Strictly Confidential: (For Internal and Restricted use only)
Senior School Certificate Examination-2020
Marking Scheme – PHYSICS THEORY (042)

(55/5/2)

General Instructions: -

1. You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully. **Evaluation is a 10-12 days mission for all of us. Hence, it is necessary that you put in your best efforts in this process.**
2. Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and marks be awarded to them.**
3. The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
4. Evaluators will mark(√) wherever answer is correct. For wrong answer 'X"be marked. Evaluators will not put right kind of mark while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
5. If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
6. If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
7. If a student has attempted an extra question, answer of the question deserving more marks should be retained and the other answer scored out.
8. No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
9. A full scale of marks 0-70 has to be used. Please do not hesitate to award full marks if the answer deserves it.
10. Every examiner has to necessarily do evaluation work for full working hours i.e. 8 hours every day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines).
11. Ensure that you do not make the following common types of errors committed by the Examiner in the past:-
    - Leaving answer or part thereof unassessed in an answer book.
    - Giving more marks for an answer than assigned to it.
    - Wrong totaling of marks awarded on a reply.
    - Wrong transfer of marks from the inside pages of the answer book to the title page.
    - Wrong question wise totaling on the title page.
    - Wrong totaling of marks of the two columns on the title page.
    - Wrong grand total.
    - Marks in words and figures not tallying.
    - Wrong transfer of marks from the answer book to online award list.

- Answers marked as correct, but marks not awarded. (Ensure that the right tick mark is correctly and clearly indicated. It should merely be a line. Same is with the X for incorrect answer.)
- Half or a part of answer marked correct and the rest as wrong, but no marks awarded.

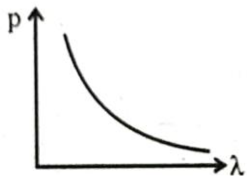
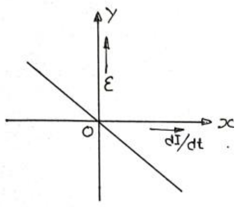
12. While evaluating the answer books if the answer is found to be totally incorrect, it should be marked as cross (X) and awarded zero (0)Marks.

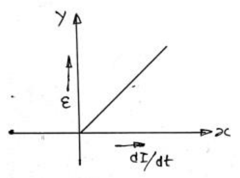
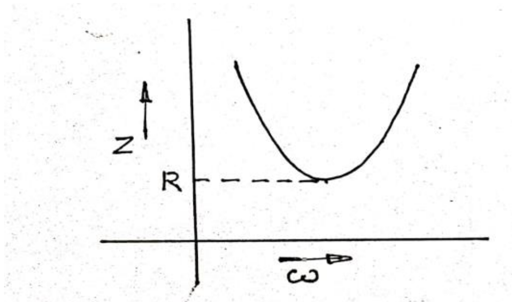
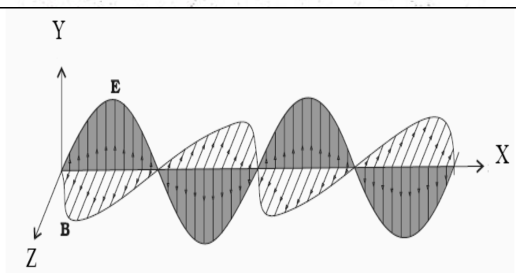
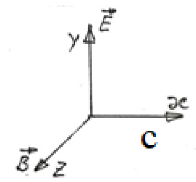
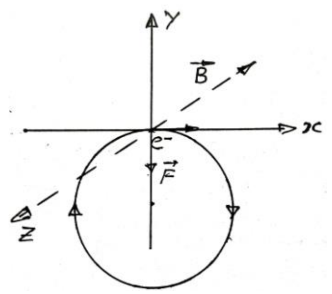
13. Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.

14. The Examiners should acquaint themselves with the guidelines given in the Guidelines for spot Evaluation before starting the actual evaluation.

15. Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title page, correctly totaled and written in figures and words.

