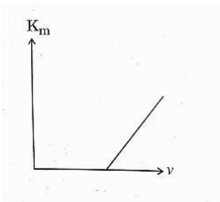
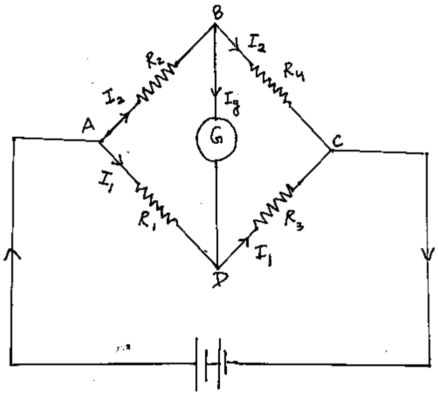
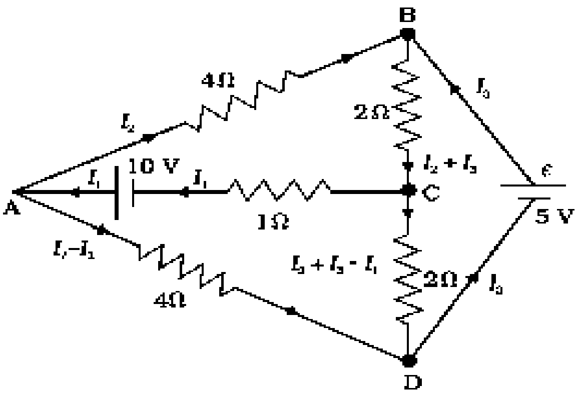
MARKING SCHEME : PHYSICS (042)			
CODE :55/3/1			
Q.NO.	**VALUE POINTS/ EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION-A		
1.	(B) Spherical surface	**1**	**1**
2.	(B) 1.6×10^{-18} J	**1**	**1**
3.	(C) $-(0.24 \text{ nT}) \hat{k}$	**1**	**1**
4.	(D) remain stationary	**1**	**1**
5.	(B) 0.3 MB	**1**	**1**
6.	(C) 15.0 V	**1**	**1**
7.	(B) l is decreased and A is increased	**1**	**1**
8.	(B) Gamma rays	**1**	**1**
9.	(B) 2	**1**	**1**
10.	(C) 	**1**	**1**
11.	(B) decreased by 87.5%	**1**	**1**
12.	(B) 0.05 eV	**1**	**1**
13.	(D) Assertion (A) is false and Reason (R) is also false.	**1**	**1**
14.	(C) Assertion (A) is true but Reason (R) is false.	**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.	(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion(A).	**1**	**1**
	SECTION- B		
17.	**(a)** Meaning of relaxation time ½ Derivation of R 1 ½		
	Average time between two successive collisions of electron in presence of electric field	½	
	Drift velocity of an electron $\upsilon_d = \frac{eE}{m}\tau \qquad ---(i)$	½	
	Current flowing through a conductor of length l and area of cross section A $I = neA\upsilon_d \qquad ---(ii)$ $I = \frac{ne^2 AE\tau}{m} = \frac{ne^2 A\tau V}{ml}$	½	
	$R = \frac{V}{I} = \frac{ml}{ne^2 \tau A}$	½	2
	OR		
	(b) Circuit diagram of Wheatstone bridge ½ Obtaining the condition when no current flows through galvanometer 1½		

