## Marking Scheme Strictly Confidential

## (For Internal and Restricted use only)

Senior School Certificate Examination, 2024

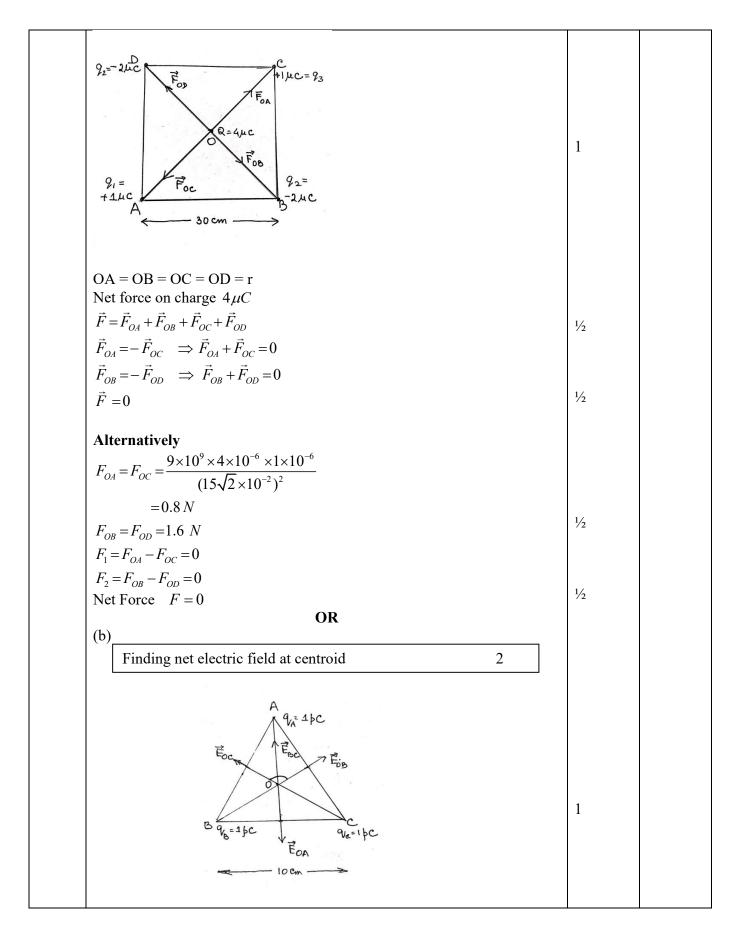
## **SUBJECT PHYSICS (CODE 55/5/3)**

General	Instru	ctions:	_
Other ar	IIISU U	cuons.	

