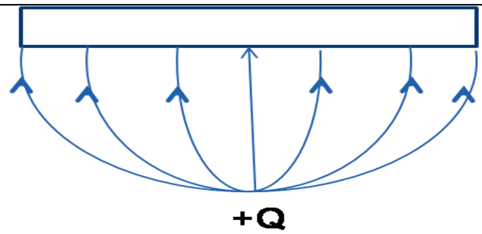
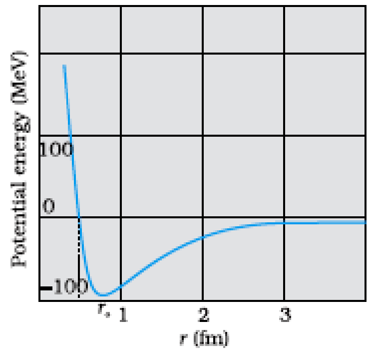
Strictly Confidential (For Internal and Restricted Use only)
Senior School Certificate Examination
Marking Scheme - Physics (Code 55/1, Code 55/2, Code 55/3)

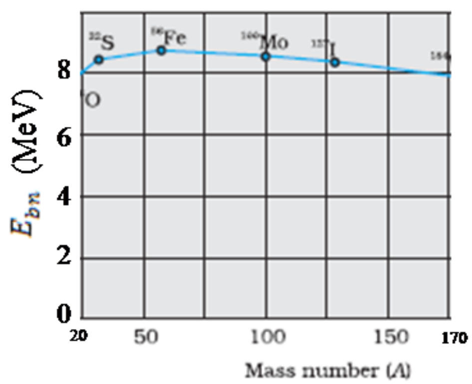
1. The marking scheme provides general guidelines to reduce subjectivity in the marking. The answers given in the marking scheme are suggested answers. The content is thus indicated. If a student has given any other answer, which is different from the one given in the marking scheme, but conveys the meaning correctly, such answers should be given full weightage.
2. In value based questions, any other individual response with suitable justification should also be accepted even if there is no reference to the text.
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 adhered to and religiously followed.
4. If a question has parts, please award in the right hand side for each part. Marks awarded for different part of the question should then be totaled up and written in the left hand margin and circled.
5. If a question does not have any parts, marks are to be awarded in the left hand margin only.
6. If a candidate has attempted an extra question, marks obtained in the question attempted first should be retained and the other answer should be scored out.
7. No marks are to be deducted for the cumulative effect of an error. The student should be penalized only once.
8. Deduct ½ mark for writing wrong units, missing units, in the final answer to numerical problems.
9. Formula can be taken as implied from the calculations even if not explicitly written.
10. In short answer type question, asking for two features / characteristics / properties if a candidate writes three features, characteristics / properties or more, only the correct two should be evaluated.
11. Full marks should be awarded to a candidate if his / her answer in a numerical problem is close to the value given in the scheme.
12. In compliance to the judgement of the Hon'ble Supreme Court of India, Board has decided to provide photocopy of the answer book(s) to the candidates who will apply for it along with the requisite fee. Therefore, it is all the more important that the evaluation is done strictly as per the value points given in the marking scheme so that the Board could be in a position to defend the evaluation at any forum.
13. The Examiner shall also have to certify in the answer book that they have evaluated the answer book strictly in accordance with the value points given in the marking scheme and correct set of question paper.
14. Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title paper, correctly totaled and written in figures and words.
15. In the past it has been observed that the following are the common types of errors committed by the Examiners
    - Leaving answer or part thereof unassessed in an answer script.
    - Giving more marks for an answer than assigned to it or deviation from the marking scheme.
    - Wrong transference 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.
    - Wrong transference to marks from the answer book to award list.
    - Answer marked as correct (√) but marks not awarded.
    - Half or part of answer marked correct (√) and the rest as wrong (×) but no marks awarded.
16. 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.

MARKING SCHEME

Q. No.	**Expected Answer/ Value Points** **SECTION A**	**Marks**	**Total Marks**
Q1		**1**	**1**
Q2	Ratio of amplitude of modulating signal A_m to amplitude of carrier wave A_C Alternatively: $$\mu = \frac{A_m}{A_C}$$ It is kept less than one to avoid distortion	½ ½	**1**
Q3	Accept both the answers : A : +ve ; B: -ve or A : -ve ; B: +ve	**1**	**1**
Q4	Resolving power is same (it does not depend on focal length of the objective.) Alternatively: Ratio of resolving power = 1:1	**1**	**1**
Q5	Definition ½ SI Unit ½ Conductivity is reciprocal of resistivity $\sigma = \frac{1}{\rho}$ SI unit : S(siemen)	½ ½	**1**
	SECTION B		
Q6	Definition 1 Calculation of Speed 1 i. Refractive index of a medium is the ratio of speed of light (c) in free space to the speed of light (v) in that medium. $$\mu = \frac{c}{v}$$ ii. $$\mu = \frac{c}{v} = \frac{1}{\sin i_c}$$ $$= \frac{3 \times 10^8}{v} = \frac{1}{30/50}$$ $$v = \frac{30}{50} \times 3 \times 10^8 = 1.8 \times 10^8\ m/s$$	**1** ½ ½	**2**

Q7	Einstein's equation ½ Expression for $\boldsymbol{v}$ ½ de Broglie relation ½ de Broglie wavelength ½		
	When work function is negligible, we have, from Einstein's equation $$\frac{1}{2}mv^2 = \frac{hc}{\lambda}$$	½	
	$$\therefore v = \sqrt{\frac{2hc}{m\lambda}}$$	½	
	$$\lambda_{de} = \frac{h}{mv}$$	½	
	$$\therefore \lambda_{dB} = \frac{h}{m}\sqrt{\frac{m\lambda}{2hc}}$$ $$= \sqrt{\frac{h\lambda}{2mc}}$$	½	
	OR		
	de Broglie formula ½ de Broglie hypothesis ½ Bohr's quantization condition 1		
	We have $\lambda = \frac{h}{p} = \frac{h}{mv_n}$	½	
	By de Broglie's hypothesis $$2\pi r_n = n\lambda \qquad n = 1,2,3$$	½	
	$$\therefore 2\pi r_n = \frac{nh}{mv_n}$$	½	
	$$\therefore mv_n r_n = \frac{nh}{2\pi}$$	½	2
Q8	Two characteristics ½ + ½ Plot of PE 1		
	a) i. Nuclear force is much stronger than coulomb or gravitational force.	½	
	ii. It is a very short range force therefore leads to saturation of forces.	½	
	iii. Nuclear force is independent of charge **[Any two]**		

	b)  	**1**	**2**
Q9	Two points of Distinction 1 + 1 i. Sky wave propagation uses reflection from ionosphere whereas space waves propagation uses line of sight of propagation. ii. Sky wave propagation is for waves of frequency between 3 to 30 MHz whereas space waves propagation is preferred for waves of frequency more than 40 MHz [Also accept or any other correct distinction]	**1** **1**	**2**
Q10	Emf of cell 1 Internal resistance 1 a) E = V for I =0 $\therefore E = 6$ V b) E = V + i r $\therefore 6 = 4 + r$ $r = 2\ \Omega$	½ ½ ½ ½	**2**
	SECTION C		
Q11	Effect on capacitance 1 Effect on charge 1 Effect on energy 1 i. $C = \frac{\epsilon_o A}{d}$ $C' = \frac{K\epsilon_o A}{d'} = \frac{10}{3}\frac{\epsilon_o A}{d} = \frac{10}{3}C$ ii. V remains same since battery is not disconnected $\therefore Q' = C'V$ $= \frac{10}{3}CV = \frac{10}{3}Q$	½ ½ ½ ½	

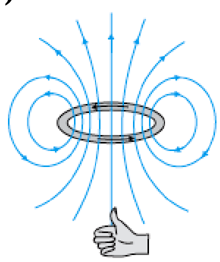
	iii. Energy density, $u_d = \frac{1}{2} \in_o E^2$ $E = \frac{V}{d}$ $u_d' = \frac{1}{2} K \in_o E'^2$ $= \frac{10}{2} \in_o \left(\frac{V}{d'}\right)^2$ $= \frac{10}{9}\left(\frac{1}{2} \in_o E^2\right)$ $= \frac{10}{9} u_d$	½ ½	3
Q12	Graph of BE 1 Calculation of energy released 2 **a)**  b) Energy released = [(110+130) x 8.5 – 240 x 7.6] MeV = 240(8.5 – 7.6) MeV = 216 MeV	1 1 1	3
Q13	Explanation / reason 1 Finding intensities 1+1 a) Interference pattern will not be observed as two independent lamps are not coherent sources. b) $I_1 = 4I_0^2 cos^2\left(\frac{\phi_1}{2}\right) = 4I_0^2 \quad \phi_1 = 0$ $I_2 = 4I_0^2 cos^2\left(\frac{\pi}{2}\right) = 0 \quad \phi_1 = \pi$ [Note: Give full two marks if the student just writes : Ratio →∞ $(as\ I_2 = 0)$]	1 1 1	3

Q14	Derivation of total energy expression 2 Wavelength of H_α line 1		
	$\frac{mv_n^2}{r_n} = \frac{1}{4\pi\epsilon_o}\frac{e^2}{r_n^2}$ $\therefore mv_n^2 r_n = \frac{1}{4\pi\epsilon_o} e^2$	½	
	Also $mv_n\ r_n = \frac{nh}{2\pi}$ (Bohr Postulate)	½	
	$\therefore v_n = \frac{e^2}{2\epsilon_o nh}$	½	
	Now total energy $E = -KE$ $\therefore E = -\frac{1}{2}mv_n^2$ $= \frac{-me^4}{8\epsilon_o n^2 h^2}$	½	
	For H_α line $n_i = 3, n_f = 2$ $\therefore \frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$	½	
	$= 1.1 \times 10^7 \left[\frac{5}{36}\right]$ $\lambda = \frac{36}{5.5} \times 10^{-7}/m$ =655nm	½	3
Q15	Name of em waves 1 Method of generation 1 Two uses ½ + ½		
	X- rays	**1**	
	Produced by bombarding a metal target with high energy electrons.	**1**	
	Uses: i. Used in diagnosis of bone fractures/	½	
	ii. Treatment of some forms of cancer [or any other use]	½	**3**

