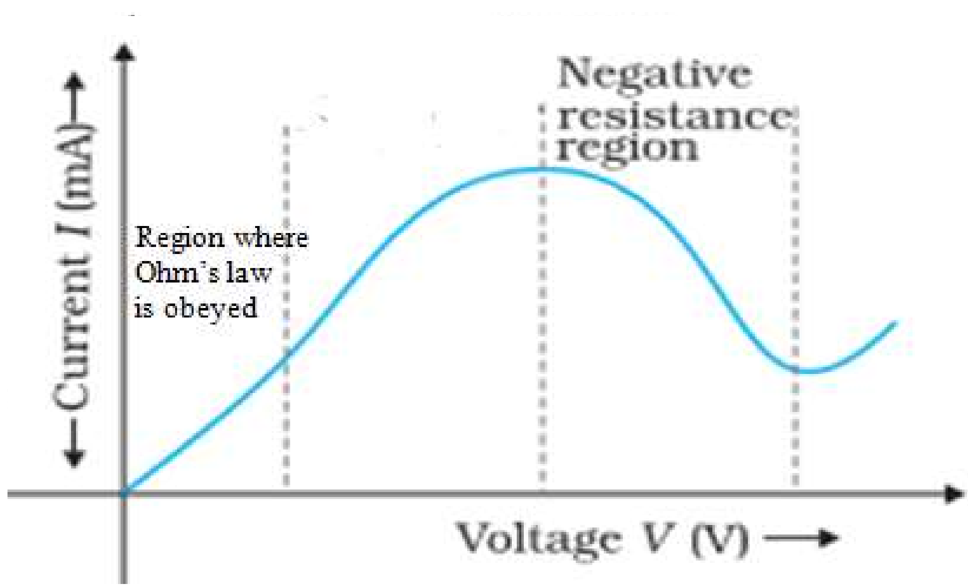
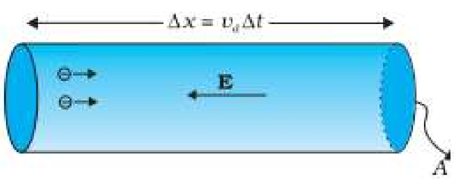
MARKING SCHEME : PHYSICS (042)			
CODE :55/1/1			
Q.NO.	**VALUE POINT/EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	Section A		
1.	(B) Zero	1	1
2.	(D) 5.0×10^{-2} J	1	1
3.	(B) 8V	1	1
4.	(C) Shrink	1	1
5.	(B) $(-0.8\ \text{mN})\,\hat{i}$	1	1
6.	(B) $\frac{G}{1000}\Omega$	1	1
7.	(A) $\frac{X}{6}$	1	1
8.	(A) I	1	1
9.	(C) $n_f = 2$ and $n_i = 4$	1	1
10.	(B) the number of conduction electrons increases	1	1
11.	(C) $\frac{1}{3}$	1	1
12.	(A) momentum	1	1
13.	(D) Assertion (A) is false and reason (R) is also false.	1	1
14.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)	1	1
15.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)	1	1
16.	(D) Assertion (A) is false and reason (R) is also false.	1	1
	Section B		
17.	Finding the temperature 2 $R = R_\circ\left[1+\alpha\left(T-T_\circ\right)\right]$ $R = 2R_\circ$ [Given] $2R_\circ = R_\circ\left[1+\alpha\left(T-T_\circ\right)\right]$ On solving $T = T_\circ + 250$ $T = 270°C$ or $543\,K$	½ ½ 1	2

18.	(a) Finding the wavelength of (i) Reflected Light 1 (ii) Refracted Light 1 (i) v = υ λ $3\times10^8 = 5\times10^{14} \times \lambda$ λ = 600 nm or 6×10^{-7}m (ii) $\lambda_{medium} = \frac{\lambda_{air}}{\mu}$ $\lambda_{medium} = \frac{600\,nm}{1.5}$ = 400 nm or 4×10^{-7}m OR (b) Calculating the radius of the curved surface 2 $\frac{1}{f} = (\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ $\frac{1}{16} = (1.4-1)\left(\frac{1}{R}-\frac{1}{\infty}\right)$ $\frac{1}{16} = 0.4\times\frac{1}{R}$ R = 16 × 0.4 R = 6.4 cm	 1 1 1 1	 2
19.	Finding the (i) position of the image formed 1 (ii) magnification of the image 1 (i) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ $\frac{1}{v} + \frac{1}{-30} = \frac{1}{-20}$ On solving v = - 60 cm	 ½ ½	