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

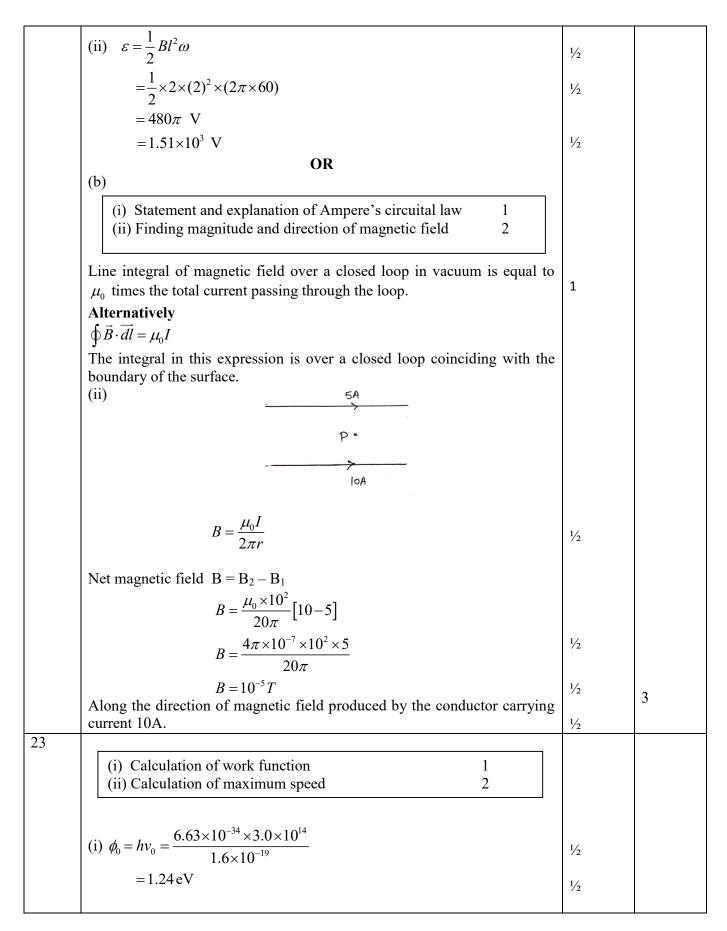
8	If a question does not have any parts, marks must be awarded in the left-hand margin and encircled. This may also be followed strictly.
9	If a student has attempted an extra question, answer of the question deserving more marks should
	be retained and the other answer scored out with a note "Extra Question".
10	No marks to be deducted for the cumulative effect of an error. It should be penalized only once.
11	A full scale of marks(example 0 to 80/70/60/50/40/30 marks as given in Question
	Paper) has to be used. Please do not hesitate to award full marks if the answer deserves it.
12	Every examiner has to necessarily do evaluation work for full working hours i.e., 8 hours every
	day and evaluate 20 answer books per day in main subjects and 25 answer books per day in other subjects (Details are given in Spot Guidelines). This is in view of the reduced syllabus and number
	of questions in question paper.
	of questions in question paper.
13	Ensure that you do not make the following common types of errors committed by the Examiner in
	the past:-
	Leaving answer or part thereof unassessed in an answer book.
	<ul> <li>Giving more marks for an answer than assigned to it.</li> </ul>
	Wrong totaling of marks awarded on an answer.
	Wrong transfer of marks from the inside pages of the answer book to the title page.
	Wrong question wise totaling on the title page.
	• Wrong totaling of marks of the two columns on the title page.
	<ul> <li>Wrong grand total.</li> <li>Marks in words and figures not tallying/not same.</li> </ul>
	<ul> <li>Wrong transfer of marks from the answer book to online award list.</li> </ul>
	• 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.)
14	<ul> <li>Half or a part of answer marked correct and the rest as wrong, but no marks awarded.</li> <li>While evaluating the answer books if the answer is found to be totally incorrect, it should be</li> </ul>
14	marked as cross (X) and awarded zero (0)Marks.
15	Any unassessed portion, non-carrying over of marks to the title page, or totaling error detected by
	the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also
	of the Board. Hence, in order to uphold the prestige of all concerned, it is again reiterated that the
16	instructions be followed meticulously and judiciously.  The Everpiness should acquaint themselves with the guidelines given in the "Cuidelines for Spot
16	The Examiners should acquaint themselves with the guidelines given in the "Guidelines for Spot Evaluation" before starting the actual evaluation.
17	Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title
	page, correctly totaled and written in figures and words.
18	The candidates are entitled to obtain photocopy of the Answer Book on request on payment of the
	prescribed processing fee. All Examiners/Additional Head Examiners/Head Examiners are once
	again reminded that they must ensure that evaluation is carried out strictly as per value points for
	each answer as given in the Marking Scheme.