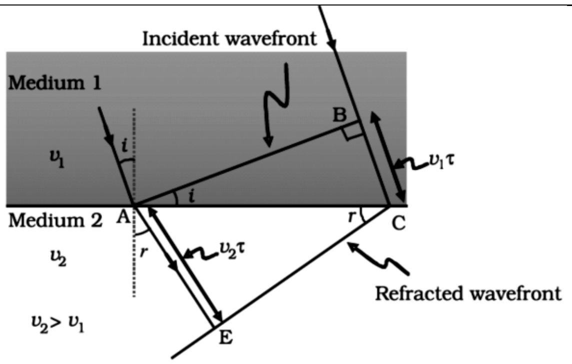
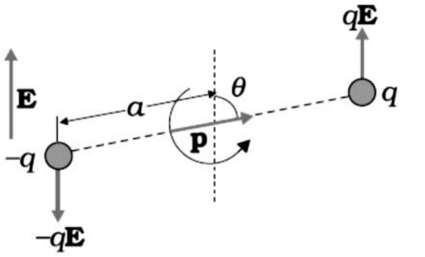
16. The Board permits candidates to obtain photocopy of the Answer Book on request in an RTI application and also separately as a part of the re-evaluation process on payment of the processing charges.

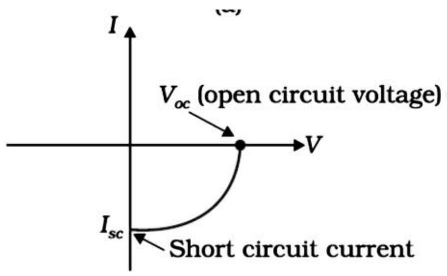
MARKING SCHEME: PHYSICS			
QUESTION PAPER CODE: 55/5/2			
Q.No.	**Value Points/Expected Answer**	**Marks**	**Total Marks**
	SECTION A		
1.	(a) Forward bias and energy gap of the semiconductor	1	1
2.	(d) 	1	1
3.	(c) L is large and R is small	1	1
4.	(d) Optical Signals	1	1
5.	(b) / (c) / (b) and (c) $v\tan\theta = c$	1	1
6.	(c) 2f	1	1
7.	(d) zero	1	1
8.	(c) 3:4	1	1
9.	(a) Net Charge enclosed and permittivity of the medium	1	1
10.	(b) $\sqrt{2}\,r$	1	1
11.	4:1	1	1
12.	Conductivity/ Resistivity (Also give full credit if a student writes semiconducting nature)	1	1
13.	Rectify	1	1
14.	Electrostatic potential difference/ Electric potential	1	1
15.	Electric current	1	1
16.	(i) for constructive interference path difference, $\Delta p = n\lambda$ (ii) for destructive interference path difference, $\Delta p = (2n+1)\frac{\lambda}{2}, n = 0,1,2,3--$ Alternatively $\Delta p = (2n-1)\frac{\lambda}{2}, n = 1,2,3--$	½ ½	1
17.	 Induced e.m.f. in a coil, $\varepsilon = -L\frac{dI}{dt}$ [Award one full mark even if the student just draws the graph without writing the expression of induced emf] (Note: Award this one mark if a student draws the graph in first quadrant as shown below.)	½ ½	1

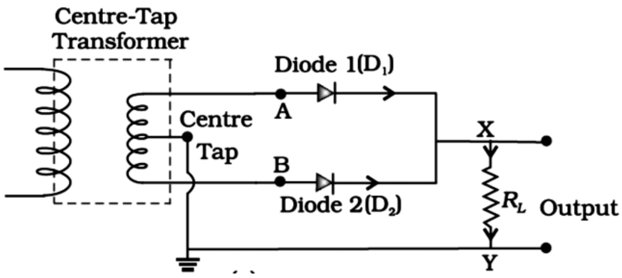
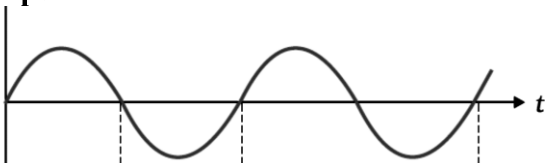
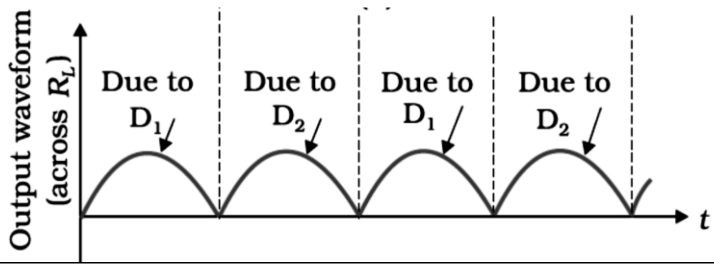
	 **OR** $Z=\sqrt{R^2+(X_L-X_C)^2}$  [Award one full mark even if the student just draws the graph without writing expression of impedance]	½ ½	1
18.	 Alternatively 	1	1
19.	 **Alternatively:** Circular path in the X-Y plane in clockwise sense. **[Note:** If the student just writes, force on the electron will be along negative Y axis, i.e. $F=-e(v\ \hat{i})\times(B(-\hat{k})=evB(-\hat{j})\ \ award\ \frac{1}{2}\ mark\ \ only)$ **OR** Magnitude of force on side NO is $=F$ **Alternatively** Let force on side MP be $=F_1$ Force on side $NO=\frac{F_1}{2}$ Magnitude of net force $=F_1-\frac{F_1}{2}=\frac{F_1}{2}=F$	1 ½+½ ½ ½	