	(ii) $m = -\frac{v}{u}$ $= -\left(\frac{-60}{-30}\right)$ $= -2$	½ ½	2
20.	Obtaining an expression for λ_n / λ_p 2 $E = \frac{hc}{\lambda p} \Rightarrow \lambda p = \frac{hc}{E}$ $\lambda n = \frac{h}{p} = \frac{h}{\sqrt{(2mE)}}$ $\frac{\lambda n}{\lambda p} = \frac{h}{\sqrt{(2mE)}} \times \frac{E}{hc}$ $\frac{\lambda n}{\lambda p} = \sqrt{\left(\frac{E}{2mc^2}\right)}$	½ ½ ½ ½	2
21.	Plotting the graph 1 Marking the region where: (a) resistance is negative ½ (b) Ohm's law is obeyed ½ 	1+ ½ + ½	2

	SECTION C		
22.	Calculating (a) the flux passing through the cube 2 (b) the charge within the cube 1		
	a) $\varphi_L = \overrightarrow{E_L} \cdot \vec{A} = -[500 \times 0.1] \times [(0.1)^2] = -0.5\ N\ m^2\ C^{-1}$	½	
	$\varphi_R = \overrightarrow{E_R} \cdot \vec{A} = [500 \times 0.2] \times [(0.1)^2] = 1\ N\ m^2\ C^{-1}$	½	
	Net flux = $\varphi_L + \varphi_R = 0.5\ N\ m^2\ C^{-1}$	1	
	b) flux, $\varphi = \frac{q}{\varepsilon_o}$	½	
	charge, $q = \varphi \times \varepsilon_o$ $= 0.5\ \varepsilon_o$ $= 4.4 \times 10^{-12}$ C	½	3
23.	a)		
	• Defining current density ½ • Whether scalar or vector ½ • Showing $\vec{j} = \alpha\ \vec{E}$ 2		
	Current density is the amount of charge flowing per second per unit area normal to the flow. Alternatively: $j = \frac{I}{A}$	½	
	It is a vector quantity.	½	
	 		
	The amount of charge crossing the area A in time Δt is I Δt, where I is the magnitude of the current. Hence, $I\,\Delta t = ne\,A\,\lvert v_d \rvert\,\Delta t$	½	

$$I \Delta t = \frac{e^2 A}{m} \tau n \Delta t |E|$$ ½

$I = |j|A$ ½

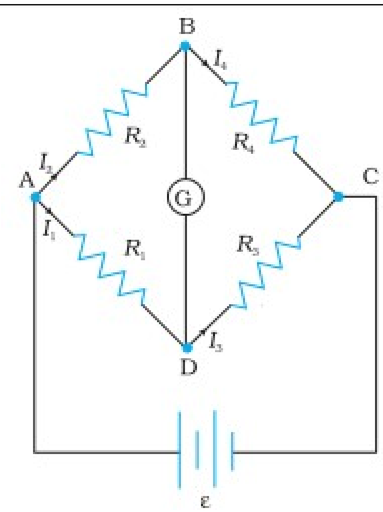
$$|j| = \frac{ne^2}{m} \tau \ |E|$$ ½

$\vec{j} = \alpha \ \vec{E}$

OR

b)

Defining Wheatstone bridge	1
Obtaining balancing conditions	2



1

Alternatively:
If the figure is explained in words full credit to be given.