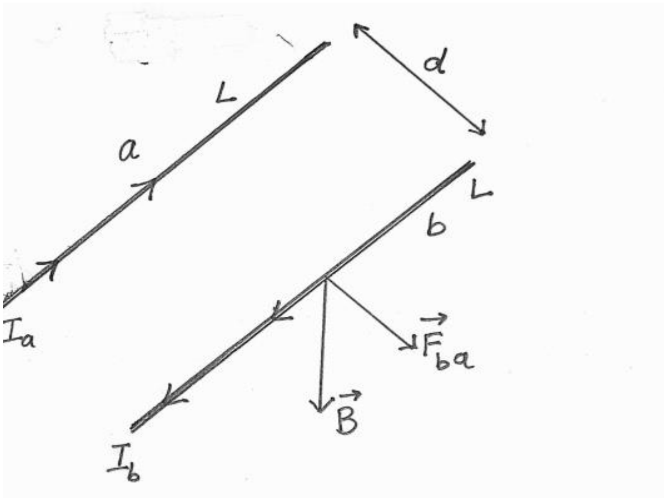
	 By applying Kirchoff's loop rule to closed loops ADBA and CBDC $-I_1R_1 + 0 + I_2R_2 = 0$ -----(i) [$I_g = 0$] $I_2R_4 + 0 - I_1R_3 = 0$ -----(ii) From eq (i)- $\frac{I_1}{I_2} = \frac{R_2}{R_1}$ From eq (ii)- $\frac{I_1}{I_2} = \frac{R_4}{R_3}$ Hence, $\frac{R_2}{R_1} = \frac{R_4}{R_3}$	½ ½ ½ ½	2
18.	Finding the focal length of objective lens 2 Magnifying power = 24 , Distance between lenses =150 cm $\frac{f_o}{f_e} = 24$ $f_o + f_e = 150\,\text{cm}$ $f_e = 6\,\text{cm}$ $f_o = 144\,\text{cm}$	½ ½ ½ ½	2
19.	(a) Explanation of magnification 1 (b) Explanation 1 (a) Yes, it offers magnification. We can keep the small object much closer to the eye than 25 cm and hence have it subtend a large angle. (b) Yes, Rays converging to a point behind a plane or convex mirror are reflected to a point in front of the mirror on a screen	½ ½ ½ ½	2
20.	Calculation of number of photons per second 2 Total Energy gained per second from photon= IA $E = N\,h\nu$	½	

	$IA = N \times \frac{hc}{\lambda}$ $N = \frac{[IA]\lambda}{hc}$		
	$N = \frac{[0.1\times10^{-9}\times0.4\times10^{-4}]\times500\times10^{-9}}{6.6\times10^{-34}\times3\times10^{8}}$	**1**	
	$N = 1.01\times10^{4}$	½	**2**
21.	Calculation of concentration of holes & electrons 2		
	$n_e n_h = n_i^2$	½	
	$n_h \approx 5\times10^{22} / m^3$ $n_e = \frac{n_i^2}{n_h}$		
	$n_e = \frac{(1.5\times10^{16})^2}{5\times10^{22}}$	½	
	$n_e = 4.5\times10^{9} / m^3$	½	
	$n_h > n_e$, it is a p- type crystal	½	**2**
	SECTION- C		
22.	Determination of current in branches AB, AC, BC 1+1+1		
			
	For closed loop ADCA , $10 - 4(I_1 - I_2) + 2(I_2 + I_3 - I_1) - I_1 = 0$ $7I_1 - 6I_2 - 2I_3 = 10$ ------(i)	½	
	For closed loop ABCA , $10 - 4I_2 - 2(I_2 + I_3) - I_1 = 0$ $I_1 + 6I_2 + 2I_3 = 10$ ------(ii)	½	
	For closed loop BCDED , $5 - 2(I_2 + I_3) - 2(I_2 + I_3 - I_1) = 0$ $2I_1 - 4I_2 - 4I_3 = -5$ -----(iii)	½	
	Current in branch AB = $I_2 = \frac{5}{8}A$	½	
	Current in branch AC = $I_1 = 2.5A$	½	
	Current in branch BC = $I_2 + I_3 = 2.5A$	½	**3**

23.

Reason for exerting force on straight parallel conductors	½
Derivation for force per unit length	2
Explanation of nature of Force	½

One conductor experiences a force due to magnetic field of the other conductor — ½



½

Magnetic field produced by conductor 'a' at all points along the length of conductor 'b'

$$B_a = \frac{\mu_0 I_a}{2\pi d}$$ ½

Force on conductor 'b' due to this magnetic field

$$F_{ba} = I_b L B_a$$ ½

$$F_{ba} = \frac{\mu_0 I_a I_b L}{2\pi d}$$

$$f_{ba} = \frac{F_{ba}}{L} = \frac{\mu_0 I_a I_b}{2\pi d}$$ directed away from a — ½

$$f_{ab} = \frac{F_{ab}}{L} = \frac{\mu_0 I_a I_b}{2\pi d}$$ directed away from b

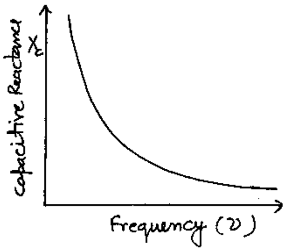
Repulsive, the forces acting on them are away from each other. — ½ — **3**

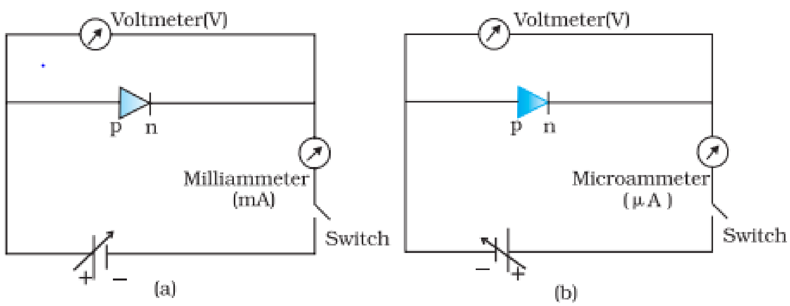
24.