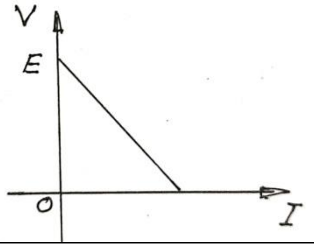
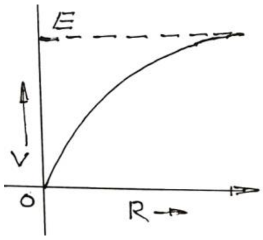
	Therefore force on side NO $= \frac{F_1}{2} = F$ Give full credit if a student calculates the force as shown below. $F = \frac{\mu_0}{2\pi} I_1 I_2$		1
20.	Angular deflection of the galvanometer coil per unit current/deflection per unit current Alternatively $I_s = \frac{\phi}{I}$ alternatively $\frac{NAB}{K}$	1	1
SECTION B			
21.	Definition of becquerel 1 Calculation of half life 1 (a) One becquerel (Bq) equals the activity of a radioactive sample that is disintegrating at the rate of on disintegration per second. **Alternatively** $1\ Bequerel = \frac{\text{one disintegration}}{\text{one second}}$ (b) $R_1 = -\lambda_1 N$ *and* $R_2 = -\lambda_2 N$ $R = R_1 + R_2 = -(\lambda_1 + \lambda_2)N$ $R = -\lambda \mathrm{N}$ $\therefore \lambda = \lambda_1 + \lambda_2$ $T_{1/2} = \frac{0.6931}{\lambda_1 + \lambda_2}$	1 ½ ½	2
22.	Effect and justification ½+½ Effect and justification ½+½ (i) On increasing the width of the slit, the size of the central bright band will decrease (ii) **Justification:** Angular width $= \frac{2\lambda}{a}$, i.e. angular width is inversely proportional to the width of the slit (iii)The intensity of central bright band will increase **Justification:** The amplitude/intensity of light passing through slit has increased.	½ ½ ½ ½	2
23.	Relevant explanation 1 Relevant explanation 1 According to wave theory photoelectrons can be emitted using high intensity incident light of any frequency. Hence, there need not be any threshold frequency for any given photosensitive surface. Increase in intensity of light increases the number of incident photons.	1 1	

	Hence the number of photoelectrons emitted and therefore, the photoelectric current increases.		2
24.	Origin of gamma rays and radio waves ½+½ Main application of each ½+½ Gamma rays are emitted by radioactive nuclei/produced in nuclear reactions. Radio waves are produced by accelerated /oscillating charges/LC circuit. Gamma rays are used for the treatment of cancer/in nuclear reactions. Radio waves are used in communication systems/radio or television communication systems/cellular phones. (or any other correct applications)	½ ½ ½ ½	2
25.	Expression for angular momentum ½ Expression for magnetic moment 1 Relation between the two ½ According to Bohr's model $L = Angular\ momentum = mvr = \frac{nh}{2\pi}$ $\mu =$ M$agnetic\ moment = current \times area\ of\ the\ orbit$ $\mu = \|e\| \times \nu \times \pi r^2 = \frac{\|e\| vr}{2}$ $\therefore \frac{L}{\mu} = \frac{mvr \times 2}{\|e\| vr} = \frac{2m}{\|e\|}$ $\mu = \frac{\|e\|}{2m} L$	½ ½ ½ ½	2
26.	Effect and justification ½+½ Effect and justification ½+½ **(i)** Intensity of light transmitted by P_1 remains unaffected when P_1 is rotated about the direction of propagation of light. **Justification:** The intensity of unpolarized light transmitted by a Polaroid does not depend on the orientation of the Polaroid with respect to the direction of propagation of light. **(ii)** The intensity of light transmitted by P_2 will vary from I_1 to zero. **Justification:** As per Malus' Law $I = I_0 \cos^2 \theta$ Where θ is the angle between the pass axis of the polaroid P_2 and the pass axis of polaroid P_1. As θ varies from 0^0 *to* $\pi/2$, I_2 will vary from I_1 *to* zero. **OR** Definition of wave front 1 Obtaining refracted wave front 1 The wave front is a surface of constant phase. **Alternatively** The wave front is the locus of all points that are oscillating in phase.	½ ½ ½ ½ 1	2

