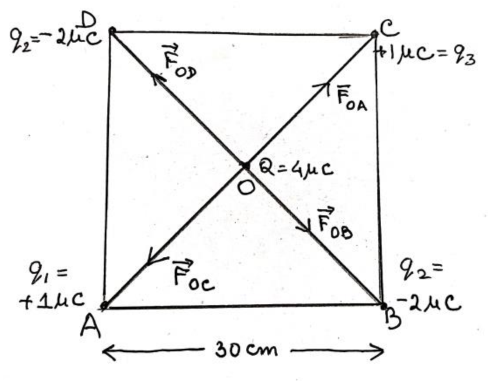
Marking Scheme Strictly Confidential (For Internal and Restricted use only) Senior School Certificate Examination, 2024 **SUBJECT PHYSICS (CODE 55/5/1)**	
General Instructions: -	
1	You are aware that evaluation is the most important process in the actual and correct assessment of the candidates. A small mistake in evaluation may lead to serious problems which may affect the future of the candidates, education system and teaching profession. To avoid mistakes, it is requested that before starting evaluation, you must read and understand the spot evaluation guidelines carefully.
2	**"Evaluation policy is a confidential policy as it is related to the confidentiality of the examinations conducted, Evaluation done and several other aspects. Its' leakage to public in any manner could lead to derailment of the examination system and affect the life and future of millions of candidates. Sharing this policy/document to anyone, publishing in any magazine and printing in News Paper/Website etc may invite action under various rules of the Board and IPC."**
3	Evaluation is to be done as per instructions provided in the Marking Scheme. It should not be done according to one's own interpretation or any other consideration. Marking Scheme should be strictly adhered to and religiously followed. **However, while evaluating, answers which are based on latest information or knowledge and/or are innovative, they may be assessed for their correctness otherwise and due marks be awarded to them. In class-X, while evaluating two competency-based questions, please try to understand given answer and even if reply is not from marking scheme but correct competency is enumerated by the candidate, due marks should be awarded.**
4	The Marking scheme carries only suggested value points for the answers These are in the nature of Guidelines only and do not constitute the complete answer. The students can have their own expression and if the expression is correct, the due marks should be awarded accordingly.
5	The Head-Examiner must go through the first five answer books evaluated by each evaluator on the first day, to ensure that evaluation has been carried out as per the instructions given in the Marking Scheme. If there is any variation, the same should be zero after delibration and discussion. The remaining answer books meant for evaluation shall be given only after ensuring that there is no significant variation in the marking of individual evaluators.
6	Evaluators will mark(√) wherever answer is correct. For wrong answer CROSS 'X" be marked. Evaluators will not put right (✓)while evaluating which gives an impression that answer is correct and no marks are awarded. **This is most common mistake which evaluators are committing.**
7	If a question has parts, please award marks on the right-hand side for each part. Marks awarded for different parts of the question should then be totaled up and written in the left-hand margin and encircled. This may be followed strictly.
8	If a question does not have any parts, marks must be awarded in the left-hand margin and

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

MARKING SCHEME : PHYSICS (042)			
CODE : 55/5/1			
Q.NO.	**VALUE POINTS/ EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION - A		
1.	(D) 0.5Ω	1	1
2.	(D) 4R	1	1
3.	(B) Sodium and Calcium	1	1
4.	(C) $5.2\,k\Omega$	1	1
5.	(A) $0.4\,\text{mH}$	1	1
6.	(B) Ultraviolet rays	1	1
7.	(D) 125	1	1
8.	(A) A	1	1
9.	(C) $3.4\,\text{eV}, -6.8\,\text{eV}$	1	1
10	(C) 8^{th}	1	1
11	(A) $0.8\,\text{fm}$	1	1
12	(B) 1.5×10^{16}	1	1
13	(C) Assertion (A) is true but Reason (R) is false.	1	1
14	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).	1	1
15	(C) Assertion (A) is true but Reason (R) is false.	1	1
16	(D) Both Assertion (A) and Reason (R) are false.	1	1
	SECTION - B		
17	(a) Diagram showing direction of forces 1 Finding net force 1  OA = OB = OC = OD = r Net force on charge $4\mu C$	1	

