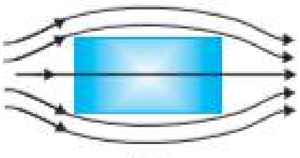
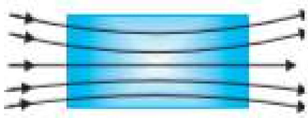
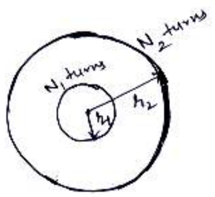
MARKING SCHEME: PHYSICS

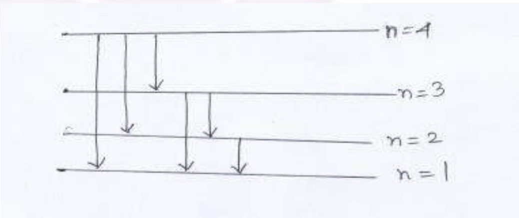
QUESTION PAPER CODE: 55/3/1

Q.No.	Value Points/Expected Answer	Marks	Total Marks
	SECTION A		
1	(D) energy will be provided by external source displacing the charge.	1	1
2	(A) $\frac{1}{\epsilon_o}$	1	1
3	(A) $\frac{C_1}{C_2}$	1	1
4	(C) Decreases with increase in its conductivity	1	1
5	(B) Mobility	1	1
6	(D) $\frac{P}{4}$	1	1
7	(D) $\frac{1}{n^2}$	1	1
8	(C) heavily doped n-side as well as p-side	1	1
9	(D) Helix	1	1
10	(D) -F	1	1
11	Cylindrical	1	1
12	Divergent lens/ Concave lens	1	1
13	Two	1	1
14	$\sqrt{3}$	1	1
15	Intensity OR $h(\upsilon - \upsilon_o)$	1	1
16	Z=R Alternatively, Impedance=Resistance	1	1
17	Copper	1	1

18	Zero Eddy currents are produced in metal block / block gets heated	1	1
19	J.C Bose observed / produced electromagnetic waves of short wavelength/ did very significant work in production of e.m waves.	1	1
20	X rays are used as diagnostic tool in medicine / Gamma rays are used to destroy cancer cells.	1	1
SECTION B			
21	Writing formula $E_1 \propto l_1$ ½ mark $E_1 - E_2 \propto l_2$ ½ mark Calculating $\frac{E_1}{E_2}$ 1 mark $E_1 \propto l_1$ $E_1 - E_2 \propto l_2$ $\frac{E_1 - E_2}{E_1} = \frac{l_2}{l_1}$ $1 - \frac{E_2}{E_1} = \frac{l_2}{l_1}$ $\frac{E_2}{E_1} = 1 - \frac{l_2}{l_1} = 1 - \frac{1}{3} = \frac{2}{3}$ $\frac{E_1}{E_2} = \frac{3}{2}$	½ ½ ½ ½	2
22	Modification in magnetic field pattern by paramagnetic material 1 mark Modification in magnetic field pattern by diamagnetic material 1 mark  (a) diamagnetic  (b) paramagnetic	1+1	2

23	Deducing the expression for Mutual Inductance: 2 marks The given system has the shape shown here Let a current I flow through the larger coil.  Magnetic field, due to the current at the centre of coil is $$B_C = \frac{\mu_o I N_2}{2r_2}$$ We can consider this to be the value of the magnetic field over the whole area of the smaller coil(as $r_1 << r_2$) ∴Magnetic flux through the smaller coil $$= B_c(\pi r_1^2)N_1 = \frac{\mu_o I N_2}{2r_2}\pi r_1^2 N_1$$ $$= \left(\frac{\mu_o \pi r_1^2}{2r_2} N_1 N_2\right) I$$ But Magnetic flux=MI Where M= mutual Inductance of the system $$\therefore MI = \frac{\mu_o \pi r_1^2 N_1 N_2}{2r_2} I$$ $$M = \frac{\mu_o \pi r_1^2 N_1 N_2}{2r_2}$$	½ ½ ½ ½	2
24	Radiation of electromagnetic wave by an oscillating charge 1 mark Relation between the frequency of radiated wave and the frequency of oscillating charge 1 mark An oscillating charge produces an oscillating electric field in space, which produces an oscillating magnetic field, which in turn, is a source of oscillating electric field, and so on. The oscillating electric and magnetic fields thus regenerate each other, as the wave propagates through the space. The frequency of the electromagnetic wave equals the frequency of oscillation of the charge.	1 1	2