For loop ADBA:
$-I_1 R_1 + I_2 R_2 + I_g G = 0$ (1) ½

For loop CBDC:
$I_4 R_4 - I_3 R_3 - I_g G = 0$ (2) ½

For balanced wheatstone bridge, Ig = 0 ½
And by applying Kirchoff's junction rule to junction D and B,

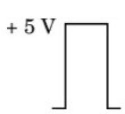
$I_1 = I_3$ & $I_2 = I_4$

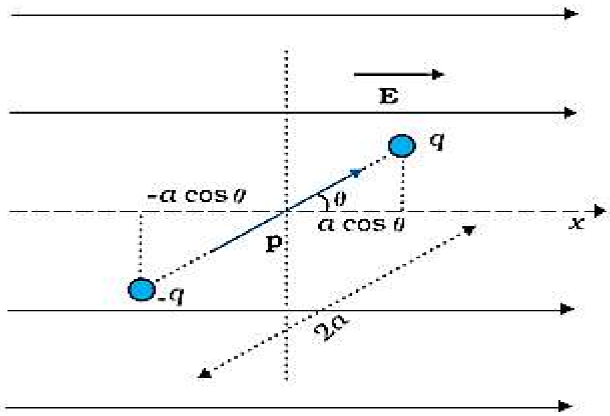
From eqn (1) and (2)

	$\frac{I_1}{I_2} = \frac{R_2}{R_1}$ and $\frac{I_1}{I_2} = \frac{R_4}{R_3}$ $\Rightarrow \frac{R_2}{R_1} = \frac{R_4}{R_3}$	½	3
24.	Calculating a) the speed of the proton 1 b) the magnitude of the acceleration of the proton 1 c) the radius of the path traced by the proton 1 a) $v = \sqrt{\left(\frac{2 \text{ x K.E.}}{m}\right)}$ $= 4 \text{ x } 10^6$ m/s b) acceleration = qvB / m $= 8 \text{ x } 10^{11}$ m/s^2 c) r = mv / Bq = 20 m	½ ½ ½ ½ ½ ½	3
25.	Deriving an expression for the average power dissipated in series LCR circuit 2 Obtaining expression for the resonant frequency 1 $v = v_m \sin\omega t$ $i = i_m \sin(\omega t+\varphi)$ Power, $P = v\,i = (v_m \sin\omega t) \text{ x } [i_m \sin(\omega t+\varphi)]$ $= \frac{v_m i_m}{2}[\cos\varphi - \cos(2\omega t+\varphi)]$ (1) The average power over a cycle is given by the average of the two terms in RHS of eqn (1). It is only the 2nd term which is time dependent. It's average is zero. Therefore, $P = \frac{v_m i_m}{2}\cos\varphi$	½ ½ ½	

	$P = V I \cos\varphi$ OR $P = I^2 Z \cos\varphi$ At resonance, $X_C = X_L$ $$\frac{1}{\omega C} = \omega L$$ $$\omega = \frac{1}{\sqrt{(LC)}}$$ => $$\upsilon = \frac{1}{2\pi\sqrt{(LC)}}$$	½ ½ ½	3
26.	a) Two examples 1 b) (i) Reason for use of short waves bands 1 (ii) Reason for x-ray astronomy from satellites 1 a) (Any Two) • Gamma radiation having wavelength of 10^{-14} m to 10^{-15} m, typically originate from an atomic nucleus. • X-rays are emitted from heavy atoms. • Radio waves are produced by accelerating electrons in a circuit. A transmitting antenna can most efficiently radiate waves having a wavelength of about the same size as the antenna. b) (i) Ionosphere reflects waves in these bands (ii) Atmosphere absorbs x-rays, while visible and radio waves can penetrate it Note: Full credit to be given for part (b) for mere attempt.	½ + ½ 1 1	3
27.	• Drawbacks of Rutherford's atomic model 1 • Bohr's explanation 1 • Showing different orbits are not equally spaced 1 Drawbacks: i) According to classical electromagnetic theory, an accelerating charged particle emits radiation in the form of electromagnetic waves. The energy of an accelerating electron should therefore, continuously decrease. The electron would spiral inward and eventually fall into the nucleus. Thus, such		

