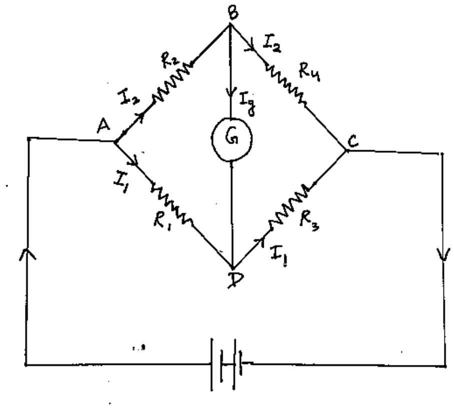
	MARKING SCHEME : PHYSICS (042)		
	CODE: 55/3/2		
Q.NO.	**VALUE POINT/ EXPECTED ANSWERS**	**MARKS**	**TOTAL MARKS**
	SECTION A		
1.	(C) –q and Q + q	**1**	**1**
2.	(B) 1.6 x 10^{-18} J	**1**	**1**
3.	(C) –(0.24nT) $\hat{k}$	**1**	**1**
4.	(D) Repel each other with a force $\frac{\mu_o I^2}{2\pi a}$, per unit length	**1**	**1**
5.	(B) 0.3 MB	**1**	**1**
6.	(D) 0.1 C	**1**	**1**
7.	(B) *l* is decreased and A is increased	**1**	**1**
8.	(C) X- rays	**1**	**1**
9.	(B) 2	**1**	**1**
10.	(C) $\phi_3 > \phi_2 > \phi_1$	**1**	**1**
11.	(B) decreases 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 $I = neA\upsilon_d \qquad ---(ii)$ $I = \frac{ne^2AE\tau}{m} = \frac{ne^2A\tau V}{ml}$	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		



½

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) ½

From eq (i)-

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

From eq (ii)-

$$\frac{I_1}{I_2} = \frac{R_4}{R_3}$$ ½

Hence,

$$\frac{R_2}{R_1} = \frac{R_4}{R_3}$$ ½ **2**

18.

Finding the focal length of objective lens	2

Magnifying power = 24 , Distance between lenses =150 cm

$\frac{f_o}{f_e} = 24$ ½

$f_o + f_e = 150\,\text{cm}$ ½

$f_e = 6\,\text{cm}$ ½

$f_o = 144\,\text{cm}$ ½ **2**

19.

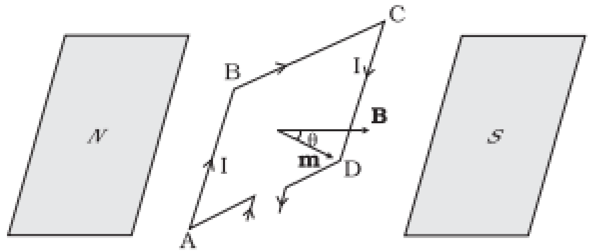
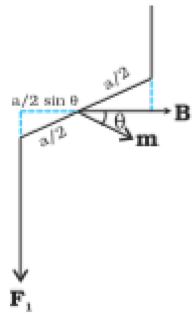
Differences between interference and diffraction of light	1+1

Interference	**Diffraction**
(i) In interference pattern width of each maxima is same. (ii) In interference pattern intensity of all maxima is same.	(i) In diffraction pattern width of central maxima is twice the width of secondary maxima. (ii) In diffraction pattern intensity of maxima goes on decreasing as we move away from central maxima.