	OR		
	a) Explaining the fact that e.m waves carry energy 1 mark b) Correct Explanation 1 mark		
	a) Consider a plane perpendicular to the direction of propagation of the electromagnetic wave. If there are, on this plane, electric charges, they will be set and sustained in motion by the electric and magnetic fields of the electromagnetic wave. The charges thus acquire energy and momentum from the waves.	1	
	b) When the sun shines on your hand, you feel the energy being absorbed from the electromagnetic waves (your hands get warm). Electromagnetic waves also transfer momentum to your hand but because c is very large, the amount of momentum transferred is extremely small and you do not feel the pressure.	1	2
	[For any other alternative correct explanation also, award full 2 marks]		
25	Determining power of the combination 1 ½ mark Nature of combination ½ mark		
	$\frac{1}{f} = \frac{1}{f_1} - \frac{1}{f_2}$	½	
	$\frac{1}{f} = \frac{f_2 - f_1}{f_1 f_2}$	½	
	$\therefore P = \frac{f_2 - f_1}{f_1 f_2}$	½	
	Because $f_2 < f_1$ ∴ P is negative ∴ nature is diverging lens	½	2
	OR		
	Writing the formula 1 mark (a) effect of wavelength on Resolving power ½ mark (b) effect of diameter of lens on Resolving power ½ mark		
	Resolving power of compound microscope is $Resolving\ Power = \frac{2\mu \sin\theta}{1.22\lambda}$	1	

	Justification of the following is based on the above formula: a) If λ decreases, Resolving Power increases. b) If diameter of objective lens is increased, $sin\theta$ increases, Resolving Power increases	½ ½	2
26	a) definition of threshold frequency ½ mark b) definition of stopping potential ½ mark incorporating these terms in Einstein's photoelectric equation 1 mark (a) Threshold Frequency: The minimum cut off frequency υ_o below which no photoelectric emission is possible, even if the intensity is large (b) Stopping Potential: The minimum negative (retarding) potential $V_o$given to the plate for which the photocurrent stops or becomes zero is called the cut off or stopping potential. $h\nu = \phi_0 + \frac{1}{2}mV_{max}^2$ $h\nu = h\nu_o + eV_o$	½ ½ ½ ½	2
27	a) Stating the number of spectral lines ½ mark Showing the transitions in energy level diagram 1 mark b) Stating the transition for the shortest wave length emission ½ mark a) number of spectral lines =6 energy level diagram  b) n=4 to n=1	½ 1 ½	2
	SECTION C		
28	a) differentiating between random velocity and drift velocity 1mark Order of magnitude 1 mark b) drawing the graph showing the variation of drift velocity as a function of Current density 1 mark		

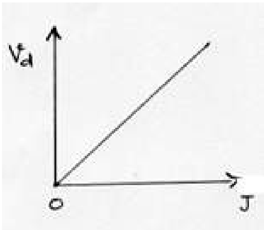
a) Write any one difference

Random Velocity υ	Drift Velocity v_d
1. The velocity acquired by the free electrons in the absence of electric field.	1. The average velocity acquired by the free electrons in presence of electric field.
2. The average random velocity is zero.	2. The average drift velocity is not zero.
3. Has quite a large value	3. Has a very small value

1

Order of magnitude of random velocity is 10^2m/s. ½
Order of magnitude of drift velocity is 10^{-3}m/s. ½

[Note: If the student writes drift speed is nearly 10^{-5} times smaller than random velocity ,award the last 1 mark]



1 | 3

[if a student writes $J = \frac{I}{A} = \frac{n\,e\,A\,v_d}{A} = nev_d$ but does not draw the graph award ½ mark only]

29

a) writing the formula for resonant angular frequency	½ mark
calculating this angular frequency	1 mark
b) writing the formula for Q value	½ mark
calculating Q value	1 mark

a)

$$\omega_o = \frac{1}{\sqrt{LC}}$$ ½

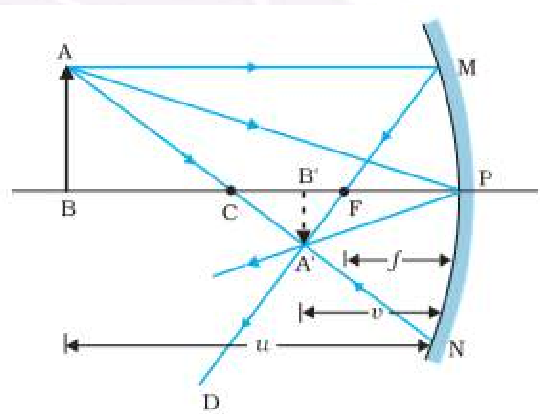
$$= \frac{1}{\sqrt{2 \times 32 \times 10^{-6}}}$$ ½