	 	1	2
27.	Derivation of the expression for the torque 1½ Identification of the orientation of stable equilibrium ½  Force on q is q**E** and a force on –q is –q**E**. Hence torque $\tau = qE \times 2a\sin\theta$ $\tau = PE\sin\theta$ $\vec{\tau} = \vec{P} \times \vec{E}$ For stable equilibrium $\theta = 0^0$ **OR** Obtaining the expression for the energy stored 1½ Definition of energy density ½ Let the charge on the capacitor plates at any instant, during charging process be q, amount of work done to supply further charge dq to the capacitor $dW = Vdq$ *where V is the potential difference and equals to* $\frac{q}{C}$ *Total work done to* charge *the capacitor upto* charge *Q* $W = \int_0^Q Vdq$ $= \int_0^Q \frac{q}{C}dq = \frac{Q^2}{2C} \left(\frac{1}{2}CV^2 = \frac{1}{2}QV\right)$ Since *Energy stored = work done* $\Rightarrow U = \frac{Q^2}{2C} \left(\frac{1}{2}CV^2 = \frac{1}{2}QV\right)$	½ ½ ½ ½ ½ ½ ½ ½	

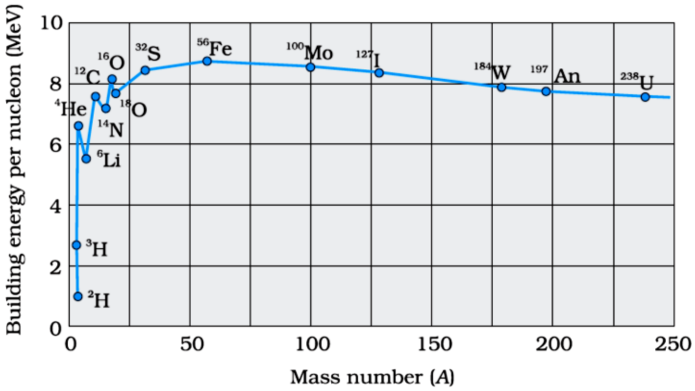
	Energy density: Electrical energy stored per unit volume is known as energy density. Alternatively: Energy density $= \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}\frac{\sigma^2}{\varepsilon_0}$		2
	SECTION C		
28.	(a) Deducing the expression for potential energy 1½ (b) Expression for energy in the presence of an external electric field 1½		
	(a) Work done in bringing the charge q_2, from infinity, to a point $= q_2 \times$ potential at the point due to charge q_1 $= q_2 \times \frac{1}{4\pi\varepsilon_0}\frac{q_1}{r_{12}}$	½	
	$\therefore$ potential energy of the system $= \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}$	1	
	(b)Let the potentials, at two points, due to an external electric field (E) be V_1 and V_2 respectively. Now the total energy of the system is: $\left[q_1V_1 + q_2V_2 + \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r_{12}}\right]$	1½	3
29.	Solar cell 1 V-I characteristics ½ Three processes involved ½+½+½		
	A solar cell is basically a p-n junction which generates emf when solar radiation falls on the p-n junction. **Alternatively:** A solar cell works on the same principle as the photodiode, however, no external bias applied to it and its junction area is much larger than that of a photodiode.	1	
	V-I Characteristics 	½	
	Three processes involved in the working of the solar cell are **Generation:** Light $(h\nu > E_g)$ generates electron-hole pairs.	½	
	Separation: Electric field, of the depletion region, separates the electron and the holes.	½	