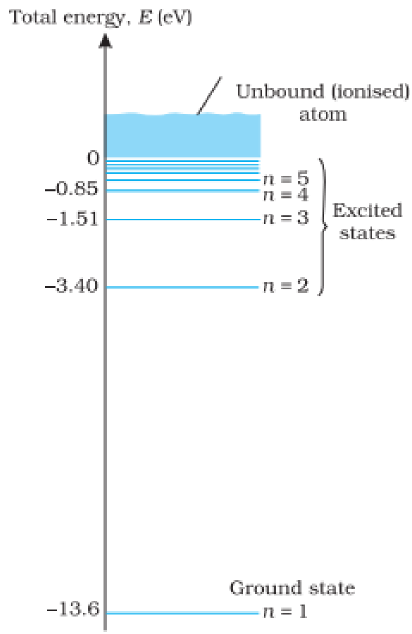
1+1

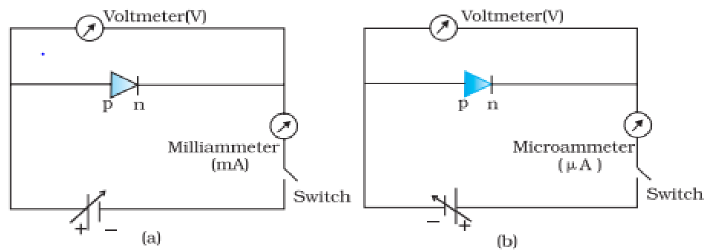
[Award full credit if students write any other two differences] **2**

20.	(i) Calculation of Kinetic energy (in eV) 1½ (ii) Stopping potential ½		
	Using Einstein Photoelectric equation $\frac{hc}{\lambda} = K.E_{\max} + \phi_0$	½	
	$K.E_{\max} = \frac{hc}{\lambda} - \phi_0$ $= \frac{1240 eV nm}{500\, nm} - 2.14 eV$	½	
	$K.E_{\max} = 0.34 eV$	½	
	$K.E_{\max} = eV_0$ $\therefore V_0 = 0.34V$	½	**2**
21.	Calculation of concentration of holes and electrons 2		
	$n_e n_h = n_i^2$ $n_h \approx 5 \times 10^{22} / m^3$	½	
	$n_e = \frac{n_i^2}{n_h}$ $n_e = \frac{(1.5 \times 10^{16})^2}{5 \times 10^{22}}$	½	
	$n_e = 4.5 \times 10^9 / m^3$	½	
	$n_h > n_e$, it is a p- type crystal	½	**2**
	SECTION C		
22.	Calculation of (a) emf of battery ½ (b) Internal resistance of battery(r) 1½ (c) external resistance (R) 1		
	(a) V= *E*=10 V(When key K is open and I=0 A)	½	
	(b) V=*E*-Ir (When key K is closed and I=2 A)	½	
	6=10-2r	½	
	r = 2Ω	½	
	(c) E=I(r+R)	½	
	10=2(2+R) R= 3 Ω	½	**3**
23.	Derivation of torque in vector form 3		

	  	1	
	Forces on the arms BC and DA are, equal opposite and collinear. Hence they will cancel each other.	½	
	The forces on arms AB and CD are $\vec{F_1}$ and $\vec{F_2}$, equal but not collinear. The magnitude of the torque on the loop is $\tau = F_1 \frac{a}{2} \sin\theta + F_2 \frac{a}{2} \sin\theta$	½	
	$= IabB\sin\theta$ $= mB\sin\theta \quad (m = IA)$	½	
	$\vec{\tau} = \vec{m} \times \vec{B}$	½	3
24.	Differences between reactance and impedance 1 Showing Ideal inductor in an ac circuit does not dissipate any power 2		
	Reactance- It is the measure of opposition to flow of current in ac circuit comprising Inductor or Capacitor.	½	
	Impedance- It is the measure of opposition to flow of current in ac circuit comprising Resistor, Capacitor and Inductor.	½	
	$\varepsilon = \varepsilon_0 \sin\omega t$ $I = I_0 \sin(\omega t - \frac{\pi}{2}) = -I_0 \cos\omega t$	½	
	$P = \varepsilon I$ $= -\varepsilon_0 I_0 \sin\omega t \cos\omega t$ $= -\frac{\varepsilon_0 I_0}{2} 2\sin\omega t \cos\omega t$ $P = \frac{\varepsilon_0 I_0}{2} \sin 2\omega t$	½	