	MARKING SCHEME : PHYSICS (042) CODE : 55/5/3		
Q.NO.	SECTION - A	MARKS	TOTAL MARKS
1.	(D) 2P	1	1
2.	(A) $\frac{\mu_0 I}{R}$	1	1
3.	(A) Aluminum	1	1
4.	$(A) 0.1\Omega$	1	1
5.	(B) 5π	1	1
6.	(A) 0.8 fm	1	1
7.	(B) $1.5 \times 10^{16}$	1	1
8.	(C) 3.4eV,-6.8eV	1	1
9.	(B) Ultraviolet rays	1	1
10	(A) A	1	1
11	(D) 125	1	1
12	(D) virtual, at a distance of 3.6 m from the surface.	1	1
13	(C) Assertion (A) is true but Reason (R) is false.	1	1
14	(D) Both Assertion (A) and Reason (R) are false.	1	1
15 16	(C) Assertion (A) is true but Reason (R) is false.  (A) Both Assertion (A) and Reason (R) are true and Reason (R) is	1	1
10	correct explanation of Assertion (A).	1	1
	SECTION - B		
17	SECTION B		
1,	Deriving an expression for magnetic force 1½ Validity and Justification for zig-zag form conductor ½		
	Total number of mobile charge carriers in a conductor of length $L$ , cross-sectional area $A$ and number density of charge carriers $n$ : $= nLA$		
	Force acting on the charge carriers in external magnetic field $\vec{B}$		
	$\vec{F} = (nAL) \vec{q} \vec{v}_d \times \vec{B}$ (1)	17	
	Where $\vec{v}_d$ is the drift velocity of the charge carriers	1/2	
	Current flowing		
	$I = V_d q n A$	1/2	
	$I\vec{L} = \vec{v}_d q n A L (2)$		
	On solving equation (1) and (2)	1/	
	$\vec{F} = I(\vec{L} \times \vec{B})$	1/2	
	Yes, because this force can be calculated by considering zig-zag conductor		
	as a collection of linear strips $(d\vec{l})$ and summing them vectorically.	1/2	2
18	(a)		
	Diagram showing direction of forces 1		
	Finding net force 1		



	$q_A = q_B = q_C = 1pC$		
	AO = BO = CO = r		
	$ E_{OA}  =  E_{OB}  =  E_{OC} $		
	$E_{BC} = E_{OB} + E_{OC}$		
	$\begin{aligned}  \vec{E}_{OA}  &=  \vec{E}_{OB}  =  \vec{E}_{OC}  \\ \vec{E}_{BC} &= \vec{E}_{OB} + \vec{E}_{OC} \\ E_{BC} &= \sqrt{E_{OB}^2 + E_{OC}^2 + 2E_{OB}E_{OC}\cos 120^0} \end{aligned}$	1/2	
	$E_{BC} = E_{OB}$ , $\vec{E}_{OA} = -\vec{E}_{BC}$		
	Net electric field $\vec{E}_O = \vec{E}_{OA} + \vec{E}_{BC}$		
	$\vec{E}_O = 0$	1/2	
	Alternative In		
	Alternatively $E_{OA} = E_{OB} = E_{OC} = 2.7 \ NC^{-1}$		
	$E_{BC} = \sqrt{E_{OB}^2 + E_{OC}^2 + 2E_{OB}E_{OC}\cos 120^{\circ}}$		
		1/2	
	$=E_{OB}$		
	$As  \vec{E}_{BC} = -\vec{E}_{OA}$ $\vec{E}_{BC} + \vec{E}_{OA} = 0$		
	$E_{BC} + E_{OA} = 0$ Net electric field is zero.	1/2	
	Net electric field is zero.		
	Alternatively		
	$\left \vec{E}_{OA}\right  = \left \vec{E}_{OB}\right  = \left \vec{E}_{OC}\right $		
	Electric field vectors are making an angle of 120 <sup>0</sup> with each other. They make a closed polygon. So vector sum of all electric field vectors will be		
	zero.		
	$\vec{E} = 0$	2	2
19	Identifying behavior of combination 1		
	Justification 1		
	T. 1911 1 19	4	
	It will behave like a conversing lens.  Power of converging lens is more than the power of diverging lens. Hence	1	
	the combination will behave like a conversing lens.	1	
	Alternatively		
	$P = P_1 + P_2$		
	$=\frac{100}{10} + \frac{100}{-15}$		
	$P = \frac{10}{3} D$		
	3 Alternatively		
	Titter mutivery		
<u></u>			