	an atom cannot be stable. ii) As the electrons spiral inwards, their angular velocities and hence their frequencies would change continuously. Thus, they would emit a continuous spectrum, in contradiction to the line spectrum actually observed. Bohr postulated stable orbits in which electrons do not radiate energy Alternatively: Bohr's postulates (Any ONE of the three) (i) An electron in an atom could revolve in certain stable orbits without the emission of radiant energy. (ii) The electron revolves around the nucleus only in those orbits for which the angular momentum is some integral multiple of $h/2\pi$ (iii) An electron might make a transition from one of its specified non-radiating orbits to another of lower energy. When it does so, a photon is emitted having energy equal to the energy difference between the initial and final states. The radius of the n^{th} orbit is found as $r_n = \left(\frac{n^2}{m}\right)\left(\frac{h}{2\pi}\right)^2 \frac{4\pi\varepsilon_0}{e^2}$ $r_n \propto n^2$ Alternatively: Difference in radius of consecutive orbits is $r_{n+1} - r_n = k\,[(n+1)^2 - n^2)]$ $= k\,(2n + 1)$ which depends on n, and is not a constant	1 1 1	3
28.	a) Stating two properties of a nucleus 1 b) Why density of a nucleus is much more than that of an atom 1 c) Showing that density of nuclear matter is same for all nuclei 1 a) (Any TWO) (i) The nucleus is positively charged (ii) The nucleus consists of protons and neutrons (iii) The nuclear density is independent of mass number (iv) The radius of the nucleus, $R = R_o A^{1/3}$ b) Atoms have large amount of empty spaces. Mass is concentrated in nucleus.	½ + ½ 1	

	c) Density = Mass / Volume $= \frac{m\,A}{\frac{4}{3}\pi R^3} = \frac{m\,A}{\frac{4}{3}\pi R_o^3\,A}$ $= \frac{m}{\frac{4}{3}\pi R_o^3}$ So, density is independent of mass number	1	3
	SECTION D		
29.	(i) (A) $\frac{2(n-1)}{R}$ (ii) (D) P/2 (iii) (B) P (iv) a) (C) 2P OR b) (A) 6.6 D	1 1 1 1	4
30.	(i) (A) $\frac{Vo}{\sqrt{2}}$ (ii) (B) half cycle of the input signal (iii) (C) One is forward biased and the other is reverse biased at the same time (iv) a) (B) 50 Hz OR b) (D) 	1 1 1 1	4

	Section E		
31.	(a) (i) • Deriving the expression for potential energy 2 • Maximum & Minimum value of potential energy (½ + ½) (ii) Finding the torque. 2 (i)  The amount of work done in rotating the dipole from θ = θ_0 to θ = θ_1 by the external torque $W = \int_{\theta_0}^{\theta_1} \tau_{ext} \, d\theta$ $= \int_{\theta_0}^{\theta_1} pE \sin\theta \; d\theta$ $W = pE(\cos\theta_0 - \cos\theta_1)$ For $\theta_0 = \frac{\pi}{2}$ and $\theta_1 = \theta$ $= pE(\cos\frac{\pi}{2} - \cos\theta)$ $U(\theta) = -pE \; \cos\theta$ $= -\vec{p}.\vec{E}$	½ ½ ½ ½	
	(1) Potential energy is maximum when: $\vec{p}$ is antiparallel to $\vec{E}$ Alternatively: $\theta = 180°$ or π radians	½	

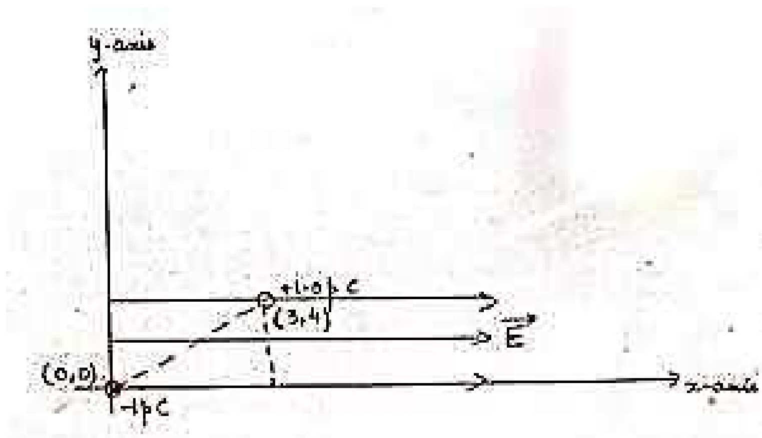
(2) Potential energy is minimum when:

$\vec{p}$ is along to $\vec{E}$ ½

Alternatively:

$\theta = 0°$

(ii)