=125 rad/s ½

b)

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}} \quad or \quad Q = \frac{L\omega}{R}$$ ½

$Q = \frac{1}{10}\sqrt{\frac{2}{32\times10^{-6}}} = 25$ Alternatively Q=$\frac{2\times125}{10} = 25$ 1 | 3

	OR		
	a) Calculating rms value of current 1 mark calculating peak value of current 1 mark b) Phase difference between current through inductor and applied voltage ½ mark change in phase difference ½ mark		
	a)		
	$X_L = \omega L = 2\pi\nu L$ $\therefore X_L = 2\pi \times 50 \times \frac{5}{\pi} = 500\ \Omega$	½	
	$I_{rms} = \frac{200}{500} = \frac{2}{5} = 0.4A$	½	
	$I_0 = \sqrt{2}\, I_{rms}$	½	
	$= \sqrt{2} \times 0.4$ $= 0.56\ A$	½	
	[Even if student expresses the answer as $(0.4\sqrt{2})A$ give the last ½ marks]		
	b) $\frac{\pi}{2}$ $or\ 90^0$ decreases	½ ½	3
30	a) Ray diagram for concave mirror ½ mark derivation of mirror formula 2 marks b) Correct explanation ½ mark		
	a) Ray diagrams for concave mirror		
		½	
	Derivation of Mirror Formula		
	From the diagram, $\Delta A'B'F\ \&\ \Delta MPF$ are similar		
	$\therefore \frac{B'A'}{PM} = \frac{B'F}{FP}$		

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$$\frac{B'A'}{BA} = \frac{B'F}{FP}\ (\because PM = AB) - - - - - - - - eq1$$

Since

$$\angle APB = \angle A'PB'$$

$\Delta A'B'P$ & ΔABP are also similar

$$\frac{B'A'}{BA} = \frac{B'P}{BP} \quad - - - - - - - - - - - eq\ 2$$

Comparing eq. 1 and eq. 2

$$\frac{B'P}{BP} = \frac{B'P - FP}{FP}$$

As per the sign convention

$B'P = -v,\quad FP = -f,\quad$ BP = -u

$$\frac{-v+f}{-f} = \frac{-v}{-u} = \frac{v}{u}$$

$$-vu + uf = -vf$$

Dividing by uvf

$$\Rightarrow \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

b) Magnification is different for different object distances
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½

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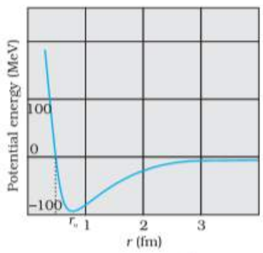
a) Explaining the high nuclear density	1 mark
b) Explaining the non-Colombian nature	1 mark
c) Drawing the graph	1 mark

a) Volume of Nucleus is very small but its mass is almost the total mass of the atom

$$Now \quad density = \frac{Mass}{Volume}$$

That is why density of nucleus is very high.
Alternatively, the matter consisting of atoms, has a very large amount of empty space.

b) Nuclear forces are very strong, attractive and independent of charge and are short ranged.
Whereas Colombian Force are charge dependent and long range.
(Accept any one point of difference)