$\vec{F} = \vec{F}_{OA} + \vec{F}_{OB} + \vec{F}_{OC} + \vec{F}_{OD}$ ½

$\vec{F}_{OA} = -\vec{F}_{OC} \quad \Rightarrow \vec{F}_{OA} + \vec{F}_{OC} = 0$

$\vec{F}_{OB} = -\vec{F}_{OD} \quad \Rightarrow \vec{F}_{OB} + \vec{F}_{OD} = 0$

$\vec{F} = 0$ ½

Alternatively

$$F_{OA} = F_{OC} = \frac{9\times10^9 \times 4\times10^{-6} \times 1\times10^{-6}}{(15\sqrt{2}\times10^{-2})^2}$$

$$= 0.8\,\text{N}$$

$F_{OB} = F_{OD} = 1.6$ N ½

$F_1 = F_{OA} - F_{OC} = 0$

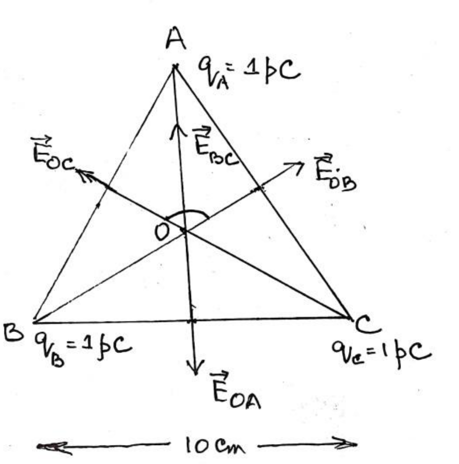
$F_2 = F_{OB} - F_{OD} = 0$

Net Force $\quad F = 0$ ½

OR

(b)