	Collection: The front contact collects the electrons reaching the n-side and back contact collects holes reaching the p-side. [**Note:** For the last part, award one mark if the student just writes the three names of three processes without giving any explanation.]	½	3
	OR Circuit diagram 1 Working 1 Input and output waveform 1		
		1	
	During one half cycle of the input a.c. signal, only diode 1 is forward biased and conducts.	½	
	During the next half cycle of the input ac signal only diode 2 is forward biased and conducts. However, due to the use of the centre tapped transformer, the current in the load flows in the same direction during both these half cycles. The current through the load is therefore unidirectional.	½	
	Input waveform 	½	
	Output waveform 	½	3
30.	(a) Definition of internal resistance 1 (b) (i) Relevant formula +Graph ½+½ (ii) Relevant formula +Graph ½+½		
	The resistance offered due to electrolyte of a cell, is called its internal resistance. $V = E - Ir$	1 ½	

	$V = IR = \left(\frac{E}{r+R}\right)R$ 	½ ½+½	3
31.	Finding the energy in the first excited state 1 Finding the associated kinetic energy 1 Finding the associated de-Broglie wavelength 1 Energy of the electron in the first excited state $E_1 = -\frac{13.6}{2^2} eV = -3.4eV$ $= -3.4 \times 1.6 \times 10^{-19} J$ $= -5.44 \times 10^{-19} J$ Associated kinetic energy =Negative of total energy $K = 5.44 \times 10^{-19} J$ de-Broglie wavelength, $\lambda = \mathrm{h/p}$ $\lambda = \frac{\mathrm{h}}{\sqrt{2\mathrm{mK}}}$ $\lambda = \frac{6.63 \times 10^{-34}}{(2 \times 9.1 \times 10^{-31} \times 5.44 \times 10^{-19})^{1/2}}$ m $\lambda = \frac{6.63 \times 10^{-34}}{(99.008)^{1/2} \times 10^{-25}}$ m $\approx 0.663 \times 10^{-9}$ m $= 0.663$nm $= 6.63 A^\circ$	½ ½ ½ ½ ½ ½	3
32.	Finding (i) The charge passed through the loop 1 (ii) Change in magnetic flux through the loop 1 (iii) Magnitude of the magnetic flux applied 1 (i) Total charge passed through the loop $Q =$ area under the I-t graph $= \frac{1}{2} \times 0.5 \times 2 = 0.5C$ (ii) Change in magnetic flux = resistance × charge passing = 10× 0.5=5 Wb (iii) change in magnetic flux = change in magnetic field× area of the loop 5 Wb = (B -0)× 10 × 10^{-4} m^2 ∴ B =5 × 10^3 Wb/ m^2 (Note: Award two marks for the first part if a student unable to do (ii) and (iii) parts of this question.)	½ ½ ½ ½ ½ ½	

33.

B.E. per nucleon versus mass number curve	1
(i) Explanation of fusion of nuclei on the ascending part	1
(ii) Explanation of fission of nuclei on the descending part	1



1

Explanation for fusion

On the ascending part of the curve B.E./A increases with mass number (A). So, B.E. of the resultant will be greater than that of the nuclei which are fused together. Hence the fusion of the nuclei on the ascending part, results in an increase in binding energy i.e. a more stable nucleus. 1

Explanation for fission

On the descending part of the curve, the B.E. of the heavier nuclei is lower . Hence the fission of the heavier nuclei, on the descending part, will again cause an increase in B.E. and, therefore, more stable nucleus. 1 **3**

34.

Identification of the optical instrument	1
Calculation of magnification	2

(a) Compound microscope 1

(b)

$$M = \frac{L \times D}{f_0 \times f_e}$$ 1

$$= \frac{L}{\left(\frac{1}{P_0}\right)} \times \frac{D}{\left(\frac{1}{P_e}\right)}$$ ½

$$= \left(\frac{20\times10^{-2}}{\frac{1}{100}}\right) \times \left(\frac{25\times10^{-2}}{\frac{1}{50}}\right)$$

$$= 20 \times 12.5$$

$$= 250$$ ½ **3**

SECTION D

35.

(a) Two important characteristics	1+1
(b) Derivation of the expression of the electric field	2½
Showing the behaviour as point charge	½

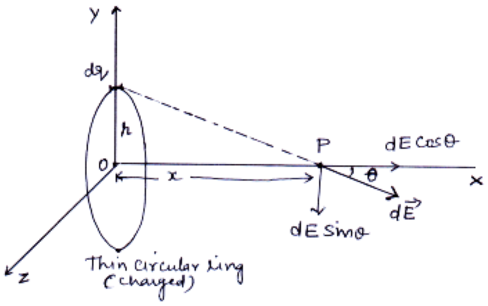
(a) For equipotential surfaces

(i) Potential has the same value at all points on the surface.