Q16

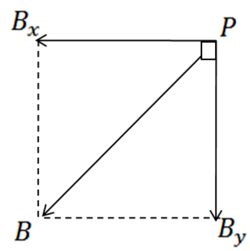
a) Diagram of magnetic field line pattern	1
b) Calculation of Magnetic field	1 ½
Direction	½

a)



1

b) $B_x = B_y = \frac{\mu_o i R^2}{2(R^2+x^2)^{\frac{3}{2}}}$ 1



B = $\sqrt{2}\, B_x$

$= \frac{\sqrt{2}\,\mu_o i R^2}{2(R^2+x^2)^{\frac{r}{2}}}$; ½

making 45^0 with either B_x or B_y ½ — **3**

Q17

Reason for use in reverse bias	1
Working Principle	1
Whether it can detect	1

The fractional change, due to photo effects, on the minority charge carrier dominated reverse bias current, is much more than the fractional change in the forward bias current. Hence, photodiode is used in reverse bias. **1**

Working principle of photodiode:

i. Generation of e –h pairs due to light close to junction. ½

ii. Separation of electrons and holes due to electric field of the depletion region. ½

Detection is possible if $E_p > E_g$ ½

$E_p = \frac{hc}{\lambda}$ J

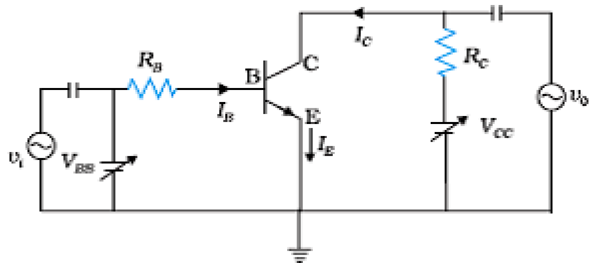
$= \frac{hc}{e\lambda}\ eV$

$= \frac{6.63\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}\times400\times10^{-9}}$ = 3.1 eV(>Eg) ½

∴ It can detect this light **3**

Q18

Circuit diagram	1
Expression for voltage gain	1
Explanation for 180^o phase difference	1



1

$A_V = \frac{V_o}{V_i} = \frac{\Delta V_{CE}}{r\,\Delta I_B}$ = - $\beta_{ac}\,\frac{R_L}{r}$ **1**

$V_{CC} = V_{CE} + I_C R_L$ ½

$\therefore\ \Delta V_{CC} = \Delta V_{CE} + R_L \Delta I_C = 0$ ½

$\therefore\ \Delta V_{CE} = -R_L \Delta I_C$

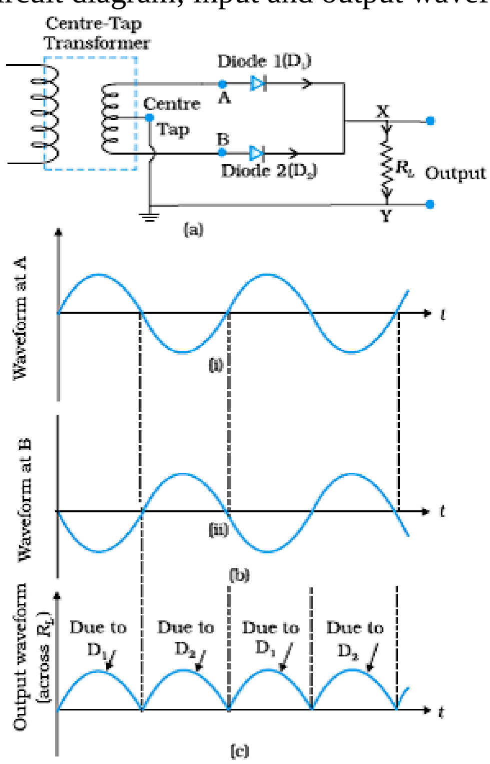
Hence, change in output is negative when the input signal is +ve.

This shows 180^0 phase difference between input and output signal.

OR

Circuit of full wave rectifier	1
Working Principle	1
Input and output waveforms	1

Circuit diagram; input and output waveforms;

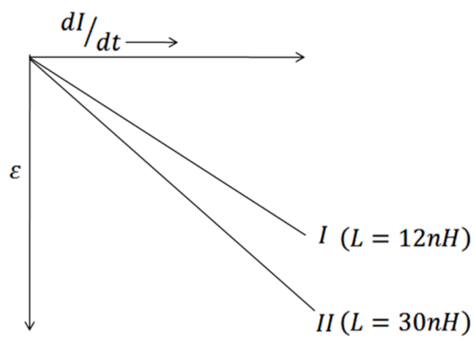
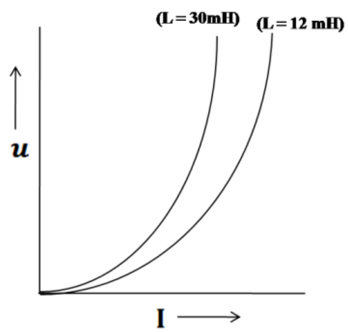


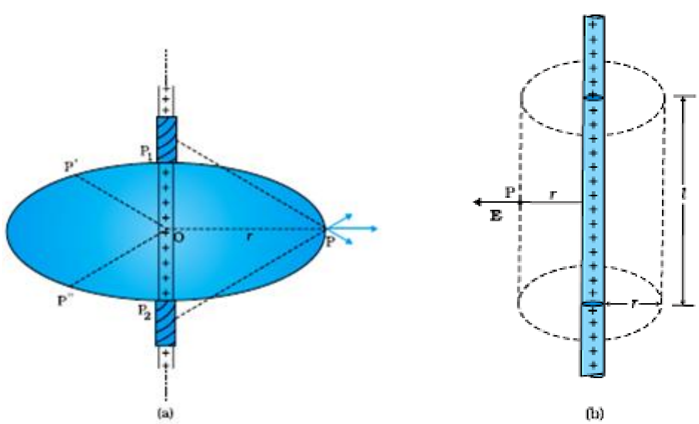
1 (circuit)

½ (input waveforms)

½ (output waveform)

	<u>Working Principle:</u> When A is +ve, B is negative Only D_1 conducts because it is forward biased Current in R_L flows from X to Y When B is positive and A is negative, only D_2 conducts and Current in R_L is once again from X to Y.	½ ½	3
Q19	Three factors justifying the Need for modulation 1+1+1 i. <u>Size of antenna</u> – The antenna should have a size comparable to the wavelength of signal (at least $\lambda/4$). For low frequency (unmodulated) signal λ may be a few km. It is not possible to have such a long antenna. Hence low frequency transmission is not possible directly. ii. <u>Power radiated by antenna</u> – Power radiated by an antenna of length ℓ is proportional to $\left(\ell/\lambda\right)^2$. Therefore, for same ℓ, power radiated increases with decreasing λ i.e. increasing frequency. Hence, for low frequency signal, power radiated by antenna is very small and good transmission of signal is not possible. **iii.** <u>Mixing up of signals:</u> All the low frequency (baseband) signals from various transmitters, can get mixed up because they have the same frequency range. They can be separated only if communication is done at high frequency and different band of frequencies are allotted to different transmitters.	**1** **1** **1**	**3**
Q20	Definition of current sensitivity 1 Ratio R_1/R_2 2 Current sensitivity of a galvanometer is deflection per unit current $\left[\text{Alternatively}: \ I_s = \frac{\phi}{I} = \frac{NAB}{K}\right]$ In circuit (i) $\frac{4}{6} = \frac{R_1}{4} \Rightarrow R_1 = \frac{8}{3}\ \Omega$ In circuit (ii) $\frac{6}{R_2} = \frac{12}{8} \Rightarrow R_2 = 4\ \Omega$ $\therefore \frac{R_1}{R_2} = \frac{2}{3}$	**1** ½ ½ **1**	**3**

Q21	Graph of emf ½ Graph of energy stored ½ Ratio of energy stored 2 **a)** 	½	
	b) 	½	
	$\frac{u_1}{u_2} = \frac{\frac{1}{2}L_1 i_1^2}{\frac{1}{2}L_2 i_2^2}$	½	
	But $\varepsilon_1 i_1 = \varepsilon_2 i_2$ ($\because$power dissipated is same)	½	
	$\therefore \frac{i_1}{i_2} = \frac{\varepsilon_2}{\varepsilon_1} = \frac{L_2}{L_1}$ $\left(\because \frac{dI}{dt}\right.$ is same and $\left.\varepsilon = -L\frac{dI}{dt}\right)$	½	
	$\therefore \frac{u_1}{u_2} = \frac{L_1}{L_2}\left(\frac{L_2}{L_1}\right)^2$ $= \frac{L_2}{L_1} = \frac{30}{12} = 2.5$	½	3
Q22	Variation of intensity 1 Separation between maxima 2 a) Intensity of diffraction pattern drops rapidly with order n because every higher order maxima gets intensity only from $\frac{1}{2n+1}$ part of the slit. The central maxima gets intensity from the whole slit (n=0)	**1**	

	1st secondary maxima gets its intensity only from 1/3 of slit 2nd secondary maxima gets its intensity only from 1/5 of slit and so on. b) Position of 1st maxima on the screen: $x_1 = \frac{3}{2}\frac{\lambda_1}{a}D$; $\lambda_1 = 590nm$ $x_2 = \frac{3}{2}\frac{\lambda_2}{a}D$; $\lambda_2 = 596nm$ Separation $\Delta x = x_2 - x_1$ $= \frac{3}{2}\frac{D}{a}(\lambda_2 - \lambda_1)$ $= \frac{3}{2}\left(\frac{2}{4 \times 10^{-3}}\right) \times 6 \times 10^{-9}$m $= 4.5 \times 10^{-6}$m	 ½ ½ ½ ½	 **3**
SECTION D			
Q23	Two values of Mr. Hiorki — 1 Two values of Mr. Kamath — 1 Meissner effect — 1 Value of μ_r — 1 a) Eager to share ideas and knowledge; Professionalism; Environment friendly nature. (any two) b) Eager to learn (open minded); observant; appreciating good ideas.(any two) c) Phenomenon of perfect diamagnetism in super conductors $\mu_r = 0$	 ½ + ½ ½ + ½ **1** **1**	 **4**
SECTION E			
Q24	a) Statement of Guass's law — 1 Derivation — 2 b) Electric flux Expression — 2 a) Electric flux through a closed surface is $\frac{1}{\epsilon_o}$ times charge enclosed by the closed surface. $\phi = \frac{Q_{enclosed}}{\epsilon_o}$  $\phi = \oint \vec{E}.\vec{ds} = \frac{Q_{enclosed}}{\epsilon_o}$	 **1** ½	