	$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ $\frac{1}{f} = \frac{1}{10} - \frac{1}{15}$		
	$\frac{1}{f} = \frac{1}{30}$ $f = 30 \text{ cm}$		
20	J = 50 cm		2
20	Calculation of energy released 1 Calculation of time 1		
	(a) Number of atoms in 2g deuterium = $6.023 \times 10^{23}$	1/2	
	Energy released /atom $=\frac{3.27}{2}=1.635 \text{MeV}$	1/2	
	$t = \frac{\text{Total energy released}}{\text{Power}}$	1/2	
	$t = \frac{6.023 \times 10^{23} \times 1.635 \times 1.6 \times 10^{-13}}{200}$	1/2	
	$t = 7.88 \times 10^8 \text{ s}$	/2	2
21	Calculating frequency of light 2		
	$v = \frac{v}{2\pi r}$	1	
	$v = \frac{2.2 \times 10^6}{2 \times \pi \times 0.53 \times 10^{-10}}$	1/2	
	$v = 6.6 \times 10^{15} \mathrm{Hz}$	1/2	2
	SECTION - C		
22	(a)		
	(i) Statement of Lenz's Law  Justification  (ii) Calculating emf induced  1  1/2		
	(i) The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it.	1	
	In a closed loop, when the polarity of induced emf is such that, the induced current favours the change in magnetic flux then the magnetic flux and consequently the current will go on increasing without any external source of energy. This violets law of conservation of energy.	1/2	



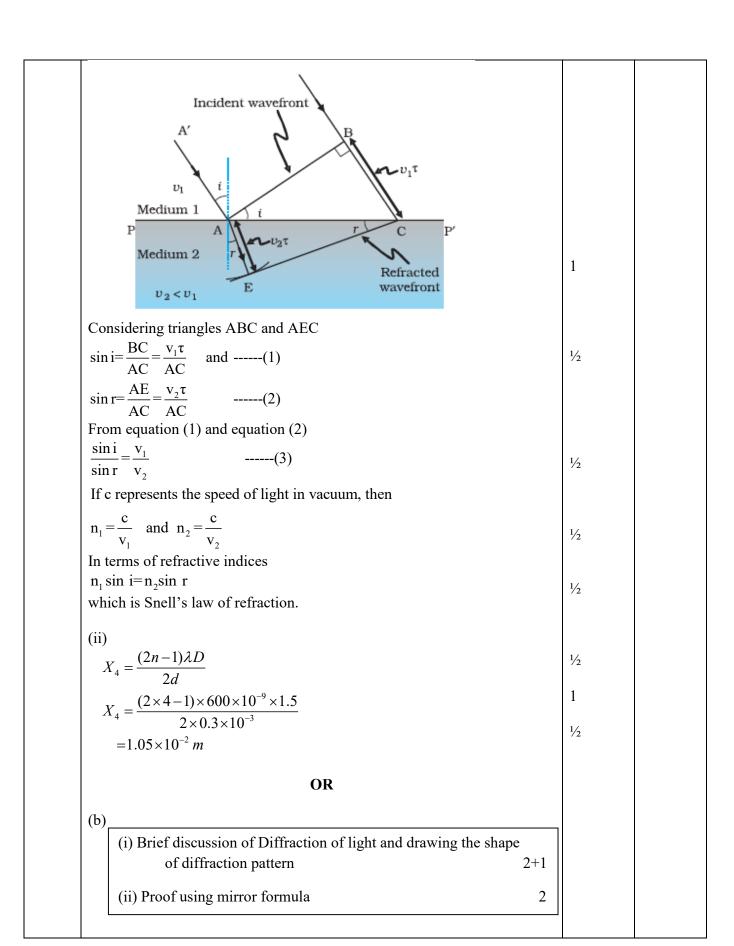
	(ii)		
	$K_{max} = hv - hv_0$	1/2	
	$\frac{1}{2}mV_{\max}^2 = h(v - v_0)$		
	$V_{\text{max}} = \left[\frac{2h(v - v_0)}{m}\right]^{\frac{1}{2}}$	1/2	
	$V_{\text{max}} = \left[ \frac{2 \times 6.63 \times 10^{-34} (9 - 3) \times 10^{14}}{9.1 \times 10^{-31}} \right]^{\frac{1}{2}}$	1/2	
	$=9.35\times10^5$ m/s	1/2	3
24	(a) Naming the parts of electromagnetic spectrum for (i) and (ii) ½ +½		
	(b) Writing one method of production and detection of each ½×4		
	(a) (i) Infrared waves (ii) Ultraviolet Rays (b) Mothed of mother time	1/2 1/2	
	(b) Method of production Infrared waves: Hot bodies / Vibration of atoms and molecules Ultraviolet Rays: Special UV lamps / Sun / Very hot bodies	1/ <sub>2</sub> 1/ <sub>2</sub>	
	Method of detection Infrared waves: Thermopiles / IR photographic film / Bolometer	1/2	
25	Ultraviolet Rays: Photocells / photographic film	1/2	3
	(a) Characteristics of p-n junction diode that makes it suitable for rectification 1 (b) Circuit diagram 1 Explanation of working of full wave rectifier 1		
	(a) p-n junction diode allows current to pass only when it is forward biased	1	
	(b) Centre-Tap Transformer  Diode $1(D_1)$ Centre A  Tap  Diode $2(D_2)$ $R_L$ Output	1	
	When input voltage to A, with respect to the centre tap at any instant is positive, at that instant voltage at B, being out of phase will be negative,		
	diode $D_1$ gets forward biased and conducts while $D_2$ being reverse biased		