(ii) Electric field is normal to the equipotential surface at all points

(iii) Work done in moving any charge between any two points on the equipotential surface is zero (any two) — 1+1

(b)



½

Electric field due to any elemental (point) charge dq, at point P.

$$= dE = \frac{1}{4\pi\varepsilon_0}\frac{dq}{(x^2+r^2)}$$ ½

This is directed along AP

Its component along the axis OP of the ring is

$$= dE\cos\theta = dE\frac{x}{\sqrt{x^2+r^2}}$$

The component, perpendicular to the axis gets cancelled by the elemental electric field due to another elemental charge symmetrically located on the other side of the axis.

Hence total electric field

$$E = \int dE\cos\theta$$ ½

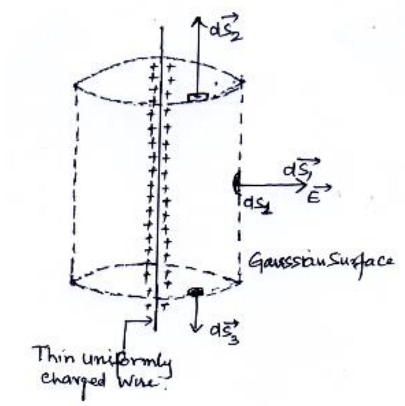
$$= \frac{1}{4\pi\varepsilon_0}\int\frac{dq}{\left(x^2+r^2\right)}\frac{x}{\sqrt{x^2+r^2}}$$

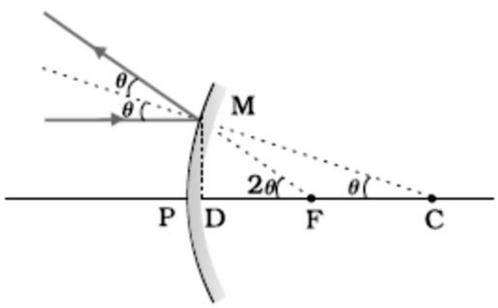
$$= \frac{1}{4\pi\varepsilon_0}\frac{x}{(x^2+r^2)^{3/2}}\int\lambda dl$$ ½

$$= \frac{1}{4\pi\varepsilon_0}\frac{x\lambda}{(x^2+r^2)^{3/2}}\times 2\pi r$$ ½

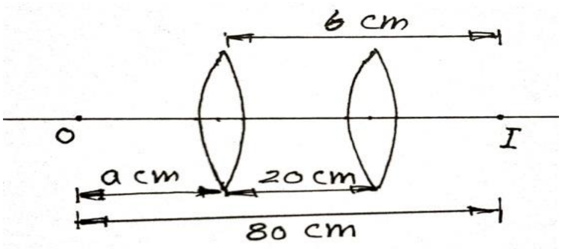
$$= \frac{Q}{4\pi\varepsilon_0}\frac{x}{(x^2+r^2)^{3/2}}$$

Where $Q = \lambda\times 2\pi r$ = total charge on the ring

	This field is directed along the axis. When x much larger than r, we have $$E=\frac{Q}{4\pi\varepsilon_0}\frac{x}{(x^2)^{3/2}}=\frac{1}{4\pi\varepsilon_0}\frac{Q}{x^2}$$	½	5
	This corresponds to the expression for the electric field due to a point charge. Thus at large distances the ring behaves like a point charge. (**Note:** Award these three marks even if a student tries to attempt this part) OR		
	(a) Statement of Gauss's law — 1 Derivation of the expression of the electric field — 2½ (b) Finding the increase in potential — 1½		
	(a) Gauss law: Electric flux through of a closed surface is $\frac{1}{\varepsilon_0}$ times the charge enclosed by the surface. Alternatively $\phi_E=\frac{q}{\varepsilon_0}$	1	
	 	½	
	Let the charge be uniformly distributed on a wire $\phi=\oint d\phi=\int_{s_1}\vec{E}\cdot d\vec{s}_1+\int_{s_2}\vec{E}\cdot d\vec{s}_2+\int_{s_3}\vec{E}\cdot d\vec{s}_3$	½	
	$=\int_{s_1}Eds_1\cos 0^0+\int_{s_2}Eds_2\cos 90^0+\int_{s_3}Eds_3\cos 90^0$ $=E\int_{s_1}ds_1=E.2\pi rl$	½	
	by Gauss's law $\frac{q}{\varepsilon_0}=E\cdot 2\pi rl$	½	
	$E=\frac{q}{2\pi\varepsilon_0 rl}=\frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$	½	