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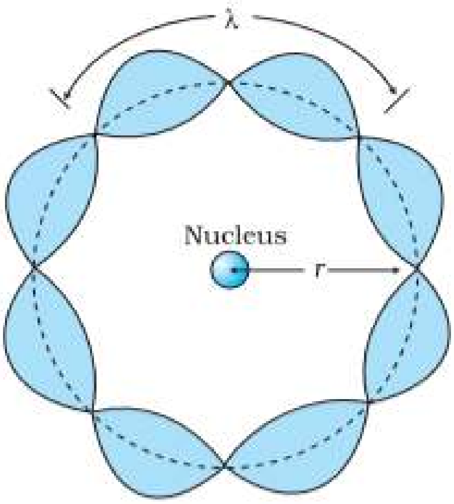
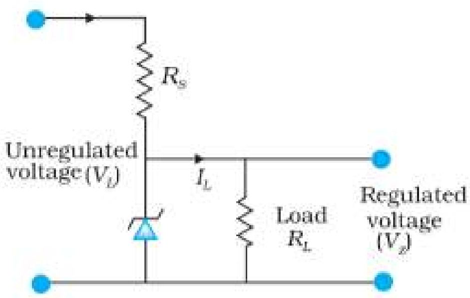
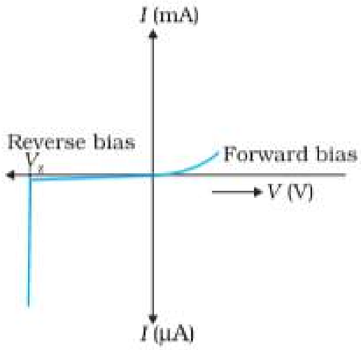
32	Meaning of wave nature of electron 1 mark Explaining the quantisation of angular momentum using de Broglie hypothesis 2 marks Moving electron can show wave characteristics.  From the diagram $2\pi r = n\lambda$ (Note: Award one mark here even if the student just writes this equation without drawing the diagram) According to de Broglie $\lambda = \frac{h}{p}$ $\therefore 2\pi r = n\lambda = \frac{nh}{p}$ $2\pi r = \frac{nh}{mv}$ $mvr = \frac{nh}{2\pi}$ where $n = 1,2,3, \ldots ..$ This explains the quantisation of angular momentum of the orbiting electron.	1 ½ ½ ½ ½	3
33	Naming the diode ½ mark Labelled circuit diagram 1 mark Working 1 mark V-I characteristics ½ mark Zener diode  	½ 1	

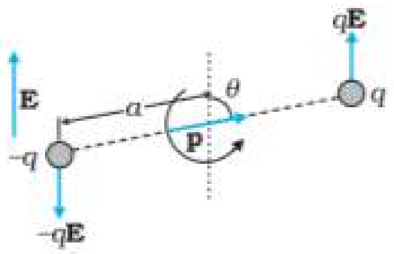
	If the input voltage increases, the current through R_s and Zener diode also increases. This increases the voltage drop across R_s without any change in the voltage across the Zener diode. This is because in the breakdown region, Zener voltage remains constant even though the current through the Zener diode changes. 	1 ½	3
34	a) Stating the reason for adding impurity atoms ½ mark b) Naming the two processes 1 mark Explaining the two processes 1 mark Creation of potential barrier ½ mark a) To increase the electrical conductivity / to increase the number density of charge carriers b) Diffusion and Drift Explanation Diffusion: During the formation of p-n junction, due to the concentration gradient across the p and n sides, the motion of majority charge carriers give rise to diffusion current. Drift: Due to the electric field developed at the junction, the motion of the minority charge carriers due to electric field is called drift. With the passage of time, diffusion current decreases whereas drift current increases and balance each other. This, creates a potential barrier.	½ ½ + ½ ½ ½ ½	3

SECTION D

35

a) Diagram	½ mark
Derivation	1 ½ mark
Orientation for maximum and half of the maximum torque	½ + ½ mark
b) Formula	½ mark
Calculation	1 mark
Result	½ mark

a)



½

From diagram

Magnitude of Torque= $(qE)(2a\ sin\theta)$ ½

$= (2qa)(E\ sin\theta)$ ½

$= pEsin\theta$

For direction

$$\vec{\tau} = \vec{p} \times \vec{E}$$ ½

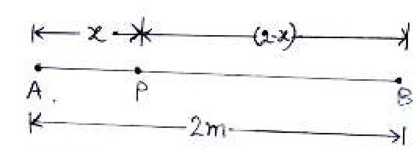
i) for maximum Torque, dipole should be placed perpendicular to the direction of electric field

$$\theta = 90^0 \ = \frac{\pi}{2}$$ ½

ii) For the torque to be half the maximum,

$$\theta = 30^0 = \frac{\pi}{6}$$ ½

(b)

