2 = V_0 \sin \omega t$		Xc ↑ \	1/2	
d) $V = V_0 \sin \omega t$ $Q = CV = CV_0 \sin \omega t$ $I = \frac{dq}{dt} = \omega c V_0 \cos \omega t$ $= I_0 \sin(\omega t + \frac{\pi}{2})$ $V = V_0 \sin \omega t$ $V = V_0 \sin \omega t$ $V = V_0 \sin \omega t$			/2	
d) $V = V_0 \sin \omega t$ $Q = CV = CV_0 \sin \omega t$ $I = \frac{dq}{dt} = \omega c V_0 \cos \omega t$ $= I_0 \sin(\omega t + \frac{\pi}{2})$ $V = V_0 \sin \omega t$ $V = V_0 \sin \omega t$ $V = V_0 \sin \omega t$				
d) $V = V_0 \sin \omega t$ $Q = CV = CV_0 \sin \omega t$ $I = \frac{dq}{dt} = \omega c V_0 \cos \omega t$ $= I_0 \sin(\omega t + \frac{\pi}{2})$ $V = V_0 \sin \omega t$ $V = V_0 \sin \omega t$ $V = V_0 \sin \omega t$		<u></u> >		-
$Q = CV = CV_0 \sin \omega t$ $I = \frac{dq}{dt} = \omega cV_0 \cos \omega t$ $= I_0 \sin(\omega t + \frac{\pi}{2})$ $V = V_0 \sin \omega t$ $V = V_0 \sin \omega t$				0
$Q = CV = CV_0 \sin \omega t$ $I = \frac{dq}{dt} = \omega cV_0 \cos \omega t$ $= I_0 \sin(\omega t + \frac{\pi}{2})$ $V = V_0 \sin \omega t$ $V = V_0 \sin \omega t$	d)	$V = V_0 \sin \omega t$	16.3	2.5
$I = \frac{dq}{dt} = \omega c V_o \cos \omega t$ $= I_O \sin(\omega t + \frac{\pi}{2})$ $V = V_o \sin \omega t$ $\frac{1/2}{2}$ $V = V_o \sin \omega t$,		1/2	
$I = \frac{uq}{dt} = \omega c V_o \cos \omega t$ $= I_O \sin(\omega t + \frac{\pi}{2})$ $V = V_o \sin \omega t$ $\frac{1}{2}$		$Q = CV = CV_0 \sin \omega t$	3	
$= I_0 \sin(\omega t + \pi/2)$ $V=V_0 \sin \omega t$ $1/2$ $1/2$		$I = \frac{dq}{dt} = \omega c V_o \cos \omega t$	1/2	
1/2			1/2	
Current leads the voltage, in phase , by $\pi/2$		$= I_0 \sin(\omega t + n/2) $ V=V _o sinwt	1./	
		Current leads the voltage, in phase, by $\pi/2$	1/2	
(Note: If the student identifies the device X as an		(Note: If the student identifies the device X as an		
Inductor but writes correct answers to parts (c) and (d) 5	15	Inductor but writes correct answers to parts (c) and (d)		5
(in terms of an inductor), the student be given full marks	- X			
for (only) these two parts)		for (only) these two parts)		
OR		OR		
a) Labelled diagram of ac generator 1				
Expression for emf 2				
b) Formula for emf ½				
Substitution ½				
Calculation of emf 1		Calculation of emf 1		

	a)		
	Coil Axle N S Slip rings Alternating emf	1	
	Carbon brushes Let ω be the angular speed of rotation of the coil. We then have		
	$\phi(t) = NBA\cos\omega t$ $\therefore E = -\frac{d\phi}{dt}$	1/2	
	$= NBA\omega \sin \omega t$	1/ ₂	
	$= E_0 \sin \omega t \qquad (E_0 = NBAw)$	1	
	b) Induced emf = BlV	1/2	
	$\therefore E = 0.3 \times 10^{-4} \times 10 \times 5 \text{ volt}$	1/2	
	$E = 1.5 \times 10^{-3} \text{V} \ (= 1.5 \text{mV})$	1	
			5
Q25	a) Definition of wavefront Verifying laws of refraction by Huygen's principle b) Polarisation by scattering Calculation of Brewster's angle 1/2		