$\tau = pE\sin\theta$ ½

$= (2aq)E\sin\theta$ ½

$= (5\times10^{-3}\times1\times10^{-12})10^{3}\times\frac{4}{5}$ ½

$= 4\times10^{-12}\ \ Nm$

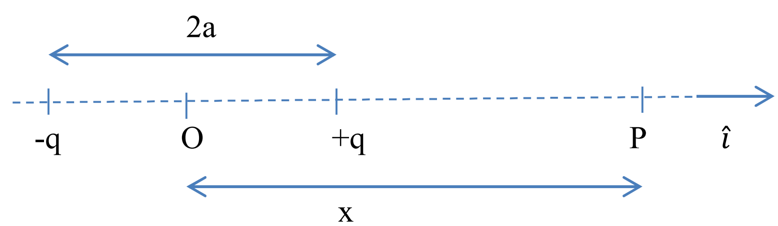
Direction is along –ve Z direction. ½

OR

(b)

(i) Deriving expression for potential	2 ½
(ii) New charge on Sphere S_1	2 ½

(i)



½

$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ ½

$V = V_{+q} - V_{-q}$

$$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{(x-a)} - \frac{q}{(x+a)}\right]$$ ½

$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{x+a-x+a}{(x^2-a^2)}\right]$$

$$V = \frac{q}{4\pi\varepsilon_0}\frac{2a}{(x^2-a^2)} = \frac{p}{4\pi\varepsilon_0(x^2-a^2)}$$

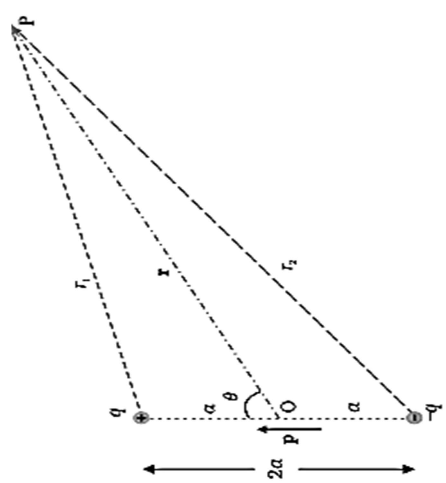
As p is along x-axis, so

$$V = \frac{1}{4\pi\varepsilon_0}\frac{\vec{p}.\hat{i}}{(x^2-a^2)}$$ ½

If x>>a

$$V = \frac{1}{4\pi\varepsilon_0}\frac{\vec{p}.\hat{i}}{x^2}$$ ½

Alternatively:



$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r_1} - \frac{q}{r_2}\right)$$ ----- (i) ½

By geometry

$$r_1^2 = r^2 + a^2 - 2ar\,cos\theta$$

$$r_2^2 = r^2 + a^2 + 2ar\,cos\theta$$

$$r_1^2 = r^2\left(1 - \frac{2acos\theta}{r} + \frac{a^2}{r^2}\right)$$

$$\cong r^2\left(1 - \frac{2a\cos\theta}{r}\right)$$ ½

Similarly, $r_2^2 \cong r^2\left(1 + \frac{2a\cos\theta}{r}\right)$ ½

Using binomial theorem & retaining terms upto the first order in $\frac{a}{r}$; we obtain

$$\frac{1}{r_1} \cong \frac{1}{r}\left(1 - \frac{2a\cos\theta}{r}\right)^{-\frac{1}{2}} \cong \frac{1}{r}\left(1 + \frac{a}{r}\cos\theta\right) \quad \text{----- (ii)}$$

$$\frac{1}{r_2} \cong \frac{1}{r}\left(1 - \frac{2a\cos\theta}{r}\right)^{-\frac{1}{2}} \cong \frac{1}{r}\left(1 - \frac{a}{r}\cos\theta\right) \quad \text{----- (iii)}$$

Using equations (i) ,(ii) & (iii) & p = 2qa

$$V = \frac{q}{4\pi\varepsilon_0}\frac{2a\cos\theta}{r^2} = \frac{p\cos\theta}{4\pi\varepsilon_0 r^2}$$ ½

$$\text{p}\cos\theta = \vec{p}\,.\,\hat{r}$$

As $\vec{r}$ is along the x – axis.