$\therefore E.2\pi rl = \frac{\lambda l}{\epsilon_o}$ — ½

$\therefore E = \frac{\lambda}{2\pi\epsilon_o r}$ — **1**

b) $dq = \lambda dx = kxdx$ — ½

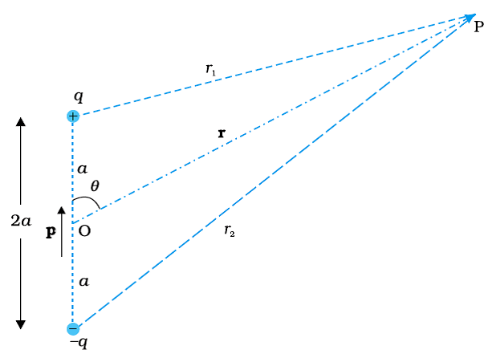
$$Q = \int_o^l dq = \int_o^l kxdx = \frac{1}{2}kl^2$$ — ½

$$\therefore \phi = \frac{Q}{\epsilon_o} = \frac{kl^2}{2\,\epsilon_o}$$ — **1**

OR

a) Derivation of expression for electric potential	3
b) Numerical Problem	2

a)



— ½

$$V = \frac{1}{4\pi\,\epsilon_o}\left[\frac{q}{r_1} - \frac{q}{r_2}\right]$$ — ½

$$r_1^2 = r^2 + a^2 - 2ar\cos\theta \approx r^2\left(1 - \frac{2a\cos\theta}{r}\right)$$ — ½

$$r_2^2 = r^2 + a^2 + 2ar\cos\theta \approx r^2\left(1 + \frac{2a\cos\theta}{r}\right)$$ — ½

If r > > a

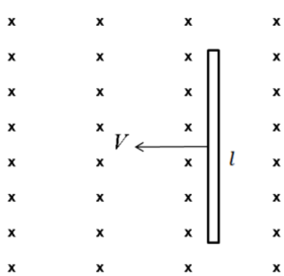
$$\frac{1}{r_1} = \frac{1}{r}\left[1 - \frac{2a\cos\theta}{r}\right]^{-\frac{1}{2}} \simeq \frac{1}{r}\left[1 + \frac{a}{r}\cos\theta\right]$$ — ½

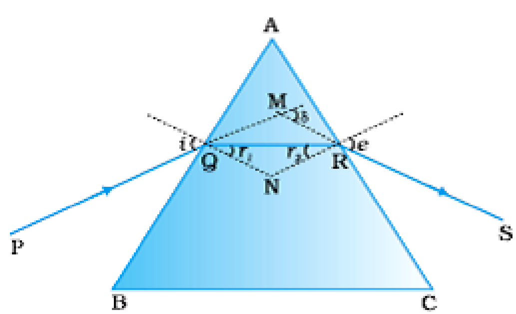
and $\frac{1}{r_2} \simeq \frac{1}{r}\left[1 - \frac{a}{r}\cos\theta\right]$

$$\therefore V = \frac{q}{4\pi\,\epsilon_o}.\frac{2a\cos\theta}{r^2}$$ — ½

$$= \frac{1}{4\pi\epsilon_o}\frac{p\cos\theta}{r^2}$$ — ½

b) $\frac{1}{4\pi\epsilon_o}\frac{4\mu C}{x^2} = \frac{1}{4\pi\epsilon_o}\frac{1\mu C}{(2-x)^2}$ — **1**

	$\therefore \frac{x}{2} = 2 - x$		
	$\therefore 3x = 4 => x = \frac{4}{3}m$	½	**5**
Q25	a) Average Power dissipation is zero 2 b) Numerical 3		
	a) Instantaneous Power = $vi= V_o sinwt\ I_o coswt$		
	Average power, P = $\frac{1}{T}\int_o^T vidt$	½	
	$= \frac{V_o I_o}{2T}\int_o^T 2\ sinwt\ coswt\ dt$	½	
	$= \frac{V_o I_o}{2T}\int_o^T sin2wt\ dt$	½	
	= 0	½	
	b)		
	i. $\omega_o = \frac{1}{\sqrt{LC}}$	½	
	$= \frac{1}{(200 \times 10^{-3} \times 400 \times 10^{-6})^{\frac{1}{2}}}$		
	$= \frac{1}{\sqrt{8 \times 10^{-5}}} s^{-1} = \frac{10^3}{\sqrt{80}} s^{-1} \simeq 111 s^{-1}$	½	
	$I = \frac{V}{R} = \frac{50}{10} = 5\ A$	**1**	
	ii. $Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{10}\sqrt{\frac{200\times10^{-3}}{400\times10^{-6}}} = \sqrt{5}$	**1**	**5**
	OR		
	a) Derivation of induced emf 2 ½ b) Numerical 2 ½		
	a)		
		½	
	$\phi_B = Blx$	½	
	$\varepsilon = \frac{-d\phi_B}{dt}$	½	
	$= -Bl\frac{dx}{dt}$	½	
	$= Blv$	½	
	b) $\omega = 360 \times \frac{2\pi}{60} = 12\,\pi$	½	

	$\varepsilon = \frac{1}{2} B_H l^2 \omega$	½	
	$\therefore 400 \text{ x } 10^{-3} = \frac{1}{2}.B_H \times (60 \times 10^{-2})^2 \times 12\pi$	½	
	$\therefore B_H = \frac{5}{27\pi}$ = 0.06T	½	
	No change in emf if no. of spokes is increased.	½	**5**
Q26	a) Explanation with reason 2 ½		
	b) Calculation of separations 2 ½		
	a) P = $\frac{1}{f} = \left(\frac{n_2 - n_1}{n_2}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$	½	
	= $\left(\frac{n_2 - n_1}{n_2}\right)\left(-\frac{2}{R}\right)$ for diverging lens		
	= negative	½	
	i. If $n_1 > n_2$		
	$\frac{n_2 - n_1}{n_1}$ becomes negative	½	
	$\therefore P = \frac{1}{f}$ becomes positive		
	$or\ lens\ become\ converging$	½	
	ii. $(n_2)_{violet} > (n_2)_{red}$		
	∴Power increases on changing to violet light	½	
	b) Rays on L_3 be incident parallel to the principal axis	½	
	image from L_1 is formed at focus of L_2	½	
	and focus of L_2 is $2f_1$ from 'O' of L_1	½	
	$\therefore L_1L_2 = 2f_1 + f_2$ = (3 x 30)cm = 90cm	½	
	L_2L_3 can be any distance	½	**5**
	OR		
	a) Derivation of expression for refractive index 2		
	Graph 1		
	b) Numerical 2		
	a)		
		½	
	$\angle A + \angle QNR = 180^o$		
	$r_1 + r_2 + \angle QNR = 180^o$	½	
	$\therefore r_1 + r_2 = \angle A$		

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

$\delta = i + e - A$

For minimum derivation,

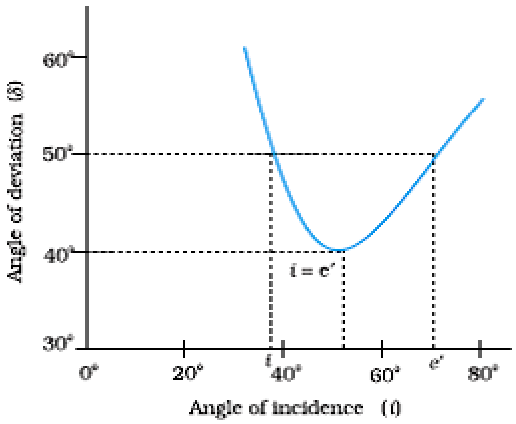
$\delta = D_m,\ i = e$ and $r_1 = r_2$

$\therefore 2r = A \Rightarrow r = \frac{A}{2}$

$D_m = 2i - A \Rightarrow i = \frac{A+D_m}{2}$ — ½

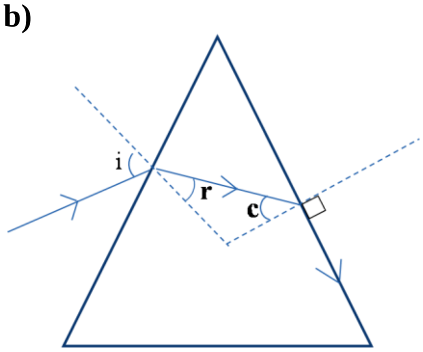
$\therefore n = \frac{n_2}{n_1} = \frac{\sin i}{\sin r}$ — ½

$= \frac{sin\left(\frac{A+D_m}{2}\right)}{\sin\frac{A}{2}}$



1

b)



Sin c $= \frac{1}{n} = \frac{1}{\sqrt{2}}$ — ½

$\Rightarrow c = 45^0$ — ½

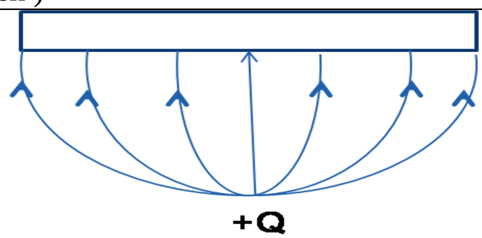
$r + c = 60^0 \quad \Rightarrow r = 15^0$

$n = \frac{\sin i}{\sin r}$

$\Rightarrow \sqrt{2} = \frac{\sin i}{\sin 15^0}$ — ½

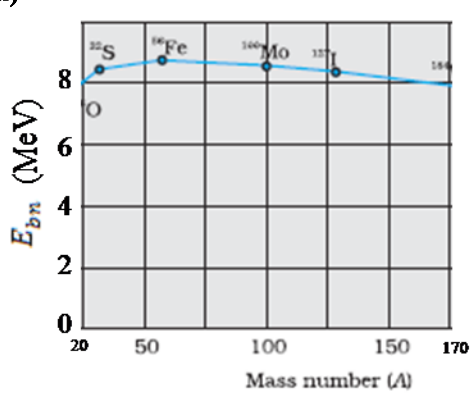
$\Rightarrow i = sin^{-1}[\sqrt{2}\sin 15^0]$ — ½ — **5**