Let a plane wavefront be incident on a surface separating two media as shown. Let v_1 and v_2 be the velocities of light in the rarer medium and denser medium respectively. From the diagram

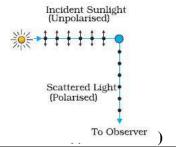
$$BC = v_1 t$$
 and $AD = v_2 t$
 $\sin i = \frac{BC}{AC}$ and $\sin r = \frac{AD}{AC}$

$$\therefore \frac{\sin i}{\sin r} = \frac{BC}{AD} = \frac{v_1 t}{v_2 t}$$

$$=\frac{v_1}{v_2}=a\;constant$$

This proves Snell's law of refraction.

b) When unpolarised light gets scattered by molecules, the scattered light has only one of its two components in it. (Also accept diagrammatic representation



1/2

1/2

1/2

1/2

1/2

March 22, 2017

1/2

We have, $\mu = \tan i_B$	1/2	
$\therefore \tan i_B = 1.5$		
$\therefore i_B = \tan^{-1} 1.5$		
(/56.3°)	1/2	
OR		5
a) Ray diagram 1		
Expression for power 2		
b) Formula ½		
Calculation of speed of light 1 ½		
a)		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	1	200
Two thin lenses, of focal length f_1 and f_2 are kept in contact. Let O be the position of object and let u be the object distance. The distance of the image (which is at I_1), for the first lens is v_1 . This image serves as object for the second lens.		
	1/2	
Let the final image be at I. We then have		
$\frac{1}{f_1} = \frac{1}{v_1} - \frac{1}{u}$ $\frac{1}{f_2} = \frac{1}{v} - \frac{1}{v_1}$	1/2	
Adding, we get $\frac{1}{f_{1}} + \frac{1}{f_{2}} = \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$	1/2	
$\therefore \frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$		
$\therefore P = P_1 + P_2$	1/2	

		I	T .
	b) At minimum deviation	1/2	
	$r = \frac{A}{2} = 30^{\circ}$	/2	
	We are given that		
	$i = \frac{3}{4}A = 45^{\circ}$	1/2	
	$\therefore \mu = \frac{\sin 45^{0}}{\sin 30^{0}} = \sqrt{2}$		
	$\therefore \mu = \frac{1}{\sin 30^0} = \sqrt{2}$	1/2	
	\therefore Speed of light in the prism = $\frac{c}{\sqrt{2}}$		
	$(\cong 2.1 \times 10^8 \mathrm{ms}^{-1})$	1/2	
	[Award ½ mark if the student writes the formula:		
	$\mu = \frac{\sin(A + D_m)/2}{\sin(A/2)}$		
	2		
	but does not do any calculations.]		
			1
			5
Q26	(a) Derivation of E along the axial line of dipole 2	(5)	
	(b) Graph between E vs r	A 11	
	(c) (i) Diagrams for stable and unstable $\frac{1}{2} + \frac{1}{2}$	2	
	equilibrium of dipole		
	(ii) Torque on the dipole in the two cases $\frac{1}{2} + \frac{1}{2}$		
	(a)		
	E _{+a} E _{-a}		
	← 2a → ← ← ← ← ← ← ← ← ← ← ← ← ← ← ← ← ← ←		
	-q +q P		
	<		
	Electric field at P due to charge $(+q) = E_1 = \frac{1}{4\pi\epsilon_0} \frac{q}{(r-a)^2}$	1/2	
	$4\pi\epsilon_0 (I-u)$		
	Electric field at P due to charge $(-q) = E_2 = \frac{1}{4\pi\epsilon_0} \frac{q}{(r+a)^2}$	1/2	
	$4\pi\varepsilon_0 (r+a)^2$		
	Net electric Field at P= $E_1 - E_2 = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r-a)^2} - \frac{1}{4\pi\varepsilon_0} \frac{q}{(r+a)^2}$	1/2	
	$\frac{1}{4\pi\varepsilon_0}\frac{1}{(r-a)^2}\frac{1}{4\pi\varepsilon_0}\frac{1}{(r-a)^2}\frac{1}{4\pi\varepsilon_0}\frac{1}{(r+a)^2}$		
	1 2nr		
	$= \frac{1}{4\pi\varepsilon_0} \frac{2pr}{(r^2 - a^2)^2} \qquad (p = q.2a)$		
	Its direction is parallel to \vec{p} .	1/2	

