Chapter-7: Physical Optics

Ques. ▶1 In Young's double slit experiment a light of wavelength 5000Å is exposed to the slits which are 0.1 mm apart. The screen is placed 2m away from the slits. *[All Board 18]*

a. What is dispersion of light? 1
b. Is the deviation of light depends on the prism angle? Explain. 2
c. Find the distance of the 10th maximum from the central maximum. 3
d. Compare with mathematical analysis between the angular position of 10th maximum and 10th minimum. 4

Answer to the question no. 1

a The phenomenon of splitting a ray of white light into seven fundamental colours while refracting through a prism is called dispersion.

b We know, from the formula of prism, $\delta = i_1 + i_2 - A$; where δ = deviation, $\hat{i}_1$ = angle of incident & $\hat{i}_2$ = angle of emergent and A = angle of prism. Now, if the prism is thin, then $\delta(\mu - 1)A$ i.e. deviation is proportional to angle of prism.
Therefore, it can be said that deviation of light depends on angle of prism.

c Here,

Wavelength, $\lambda = 5000\text{Å} = 5 \times 10^{-7}$ m
Distance between two stits, $a = 0.1$ mm $= 10^{-4}$ m
Distance screen, $D = 2$m
∴ Distance of the 10th bright fringe from central bright fringe,

$$X_{10} = \frac{10\,\lambda D}{a} = \frac{10 \times 5 \times 10^{-7} \times 2}{10^{-4}}\ \text{m}$$
$$= 0.1\ \text{m}$$
$$= 10\ \text{cm}\ \textbf{(Ans.)}$$

d Distance of the 10th bright fringe from central bright fringe, $X_{10} = 10$ cm
Distance of the 10th bright fringe from dark fringe,

$$\overline{X}_{10} = \frac{2n-1}{2}\left(\frac{D\lambda}{a}\right)$$
$$= \frac{2 \times 10 - 1}{2} \times \frac{2 \times 5 \times 10^{-7}}{10^{-4}}\ \text{m}$$
$$= 0.95\ \text{cm}$$
$$= 0.095\ \text{m}$$

∴ Difference of angular position, $\Delta\theta = \tan^{-1}\frac{X_{10}}{D} - \tan^{-1}\frac{\overline{X}_{10}}{D}$

$$= \tan^{-1}\left(\frac{0.1}{2}\right) - \tan^{-1}\left(\frac{0.095}{2}\right)$$
$$= 0.143^\circ = 8'\,34''$$

Therefore, difference of angular position between 10th bright fringe and 10th dark fringe is 8′ 34″.

Ques. ▶2 In a double slit experiment placing two slits 0.4 mm apart a monochromatic light of 5000Å is used. For this 1 m away from the two slits in the screen two successive bright and dark fringes is produced. *[R.B. 16]*

a. What is called accommodation power of eye? 1
b. What is meant by the length of tube of an astronomical telescope for normal vision is 22 cm? 2
c. Find the distance between two successive bright and dark fringes. 3
d. Analyze what change of fringes be seen on the screen if one slit is closed. 4

Answer to the question no. 2

a The curvature of the eye lens is adjusted by the expansion and contraction of the ciliary muscles attracted to it and thus image is always formed on the retina. This is known as power of accommodation of lens (eye).

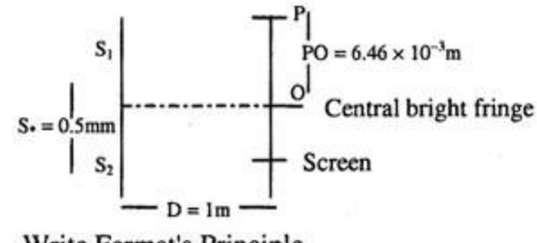
b Then length of tube of an astronomical telescope for normal vision is 22 cm means if the distance between objective and ee-piece be 22 cm, then an inverted magnified image is formed at infinity.

c Here,
distance between two slits, $a = 0.4\text{mm} = 0.4 \times 10^{-3}$ m
Wevelength of light, $\lambda = 5000\text{Å} = 5000 \times 10^{-10}$ m
Distance of screen from slit, $D = 1$ m
Distance between two successive bright fringes, $\Delta x = ?$
We know, $\Delta x = \frac{\lambda D}{a}$

$$= \frac{5000 \times 10^{-10} \times 1}{0.4 \times 10^{-3}}$$
$$= 1.25 \times 10^{-3}\ \text{m}\ \textbf{(Ans.)}$$

d When any one slit is closed, then there will be no more interference, rather it (the slit) acts as a source of monochromatic light and from the same wave front the incident secondary waves due to superposition diffraction will produced. As a result on the screen we will see diffraction spectrum instead of interference spectrum. In case of interference though the width of fringes are equal, but in case of diffraction the width of fringes are not equal. In this dark fringes are not completely dark. In this case also, width of the intensity of bright fringes are not equal. In case of diffraction, the central bright band is thick and this thickness gradually decreases to outwards.