output voltage across R <sub>L</sub> is obtain voltage at A becomes negative we would be positive. Hence D <sub>1</sub> wo	chis half cycle an output current and ned. During second half of the cycle when with respect to centre tap, the voltage at B ald not conduct but D <sub>2</sub> would be giving an		
output current and output voltage both halves of the cycle.	e. Thus output voltage is obtained during	1	3
26			
Explanation of (a), (b) and(c)	1+1+1		
(a) Charge of additional charge of the ionised cores in the lattice.	arriers is just equal and opposite to that of	1	
(b) Under equilibrium, the diffus	ion current is equal to the drift current.	1	
(c) Reverse current is limited due carriers on either side of the junc	e to concentration of minority charge tion.	1	3
27	C 1 1: 2		
(a) Calculation for magnetic (b) Tracing the path	force and radius 2 1		
(a) $\vec{F}_B = q(\vec{\mathbf{v}} \times \vec{\mathbf{B}})$		17	
$= -1.6 \times 10^{-19} \left[ (3 \times 10^6 \hat{i}) \times \right]$	$(91\times10^{-3}\hat{k})$	1/2	
$=1.6\times10^{-19} \left[ 3\times10^{6}\times91\times10^{6} \right]$	<del>-</del>		
$=4.368\times10^{-14}\hat{j}$ N	_	17	
$r = \frac{mV}{R}$		1/2	
qB 9.1×10 <sup>-31</sup> ×3×10 <sup>6</sup>		1/2	
$r = \frac{9.1 \times 10^{-31} \times 3 \times 10^{6}}{1.6 \times 10^{-19} \times 91 \times 10^{-3}} \mathrm{m}$			
$r = 1.875 \times 10^{-4} \text{ m}$			
(b) Anticlockwise circular path		1/2	
	0.45 - 1.75 - 2.75		
R			
		1	3
28			
(a) Calculating the drift speed	$1\frac{1}{2}$ ime $1\frac{1}{2}$		
(b) Calculation of Relaxation t	ime $1\frac{1}{2}$		