	(b) $E = 10r+5$ $dV = -E \cdot dr$ $\int dV = -\int_1^{10} \vec{E}\, d\vec{r}$ $= -\int_1^{10} (10r+5)dr$ $V = -\left[\int_1^{10} 10r\, dr + \int_1^{10} 5dr\right]$ $V = 10\left[\frac{r^2}{2}\right]_1^{10} + 5(r)_1^{10}$ $V = -5[100-1] + 5[10-1]$ $V = -5 \times 99 + 5 \times 9 = -540V$	½ ½ ½	5
36.	(a)Definition of focal length — 1 Obtaining the relation between focal length and radius of curvature — 1½ (b)Calculation of angle of emergence — 2 Qualitative change in the angle of emergence — ½ (a) **Focal length of mirror**: It is the distance of the point from the pole of mirror through which ray of light moving parallel to its principle axis passes (or appear to come from). **Alternatively:** It is half of the distance of its centre of curvature from the pole of a mirror.  Let C be the centre of curvature of mirror, MD be the perpendicular from M to the principal axis. $\angle MCP = \theta$ and $\angle MFP = 2\theta$ $\tan\theta = \frac{MD}{CD}$, $\tan 2\theta = \frac{MD}{FD}$ (1) For small angles, $\tan\theta \approx \theta$ and $\tan 2\theta \approx 2\theta$	1 ½ ½	

	From equation 1, $\frac{MD}{FD} = 2\frac{MD}{CD}$ $FD = \frac{CD}{2}$ ----equation (2) For small θ, the point D is very close to the point P $\therefore$ FD $\simeq$ FP $= f$ and CD $\simeq$ CP $= R$ $\therefore$ from equation 2, we get $f = \frac{R}{2}$	½	
	(b) Applying Snell's law at face AB, we get $\sqrt{3}\sin 30 = 1 \cdot \sin e$ $\sqrt{3} \times \frac{1}{2} = \sin e$ $\frac{\sqrt{3}}{2} = \sin e$ $\sin 60 = \sin e$ $e = 60^0$	½ ½ ½ ½ ½	
	When the medium (the air) in which the prism is kept is replaced with a liquid of refractive index 1.3 the angle of emergence would decrease. It is because bending in the ray of light will be lesser.	½	
	OR (a) Definition of resolving power — 1 (i) Effect and justification — ½+½ (ii) Effect and justification — ½+½ (b) Calculation of focal length — 2		
	Resolving power of a telescope is defined as the reciprocal of the smallest angular separation between two distinct objects whose image can be just resolved by it.	1	
	Alternatively: Resolving power $= \frac{1}{d\theta} = \frac{D}{1.22\lambda}$ **Alternatively** It is the reciprocal of the limit of resolution.		
	(i) As λ increases, R.P. decreases Reason R.P.$= \frac{D}{1.22\lambda}$ i.e. $R.P. \alpha \frac{1}{\lambda}$ (*ii*) As D increases, R.P. increases Reason R.P.$= \frac{D}{1.22\lambda}$ i.e. $R.P. \alpha D$	½ ½ ½ ½	

	The two positions of the lens are as shown		
			
	for position 1		
	$u = -a\ cm$	½	
	$v = b = +(80 - a)\ cm$		
	for position 2	½	
	$u = -(a + 20)\ cm$		
	$v = +(b - 20) = +(60 - a)\ cm$		
	By lens formula		
	$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$	½	
	$\therefore \frac{1}{(80-a)} + \frac{1}{a} = \frac{1}{(60-a)} + \frac{1}{(20+a)}$		
	This gives		
	a(80-a)=(a+20)(60-a)		
	or $80a - a^2 = 40a + 1200 - a^2$		
	or $a = 30cm$		
	$\therefore \frac{1}{f} = \frac{1}{50} + \frac{1}{30} = \frac{3+5}{150} = \frac{8}{150}$		
	$\therefore f = \frac{150}{8} cm = 18.75cm$	½	
	Alternatively		
	$F = \left(\frac{D^2 - x^2}{4D} \right) = \frac{80^2 - 20^2}{4 \times 80} = 18.75cm$	1+1	
	Alternatively The values of		
	$a = \|u\|$ *and* $b = \|v\|$ simply get interchanged in the two positions.	½	
	$b + a = 80cm$		
	$b - a = 20cm$	½	
	This gives $b = 50cm$ *and* $a = 30cm$		
	$\therefore \frac{1}{f} = \frac{1}{50} - \left(\frac{1}{-30} \right) = \frac{8}{150}$	½	
	$f = 18.75\ cm$	½	5

37.