Ques. ▶3 In the stem, using a light of wavelength 3800Å an experiment of Young's double slit is performing. In figure, $S_1S_2 = 0.5$mm, OP $= 6.46 \times 10^{-3}$m, D = 1m. *[C.B. 16]*



a. Write Fermat's Principle. 1
b. Why is the white light when passes through glass prism dispersed? 2
c. What is the distance of 5th dark fringe from central bright fringe? 3
d. At the point P of the stem does the constructive or destructive interference form? Give your opinion with the mathematical analysis. 4

Answer to the question no. 3

a When a light ray is reflected or refracted from a plane surface obeying the laws of reflection or refraction, it will always travel in such a way that the path will be least.

b When white light passes through a glass prism the refracted ray splits into seven different colours and these colours move toward the prism. The phenomenon of splitting a ray of white light into seven colours is called dispersion.

The refractive index of different colours are different. So, though the angle of incidence is same, but angle of refractions are different. In the prism light refracted in two times. So though the angle of incidence is same, yet the angle of emergent is different. We can show, deviation, $\delta = (i_1 + i_2) - A$; where A = angle of prism, i_1 = angle of incident and i_2 = angle of emergent. For this reason when white light ray passes through prism, at the time of refraction it is deviated.

c Given,
Wavelength, $\lambda = 3800\text{Å} = 3800 \times 10^{-10}\text{m}$
S, S_2 = distance of two slits = d = 0.5mm = 0.5×10^{-3} m
D = distance of screen from slit = 1m, n = 5
Distance of 5th fringe, x_n = ?
We known, distance of n^{th} dark fringe,

$$x_n = (2n-1)\frac{\lambda D}{2d}$$
$$= (2\times 5 - 1)\frac{3800\times 10^{-10}\text{m}\times 1\text{m}}{2\times 0.5\times 10^{-3}\text{m}}$$
$$= 3.42\times 10^{-3}\text{m}$$

∴ Distance of 5th dark fringe = 3.42×10^{-3} m = 3.42 mm

d We know,

$$S_2P - S_1P = \frac{xd}{D}$$
$$= \frac{6.46\times 10^{-3}\text{m}\times 0.5\times 10^{-3}\text{m}}{1\text{m}}$$
$$= 3.23\times 10^{-6}\text{m}$$

Here,
$x = 6.46 \times 10^{-3}$m
$a = 0.5 \times 10^{-3}$m
D = 1m
$\lambda = 3800 \times 10^{-10}$m

We know, from the condition of interference,

$$S_2P - S_1P = n\lambda$$
$$\therefore n = \frac{S_2P - S_1P}{\lambda}$$
$$= \frac{3.23\times 10^{-6}\text{m}}{3800\times 16^{-10}\text{m}} = \frac{17}{2} = 17\times\frac{1}{2}$$

If n is an integer constructive and if the multiple of half odd integer, then destructive interference will produce.
Here, n is odd multiple.
∴ At the point P destructive interference will produce.

Ques. ▶4 In a lab, Rayhan inflicted 600nm light perpendicularly on a diffraction grating with 2 μm width. He assumed that he would see 9 points. *[S.B. 17]*

a. What is an electromagnetic wave? 1
b. The power of a lens is–5 D'- Explain. 2
c. What is the angular distance between the points? 3
d. Was his assumption correct? 4

Answer to the question no. 4

a According to the theory of electromagnetic of Maxwell, if an alternating electric field and a magnetic field are oscillated at right angle to each other and in the same phase, then an wave traverse with a very high velocity and at right angle to both of them is called electro magnetic wave or radiation.

b 'The power of a pair of spectacles is – 5D' means that the lens is a concave and its focal length, $f = -\frac{1}{5}\text{m} = -0.20\text{m}$.

c Given,
Wavelength of light, $\lambda = 600\text{ nm} = 600\times 10^{-9}$m
Order no. n = 1
Width of slit, $a = 2\mu\text{m} = 2\times 10^{-6}$m
Wanted, angular distance between the first order maxima, $2\theta'_n$ = ?
We know,

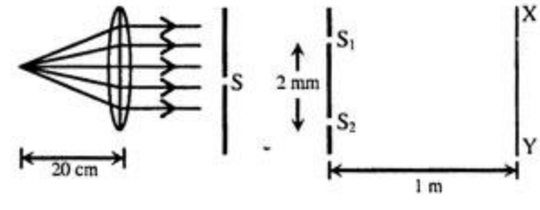
$$a\sin\theta'_n = (2n+1)\frac{\lambda}{2}$$
or, $$\sin\theta'_n = (2n+1)\frac{\lambda}{2a}$$
or, $$\sin\theta'_n = (2n+1)\times\frac{600\times 10^{-9}}{2\times 2\times 10^{-6}}$$
or, $\sin\theta'_n = 0.45$
or, $\theta'_n = \sin^{-1}(0.45) = 26.74°$
∴ $2\theta'_n = 2\times 26.74 = 53.48°$ **(Ans.)**