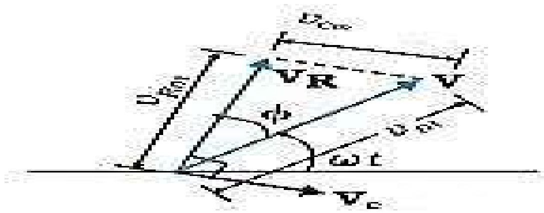
$$\Rightarrow \vec{p}\,.\hat{r} = \vec{p}\,.\hat{i}$$ ½

$$\Rightarrow V = \frac{1}{4\pi\varepsilon_0}\frac{\vec{p}\,.\hat{i}}{x^2}$$

	(ii) Charge on sphere S_1 : Q_1 = surface charge density × surface Area $= \left(\frac{2}{\pi}\times 10^{-9}\right)\times 4\pi\,(1\times 10^{-2})^2$ $= 8\times 10^{-13}\,C$	½	
	Charge on sphere S_2 : Q_2 = surface charge density × surface Area $= \left(\frac{2}{\pi}\times 10^{-9}\right)\times 4\pi(3\times 10^{-2})^2$ $= 72\times 10^{-13}\,C$	½	
	When connected by a thin wire they acquire a common potential V and the charge remains conserved. $Q_1 + Q_2 = Q_1' + Q_2'$ $= C_1V + C_2V$ $Q_1 + Q_2 = (C_1 + C_2)V$ $\text{Common potential(V)} = \frac{Q_1+Q_2}{C_1+C_2}$ $C_1 = 4\pi\varepsilon_0 r_1 = \frac{1}{9\times 10^9}\times 10^{-2} = \frac{1}{9}\times 10^{-11}F$ $C_2 = 4\pi\varepsilon_0 r_2 = \frac{1}{9\times 10^9}\times 3\times 10^{-2} = \frac{1}{3}\times 10^{-11}F$	½	
	$V = \frac{80\times 10^{-13}}{\left(\frac{1}{9}+\frac{1}{3}\right)\times 10^{-11}} = 1.8\,V$	½	
	$Q_1' = C_1V = \frac{1}{9}\times 10^{-11}\times 1.8$ $Q_1' = 2\times 10^{-12}\,C$	½	

	Alternatively: Charge on sphere S_1 : Q_1 = surface charge density × surface Area $= \left(\frac{2}{\pi}\times 10^{-9}\right)\times 4\pi(1\times 10^{-2})^2$ $= 8\times 10^{-13}\,C$ Charge on sphere S_2 : Q_2 = surface charge density × surface Area $= \left(\frac{2}{\pi}\times 10^{-9}\right)\times 4\pi(3\times 10^{-2})^2$ $= 72\times 10^{-13}\,C$ When connected by a thin wire they acquire a common potential V and the charge remains conserved. $Q_1 + Q_2 = Q_1' + Q_2'$ $\frac{Q_2'}{Q_1'} = \frac{r_2}{r_1}$ On solving, $Q_1' = 2\times 10^{-12}\,C$	½ ½ ½ ½ ½	5
32.	(a) (i) Deriving expression for impedance 2 (ii) Reason 1 (iii) Inductance of coil 2		

(i)



$V_C + V_R = V$ ½

$v_m^2 = v_{rm}^2 + v_{cm}^2$

$v_{rm} = i_m R$

$v_{cm} = i_m X_c$

$v_m^2 = (i_m R)^2 + (i_m X_c)^2$ ½

$= i_m^2 \left[R^2 + X_c^2\right]$

$\Rightarrow i_m = \dfrac{v_m}{\sqrt{R^2 + X_c^2}}$ ½

$\Rightarrow \text{Impedance } Z = \sqrt{R^2 + X_c^2}$ ½

(ii) For direct current (dc), an inductor behaves as a conductor.