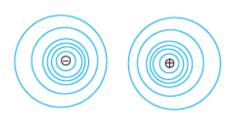
	(i) $v_d = \frac{I}{enA}$	1/2	
	$= \frac{4.25}{1.6 \times 10^{-19} \times 8.5 \times 10^{28} \times 10^{-6}} \text{ m/s}$	1/	
	$= 3.125 \times 10^{-4} \text{ m/s}$	1/ <sub>2</sub> 1/ <sub>2</sub>	
	3.125 \ 10 115	72	
	$v_d m l$		
	(ii) $\tau = \frac{\mathbf{v}_d m l}{eV}$	1/2	
	$= \frac{3.12 \times 10^{-4} \times 9.1 \times 10^{-31} \times 5}{1.6 \times 10^{-19} \times 1} \text{ m/s}$	1/2	
	$1.6 \times 10^{-19} \times 1$	, 2	
	$= 88.72 \times 10^{-16} \text{ s}$	17	2
	$= 8.872 \times 10^{-15} \text{ s}$	1/2	3
	SECTION - D		
29	(i) (C) greater than $\theta_2$	1	
	(ii) (C) $\lambda$ decreases but $\nu$ is unchanged	1	
	(iii) (a) (D) violet colour	1	
	OR		
	(iii) (b) (C) $r_R < r_y < r_y$		
		1	4
	(iv) (D) undergo total internal reflection		
30	(i) (D) HCl	1	
	(ii) (B) The net dipole moment of induced dipoles is along the		
	direction of the applied electric field.	1	
	(iii) (B) decreases and the electric field also decreases.	1	
	$\left[\begin{array}{ccc} 5K \end{array}\right]_{-\infty}$		
	(iv) (a) (C) $\left  \frac{5K}{4K+1} \right  C_0$	1	
	OR		
	(iv) (b) (D) $\frac{3}{16}$		4
	(iv) (b) (D) $\frac{3}{16}$		4
	SECTION - E		
31			
	(i) To identify the circuit element X, Y & Z 1½ (ii) To establish relation for impedance 2		
	Showing variation in current with frequency ½		
	(iii) To obtain condition for-		
	(i) Minimum impedance ½		
	(ii) Wattless current ½		
	(i) X: Resistor	1/2	
	Y : real inductor (such that its reactance is equal to its resistance) /		

Inductor	1/2	
Z: real capacitor (such that its reactance is equal to its resistance)/		
Capacitor	1/2	
(ii)		
$U_{\alpha} = v$		
$v_{c_m} - v_{l_m}$		
VP		
100		
$\omega_t$	1/2	
	/2	
$\mathbf{v}_{c} + \mathbf{v}_{r}$		
Even the fix		
From the fig. $V^2 + (V - V)^2$	1/2	
$V_m^2 = V_{Rm}^2 + (V_{Cm} - V_{Lm})^2$		
$V_m^2 = (i_m R)^2 + (i_m X_C - i_m X_L)^2$	1/2	
Impedance (Z) = $\frac{V_m}{I_m} = \sqrt{R^2 + (X_C - X_L)^2}$	1/2	
<i>m</i>		
(i)		
-     (a)		
ji		
(ii)		
$\omega_0$	1/2	
$\omega_0$		
ω, Γ'rad/s →		
(iii) $Z = \sqrt{R^2 + (X_C - X_L)^2}$		
For the minimum value of impedance		
$(i)   X_C = X_L$	1/2	
	/ 2	
(ii) Average power consumed in A.C. circuit over a cycle		
$P = VI \cos \varphi$		
For wattless current $P = 0$		
Since $V \neq 0$ , $I \neq 0$		
$\cos \varphi = 0$		
i.e. $\varphi = \frac{\pi}{2}$	1/2	
OR		