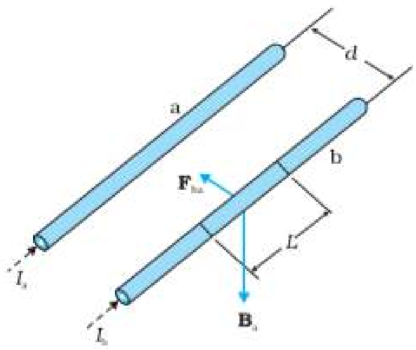


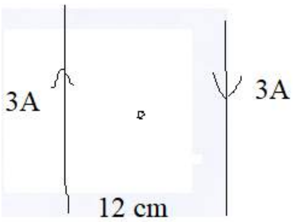
$$E_{PA} = E_{PB} \quad ; \quad E = \frac{kq}{r^2}$$

$$\frac{kq_A}{x^2} = \frac{kq_B}{(2-x)^2}$$ ½

$$\frac{1}{x^2} = \frac{4}{2-x)^2}$$ ½

$$\frac{1}{x} = \frac{2}{2-x}$$ ½

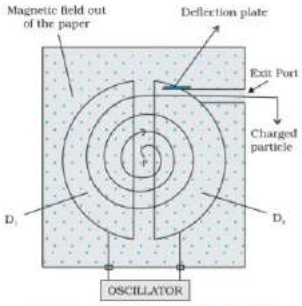
	$x = \frac{2}{3}\,m$ OR a) Derivation of expression for energy stored 2 ½ marks Form of energy stored ½ mark b) formula 1 mark calculation ½ mark result ½ mark a) Work done in adding a charge dq $= dW$ $= Vdq$ $= \frac{q}{c}dq$ ∴Total Amount of work(W)in charging a capacitor $W = \int dW = \frac{1}{C}\int_0^Q qdq$ $W = \frac{Q^2}{2C}$ $= \frac{(CV)^2}{2C} = \frac{1}{2}CV^2$ The electrostatic Energy/ potential energy is stored in the electric field between the plates. b) $C = 1\mu F = 1 \times 10^{-6}F;\quad V = 10\ volt$ $Q = CV$ $= 1 \times 10^{-6} \times 10$ $= 10^{-5} coulomb$	½ ½ ½ ½ ½ ½ ½ 1 ½ ½	5 5
36	a) Diagram showing direction ½ mark Derivation of expression 1 ½ marks Definition of 1 ampere 1 mark b) Magnetic fields of the wires ½ mark Net magnetic field and its direction 1 + ½ mark a) 	½	

	$B_1 = \frac{\mu_o I_1}{2\pi d}$ $\vec{F} = I(\vec{l} \times \vec{B})$ $F_{21} = I_2 l_2 B_1 sin90^o$	½	
	$= I_2 l_2 \frac{\mu_o I_1}{2\pi d}$	½	
	Force per unit length $f_{21} = \frac{F_{21}}{l_2} = \frac{\mu_o I_1 I_2}{2\pi d}$	½	
	<u>Definition of 1 ampere</u> – One ampere is defied as that steady current which, when maintained in each of the two very long, straight parallel conductors of negligible cross section, and placed at a distance 1 meter apart in vacuum, will produce on each of the conductors a force equal to $2 \times 10^{-7} N$ per metre of length. Alternatively, $I_1 = I_2 = IA,\ d = 1m, \frac{F}{l} = 2 \times 10^{-7} N/m$	1	
	b)  $\vec{B} = \vec{B_1} + \vec{B_2}$	½	
	$B = \frac{\mu_o I_1}{2\pi r_1} + \frac{\mu_o I_2}{2\pi r_2}$ $= \frac{\mu_o}{2\pi}\left(\frac{3}{6 \times 10^{-2}} + \frac{3}{6 \times 10^{-2}}\right)$ $= \frac{4\pi \times 10^{-7} \times 3}{\pi \times 6 \times 10^{-2}}$ $= 2 \times 10^{-5}\ tesla$	1	
	Direction of $\vec{B}$ at midpoint is perpendicular to the plane containing the two conductors and pointing downwards. (Note: give full credit of this direction if student takes direction opposite to the shown in fig and answer accordingly)	½	5

OR

a) Diagram	1 mark
explaining the shape of the path	2 marks
b) formula	½ mark
calculation	1 mark
result	½ mark

a)



1

Inside the dee, the magnetic field makes the charged particle to move in semi-circular path. ½

Electric field between the dees accelerates the charged particle. ½

The sign of Electric field is changed in tune with the circular motion of the particle. ½

Each time, the acceleration increases the energy of the particle.

As the energy increases, radius of circular path increases.