Finding net electric field at centroid	2



1

$q_A = q_B = q_C = 1\text{pC}$

$AO = BO = CO = r$

$|\vec{E}_{OA}| = |\vec{E}_{OB}| = |\vec{E}_{OC}|$

$\vec{E}_{BC} = \vec{E}_{OB} + \vec{E}_{OC}$

$E_{BC} = \sqrt{E_{OB}^2 + E_{OC}^2 + 2E_{OB}E_{OC}\cos120^0}$ ½

$E_{BC} = E_{OB} \quad , \quad \vec{E}_{OA} = -\vec{E}_{BC}$

Net electric field $\vec{E}_O = \vec{E}_{OA} + \vec{E}_{BC}$

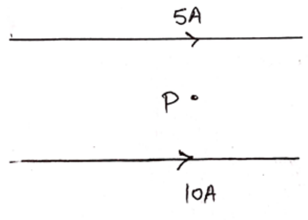
$\vec{E}_O = 0$ ½

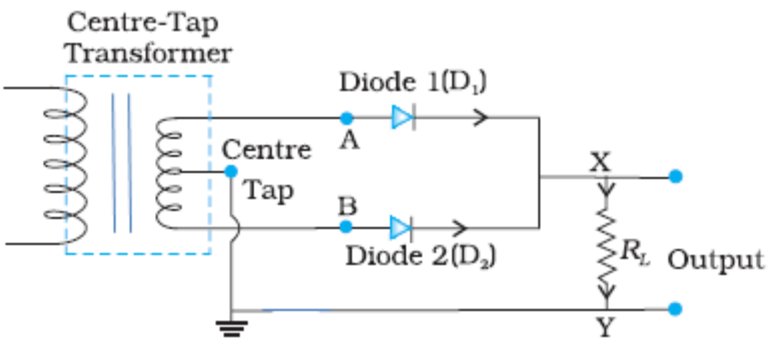
Alternatively

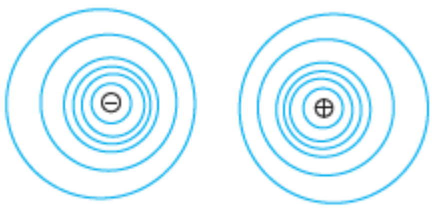
	$E_{OA} = E_{OB} = E_{OC} = 2.7\ \text{NC}^{-1}$ $E_{BC} = \sqrt{E_{OB}^2 + E_{OC}^2 + 2E_{OB}E_{OC}\cos 120^0}$ $= E_{OB}$ $As\ \ \vec{E}_{BC} = -\vec{E}_{OA}$ $\vec{E}_{BC} + \vec{E}_{OA} = 0$ Net electric field is zero. **Alternatively** $\lvert\vec{E}_{OA}\rvert = \lvert\vec{E}_{OB}\rvert = \lvert\vec{E}_{OC}\rvert$ Electric field vectors are making an angle of 120^0 with each other. They make a closed polygon. So vector sum of all electric field vectors will be zero. $\vec{E} = 0$	½ ½ 2	2
18	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 $\vec{B}$ $\vec{F} = (nAL)\,q\vec{v}_d \times \vec{B}$ ------(1) Where $\vec{v}_d$ is the drift velocity of the charge carriers Current flowing $I = v_d qnA$ $I\vec{L} = \vec{v}_d qnAL$ ------(2) On solving equation (1) and (2) $\vec{F} = I(\vec{L} \times \vec{B})$ 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.	½ ½ ½ ½	2
19	Calculation of magnifying power 1 Calculation of image distance 1 $\lvert m\rvert = \dfrac{f_0}{f_e}$ $= \dfrac{150}{5} = 30$ $\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u}$	½ ½ ½	

	$\frac{1}{150}=\frac{1}{v}-\frac{1}{\infty}$ $v=150\,\text{cm}$ (Note: Award full credit of this part, if a student writes correct distance of image without calculation i.e. using object position at infinity.)	½	2
20	(a) Finding the wavelength 1½ (b) Identifying series ½ (a) $E_2-E_1=\frac{hc}{\lambda}$ Given $E_2-E_1=2.55\times1.6\times10^{-19}$ J $\Rightarrow \quad \lambda=\frac{6.63\times10^{-34}\times3\times10^{8}}{2.55\times1.6\times10^{-19}}=487.5\,\text{nm}$ (b) Balmer series	½ ½ ½ ½	2
21	Finding the quantum number 2 Using Bohr's model $mvr=\frac{nh}{2\pi}$ $n=\frac{2\pi\times6.0\times10^{24}\times30\times10^{3}\times1.5\times10^{11}}{6.63\times10^{-34}}$ $n=2.558\times10^{74}$	1 ½ ½	2
	SECTION - C		
22	(a) Writing Einstein's photoelectric equation 1½ Milliken's proof for the validity (b) Explanation of existence of threshold frequency 1½ (a) $h\nu=h\nu_0+K_{max}=h\nu_0+eV_0$ By finding the value of Planck's constant using V_0 versus υ straight line plot for sodium. (b) Since K_{max} must be non- negative therefore photo-electric emission is possible only when $h\nu > h\nu_0$, which implies the existence of ν_0.	1½ 1½	3
23	(a) Defining the term electric flux 1 Writing dimensions ½ (b) Finding the electric flux 1½ (a) It is the measure of the total number of electric field lines passing through a surface normally. **Alternatively**	1	