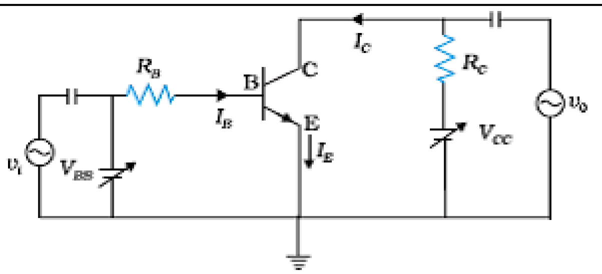
MARKING SCHEME

Q. No.	Expected Answer/ Value Points **SECTION A**	Marks	Total Marks
Q1	Because waves of frequency greater than 30 MHz penetrate through the ionosphere and do not get reflected by it.	**1**	**1**
Q2	Definition ½ SI Unit ½ Conductivity is reciprocal of resistivity $\sigma = \frac{1}{\rho}$ SI unit : S(siemen)	½ ½	1
Q3		**1**	**1**
Q4	Resolving power is same (it does not depend on focal length of the objective.) Alternatively: Ratio of resolving power = 1:1	**1**	**1**
Q5	Accept both the answers : A : +ve ; B: -ve or A : -ve ; B: +ve	**1**	**1**
	SECTION B		
Q6	Emf of cell 1 Internal resistance 1 a) E = V for I =0 $\therefore E = 6$ V b) E = V + i r $\therefore 6 = 4 + r$ $r = 2\ \Omega$	½ ½ ½ ½	**2**
Q7	Two points of Distinction 1 + 1 i. Sky wave propagation uses reflection from ionosphere whereas space waves propagation uses line of sight of propagation. ii. Sky wave propagation is for waves of frequency between 3 to 30 MHz whereas space waves propagation is preferred for waves of frequency more than 40 MHz [Also accept or any other correct distinction]	**1** **1**	**2**

Q8	Definition 1 Calculation of Speed 1 i. Refractive index of a medium is the ratio of speed of light (c) in free space to the speed of light (v) in that medium. $\mu = \frac{c}{v}$ ii. $\mu = \frac{c}{v} = \frac{1}{sin\ i_c}$ $= \frac{3 \times 10^8}{v} = \frac{1}{30/50}$ $v = \frac{30}{50} \times 3 \times 10^8 = 1.8 \times 10^8\ m/s$	1 ½ ½	 2
Q9	Two Characteristics ½ + ½ Relation 1 a) i. Nuclear force is much stronger than the Coulomb or gravitational force. ii. It is a very short range force, leads to saturation of forces. iii. Nuclear force is charge independent **[Any two]** $T_{1/2} = \frac{ln2}{\lambda} = \frac{0.693}{\lambda}$ **OR** Formula 1 Calculation 1 $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mk}}$ $\therefore$ 1 x $10^{-10} = \frac{6..63\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}K}}$ $\therefore$ K = $\frac{(6..63\times10^{-34})^2}{10^{-20}\times2\times9.1\times10^{-31}}$J =2.4 × 10^{-17}J =1.5 × 10^2eV = 150eV	½ ½ 1 1 1	 2
Q10	Formula 1 Comparison of the rates of disintegration 1 $\frac{dN}{dt} = -\lambda N; N = N_o e^{-\lambda t}$ Given time = 12hrs = $4(T_x)_{\frac{1}{2}}$ $= 3(T_y)_{\frac{1}{2}}$	½	

	$\therefore \frac{N_x}{N_o} = \left(\frac{1}{2}\right)^4 = \frac{1}{16} => N_x = \frac{N_o}{16}$ and $\frac{N_y}{N_o} = \left(\frac{1}{2}\right)^3 = \frac{1}{8} => N_y = \frac{N_o}{8}$ $R_x = \left(\frac{dN}{dt}\right)_x = \frac{.693}{\left(T_{1/2}\right)_x} . \frac{N_o}{16}$ $R_y = \left(\frac{dN}{dt}\right)_y = \frac{.693}{\left(T_{1/2}\right)_y} . \frac{N_o}{8}$ $\therefore \frac{R_x}{R_y} = \frac{1}{2} \frac{\left(T_{1/2}\right)_x}{\left(T_{1/2}\right)_y} = \frac{1}{2} \times \frac{4}{3} = \frac{2}{3}$	½ ½ ½	 **2**
SECTION C			
Set1 Q11	Reason 1 Ratio of Intensity 2 If sources are not coherent, the superposition pattern (the intensity pattern) is not stable. It keeps on changing with time ∴ It is necessary to have coherent sources to observe interference. $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\, cos\phi$ $I_{max} = I_1 + I_2 + 2\sqrt{I_1 I_2}\, ;\ \phi = 0$ $I_{min} = I_1 + I_2 - 2\sqrt{I_1 I_2}\, ;\ \phi = \pi$ $\therefore \frac{I_{max}}{I_{min}} = \frac{4x + 9x + 12x}{4x + 9x - 12x} = \frac{25x}{x}$ $= \frac{25}{1}$ Alternatively : $\frac{A_1}{A_2} = \sqrt{\frac{I_1}{I_2}} = \frac{2}{3}$ $\therefore \frac{I_{max}}{I_{min}} = \left(\frac{A_2 + A_1}{A_2 - A_1}\right)^2 = \left(\frac{3+2}{3-2}\right)^2 = \frac{25}{1}$	 ½ ½ ½ ½ ½ ½ ½ ½ + ½ + ½	 **3**
Q12	Effect on capacitance 1 Effect on charge 1 Effect on energy 1 i. $C = \frac{\epsilon_o A}{d}$	 ½	

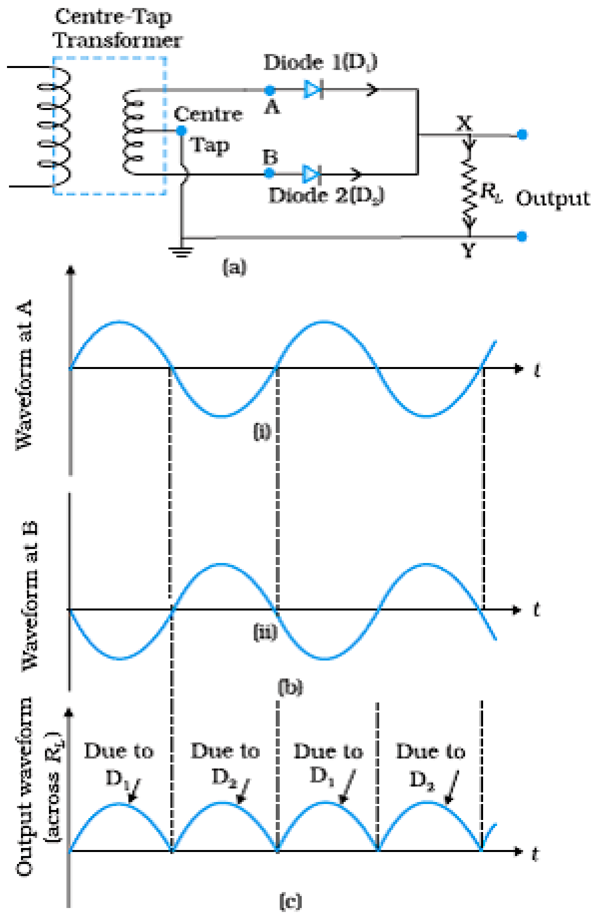
	$C' = \frac{K \epsilon_o A}{d'} = \frac{10}{3} \frac{\epsilon_o A}{d} = \frac{10}{3} C$ ii. V remains same since battery is not disconnected $\therefore Q' = C'V$ $= \frac{10}{3} CV = \frac{10}{3} Q$ iii. Energy density, $u_d = \frac{1}{2} \epsilon_o E^2$ $E = \frac{V}{d}$ $u'_d = \frac{1}{2} K \epsilon_o E'^2$ $= \frac{10}{2} \epsilon_o \left(\frac{V}{d'}\right)^2$ $= \frac{10}{9} \left(\frac{1}{2} \epsilon_o E^2\right)$ $= \frac{10}{9} u_d$	½ ½ ½ ½ ½	3
Q13	Energy of Photon 1 Einstein's Equation 1 Calculation of work function 1 Energy of photon = [(13.6)-(3.4)]eV = 10.2eV $E = eV_o + \phi_o$ $\therefore 10.2 = 5 + \phi_o$ $\therefore \phi_o = 5.2\ eV$	**1** **1** ½ ½	**3**
Q14	Graph of BE 1 Calculation of energy released 2 **a)**  b) Energy released = [(110+130) x 8.5 – 240 x 7.6] MeV = 240(8.5 – 7.6) MeV = 216 MeV	**1** **1** **1**	**3**

Q15	Reason for use in reverse bias 1 Working Principle 1 Whether it can detect 1 The fractional change, due to photo effects, on the minority charge carrier dominated reverse bias current, is much more than the fractional change in the forward bias current. Hence, photodiode is used in reverse bias. Working principle of photodiode: i. Generation of e –h pairs due to light close to junction. ii. Separation of electrons and holes due to electric field of the depletion region. Detection is possible if $E_p > E_g$ $E_p = \frac{hc}{\lambda}$ J $= \frac{hc}{e\lambda}\ eV$ $= \frac{6.63\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}\times400\times10^{-9}}$ = 3.1 eV(>Eg) ∴ It can detect this light	1 ½ ½ ½ ½	 3
Q16	Name of em wave 1 Method of generation 1 Two uses ½ + ½ Microwaves Produced by special vacuum tubes - Klystron, magnetron, gunn diodes Uses i. In Radar system for aircraft navigation ii. In ovens for heating/ cooking	1 1 ½ + ½	 3
Q17	Circuit diagram 1 Expression for voltage gain 1 Explanation for 180^o phase difference 1  $A_V = \frac{V_o}{V_i} = \frac{\Delta V_{CE}}{r\Delta I_B} = -\beta_{ac}\frac{R_L}{r}$ $V_{CC} = V_{CE} + I_C R_L$ $\therefore \Delta V_{CC} = \Delta V_{CE} + R_L \Delta I_C = 0$ $\therefore \Delta V_{CE} = -R_L \Delta I_C$ Hence, change in output is negative when the input signal is +ve. This shows 180^0 phase difference between input and output signal.	1 1 ½ ½	

OR

Circuit of full wave rectifier	1
Working Principle	1
Input and output waveforms	1

Circuit diagram; input and output waveforms;



1

½

½

Working Principle:

When A is +ve, B is negative

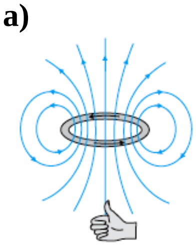
Only D_1 conducts because it is forward biased Current in R_L flows from X to Y ½

When B is positive and A is negative, only D_2 conducts and Current in R_L is once again from X to Y. ½ **3**

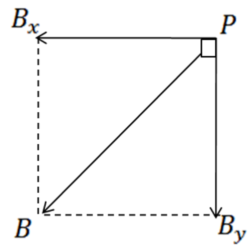
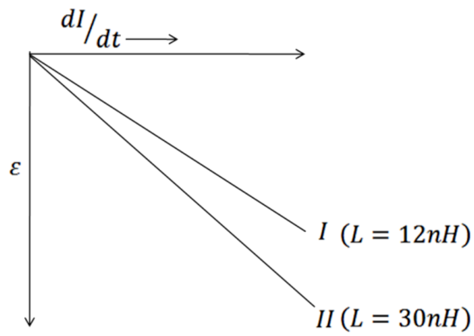
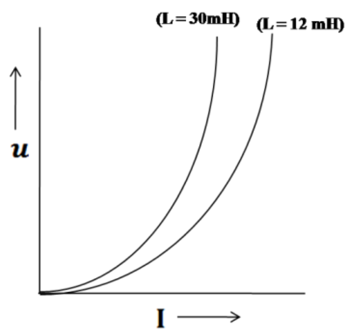
Q18

a)	Diagram of magnetic field line pattern	1
b)	Calculation of Magnetic field	1 ½
	Direction	½

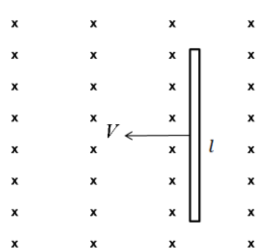
a)



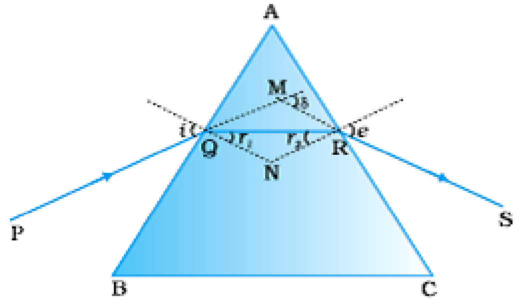
1

	b) $B_x = B_y = \frac{\mu_o i R^2}{2(R^2+x^2)^{\frac{3}{2}}}$  B = $\sqrt{2}\, B_x$ $= \frac{\sqrt{2}\,\mu_o i R^2}{2(R^2+x^2)^{\frac{r}{2}}}$; making 45^0 with either B_x or B_y	**1** ½ ½	 **3**
Q19	Graph of emf ½ Graph of energy stored ½ Ratio of energy stored 2 **a)**  **b)**  $\frac{u_1}{u_2} = \frac{\frac{1}{2}L_1 i_1^2}{\frac{1}{2}L_2 i_2^2}$ But $\varepsilon_1 i_1 = \varepsilon_2 i_2$ (∵power dissipated is same) $\therefore \frac{i_1}{i_2} = \frac{\varepsilon_2}{\varepsilon_1} = \frac{L_2}{L_1}$ $\left(\because \frac{dI}{dt}\right.$ is same and $\left.\varepsilon = -L\frac{dI}{dt}\right)$ $\therefore \frac{u_1}{u_2} = \frac{L_1}{L_2}\left(\frac{L_2}{L_1}\right)^2$ $= \frac{L_2}{L_1} = \frac{30}{12} = 2.5$	 ½ ½ ½ ½ ½ ½	 **3**

Q20	Two points of distinction ½ + ½ Calculation of separation between maxima 2 i. All fringes in interference pattern have same width; in diffraction central maxima is twice the width of secondary maxima. ii. Intensity of all maxima is same in interference pattern; in diffraction higher order maxima have lower intensities [alternatively maxima do not have same intensity] Separation $\Delta x = x_2 - x_1$ $= \frac{5}{2}\frac{\lambda_2 D}{a} - \frac{5}{2}\frac{\lambda_1 D}{a} = \frac{5}{2}\frac{D}{a}(\lambda_2 - \lambda_1)$ $= \frac{5}{2}\left(\frac{2}{2\times10^{-3}}\right) \times 10 \times 10^{-9}$m $= 2.5 \times 10^{-5}$m	½ ½ 1 1	3
Q21	Three factors justifying the Need for modulation 1+1+1 i. <u>Size of antenna</u> – The antenna should have a size comparable to the wavelength of signal (at least $\lambda/4$). For low frequency (unmodulated) signal λ may be a few km. It is not possible to have such a long antenna. Hence low frequency transmission is not possible directly. ii. <u>Power radiated by antenna</u> – Power radiated by an antenna of length ℓ is proportional to $\left(\ell/\lambda\right)^2$. Therefore, for same ℓ, power radiated increases with decreasing λ i.e. increasing frequency. Hence, for low frequency signal, power radiated by antenna is very small and good transmission of signal is not possible. **iii.** <u>Mixing up of signals:</u> All the low frequency (baseband) signals from various transmitters, can get mixed up because they have the same frequency range. They can be separated only if communication is done at high frequency and different band of frequencies are allotted to different transmitters.	1 1 1	3
Q22	Definition of current sensitivity 1 Ratio $\frac{R_1}{R_2}$ Current sensitivity of a galvanometer is deflection per unit current (Alternatively $I_s = \frac{\phi}{I} = \frac{NAB}{K}$) In circuit i. $\frac{6}{9} = \frac{R_1}{12} \Rightarrow R_1 = 8\Omega$ ii. $\frac{9}{R_2} = \frac{15}{10} \Rightarrow R_2 = 6\Omega$ $\therefore \frac{R_1}{R_2} = \frac{4}{3}$	1 ½ ½ 1	3

	SECTION D		
Q23	Two values of Mr. Hiorki 1 Two values of Mr. Kamath 1 Meissner effect 1 Value of μ_r 1		
	a) Eager to share ideas and knowledge; Professionalism; Environment friendly nature. (any two)	½ + ½	
	b) Eager to learn (open minded); observant; appreciating good ideas.(any two)	½ + ½	
	c) Phenomenon of perfect diamagnetism in super conductors	**1**	
	$\mu_r = 0$	**1**	**4**
	SECTION E		
Q24	a) Average Power dissipation is zero 2 b) Numerical 3		
	a) Instantaneous Power = $vi = V_o sinwt\ I_o coswt$		
	Average power, P = $\frac{1}{T}\int_o^T vidt$	½	
	$= \frac{V_o I_o}{2T}\int_o^T 2\ sinwt\ coswt\ dt$	½	
	$= \frac{V_o I_o}{2T}\int_o^T\ sin2wt\ dt$	½	
	$= 0$	½	
	b)		
	i. $\omega_o = \frac{1}{\sqrt{LC}}$	½	
	$= \frac{1}{(200 \times 10^{-3} \times 400 \times 10^{-6})^{\frac{1}{2}}}$		
	$= \frac{1}{\sqrt{8 \times 10^{-5}}}\ s^{-1} = \frac{10^3}{\sqrt{80}}\ s^{-1} \simeq 111 s^{-1}$	½	
	$I = \frac{V}{R} = \frac{50}{10} = 5\ A$	**1**	
	ii. $Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{10}\sqrt{\frac{200 \times 10^{-3}}{400 \times 10^{-6}}} = \sqrt{5}$	**1**	**5**
	OR		
	a) Derivation of induced emf 2 ½ b) Numerical 2 ½		
	a)  	½	

	$\phi_B = Blx$ $\varepsilon = \frac{-d\phi_B}{dt}$ $= -Bl\frac{dx}{dt}$ $= Blv$ b) $\omega = 360 \times \frac{2\pi}{60} = 12\pi$ $\varepsilon = \frac{1}{2}B_H l^2\omega$ $\therefore 400 \text{ x } 10^{-3} = \frac{1}{2}.B_H \times (60\times10^{-2})^2 \times 12\pi$ $\therefore B_H = \frac{5}{27\pi}$ = 0.06T No change in emf if no. of spokes is increased.	½ ½ ½ ½ ½ ½ ½ ½ ½	5
Q25	a) Explanation with reason 2 ½ b) Calculation of separations 2 ½ a) P = $\frac{1}{f} = \left(\frac{n_2-n_1}{n_2}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $= \left(\frac{n_2-n_1}{n_2}\right)\left(-\frac{2}{R}\right)$ for diverging lens = negative i. If $n_1 > n_2$ $\frac{n_2-n_1}{n_1}$ becomes negative $\therefore P = \frac{1}{f}$ becomes positive *or lens become converging* ii. $(n_2)_{violet} > (n_2)_{red}$ ∴Power increases on changing to violet light b) Rays on L_3 be incident parallel to the principal axis image from L_1 is formed at focus of L_2 and focus of L_2 is $2f_1$ from 'O' of L_1 $\therefore L_1L_2 = 2f_1 + f_2$ = (3 x 30)cm = 90cm L_2L_3 can be any distance **OR** a) Derivation of expression for refractive index 2 Graph 1 b) Numerical 2 **a)**	 ½ ½ ½ ½ ½ ½ ½ ½ ½ ½	 5



½

½

$\angle A + \angle QNR = 180^o$

$r_1 + r_2 + \angle QNR = 180^o$

$\therefore r_1 + r_2 = \angle A$

$\delta = (i - r_1) + (e - r_2)$ ½

$\delta = i + e - A$

For minimum derivation,

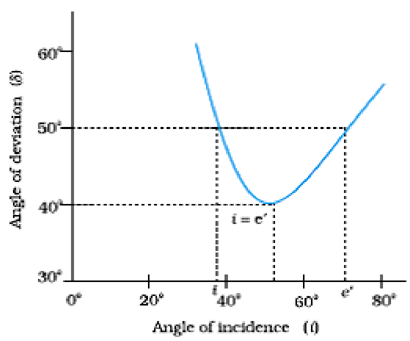
$\delta = D_m,\ i = e$ and $r_1 = r_2$

$\therefore 2r = A \Rightarrow r = \frac{A}{2}$ ½

$D_m = 2i - A \Rightarrow i = \frac{A+D_m}{2}$

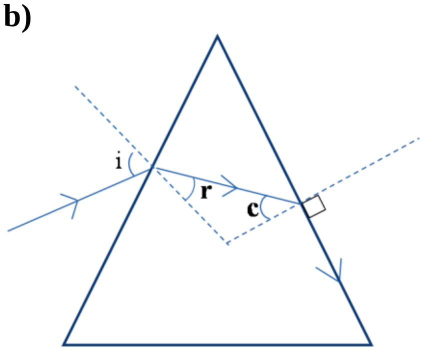
$$\therefore n = \frac{n_2}{n_1} = \frac{\sin i}{\sin r}$$

$$= \frac{sin\left(\frac{A+D_m}{2}\right)}{\sin\frac{A}{2}}$$



1

b)