	$\langle P\rangle = \frac{\int_0^T P dt}{\int_0^T dt}$	½	
	$\langle P\rangle = \frac{\int_0^T \frac{\varepsilon_0 I_0}{2}\sin 2\omega t dt}{T}$ $= \frac{\varepsilon_0 I_0}{2T}\int_0^T \sin 2\omega t dt$ $= -\frac{\varepsilon_0 I_0}{2T}(\cos \omega t)_0^T = \frac{\varepsilon_0 I_0}{2T}(1-1)$		
	$\langle P\rangle = 0$ Hence average power associated with inductor is zero.	½	
	Alternatively $P = \varepsilon_{rms} I_{rms}\cos\phi$ For inductive circuit $\phi = \pi/2$	**1**	
	$P = \varepsilon_{rms} I_{rms}\cos\frac{\pi}{2}$	½	
	$P = 0$	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) $k = \frac{2\pi}{\lambda}$	½	
	$\lambda = \frac{2\pi}{K} = \frac{4\pi}{3}\text{m} = 4.18\text{m}$ $\omega = 2\pi\upsilon$	½	
	$\nu = \frac{\omega}{2\pi} = \frac{4.5\times10^8}{2\pi}\text{Hz}$	½	
	$\nu = \frac{9}{4\pi}\times10^8\text{ Hz}$ $\nu = 7.16\times10^{-1}\text{ Hz}$	½	
	(b) $B_0 = \frac{E_0}{c}$ $B_0 = \frac{6.3}{3\times10^8} = 2.1\times10^{-8}\text{T}$	½	
	(c) $\vec{B} = 2.1\times10^{-8}[(\cos 1.5\text{rad/ m})\text{y} + (4.5\times10^8\text{ rad/ s})\text{t}]\hat{\text{k}}\text{ T}$	½	**3**

26.	Explanation of origin of spectral lines of hydrogen atom 1 Energy level diagram showing various spectral series of hydrogen atom 2 When an electron makes a transition from higher energy level to a lower energy orbit, a photon is emitted having energy equal to energy difference between these two orbits.  **[Do not deduct marks for not showing transition in diagram]**	**1** **2**	**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] — 1

Salient features

(i) **Forward biasing**- After threshold voltage or cut in voltage diode current increase significantly (exponentially), even for a small increase in the diode bias voltage. — 1

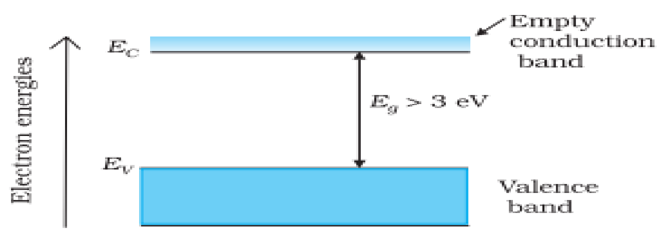
(ii) **Reverse biasing**- Current is very small (~μA) and almost remains constant and it increases rapidly after breakdown voltage. — 1

OR

(b)

Energy band diagrams Difference between (i) an insulator (ii) a semiconductor (iii) a metal 1+1+1

(i)



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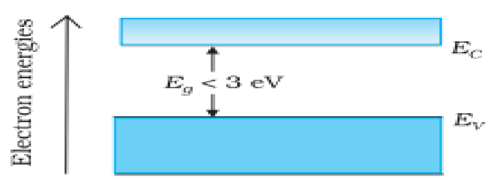
(ii)



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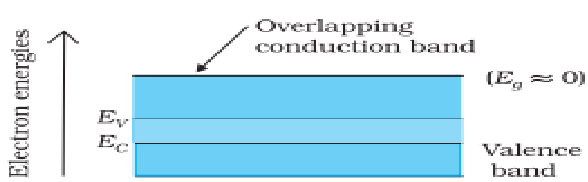
(iii)



— 1

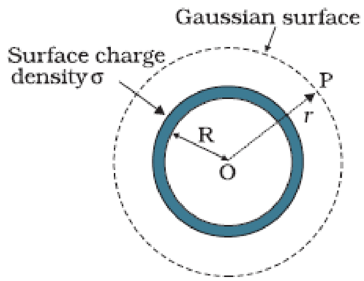
Total: 3

SECTION D

Q. No.	Answer	Marks	Total
29.	(i) (D) IV	1	
	(ii) (D) accelerate along $-\hat{i}$	1	
	(iii) (A) $V = V_0 + \alpha x$	1	
	(iv) (a) (C) $E_4 > E_3 > E_2 > E_1$ **OR** (b) (B) 2.6×10^6 m/s	1	4