	Surface integral of electric field over a surface. **Alternatively** $\phi_E = \vec{E}\cdot\vec{A}$ $\left[ML^3T^{-3}A^{-1}\right]$ (b) $\phi_E = \vec{E}.\vec{A}$ $=(100\hat{i}).(10^{-4}\,\hat{n})$ $=(100\hat{i}).(0.8\hat{i}+0.6\hat{k})10^{-4}$ $=8\times10^{-3}\ \text{Nm}^2\text{C}^{-1}$	½ ½ ½ ½	3
24	**(a)** (i) Statement of Lenz's Law — 1 Justification — ½ (ii) Calculating emf induced — 1½ (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. 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 violates law of conservation of energy. $\varepsilon = \frac{1}{2}Bl^2\omega$ $=\frac{1}{2}\times2\times(2)^2\times(2\pi\times60)$ $=480\pi\ \ \text{V}$ $=1.51\times10^3\ \ \text{V}$ **OR** **(b)** (i) Statement and explanation of Ampere's circuital law — 1 (ii) Finding magnitude and direction of magnetic field — 2 (i) Line integral of magnetic field over a closed loop in vacuum is equal to μ_0 times the total current passing through the loop. **Alternatively** $\oint \vec{B}\cdot\vec{dl} = \mu_0 I$ The integral in this expression is over a closed loop coinciding with the boundary of the surface.	1 ½ ½ ½ ½ 1	

	(ii)  $B=\frac{\mu_0 I}{2\pi r}$ Net magnetic field B = $B_2 - B_1$ $B=\frac{\mu_0\times10^2}{20\pi}[10-5]$ $B=\frac{4\pi\times10^{-7}\times10^2\times5}{20\pi}$ $B=10^{-5}\,\mathrm{T}$ Along the direction of magnetic field produced by the conductor carrying current 10A.	½ ½ ½ ½	3
25	Finding the radius of circular path 1 Answer for linear path ½ Calculation of linear distance covered 1½ Radius of circular path $r=\frac{m\mathrm{v}_x}{eB}$ $r=\frac{9.1\times10^{-31}\times1\times10^7}{1.6\times10^{-19}\times0.5\times10^{-3}}$ $=11.38\times10^{-2}\,\mathrm{m}$ Yes, it traces a linear path too. Linear distance during period of one revolution $y=\frac{2\pi m}{eB}\times\mathrm{v}_y$ $=\frac{2\times\pi\times9.1\times10^{-31}\times0.5\times10^7}{1.6\times10^{-19}\times0.5\times10^{-3}}$ $=0.357\,\mathrm{m}$ $=0.36$ m	½ ½ ½ ½ ½ ½	3
26	(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	½ ½	

	(b) Method of production Infrared waves: Hot bodies / Vibration of atoms and molecules Ultraviolet Rays: Special UV lamps / Sun / Very hot bodies Method of detection Infrared waves: Thermopiles / IR photographic film / Bolometer Ultraviolet Rays: Photocells / photographic film	½ ½ ½ ½	3
27	(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 (b)  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 does not conduct. Hence during this half cycle an output current and output voltage across R_L is obtained. During second half of the cycle when voltage at A becomes negative with respect to centre tap, the voltage at B would be positive. Hence D_1 would not conduct but D_2 would be giving an output current and output voltage. Thus output voltage is obtained during both halves of the cycle.	 1 1 1	 3
28	Explanation of (a), (b) and(c) 1+1+1 (a) Charge of additional charge carriers is just equal and opposite to that of the ionised cores in the lattice. (b) Under equilibrium, the diffusion current is equal to the drift current. (c) Reverse current is limited due to concentration of minority charge carriers on either side of the junction.	 1 1 1	 3
	SECTION - D		
29	(i) (D) HCl (ii) (B) The net dipole moment of induced dipoles is along the direction of the applied electric field.	1 1	