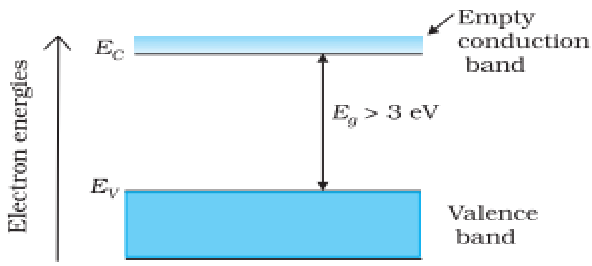
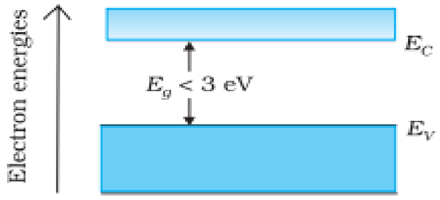
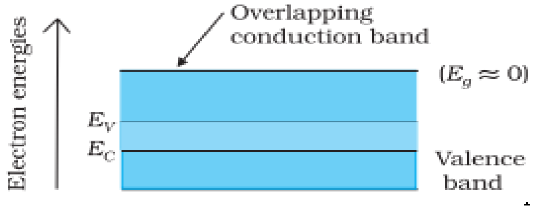
(a) Identifying the element X	½
(b) Writing the formula for reactance	½
(c) Showing variation of reactance with frequency	1
(d) Explanation of behavior of element with	
(i) an ac circuit	½
(ii) a dc circuit	½

(a) Capacitor — ½

(b) $X_c = \frac{1}{\omega c}$ — ½

	(c) 	1	
	(d) (i) For ac X_c is finite and therefore allows the ac to pass.	½	
	(ii) For dc X_c is infinite and therefore does not allow the dc to pass.	½	3
25.	(a) Finding the wavelength and frequency — 1+1 (b) Finding the amplitude of magnetic field — ½ (c) Writing expression for magnetic field — ½		
	(a) $k = \dfrac{2\pi}{\lambda}$	½	
	$\lambda = \dfrac{2\pi}{K} = \dfrac{4\pi}{3}\text{m} = 4.18\text{m}$	½	
	$\omega = 2\pi\upsilon$ $\nu = \dfrac{\omega}{2\pi} = \dfrac{4.5\times10^8}{2\pi}\text{Hz}$	½	
	$\nu = \dfrac{9}{4\pi}\times10^8\ \text{Hz}$ $\nu = 7.16\times10^{-1}\ \text{Hz}$	½	
	(b) $B_0 = \dfrac{E_0}{c}$ $B_0 = \dfrac{6.3}{3\times10^8} = 2.1\times10^{-8}\text{T}$	½	
	(c) $\vec{B} = 2.1\times10^{-8}[(\cos 1.5\,\text{rad/m})\,y + (4.5\times10^8\,\text{rad/s})\,t]\,\hat{k}\,\text{T}$	½	3
26.	Statements of Bohr's first and second Postulates — ½+½ Derivation of expression for radius of nth orbit — 2		
	• **Bohr's first postulate** An electron in an atom revolves in certain stable orbits without the emission of radiant energy.	½	
	• **Bohr's second postulate** Electron revolves around the nucleus only in those orbits for which the angular momentum is integral multiple of $\dfrac{h}{2\pi}$.	½	
	Electrostatic force between revolving electron and nucleus provides requisite centripetal force $\dfrac{mv_n^2}{r_n} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{e^2}{r_n^2}$	½	