(i) Description of Construction and working Obtaining relation $\left(\frac{V_s}{V_p}\right)$ (ii) Causes of energy losses  2  (i) Construction: A transformer consists of two sets of coils, insulated from each other. They are wound on a soft-iron core, either one on top of other or on separate limbs of the core.  Alternatively  Working: When an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links with the secondary and induces an e.m.f. in it.  For an ideal transformer the induced e.m.f. ( $\varepsilon_p$ ) in primary coil for applied alternating voltage ( $V_p$ ) $\varepsilon_p = V_p = -N_p \frac{d\phi}{dt} \qquad (1)$ e.m.f. induced $\varepsilon_s$ in the secondary coil $\varepsilon_s = V_s = -N_s \frac{d\phi}{dt} \qquad (2)$ From eq. (1) and (2) $\frac{V_s}{V_p} = \frac{N_s}{N_p}$ (ii) Any four energy losses 1. Flux leakage. 2. Resistance of windings/ copper loss. 3. Eddy currents/fron loss. 4. Hysteresis. 5. Magnetostriction.  (a)  (i) Drawing refracted wavefront and Verification of Snell's law 3 (ii) Calculation of distance		(b)		
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resulting current produces an alternating magnetic flux which links with the secondary and induces an e.m.f. in it.  For an ideal transformer the induced e.m.f. ( $\varepsilon_p$ ) in primary coil for applied alternating voltage ( $V_P$ ) $\varepsilon_p = V_P = -N_P \frac{d\phi}{dt} \qquad$				
applied alternating voltage ( $V_P$ ) $\varepsilon_p = V_P = -N_P \frac{d\phi}{dt} \qquad$		resulting current produces an alternating magnetic flux which links with the secondary and induces an e.m.f. in it.	1	
$\varepsilon_p = V_p = -N_p \frac{d\phi}{dt} \qquad$		•		
e.m.f. induced $\varepsilon_s$ in the secondary coil $\varepsilon_s = V_s = -N_s \frac{d\phi}{dt} \qquad$			1/2	
$\varepsilon_{S} = V_{S} = -N_{S} \frac{d\phi}{dt} \qquad(2)$ From eq. (1) and (2) $\frac{V_{S}}{V_{P}} = \frac{N_{S}}{N_{P}} \qquad 1/2$ (ii) Any four energy losses 1. Flux leakage. 2. Resistance of windings/ copper loss. 3. Eddy currents/iron loss. 4. Hysteresis. 5. Magnetostriction.  2 (a) (i) Drawing refracted wavefront and Verification of Snell's law 3 (ii) Calculation of distance 2				
From eq. (1) and (2) $ \frac{V_S}{V_P} = \frac{N_S}{N_P} $ (ii) Any four energy losses 1. Flux leakage. 2. Resistance of windings/ copper loss. 3. Eddy currents/iron loss. 4. Hysteresis. 5. Magnetostriction.  (a)  (i) Drawing refracted wavefront and Verification of Snell's law 3 (ii) Calculation of distance  2. (a)				
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2. Resistance of windings/ copper loss. 3. Eddy currents/iron loss. 4. Hysteresis. 5. Magnetostriction.  (i) Drawing refracted wavefront and Verification of Snell's law 3 (ii) Calculation of distance  2 (a)		(ii) Any four energy losses		
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(a) (i) Drawing refracted wavefront and Verification of Snell's law 3 (ii) Calculation of distance 2			2 4	
(ii) Calculation of distance 2	2			
(i)				
		(i)		
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(i) A beam of light falls normally on a single slit and bends around its corners. This phenomenon is called diffraction.	1	
When a beam of light falls normally on a narrow single slit, then diffracte light goes on to meet a screen. It is observed that at the center of the screen intensity is maximum and goes on decreasing as one move away from the center on either side of screen.	d 1	
Incoming wave Viewing screen	1	
(ii) $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ $v = \frac{uf}{u - f}$		
Following new cartesian sign conversion $v = \frac{(-u)(-f)}{-u - (-f)}$ $v = \frac{uf}{f - u}  \text{as } f > u$	1	
v is +ve, So image is virtual. $m=-\frac{v}{u}=\frac{f}{f-u}>1$ i.e. Enlarged image	1	5
(i) Drawing equipotential surfaces (ii) Obtaining an expression for potential energy (iii) Finding the change in potential energy 2		
(i)		