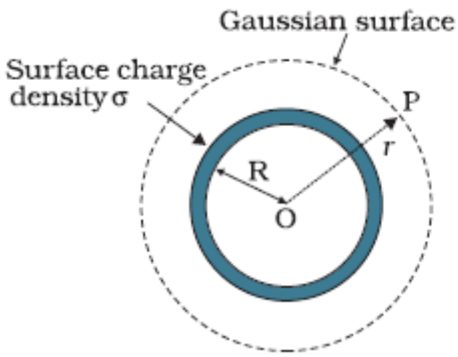
	(iii) (B) decreases and the electric field also decreases. (iv) (a) (C) $\left[\frac{5K}{4K+1}\right]C_0$ **OR** (iv) (b) (D) $\frac{3}{16}$	1 1	4
30	(i) (C) greater than θ_2 (ii) (C) λ decreases but ν is unchanged (iii) (a) (D) violet colour OR (iii) (b) (C) $r_R < r_Y < r_V$ (iv) (D) undergo total internal reflection	1 1 1 1	4
	SECTION - E		
31	(a) (i) Drawing equipotential surfaces — 1 (ii) Obtaining an expression for potential energy — 2 (iii) Finding the change in potential energy — 2 (i)  (ii) Work done in bringing a charge q_1 from infinity to $\vec{r}_1$: $W_1 = q_1V(\vec{r}_1)$ -------------(1) Work done in bringing a charge q_2 from infinity to $\vec{r}_2$ against the external field : $W_2 = q_2V(\vec{r}_2)$ -------------(2) Work done on q_2 against the field due to q_1: $W_{12} = \frac{q_1q_2}{4\pi\varepsilon_0 r_{12}}$ -----------------(3) Potential energy of the system = Total work done $= q_1V(\vec{r}_1) + q_2V(\vec{r}_2) + \frac{q_1q_2}{4\pi\varepsilon_0 r_{12}}$ (iii) Change in Potential energy = Work done $W = pE[\cos\theta_0 - \cos\theta_1]$ $W = 10^{-30} \times 10^5 [\cos 0^0 - \cos 60^0]$ $W = 5.0 \times 10^{-26}$ J **OR**	 1 ½ ½ ½ ½ 1 ½ ½	

(b)

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

(i)

(i) **Electric Field outside the shell**



½

Electric flux through Gaussian surface

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

Charge enclosed by the Gaussian surface

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

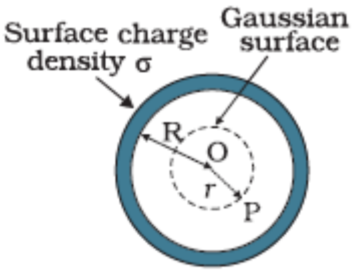
Using Gauss' law: $\int \vec{E}.\vec{ds} = \dfrac{Q}{\varepsilon_0}$ ½

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

$\therefore\ E = \dfrac{\sigma R^2}{\varepsilon_0 r^2}$ ½

$\vec{E} = \dfrac{\sigma R^2}{\varepsilon_0 r^2}\hat{r}$

(ii) **Field inside the shell**



½

Electric flux through Gaussian surface

$\Phi = E \times 4\pi r^2 \qquad (\because r < R)$

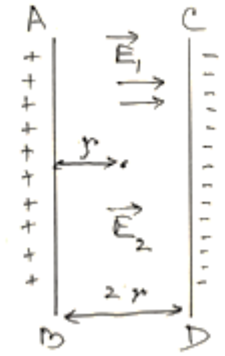
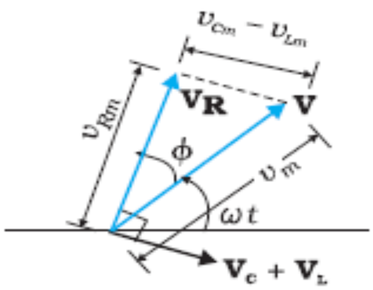
Charge enclosed by the Gaussian surface