30.	(i) (D) 6 (ii) (C) 3 (iii) (a) (C) 6 **OR** (b) (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 capacitance, there is induced charge density σ_P which opposes the original charge density (σ) on the plate of capacitance. Electric field with dielectric medium is $E = \frac{(\sigma - \sigma_P)}{\varepsilon_0}$ $V = E \times d = \frac{(\sigma - \sigma_P)}{\varepsilon_0} d$ $(\sigma - \sigma_P) = \frac{\sigma}{K}$ $V = \frac{\sigma d}{\varepsilon_0 K} = \frac{Qd}{A\varepsilon_0 K}$ $C = \frac{Q}{V} = \frac{K\varepsilon_0 A}{d}$ (ii) Electric potential due to a point charge $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ (i) At the surface $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} = \frac{9\times10^{9}\times6\times10^{-6}}{0.2}$ $V = 2.7 \times 10^5$ V (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.. $V = 2.7 \times 10^5$ V **OR** **(b)** (i) Expression for electric field at appoint lying (i) inside 1 (ii) outside 2 (ii) Explanation 2	 ½ ½ ½ ½ ½ ½ ½ ½ ½ ½	

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



The Flux through the Gaussian surface is

$= E \times 4\pi R^2$ ½

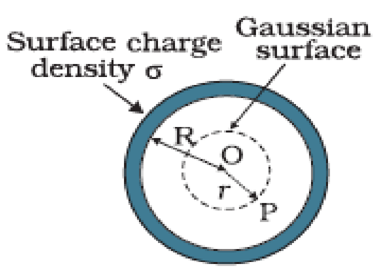
In this case Gaussian surface enclosed no charge.

Hence $E \times 4\pi R^2 = 0$

$E = 0$ 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) <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

$$E \times 4\pi r^2 = \frac{(\sigma\, 4\pi R^2)}{\varepsilon_0}$$ ½

Using Gauss's law:

$$\int \vec{E}.\overrightarrow{ds} = \frac{Q}{\varepsilon_0}$$ ½

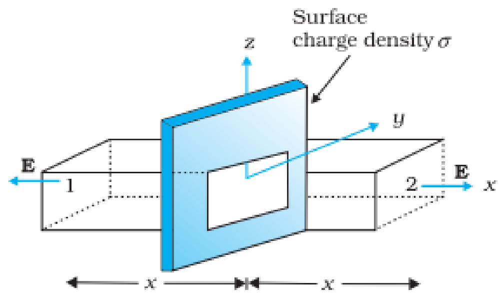
$$E \times 4\pi r^2 = \frac{(\sigma\, 4\pi R^2)}{\varepsilon_0}$$

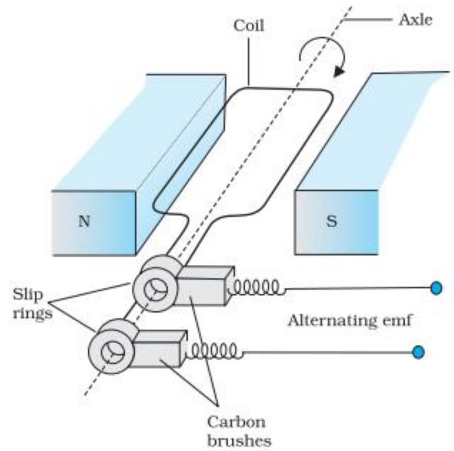
$$E = \frac{\sigma}{\varepsilon_0}\frac{R^2}{r^2} = \frac{q}{4\pi\varepsilon_0 r^2}$$

(ii) For conducting sheet,

Electric field due to a conducting sheet ½

$$E_c = \frac{\sigma}{\varepsilon_0}$$

	 For non-conducting sheet $E_{nc} = \frac{\sigma}{2\varepsilon_0}$ Since surface charge density is same. $2E_{nc} = E_c$	½ ½ 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**, $\frac{\phi}{I} = \frac{NBA}{K}$ **Factors** No. of turns in coil, Magnetic field intensity, Area of coil, Torsional Constant **(Any two)** (2) $R = \frac{V}{I} - G$ for (0-V) Range $R_1 = \frac{V}{2I} - G$ for (0-V/2) Range $\frac{V}{I} = R + G$ $R_1 = \left(\frac{R+G}{2}\right) - G$ $R_1 = \frac{R-G}{2}$ (ii) $\phi = (2.0t^3 + 5.0t^2 + 6.0t)$ mWb $\lvert\varepsilon\rvert = \frac{d\phi}{dt} = 50 \times 10^{-3}$ V $I = \frac{\lvert\varepsilon\rvert}{R}$ $I = \frac{50\times10^{-3}}{5}$ A=10 mA **OR** **(b)** (i) Obtaining the expression of emf induced 3 (ii) Calculation of mutual inductance 2	 **1** ½+½ ½ ½ ½ ½ ½ ½	