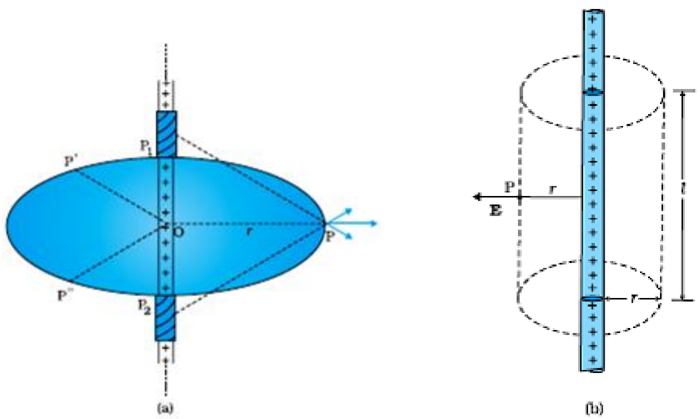


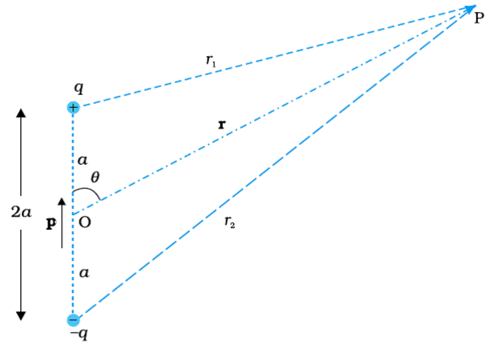
½

½

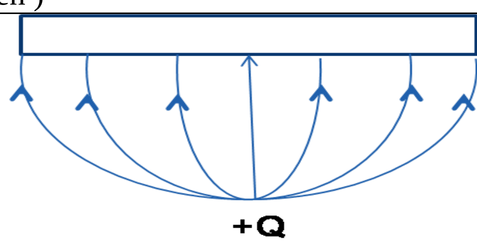
Sin c = $\frac{1}{n} = \frac{1}{\sqrt{2}}$

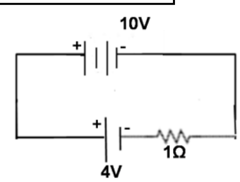
$\Rightarrow c = 45^0$ ½

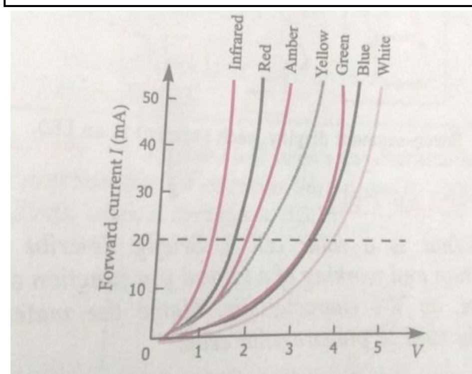
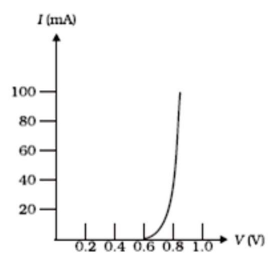
	$r + c = 60^0 \quad => r = 15^0$ $n = \frac{\sin i}{\sin r}$ $\Rightarrow \sqrt{2} = \frac{\sin i}{\sin 15^0}$ $\Rightarrow i = sin^{-1}[\sqrt{2}\sin 15^0]$	½	5
Q26	a) Statement of Guass's law 1 Derivation 2 b) Electric flux Expression 2		
	a) Electric flux through a closed surface is $\frac{1}{\epsilon_o}$ times charge enclosed by the closed surface. $\phi = \frac{Q_{enclosed}}{\epsilon_o}$	1	
		½	
	$\phi = \oint \vec{E}.\vec{ds} = \frac{Q_{enclosed}}{\epsilon_o}$		
	$\therefore E.2\pi rl = \frac{\lambda l}{\epsilon_o}$	½	
	$\therefore E = \frac{\lambda}{2\pi\epsilon_o r}$	1	
	b) $dq = \lambda dx = kxdx$	½	
	$Q = \int_o^l dq = \int_o^l kxdx = \frac{1}{2}kl^2$	½	
	$\therefore \phi = \frac{Q}{\epsilon_o} = \frac{kl^2}{2\,\epsilon_o}$	1	
	OR		
	a) Derivation of expression for electric potential 3 b) Numerical Problem 2		
	a)		

		½	
	$V = \frac{1}{4\pi \in_o}\left[\frac{q}{r_1} - \frac{q}{r_2}\right]$	½	
	$r_1^2 = r^2 + a^2 - 2ar\cos\theta \approx r^2\left(1 - \frac{2a\cos\theta}{r}\right)$	½	
	$r_2^2 = r^2 + a^2 + 2ar\cos\theta \approx r^2\left(1 + \frac{2a\cos\theta}{r}\right)$	½	
	If r > > a		
	$\frac{1}{r_1} = \frac{1}{r}\left[1 - \frac{2a\cos\theta}{r}\right]^{-\frac{1}{2}} \simeq \frac{1}{r}\left[1 + \frac{a}{r}\cos\theta\right]$	½	
	and $\frac{1}{r_2} \simeq \frac{1}{r}\left[1 - \frac{a}{r}\cos\theta\right]$	½	
	$\therefore V = \frac{q}{4\pi \in_o} . \frac{2a\cos\theta}{r^2}$		
	$= \frac{1}{4\pi\in_o}\frac{p\cos\theta}{r^2}$	½	
	b) $\frac{1}{4\pi\in_o}\frac{4\mu C}{x^2} = \frac{1}{4\pi\in_o}\frac{1\mu C}{(2-x)^2}$	**1**	
	$\therefore \frac{x}{2} = 2 - x$		
	$\therefore 3x = 4 => x = \frac{4}{3}m$	½	**5**

MARKING SCHEME

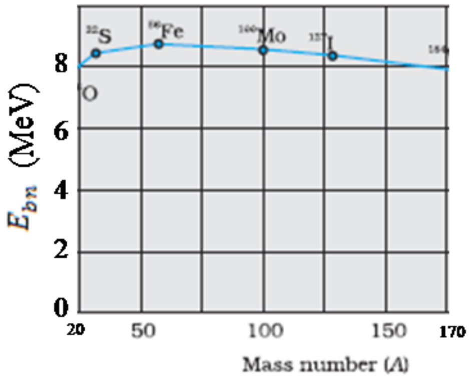
Q. No.	Expected Answer/ Value Points **SECTION A**	Marks	Total Marks
Q1	For higher magnification both objective and eyepiece must have short focal length (Alternatively : $\because m \propto \frac{1}{f_o f_e}$)	**1**	**1**
Q2	Accept both the answers : A : +ve ; B: -ve or A : -ve ; B: +ve	**1**	**1**
Q3	Any two of the following i. Length of transmitting antenna is short. ii. Power radiated is more. iii. Mixing of signals can be avoided.	**½ + ½**	**1**
Q4	Definition ½ SI Unit ½ Conductivity is reciprocal of resistivity $\sigma = \frac{1}{\rho}$ SI unit : S(siemen)	½ ½	**1**
Q5	 	**1**	**1**
	SECTION B		
Q6	Two properties of photon ½ + ½ Reason for different energies of photoelectrons 1 i. Photon is electrically neutral ii. Photon has an energy $h\nu$ [Or any other property] **Reason:** In addition to the work done to free them from the surface, different (emitted) photoelectrons need different amounts of work to be done on them to reach the surface. OR Energy of photon ½ KE of proton 1 Comparison ½	½ ½ **1**	

	Energy of photon, $K_1 = \frac{hc}{\lambda}$ For proton: $\lambda = \frac{h}{\sqrt{2mK_2}}$ $\therefore K_2 = \frac{h^2}{2m\lambda^2}$ $\therefore \frac{K_1}{K_2} = 2mc\lambda/h$	½ ½ ½ ½	2
Q7	Distinction between nuclear fission and fusion 1 Cause of release of energy 1 In nuclear fission a heavy nucleus breaks up into smaller nuclei accompanied by release of energy where as in nuclear fusion two light nuclei combine to form a heavier nucleus accompanied by release of energy. In both the cases, some mass(= mass defect) gets converted into energy as per the relation. E = $\Delta\, mc^2$	½ + ½ **1**	**2**
Q8	Calculation of Current 1 Calculation of Terminal Voltage 1 10-4 = I(1+5) $\therefore$I = 1A $\therefore$ terminal voltage across cell = (4 + 1 x 1)V = 5V 	½ ½ ½ ½	**2**
Q9	Distinction between ‘point to point’ and broadcast modes 1 One example for each ½ + ½ Point to point communication takes place between a single transmitter and a receiver. In broadcast mode, a large number of receivers can receive signal from a single transmitter. Example of point to point mode : telephony Example of Broadcast mode: Radio/TV	½ ½ ½ ½	**2**
Q10	Definition 1 Calculation of Speed 1 i. Refractive index of a medium is the ratio of speed of light (c) in free space to the speed of light (v) in that medium. $\mu = \frac{c}{v}$	**1**	

	ii. $$\mu = \frac{c}{v} = \frac{1}{sin\ i_c}$$ $$= \frac{3 \times 10^8}{v} = \frac{1}{30/50}$$ $$v = \frac{30}{50} \times 3 \times 10^8 = 1.8 \times 10^8\ m/s$$	½ ½	**2**
SECTION C			
Q11	VI characteristics 1 Two advantages ½ + ½ Factors ½ + ½  **OR**  Advantages (any two) i. Low operational voltage. ii. less power consumption. iii. Long life iv. ruggedness [or any other] a. Energyband gap controls the wavelength of light emitted. **b.** Forward current controls the intensity of emitted light.	**1** ½ ½ ½ ½	**3**
Q12	Formula for magnetic field of toroid 1 Calculation of magnetic field 1 ½ Effect of change of core ½ $B = \mu_r \mu_o n\ I$ $= (800 \times 4\pi \times 10^{-7}) \times \left(\frac{4000}{2\pi \times 20 \times 10^{-2}}\right) \times 3$ =9.6T	**1** ½ **1**	