$Q = 0$

By Gauss' Law

$E \times 4\pi r^2 = 0$ ½

i.e. $E = 0$ ½

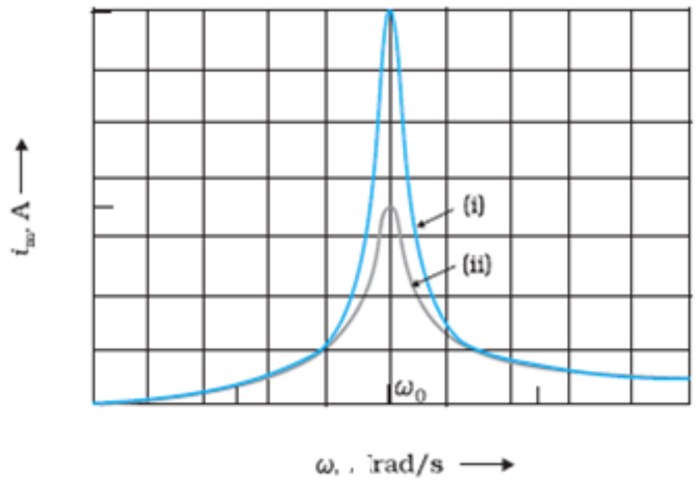
	(Note: Award full credit of this part if a student writes directly E=0, mentioning as there is no charge enclosed by Gaussian surface) **(ii)** Electric field due to a long straight charged wire of linear charged density λ $E = \dfrac{\lambda}{2\pi\varepsilon_0 r}$  Net electric field at the mid-point $E_{net} = E_1 + E_2$ $= \dfrac{\lambda_1}{2\pi\varepsilon_0 r} + \dfrac{\lambda_2}{2\pi\varepsilon_0 r}$ $E_{net} = \dfrac{1}{2\pi\varepsilon_0 r}[\lambda_1 + \lambda_2]$ $= \dfrac{2\times9\times10^{9}}{0.5}[10+20]\times10^{-6}$ $= 1.08 \times 10^{6}\ NC^{-1}$ $\vec{E}_{net}$ is directed towards CD.	½ ½ ½ ½	5
32	(a) (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 Y : real inductor (such that its reactance is equal to its resistance) / Inductor Z : real capacitor (such that its reactance is equal to its resistance)/ Capacitor (ii) 	½ ½ ½ ½	

From the fig.

$V_m^2 = V_{Rm}^2 + (V_{Cm} - V_{Lm})^2$ ½

$V_m^2 = (i_m \mathrm{R})^2 + (i_m X_C - i_m X_L)^2$ ½

Impedance $(Z) = \dfrac{V_m}{I_m} = \sqrt{R^2 + (X_C - X_L)^2}$ ½



½

(iii) $Z = \sqrt{R^2 + (X_C - X_L)^2}$

For the minimum value of impedance

(i) $X_C = X_L$ ½

(ii) Average power consumed in A.C. circuit over a cycle

P = VI cos φ

For wattless current P = 0

Since V ≠ 0 , I ≠ 0

cos φ = 0

i.e. $\varphi = \frac{\pi}{2}$ ½

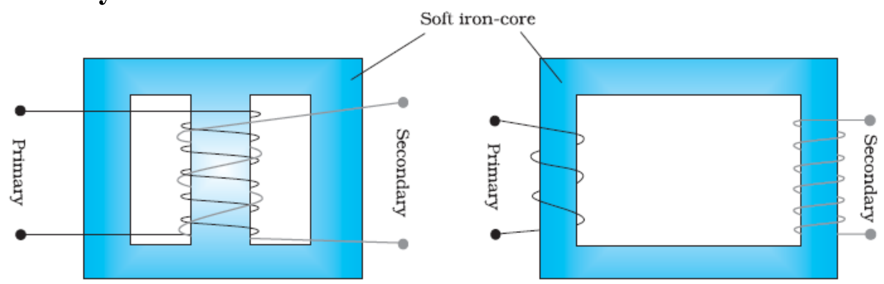
OR

(b)

(i) Description of Construction and working	1+1
Obtaining relation ($\frac{V_S}{V_P}$)	1
(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



(a) (b)