1

(ii) Work done in bringing a charge  $q_1$  from infinity to  $\vec{r}_1$ :

$$W_1 = q_1 V(\vec{r}_1)$$
 -----(1)

 $\frac{1}{2}$ 

Work done in bringing a charge  $q_2$  from infinity to  $\vec{r}_2$  against the external field:

$$W_2 = q_2 V(\vec{r}_2)$$
 -----(2)

1/2

Work done on  $q_2$  against the field due to  $q_1$ :

$$W_{12} = \frac{q_1 q_2}{4\pi \varepsilon_0 r_{12}} \qquad -----(3)$$

Potential energy of the system = Total work done

$$= q_1 V(\vec{r}_1) + q_2 V(\vec{r}_2) + \frac{q_1 q_2}{4\pi\varepsilon_0 r_{12}}$$

(iii) Change in Potential energy = Work done

$$W = pE [\cos\theta_0 - \cos\theta_1]$$

$$W = 10^{-30} \times 10^5 [\cos\theta_0 - \cos6\theta_0]$$

$$W = 5.0 \times 10^{-26} J$$

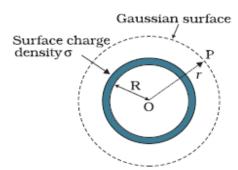
1  $\frac{1}{2}$  $\frac{1}{2}$ 

OR

- (i) Deduction of an expression for electric field for (i) and (ii) 3 2
  - (ii) Finding magnitude and direction of the net electric field

(i)

(i) Electric Field outside the shell



 $\frac{1}{2}$ 

Electric flux through Gaussian surface

$$\Phi = E \times 4\pi r^2$$

Charge enclosed by the Gaussian surface

$$Q = \sigma \times 4\pi R^2$$

Using Gauss' law: $\int \vec{E} \cdot d\vec{s} = \frac{Q}{\varepsilon_0}$	1/2	
Using Gauss' law: $\int \vec{E} \cdot \vec{ds} = \frac{Q}{\varepsilon_0}$ $E \times 4\pi r^2 = \frac{(\sigma 4\pi R^2)}{\varepsilon_0}$		
$\therefore E = \frac{\sigma R^2}{\varepsilon_0 r^2}$		
$\therefore E = \frac{\sigma R^2}{\varepsilon_0 r^2}$ $\vec{E} = \frac{\sigma R^2}{\varepsilon_0 r^2} \hat{r}$	1/2	
(ii) Field inside the shell		
Surface charge Gaussian surface density o		
T P	1/2	
Electric flux through Gaussian surface $\Phi = E \times 4 \pi r^2$ (: $r < R$ )  Charge enclosed by the Gaussian surface $Q = 0$		
By Gauss' Law $E \times 4\pi r^2 = 0$ i.e. $E = 0$ (Note: Award full credit of this part if a student writes directly E=0, mentioning as there is no charge enclosed by Gaussian surface)	1/2 1/2	
(ii) Electric field due to a long straight charged wire of linear charged density $\lambda$		
$\mathrm{E}=rac{\lambda}{2\piarepsilon_0 r}$	1/2	
$ \begin{array}{c c} A \\ + \\ + \\ + \\ + \\ + \\ + \\ + \\ + \\ + \\ +$		
Net electric field at the mid-point $E_{\text{net}} = E_1 + E_2$		

$2\pi\epsilon_0 r$	1/2	
$E_{\text{net}} = \frac{1}{2\pi\varepsilon_0 r} [\lambda_1 + \lambda_2]$		
$E_{\text{net}} = \frac{1}{2\pi\varepsilon_0 r} [\lambda_1 + \lambda_2]$ $= \frac{2 \times 9 \times 10^9}{0.5} [10 + 20] \times 10^{-6}$ $= 1.08 \times 10^6 \text{ NC}^{-1}$	1/2	
$\vec{F}$	1/2	5