	$v_n = \dfrac{e}{\sqrt{4\pi\varepsilon_0 m r_n}}$ ------(i) $mv_n r_n = \dfrac{nh}{2\pi}$ -------(ii) using equations (i) and (ii) $r_n = \left(\dfrac{n^2}{m}\right)\left(\dfrac{h}{2\pi}\right)^2 \dfrac{4\pi\varepsilon_0}{e^2}$	½ ½ ½	3
27.	(a) Definition of atomic mass unit (u) 1 (b) Calculation of energy required 2 (a) atomic mass unit (u) is defined as 1/12th of the mass of the carbon (^{12}C) atom. (b) $m\left({}_1H^2\right) \rightarrow m\left({}_1H^1\right) + m\left({}_0n^1\right)$ $Q = (m_R - m_P) \times 931.5\,MeV$ $= (2.014102 - 1.007825 - 1.008665) \times 931.5\,MeV$ $= -0.002388 \times 931.5\,MeV$ $= -2.224\,MeV$ Hence energy required is 2.224 MeV	1 ½ ½ ½ ½	3
28.	**(a)** (a) Drawing the circuit diagram for V-I characteristics 1 Salient features of V-I characteristics in (i) Forward biasing 1 (ii) Reverse biasing 1  **[any one circuit diagram]** **Salient features** (i) **Forward biasing**- After threshold voltage or cut in voltage diode current increases significantly (exponentially), even for a small increase in the diode bias voltage. (ii) **Reverse biasing**- Current is very small (~μA) and almost remains constant and it increases rapidly after breakdown voltage. **OR**	1 1 1	

	(b) Energy band diagrams Difference between (i) an insulator (ii) a semiconductor (iii) a metal 1+1+1		
	(i) 	1	
	(ii) 	1	
	(iii) 	1	3
	SECTION- D		
29.	(i) (D) IV (ii) (D) accelerate along $-\hat{i}$ (iii) (A) V= $V_0 + \alpha x$ (iv) (a) (C) $E_4 > E_3 > E_2 > E_1$ **OR** (b) (B) 2.6×10^6 m/s	1 1 1 1	4
30.	(i) (D) 6 (ii) (C) 3 (iii) (a) (C) 6 **OR** (b) $\sin^{-1}(0.225)$ (iv) (D) 10	1 1 1 1	4
	SECTION-E		
31.	**(a)** (i) Obtaining expression for the capacitance 3 (ii) Finding the electric potential 2 (i) at the surface (ii) at the centre (i) When a dielectric slab is inserted between the plates of capacitor, there is induced charge density σ_P which opposes the original charge density		

(σ) on the plate of capacitance. ½

Electric field with dielectric medium is

$E = \frac{(\sigma - \sigma_P)}{\varepsilon_0}$ ½

V=E×d = $\frac{(\sigma - \sigma_P)}{\varepsilon_0} d$ ½

$(\sigma - \sigma_P) = \frac{\sigma}{K}$ ½

V= $\frac{\sigma\, d}{\varepsilon_0 K} = \frac{Qd}{A\varepsilon_0 K}$ ½

C = $\frac{Q}{V} = \frac{K\varepsilon_0 A}{d}$ ½

(ii) Electric potential due to a point charge

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

(i) At the surface

V= $\frac{1}{4\pi\varepsilon_0}\frac{q}{r} = \frac{9\times10^9\times6\times10^{-6}}{0.2}$ ½

$V = 2.7 \times 10^5$ V ½

(ii) Since electric field inside the hollow sphere is zero, hence V is same as that of the surface and remains constant throughout the volume. ½

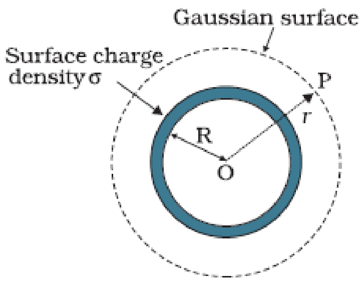
$V = 2.7 \times 10^5$ V

OR

(b)

(i) Expression for electric field at a point lying	
(i) inside	1
(ii) outside	2
(ii) Explanation	2

(i) **<u>Field inside the shell</u>**



The Flux through the Gaussian surface is

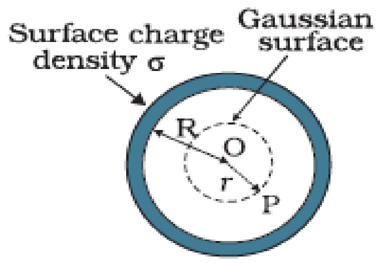
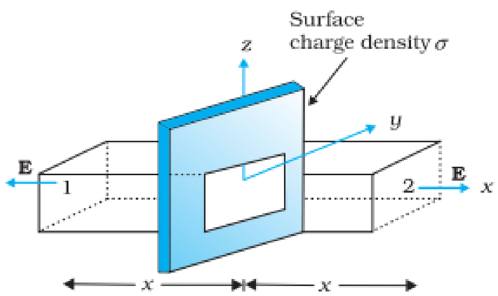
= E × 4πR² ½