Value points	Marks
(a) Showing No dissipation of power	2
(b) (i) Calculation of self inductance	1
(ii) Calculation of capacitance	2

(a)

$V = V_0 \sin \omega t$

$I = I_0 \sin(\omega t - \pi / 2)$ ½

The instantaneous power supplied to the inductor

$P_L = IV$ ½

$= I_0 \sin(\omega t - \pi / 2)(V_0 \sin \omega t)$

$= -I_0 V_0 \cos\omega t \sin\omega t$

$= -\dfrac{I_0 V_0}{2} \sin 2\omega t$ ½

Now average power over a completer cycle,

$\langle P_L \rangle = \left\langle -\dfrac{I_0 V_0}{2} \sin 2\omega t \right\rangle$

$= -\dfrac{I_0 V_0}{2} \langle \sin 2\omega t \rangle = 0$ ½

$\therefore$ Average value of $\sin 2\omega t$ over a complete cycle is zero.

Thus average power dissipated over a complete cycle is zero.

(b) $(i) X_L = 2\pi f L$ ½

$L = \dfrac{X_L}{2\pi f} = \dfrac{40}{2\pi \times 200} = 0.1/\pi \; henry = 0.032H$ ½

Maximum power dissipation takes place at resonance ½

$\nu = \dfrac{1}{2\pi\sqrt{LC}}$ ½

$\therefore C = \dfrac{1}{L \times 300^2 \times 4\pi^2} F$ ½

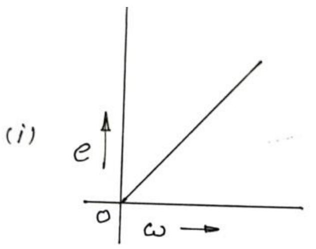
$C = \dfrac{\pi}{0.1 \times 9 \times 10^4 \times 4\pi^2} F = 8.8\mu F$ ½ **5**

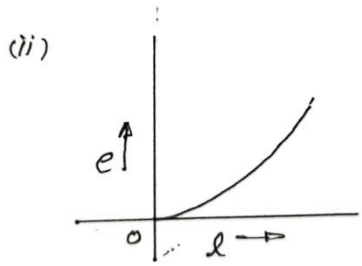
OR

Value points	Marks
(a) Formula	1
Plot of two graphs	½+½
(b) (i) Finding the coefficient of mutual induction	1½
(ii) Finding the induced emf	1½

e.m.f. induced in the rod $= \left|-\frac{d\phi}{dt}\right|$ ½

$\therefore e = \frac{1}{2}Bl^2\omega$ ½





½+½

(i) Imagine a current I to flow through the larger coil.

Magnetic flux linked with linked with the smaller coil $= MI$

½

$= B_{centre} \times \pi \times 10^{-4}$ Wb

$= \frac{\mu_0 I}{2 \times 20 \times 10^{-2}} \times \pi \times 10^{-4}$ Wb

½

$\Rightarrow M = \frac{\mu_0 \pi}{4} \times 10^{-3}$ H

$= \frac{4\pi \times 10^{-7} \pi \times 10^{-3}}{4} H$

$= 9.9 \times 10^{-10} H$

½

$= 10^{-9} H$

(ii) ½

$e.m.f.\ induced = -M\frac{dI}{dt}$ ½

$= -10^{-9} \times \frac{5}{10^{-3}} V$ ½

$= -5 \times 10^{-6} V$

Alternatively

$e.m.f.\ induced = -\frac{d\phi}{dt}$

$= -\frac{d}{dt}(B_c A_i) = -A_i \frac{dB_c}{dt}$ ½

	$= -A_i \frac{d}{dt}\left(\frac{\mu_0 I}{2R}\right)$ $= -\frac{A_i \mu_0}{2R}\frac{dI}{dt}$ $= \frac{-\pi \times 10^{-4} \times 4\pi \times 10^{-7} \times 5}{2 \times \left(20 \times 10^{-2}\right) \times 10^{-3}} V$ $= -\frac{20\pi^2 \times 10^{-6}}{2 \times 20} V$ $= -5 \times 10^{-6} V$	½ ½	5