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

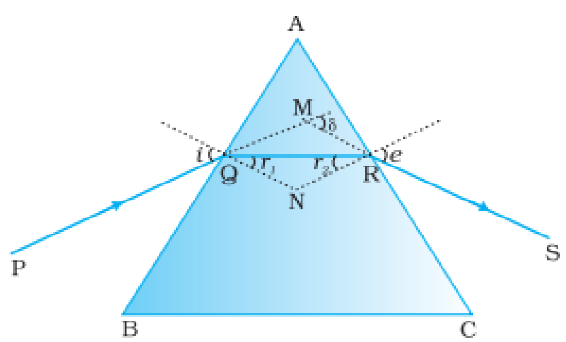
$$= 2\times10^{-10}\,\text{H}$$ ½ **5**

33.

(a)

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

(i)



½

For quadrilateral AQNR,

∠A + ∠QNR = 180° --- (i) ½

For triangle QNR

$r_1 + r_2$ + ∠QNR = 180° ---- (ii)

comparing equation (i) and (ii)

$r_1 + r_2 = A$ ------ (iii) ½

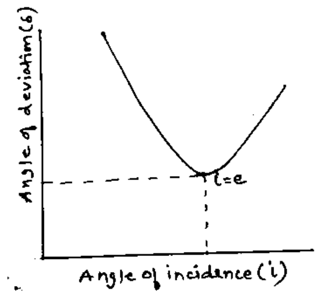
The angle of deviation

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

from equation (iii) and (iv)

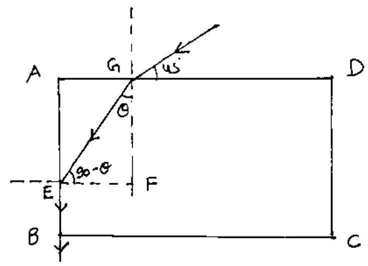
$\delta = i + e - A$ ½

Graph



1

(ii)



$$\frac{\sin 45^0}{\sin\theta} = \mu$$ ½

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

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

$$\sin\theta = \frac{1}{\sqrt{3}}$$

$$\mu = \sqrt{\frac{3}{2}}$$ ½

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

$y = y_1 + y_2$

$y = a\cos\omega t + a\cos(\omega t + \phi)$ ½

	$y = a\cos\omega t + a\cos\omega t\cos\phi - a\sin\omega t\sin\phi$ $y = a\cos\omega t(1+\cos\phi) - a\sin\phi\sin\omega t$ Let, $a(1+\cos\phi) = A\cos\theta$ ------- (i) $a\sin\phi = A\ \sin\theta$ --------(ii) Squaring and adding equation (i) and (ii) $A^2 = a^2(1+\cos\phi)^2 + a^2\sin^2\phi$ $= a^2(1+\cos^2\phi + 2\cos\phi) + a^2\sin^2\phi$ $= 2a^2(1+\cos\phi)$ $= 4a^2\cos^2\phi/2$ $I\alpha A^2$ $I = kA^2$ where k is constant $I = 4ka^2\cos^2\phi/2$ (ii) $\phi_1 = \frac{2\pi}{\lambda}\times\frac{\lambda}{6} = \pi/3$ $I_1 = 4I_0\cos^2\phi/2$ $= 4I_0\cos^2(\pi/6)$ $I_1 = 3I_0$ $\phi_2 = \frac{2\pi}{\lambda}\times\frac{\lambda}{12} = \pi/6$ $I_2 = 4I_0\cos^2(\pi/12)$ $I_2 = 4I_0\cos^2 15^0$ $\frac{I_1}{I_2} = \frac{3}{4\cos^2 15^0}$	½ ½ ½ ½ ½ ½ ½ ½ ½	5