As $X_L = \omega L = 2\pi \nu L$

For dc $\nu = 0 \Rightarrow X_L = 0$ 1

Alternatively: -

Induced emf $(\varepsilon) = -\dfrac{LdI}{dt}$

For dc; $dI = 0 \Rightarrow \varepsilon = 0$

	(iii) R = $\frac{110}{11}$ = 10 Ω $i_{rms} = \frac{v_{rms}}{\sqrt{R^2 + X_L^2}} = \frac{220}{\sqrt{100 + X_L^2}}$ $11 = \frac{220}{\sqrt{100 + X_L^2}}$ $\sqrt{100 + X_L^2} = \frac{220}{11} = 20\Omega$ Squaring both sides: $\Rightarrow 100 + X_L^2 = 400$ $\Rightarrow X_L^2 = 300 \Rightarrow X_L = 10\sqrt{3}\,\Omega$ $X_L = 2\pi fL \Rightarrow 10\sqrt{3} = 2\pi \times 50 \times L$ L = $\frac{\sqrt{3}}{10\pi} H$ OR	½ ½ ½ ½	
	(b) (i) Labelled diagram of step – up transformer — 1 Describing working principle — ½ Three causes — 1 ½ (ii) Explanation — 1 (iii) (1) Output voltage across secondary coil — ½ (2) Current in primary coil — ½		

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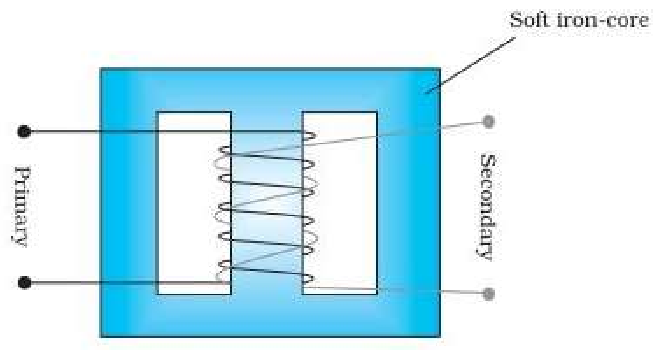
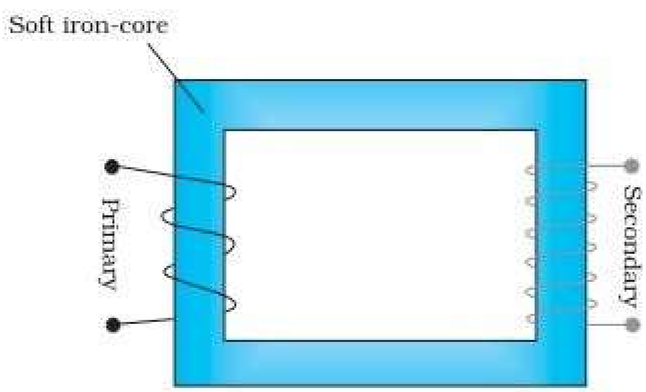
(i)



(a)

OR



(b)

The working principle of transformer is mutual induction.

When an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf in it.

Causes of energy losses (Any three)

(a) Flux leakage

(b) Resistance of the windings

(c) Eddy currents
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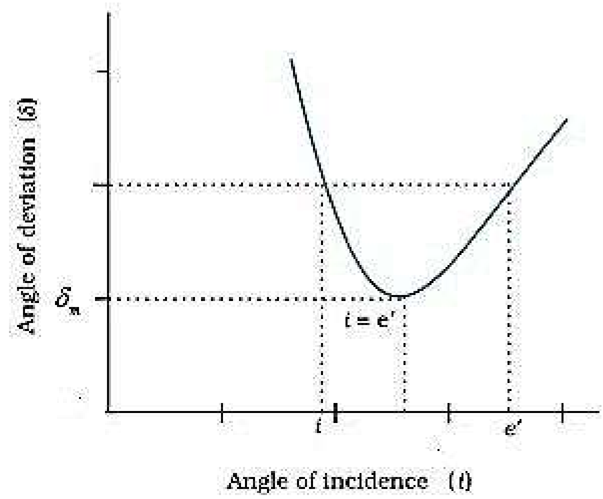
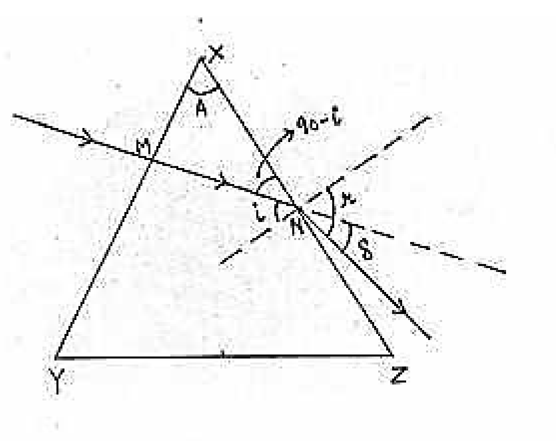
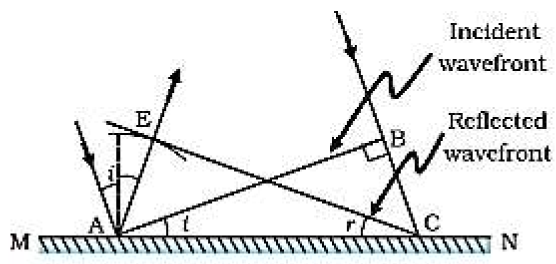
	(d) Hysteresis (ii) No Current changes correspondingly. So, the input power is equal to the output power. (iii) (1) $\frac{V_s}{V_P} = \frac{N_s}{N_P}$ $V_s = \frac{N_s}{N_P} \times V_P = \frac{3000}{200} \times 90$ $V_s = 1350\,V$ (2) $\frac{I_P}{I_s} = \frac{N_s}{N_P}$ $I_P = \frac{3000}{200} \times 2 = 30$ A	½ + ½ + ½ ½ ½ ½ ½	5
33.	(a) (i) Graph showing variation of angle of deviation with angle of incidence — 1 Defining angle of minimum deviation — 1 (ii) Proof of refractive index $n = \frac{\sin(A+\delta)}{\sin A}$ — 1 (iii) (1) Finding angle of minimum deviation — 1 (2) Angle of Incidence — 1		