So, the path is spiral. ½

b)

$$R = \frac{V}{i_g} - G$$ ½

$$R_1 = \frac{2V}{i_g} - G = R_o - G$$

$$R_1 + G = 2R_o$$ ½

$$\left[Where\ R_o = \frac{V}{i_g}\right]$$

Similarily

$$R_2 + G = R_o$$

$$R_3 + G = R_o/2$$ ½

From the above equations,

$$R_1 - R_2 = 2(R_2 - R_3$$

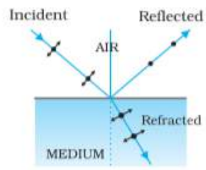
$$R_1 - 3R_2 + 2R_3 = 0$$ ½

5

37

a) Meaning of plane polarised light	1 mark
Diagram	½ mark
Derivation of the relationship between μ *and* θ	1 ½ marks
b) Each graph	1+1 marks

a) A light whose electric vector direction does not change with time is a plane polarised light.
Alternatively, if electric vector is confined to one particular plane, containing direction of propagation it is referred to as plane polarized light. — 1



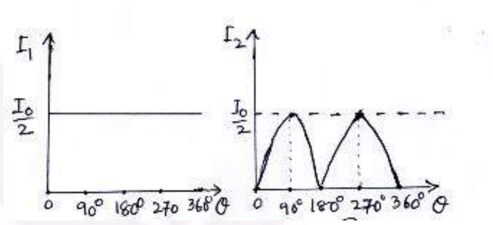
— ½

$$\mu = \frac{\sin i}{\sin r}$$ — ½

$$= \frac{sin\theta}{\sin\left(\frac{\pi}{2} - \theta\right)} = \quad if\ i = \theta$$ — ½

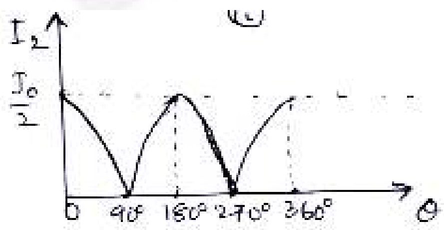
$$= \frac{sin\theta}{cos\theta} = \tan\theta$$ — ½

b) (i) (ii)



— 1+1 — 5

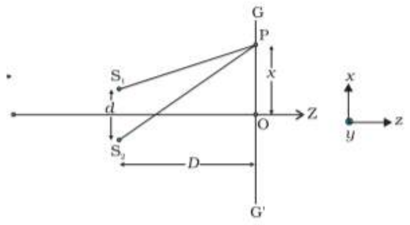
[Note: also accept if a student plots (ii) graph as follows]



OR

a) description of experiment with diagram	1 mark
derivation of the expression for fringe width	2 marks
b) finding the wavelength of refracted light	1 mark
finding the speed of refracted light	1 mark

a)



½

S is a monochromatic source of light. S_1 and S_2 are two pinholes separated by a distance d. GG' is the screen placed at the distance D from the pinholes. ½

P is a general point on the screen.

Derivation

$$(S_2P)^2 - (S_1P)^2 = \left[D^2 + \left(x + \frac{d}{2}\right)^2\right] - \left[D^2 + \left(x - \frac{d}{2}\right)^2\right]$$ ½

$$= D^2 + x^2 + \frac{d^2}{4} + xd - D^2 - x^2 - \frac{d^2}{4} + xd$$

$$= 2xd$$

$$path\ difference = S_2P - S_1P = \frac{2xd}{S_2P + S_1P} \approx \frac{2xd}{2D}$$ ½

$$Path\ difference = \frac{xd}{D}$$

For maxima

$$\frac{xd}{D} = n\lambda, \qquad n = 0,1,2 \ldots$$ ½

$$or \quad x_n = \frac{n\lambda D}{d}$$

$$x_{n+1} = \frac{(n+1)\lambda D}{d}$$

$$\beta = x_{n+1} - x_n$$

$$\beta = \frac{\lambda D}{d}$$ ½

b) 5

$$\mu_w = \frac{c_0}{c_w} = \frac{\upsilon\lambda_0}{\upsilon\lambda_w} = \frac{\lambda_0}{\lambda_w}$$ ½

$$\lambda_w = \frac{\lambda_0}{\mu_w} = \frac{588 \times 3}{4} = 441\ nm$$ ½

$$c_w = \frac{c_0}{\mu_w} = \frac{3 \times 10^8 \times 3}{4} = 2.25 \times 10^8\ m/s$$ ½ + ½