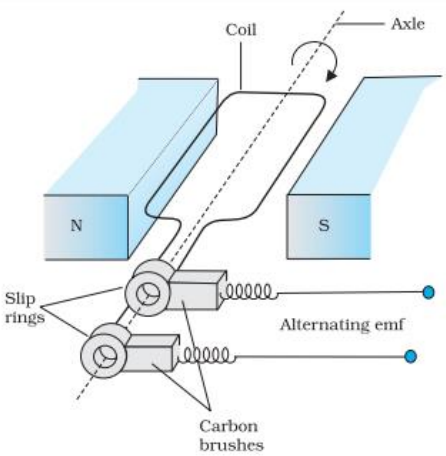
In this case Gaussian surface encloses no charge.

Hence $E \times 4\pi R^2 = 0$ ½

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)

	(ii) <u>Field outside the shell</u>- 	½	
	Electric flux through Gaussian surface $E \times 4\pi r^2 = \frac{(\sigma\, 4\pi R^2)}{\varepsilon_0}$	½	
	Charge enclosed by the Gaussian surface $E \times 4\pi r^2 = \frac{(\sigma\, 4\pi R^2)}{\varepsilon_0}$		
	Using Gauss's law: $\int \vec{E}.\overrightarrow{ds} = \frac{Q}{\varepsilon_0}$ $E \times 4\pi r^2 = \frac{(\sigma\, 4\pi R^2)}{\varepsilon_0}$	½	
	$E = \frac{\sigma}{\varepsilon_0}\frac{R^2}{r^2} = \frac{q}{4\pi\varepsilon_0 r^2}$	½	
	(ii) For conducting sheet, Electric field due to a conducting sheet $E_c = \frac{\sigma}{\varepsilon_0}$	½	
			
	For non-conducting sheet $E_{nc} = \frac{\sigma}{2\varepsilon_0}$	½	
	Since surface charge density is same.	½	
	$2E_{nc} = E_c$	½	**5**
32.	**(a)** (i)(1) Meaning of current sensitivity, mentioning factors 2 (2) Finding the required resistance 1½ (ii) Finding the induced current 1½		
	(i) (1). Current sensitivity of galvanometer is defined as the deflection per unit current. **Alternatively**, $\frac{\phi}{I} = \frac{NBA}{K}$	**1**	
	Factors Number of turns in coil, Magnetic field intensity, Area of coil, Torsional Constant **(Any two)**	½+½	

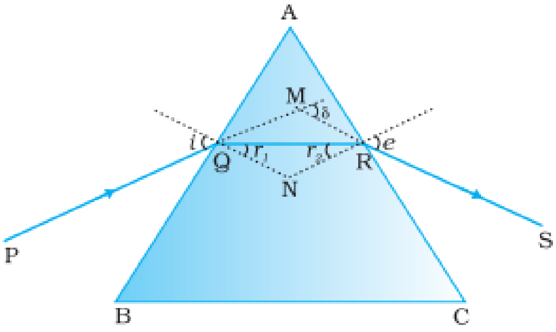
	(2) $R = \frac{V}{I} - G$ for (0-V) Range	½	
	$R_1 = \frac{V}{2I} - G$ for (0-$\frac{V}{2}$) Range	½	
	$\frac{V}{I} = R + G$		
	$R_1 = \left(\frac{R+G}{2}\right) - G$		
	$R_1 = \frac{R-G}{2}$	½	
	(ii) $\phi = (2.0t^3 + 5.0t^2 + 6.0t)$ mWb		
	$\lvert\varepsilon\rvert = \frac{d\phi}{dt}$ = 50×10^{-3} V	½	
	I= $\frac{\lvert\varepsilon\rvert}{R}$	½	
	I= $\frac{50\times10^{-3}}{5}$ A=10 mA	½	
	OR		
	(b) (i) Obtaining the expression of emf induced — 3 (ii) Calculation of mutual inductance — 2		
		1	
	(i) The flux at any instant t is		
	$\phi = NBA\cos\theta$=NBA $\cos\omega t$	½	
	From Faraday's law		
	$\boldsymbol{\varepsilon} = -\frac{d\phi_B}{dt}$	½	
	$= -NBA\frac{d}{dt}(\cos\omega t)$	½	
	$\boldsymbol{\varepsilon} = -NBA\,\omega\sin\omega t$	½	
	(ii) $M = \frac{\mu_0\pi r_1^2}{2r_2} = \frac{4\pi\times10^{-7}\times\pi r_1^2}{2r_2}$	½+½	
	$= \frac{2\times10\times10^{-7}\times(10^{-2})^2}{100\times10^{-7}}$	½	
	$= 2\times10^{-10}$ H	½	5

33.