	(i)  Minimum deviation angle is defined as the angle at which angle of incidence is equal to the angle of emergence. Alternatively At minimum deviation refracted ray inside the prism becomes parallel to the base of the prism. (ii)  At the face XZ :- $\mu \sin i = 1 \times \sin r$ ----- (1) r = i + δ [from diagram] ----- (2) In ΔXMN ; A+(90 –i) + 90 =180	1 1 ½	

	$\Rightarrow A = i$ ----- (3) Putting eq. (3) & (2) in eq. (1) $\mu \sin A = \sin (A+\delta)$ $\mu = \dfrac{\sin (A+\delta)}{\sin A}$ (iii) (1) $\mu = \dfrac{\sin\left(\dfrac{A+\delta_m}{2}\right)}{\sin \dfrac{A}{2}}$ $\sqrt{2} = \dfrac{\sin\left(\dfrac{60+\delta_m}{2}\right)}{\sin 30^\circ}$ $\Rightarrow \sin\left(\dfrac{60+\delta_m}{2}\right) = \dfrac{1}{\sqrt{2}} = \sin 45^\circ$ $\dfrac{60+\delta_m}{2} = 45^\circ \Rightarrow \delta_m = 30^\circ$ (2) $i = \dfrac{A+\delta_m}{2}$ $\Rightarrow i = \dfrac{60+30}{2}$ $i = 45^\circ$ OR	½ ½ ½ ½ ½	
	(b) (i) Statement of Huygens' Principle ½ Construction of reflected wave front ½ Proof of angle of reflection is equal to angle of incidence 1 (ii) Definition of coherent sources ½ Explanation 1 (iii) Finding the unknown wavelength 1 ½ (i) Each point of the wavefront is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions with the spread of the wave. Each point of the wavefront is the source of a		

	secondary disturbance and the wavelets emanating from these points spread out in all directions with the speed of the wave. These wavelets emanating from the wavefront are usually referred to as secondary wavelets and if we draw a common tangent to all these spheres, we obtain the new position of the wavefront at a later time.	½	
		½	
	ΔEAC is congruent to ΔBAC; so $\angle i = \angle r$	1	
	(ii) Two sources are said to be coherent if the phase difference between them does not change with time.	½	
	No, two independent sodium lamps cannot be coherent.	½	
	Two independent sodium lamps cannot be coherent as the phase between them does not remain constant with time.	½	
	(iii) $4\beta_2 = 5\beta_1$ $4 \times \frac{\lambda D}{d} = 5 \times \frac{\lambda_{known} D}{d}$	½	
	$\Rightarrow \lambda = \frac{5}{4} \times \lambda_{known}$ $= \frac{5}{4} \times 520$ $= 650$ nm	1	5