1

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 emf. in it. 1

For an ideal transformer the induced emf (ε_p) in primary coil for applied alternating voltage (V_P)

$$\varepsilon_p = V_P = -N_P \frac{d\phi}{dt} \quad \text{-------------------(1)}$$ ½

e.m.f. induced ε_S in the secondary coil

$$\varepsilon_S = V_S = -N_S \frac{d\phi}{dt} \quad \text{-------------------(2)}$$

From eq. (1) and (2)

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$ ½

(ii) Any four energy losses

1. Flux leakage.
2. Resistance of windings/ copper loss.
3. Eddy currents/iron loss.
4. Hysteresis.
5. Magnetostriction.

$\frac{1}{2} \times 4$ | 5

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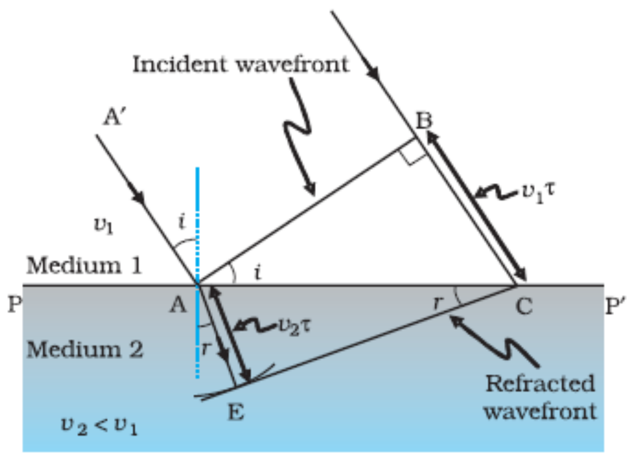
33 (a)

(i) Drawing refracted wavefront and Verification of Snell's law	3
(ii) Calculation of distance	2

(i)



1

Considering triangles ABC and AEC

$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$ and ------(1)

$\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$ ------(2) ½

From equation (1) and equation (2)

$\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$ ------(3) ½

If c represents the speed of light in vacuum, then

$n_1 = \frac{c}{v_1}$ and $n_2 = \frac{c}{v_2}$ ½

In terms of refractive indices

$n_1 \sin i = n_2 \sin r$ ½

which is Snell's law of refraction.

(ii)

$X_4 = \frac{(2n-1)\lambda D}{2d}$ ½

$X_4 = \frac{(2\times 4-1)\times 600\times 10^{-9}\times 1.5}{2\times 0.3\times 10^{-3}}$ 1

$=1.05\times 10^{-2}$ m ½

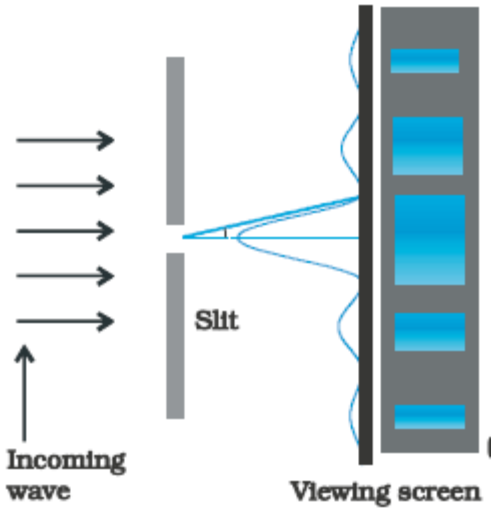
OR

(b)

(i) Brief discussion of Diffraction of light and drawing the shape of diffraction pattern	2+1
(ii) Proof using mirror formula	2

(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 diffracted light goes on to meet on 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. 1



1

	(ii) $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$ $v=\frac{uf}{u-f}$ Following new cartesian sign conversion $v=\frac{(-u)(-f)}{-u-(-f)}$ $v=\frac{uf}{f-u}$ as $f>u$ v is +ve, So image is virtual. $m=-\frac{v}{u}=\frac{f}{f-u}>1$ i.e. Enlarged image	 1 1	 5