	Since Bismith is diamagnetic, its $\mu_r < 1$ ∴ The magnetic field in the core will get very much reduced.	½	**3**
Q13	Name of em wave 1 Method of generation 1 Two uses 1 Em waves : ultra violet Sun is an important source of UV rays. Some special lamps and very hot bodies also produce UV rays. Uses i. In lasik eye surgery ii. UV lamps are used to kill germs in water purifiers.	 **1** **1** ½ ½	 **3**
Q14	Formula for de Broglie's wavelength 1 Calculation of de Broglie's wavelength ½ Formula for RP 1 Comparison of RP ½ $\lambda = \frac{1.227}{\sqrt{V}} nm$ $= \frac{1.227}{\sqrt{5000}} \approx 0.02$nm R.P = $\frac{2n sin\beta}{1.22\lambda}$ $\frac{\text{R.P. of electron microscope}}{\text{R.P. of optical microscope}} = \frac{\lambda_o}{\lambda_e}$ $= \frac{550}{0.02} = 27500$	 **1** ½ **1** ½	 **3**
Q15	Explanation / reason 1 Finding intensities 1+1 a) Interference pattern will not be observed as two independent lamps are not coherent sources. b) $I_1 = 4I_0^2 cos^2\left(\frac{\phi_1}{2}\right) = 4I_0^2 \quad \phi_1 = 0$ $I_2 = 4I_0^2 cos^2\left(\frac{\pi}{2}\right) = 0 \quad \phi_1 = \pi$ [Note: Give full two marks if the student just writes : Ratio →∞ $(as\ I_2 = 0)$]	 **1** **1** **1**	 **3**

Q16	Definition of current sensitivity 1 Ratio R_1/R_2 2		
	Current sensitivity of a galvanometer is deflection per unit current	**1**	
	$\left[\text{Alternatively: } I_s = \frac{\phi}{I} = \frac{NAB}{K}\right]$		
	In circuit (i) $\frac{4}{6} = \frac{R_1}{4} \Rightarrow R_1 = \frac{8}{3}\ \Omega$	½	
	In circuit (ii) $\frac{6}{R_2} = \frac{12}{8} \Rightarrow R_2 = 4\ \Omega$	½	
	$\therefore \frac{R_1}{R_2} = \frac{2}{3}$	**1**	**3**
Q17	Effect on capacitance 1 Effect on charge 1 Effect on energy 1		
	i. $C = \frac{\epsilon_o A}{d}$	½	
	$C' = \frac{K\epsilon_o A}{d'} = \frac{10}{3}\frac{\epsilon_o A}{d} = \frac{10}{3}C$	½	
	ii. V remains same since battery is not disconnected	½	
	$\therefore Q' = C'V$ $= \frac{10}{3}CV = \frac{10}{3}Q$	½	
	iii. Energy density, $u_d = \frac{1}{2}\epsilon_o E^2$ E = $\frac{V}{d}$ $u_d' = \frac{1}{2}K\epsilon_o E'^2$		
	$= \frac{10}{2}\epsilon_o \left(\frac{V}{d'}\right)^2$ $= \frac{10}{9}\left(\frac{1}{2}\epsilon_o E^2\right)$	½	
	$= \frac{10}{9}u_d$	½	**3**

<table>
<tr>
<td>Q18</td>
<td>
<table><tr><td>Graph of BE</td><td>1</td></tr><tr><td>Calculation of energy released</td><td>2</td></tr></table>
a)


b) Energy released
= [(110+130) x 8.5 – 240 x 7.6] MeV
= 240(8.5 – 7.6) MeV
= 216 MeV
</td>
<td>1

1

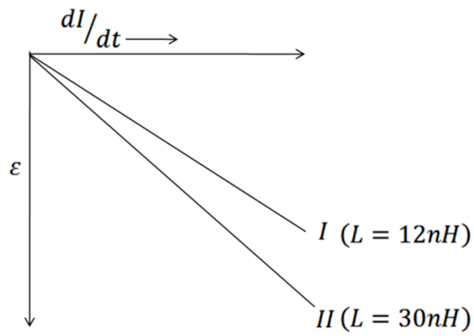
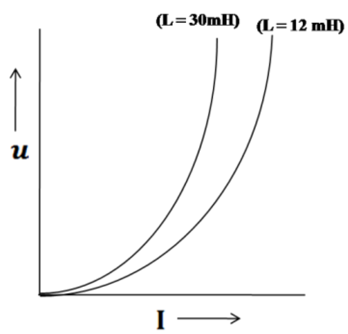
1</td>
<td>3</td>
</tr>
<tr>
<td>Q19</td>
<td>
<table><tr><td>Variation of intensity</td><td>1</td></tr><tr><td>Separation between maxima</td><td>2</td></tr></table>
a) Intensity of diffraction pattern drops rapidly with order n because every higher order maxima gets intensity only from $\frac{1}{2n+1}$ part of the slit. The central maxima gets intensity from the whole slit (n=0)
1st secondary maxima gets its intensity only from 1/3 of slit
2nd secondary maxima gets its intensity only from 1/5 of slit
and so on.

b) Position of 1st maxima on the screen:
$x_1 = \frac{3}{2}\frac{\lambda_1}{a}D$; $\lambda_1 = 590nm$
$x_2 = \frac{3}{2}\frac{\lambda_2}{a}D$; $\lambda_2 = 596nm$
Separation $\Delta x = x_2 - x_1$
$= \frac{3}{2}\frac{D}{a}(\lambda_2 - \lambda_1)$
$= \frac{3}{2}\left(\frac{2}{4 \times 10^{-3}}\right) \times 6 \times 10^{-9}$m
$= 4.5 \times 10^{-6}$m
</td>
<td>1

½

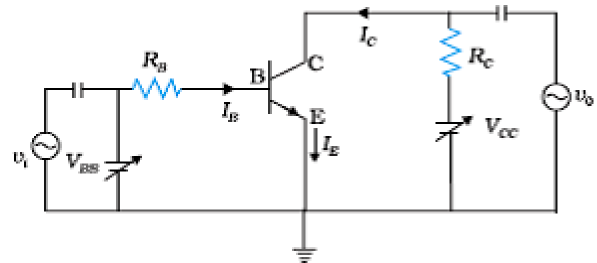
½
½

½</td>
<td>3</td>
</tr>
</table>

Q20	Graph of emf ½ Graph of energy stored ½ Ratio of energy stored 2 **a)** 	½	
	b) 	½	
	$\frac{u_1}{u_2} = \frac{\frac{1}{2}L_1 i_1^2}{\frac{1}{2}L_2 i_2^2}$	½	
	But $\varepsilon_1 i_1 = \varepsilon_2 i_2$ (∵power dissipated is same)	½	
	$\therefore \frac{i_1}{i_2} = \frac{\varepsilon_2}{\varepsilon_1} = \frac{L_2}{L_1}$ $\left(\because \frac{dI}{dt} \text{ is same and } \varepsilon = -L\frac{dI}{dt}\right)$	½	
	$\therefore \frac{u_1}{u_2} = \frac{L_1}{L_2}\left(\frac{L_2}{L_1}\right)^2$ $= \frac{L_2}{L_1} = \frac{30}{12} = 2.5$	½	**3**
Q21	Function of each of the three devices 1+1+1		
	<u>Transducer</u> :It converts one form of energy into another	**1**	
	<u>Transmitter</u> :It processes the incoming message so as to make it suitable for transmission through a channel.	**1**	
	<u>Repeater</u> :It picks up signal from the transmitter, amplifies and retransmits it to the receiver sometimes with a change in carrier frequency. [Alternatively : Repeaters are used to extend the range of communication.]	**1**	**3**

Q22

Circuit diagram	1
Expression for voltage gain	1
Explanation for 180^o phase difference	1



1

$A_V = \frac{V_o}{V_i} = \frac{\Delta V_{CE}}{r\,\Delta I_B}$ = - $\beta_{ac}\,\frac{R_L}{r}$ **1**

$V_{CC} = V_{CE} + I_C R_L$ **½**

$\therefore\ \Delta V_{CC} = \Delta V_{CE} + R_L \Delta I_C = 0$ **½**

$\therefore\ \Delta V_{CE} = -R_L \Delta I_C$

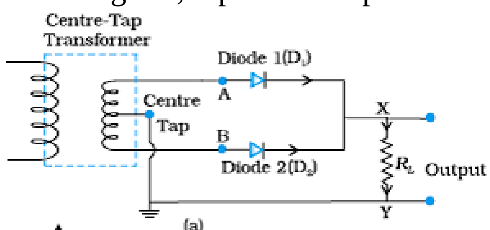
Hence, change in output is negative when the input signal is +ve.

This shows 180^0 phase difference between input and output signal.