(a)

(i) Tracing the path of ray	½
Obtaining an expression for angle of deviation	1½
Drawing Graph	1
(ii) Finding the refractive index	2

(i)



— ½

For quadrilateral AQNR,

$\angle A + \angle QNR = 180^o$ --- (i) — ½

For triangle QNR

$r_1 + r_2 + \angle QNR = 180^o$ ---- (ii)

comparing equation (i) and (ii)

$r_1 + r_2 = A$ ------ (iii) — ½

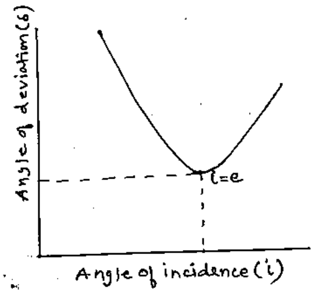
The angle of deviation

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

from equation (iii) and (iv)

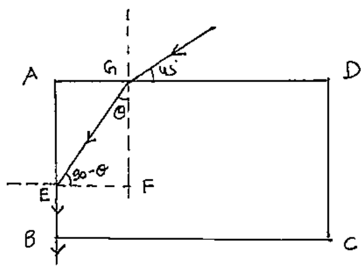
$$\delta = i + e - A$$ — ½

Graph



— **1**

(ii)



$$\frac{\sin 45^0}{\sin \theta} = \mu$$

$$\frac{1}{\sqrt{2}} = \mu \sin \theta$$ — ½

For second surface,

$$\frac{\sin(90^0 - \theta)}{\sin 90^0} = \frac{1}{\mu}$$ — ½

	$\frac{1}{\sqrt{2}}\frac{\cos\theta}{\sin\theta} = 1$		
	$\tan\theta = \frac{1}{\sqrt{2}}$	½	
	From the triangle GEF		
	$\sin\theta = \frac{1}{\sqrt{3}}$	½	
	$\mu = \sqrt{\frac{3}{2}}$		
	OR		
	(b) (i) Expression for resultant intensity 3		
	(ii) Ratio of intensities 2		
	(i) $y_1 = a\cos\omega t$		
	$y_2 = a\cos(\omega t + \phi)$		
	According to the principle of superposition		
	$y = y_1 + y_2$	½	
	$y = a\cos\omega t + a\cos(\omega t + \phi)$		
	$y = a\cos\omega t + a\cos\omega t\cos\phi - a\sin\omega t\sin\phi$		
	$y = a\cos\omega t(1 + \cos\phi) - a\sin\phi\sin\omega t$	½	
	Let,		
	$a(1+\cos\phi) = A\cos\theta$ ------- (i)		
	$a\sin\phi = A\sin\theta$ --------(ii)	½	
	Squaring and adding equation (i) and (ii)		
	$A^2 = a^2(1+\cos\phi)^2 + a^2\sin^2\phi$		
	$= a^2(1+\cos^2\phi + 2\cos\phi) + a^2\sin^2\phi$		
	$= 2a^2(1+\cos\phi)$	½	
	$= 4a^2\cos^2\phi/2$	½	
	$I \alpha A^2$		
	$I = kA^2$		
	where k is constant		
	$I = 4ka^2\cos^2\phi/2$	½	
	[Award full credit for this part for any other alternative methods]		
	(ii) $\phi_1 = \frac{2\pi}{\lambda}\times\frac{\lambda}{6} = \pi/3$	½	
	$I_1 = 4I_0\cos^2\phi/2$		
	$= 4I_0\cos^2(\pi/6)$		
	$I_1 = 3I_0$	½	
	$\phi_2 = \frac{2\pi}{\lambda}\times\frac{\lambda}{12} = \pi/6$		
	$I_2 = 4I_0\cos^2(\pi/12)$	½	
	$I_2 = 4I_0\cos^2 15^0$		
	$\frac{I_1}{I_2} = \frac{3}{4\cos^2 15^0}$	½	5