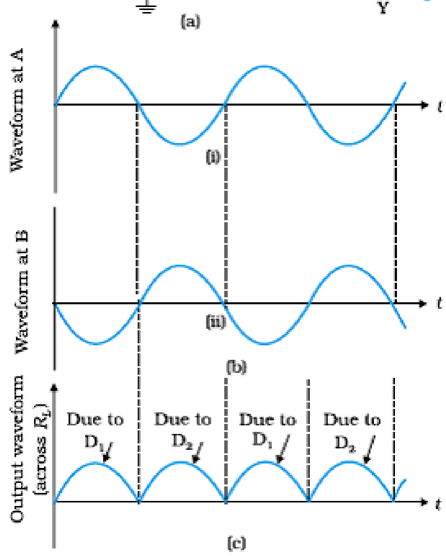
OR

Circuit of full wave rectifier	1
Working Principle	1
Input and output waveforms	1

Circuit diagram; input and output waveforms;



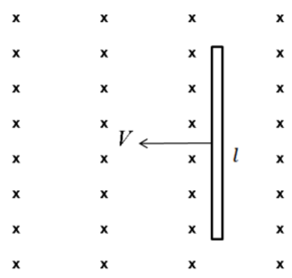
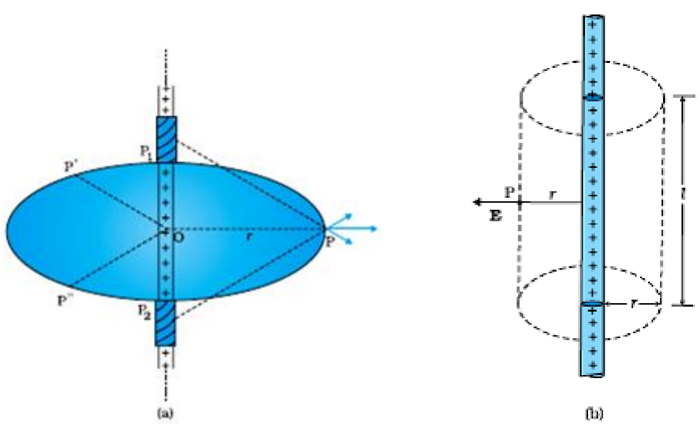
1



½

½

	<u>Working Principle:</u> When A is +ve, B is negative Only D_1 conducts because it is forward biased Current in R_L flows from X to Y When B is positive and A is negative, only D_2 conducts and Current in R_L is once again from X to Y.	½ ½	3
	SECTION D		
Q23	Two values of Mr. Hiorki 1 Two values of Mr. Kamath 1 Meissner effect 1 Value of μ_r 1 a) Eager to share ideas and knowledge; Professionalism; Environment friendly nature. (any two) b) Eager to learn (open minded); observant; appreciating good ideas.(any two) c) Phenomenon of perfect diamagnetism in super conductors $\mu_r = 0$	½ + ½ ½ + ½ **1** **1**	**4**
	SECTION E		
Q24	a) Average Power dissipation is zero 2 b) Numerical 3 a) Instantaneous Power = $vi= V_o sinwt\, I_o coswt$ Average power, P = $\frac{1}{T}\int_o^T vidt$ $= \frac{V_o I_o}{2T}\int_o^T 2\, sinwt\, coswt\, dt$ $= \frac{V_o I_o}{2T}\int_o^T sin2wt\, dt$ $= 0$ b) i. $\omega_o = \frac{1}{\sqrt{LC}}$ $= \frac{1}{(200\times10^{-3}\times400\times10^{-6})^{\frac{1}{2}}}$ $= \frac{1}{\sqrt{8\times10^{-5}}}\, s^{-1} = \frac{10^3}{\sqrt{80}}\, s^{-1} \simeq 111 s^{-1}$ $I = \frac{V}{R} = \frac{50}{10} = 5\ A$ ii. $Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{10}\sqrt{\frac{200\times10^{-3}}{400\times10^{-6}}} = \sqrt{5}$ OR a) Derivation of induced emf 2 ½ b) Numerical 2 ½ a)	 ½ ½ ½ ½ ½ ½ **1** **1**	 **5**

		½	
	$\phi_B = Blx$ $\varepsilon = \frac{-d\phi_B}{dt}$ $= -Bl\,\frac{dx}{dt}$ $= Blv$ b) $\omega = 360\ \times \frac{2\pi}{60} = 12\,\pi$ $\varepsilon = \frac{1}{2} B_H l^2 \omega$ $\therefore 400 \text{ x } 10^{-3} = \frac{1}{2} . B_H \times (60 \times 10^{-2})^2 \times 12\pi$ $\therefore B_H = \frac{5}{27\pi} = 0.06\text{T}$ No change in emf if no. of spokes is increased.	½ ½ ½ ½ ½ ½ ½ ½ ½	**5**
Q25	a) Statement of Guass's law — 1 Derivation — 2 b) Electric flux Expression — 2 a) Electric flux through a closed surface is $\frac{1}{\epsilon_o}$ times charge enclosed by the closed surface. $\phi = \frac{Q_{enclosed}}{\epsilon_o}$  $\phi = \oint \vec{E}.\overrightarrow{ds} = \frac{Q_{enclosed}}{\epsilon_o}$ $\therefore \text{E}.2\pi r l = \frac{\lambda l}{\epsilon_o}$	**1** ½ ½	

$\therefore E = \frac{\lambda}{2\pi \epsilon_o r}$ **1**

b) $dq = \lambda dx = kxdx$ ½

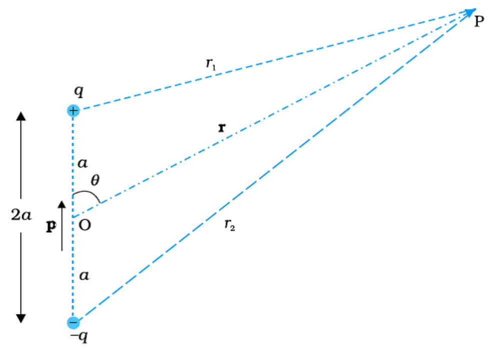
$$Q = \int_o^l dq = \int_o^l kxdx = \frac{1}{2}kl^2$$ ½

$$\therefore \phi = \frac{Q}{\epsilon_o} = \frac{kl^2}{2\,\epsilon_o}$$ **1**

OR

a)	Derivation of expression for electric potential	3
b)	Numerical Problem	2

a)



½

½

$$V = \frac{1}{4\pi\,\epsilon_o}\left[\frac{q}{r_1} - \frac{q}{r_2}\right]$$ ½

$$r_1^2 = r^2 + a^2 - 2ar\cos\theta \approx r^2\left(1 - \frac{2a\cos\theta}{r}\right)$$ ½

$$r_2^2 = r^2 + a^2 + 2ar\cos\theta \approx r^2\left(1 + \frac{2a\cos\theta}{r}\right)$$

If r > > a

$$\frac{1}{r_1} = \frac{1}{r}\left[1 - \frac{2a\cos\theta}{r}\right]^{-\frac{1}{2}} \simeq \frac{1}{r}\left[1 + \frac{a}{r}\cos\theta\right]$$ ½

and $\frac{1}{r_2} \simeq \frac{1}{r}\left[1 - \frac{a}{r}\cos\theta\right]$ ½

$$\therefore V = \frac{q}{4\pi\,\epsilon_o}\cdot\frac{2a\cos\theta}{r^2}$$

$$= \frac{1}{4\pi\epsilon_o}\frac{p\cos\theta}{r^2}$$ ½

b) $\frac{1}{4\pi\epsilon_o}\frac{4\mu C}{x^2} = \frac{1}{4\pi\epsilon_o}\frac{1\mu C}{(2-x)^2}$ **1**

$$\therefore \frac{x}{2} = 2 - x$$

$$\therefore 3x = 4 \Rightarrow x = \frac{4}{3}m$$ ½ **5**

Q26

a) Explanation with reason	2 ½
b) Calculation of separations	2 ½

a) P = $\frac{1}{f} = \left(\frac{n_2 - n_1}{n_2}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ½

$= \left(\frac{n_2 - n_1}{n_2}\right)\left(-\frac{2}{R}\right)$ for diverging lens

= negative ½

i. If $n_1 > n_2$

$\frac{n_2 - n_1}{n_1}$ becomes negative ½

$\therefore P = \frac{1}{f}$ becomes positive ½

or lens become converging

ii. $(n_2)_{violet} > (n_2)_{red}$ ½

∴Power increases on changing to violet light

b) Rays on L_3 be incident parallel to the principal axis ½

image from L_1 is formed at focus of L_2 ½

and focus of L_2 is $2f_1$ from 'O' of L_1 ½

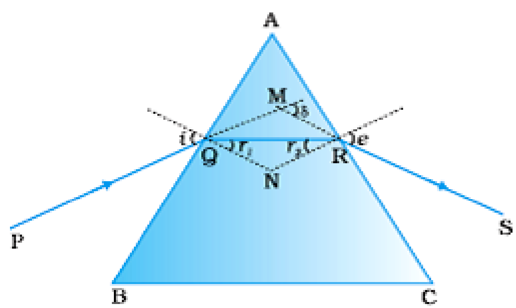
$\therefore L_1L_2 = 2f_1 + f_2$ = (3 x 30)cm = 90cm ½

L_2L_3 can be any distance ½ **5**

OR

a) Derivation of expression for refractive index	2
Graph	1
b) Numerical	2

a)



½

$\angle A + \angle QNR = 180^o$

$r_1 + r_2 + \angle QNR = 180^o$ ½

$\therefore r_1 + r_2 = \angle A$

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

$\delta = i + e - A$

For minimum derivation,

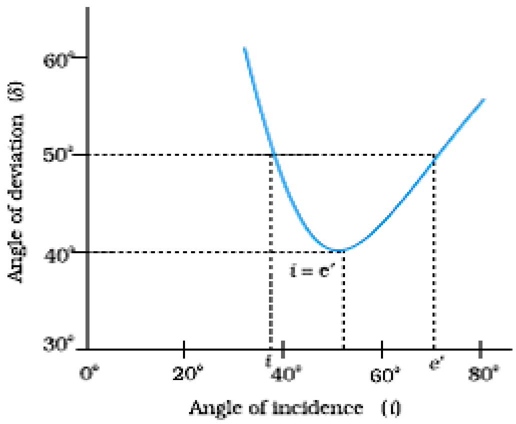
$\delta = D_m$, $i = e$ and $r_1 = r_2$

$\therefore 2r = A \Rightarrow r = \frac{A}{2}$

$D_m = 2i - A \Rightarrow i = \frac{A + D_m}{2}$ ½

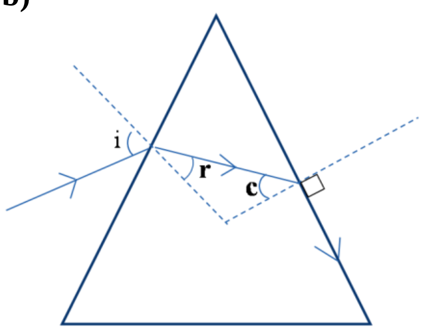
$\therefore n = \frac{n_2}{n_1} = \frac{\sin i}{\sin r}$ ½

$= \frac{sin\left(\frac{A+D_m}{2}\right)}{\sin\frac{A}{2}}$



1

b)



Sin c = $\frac{1}{n} = \frac{1}{\sqrt{2}}$ ½

$\Rightarrow c = 45^0$ ½

$r + c = 60^0 \quad => r = 15^0$

$n = \frac{\sin i}{\sin r}$

$\Rightarrow \sqrt{2} = \frac{\sin i}{\sin 15^0}$ ½

$\Rightarrow i = sin^{-1}[\sqrt{2}\sin 15^0]$ ½ 5