d From stem we get,
Wavelength of light, $\lambda = 600\text{ nm} = 600\times 10^{-9}$m
Width slit, $a = 2\mu\text{m} = 2\times 10^{-6}$ m
Maximum angle of diffraction may be θ = 90°. Here if at any side, maximum order point is produced then,

$$a\sin 90° = (2n+1)\frac{\lambda}{2};\ n = 0, 1, 2, 3\ ....$$
or, $$2n+1 = \frac{2a}{\lambda}$$
or, $$2n = \frac{2a}{\lambda} - 1$$
or, $$n = \frac{a}{\lambda} - \frac{1}{2} = \frac{2\times 10^{-6}}{600\times 10^{-9}} - \frac{1}{2}$$

or, n = 2.83 ≈ 2 (∵ n cannot be fraction). Rayhan on both sides 2 central maximum points will seen i.e. Rayhan will observe total 2 + 2 + 1 = 5 maximum points.

Ques. ▶5 An arrangement of Young's double slit experiment is shown in the folloiwing diagram, where S_1 and S_2 are two coherent sources. Wavelength of used light is 5800 Å.



[B.B. 16]

a. Write Fermat's Principle. 1
b. When the focal length of a simple microscope is reduced, its magnification is increased' — Explain. 2
c. Determine the power of the lens used in the stem. 3
d. Is it possible to get the band of same width when the distance of screen is increased 20 cm? Give your opinion with mathematical analysis. 4

Answer to the question no. 5

a When a light ray is reflected from a plane surface obeying the laws of reflection or refraction, it will always travel in such a way that the path will be least.

b In case of simple microscope, magnification, $M = 1 + \frac{D}{f}$; where f = focal length of the convex lens and d = least distance of distinct vision = 25 cm (for normal eye). So, from the above equation it is seen that if the focal length (f) reduced, the magnification will increase.

c From stem we get,
Focal length of lens, f = +20 cm = +0.2 m
Power of lens, P = ?
We know,
$$P = \frac{1}{f} = \frac{1}{+0.2} = +5 \text{ D (Ans.)}$$

d From stem we get,

Wavelength $\lambda = 5800\text{Å} = 5800 \times 10^{-10}$ m
Distance between two slits, $d = 2\text{mm} = 2 \times 10^{-3}$ m
Distance of screen, D = 1m
Width of band, x = ?
We know,
$$x = \frac{\lambda D}{2d} = \frac{5800 \times 10^{-10} \times 1}{2 \times 2 \times 10^{-3}}$$
$$= 1.45 \times 10^{-4} \text{ m}$$
Increasing the distance of screen 20 cm, it is possible to get the band of same width in that case wavelength of light is to be changed.
Changed screen distance, D′ = 1m + 20 cm = 1.2 m
Let, changed of wavelength is, = λ′
We know, $x = \frac{\lambda' D'}{2d}$
or, $\lambda' = \frac{2dx}{D'} = \frac{2 \times 2 \times 10^{-3} \times 1.45 \times 10^{-4}}{1.2}$
$$= 4.83 \times 10^{-7} \text{ m}$$
$$= 4833.3\text{Å}$$

Therefore increasing the distance of screen 20 cm, to get the band of same width, the light of wavelength 4833.3Å is to be used.

Ques. ▶ 6 Young's double slits are illuminated by green light (λ=5640Å). Distance between two slits is 0.1mm and interference pattern is observed at a distance 1m from the slits. If this arrangement is submerged into water (μ_w=4/3), it is observed that width of the fringe changes.

[Notre Dame College, Dhaka]

a. Write down Huygens's principle. 1
b. Is it possible to produce interference pattern by using white light?– Explain. 2
c. Calculate the angular position of 3rd dark fringe. 3
d. Is the observation correct or not? -analyze mathematically. 4

Answer to the question no. 6

a Huygens's principle states that every point of a wavefront is itself the source of spherical wavelets.

b White light is made of seven different chromatic light. An interference pattern is a result of super position of light waves. Generally white light doesn't produce interference pattern but with special treatment, only a few orders of pattern can be observed.

c If angular position of third bright fringe is θ, then,
$a\sin\theta = n\lambda$
$$\therefore \theta = \sin^{-1}\left(\frac{n\lambda}{a}\right)$$
$$= \sin^{-1}\left(\frac{3 \times 5640 \times 10^{-10}}{0.1 \times 10^{-3}}\right)$$
$$= 0.9695° \text{ (Ans.)}$$

Here,
Order of right fringe, n = 3
Distance between slits,
$a = 0.1\text{mm}$
$= 0.1 \times 10^{-3}$
Wavelength, $\lambda = 5640\text{Å}$
$= 5640 \times 10^{-10}$

d If same light wave is used in the new medium, then the wavelength of the light will change. And if changed wavelength is, λ_2,

$$\lambda_2 = \frac{\mu_1 \lambda_1}{\mu_2}$$

So, value of x_n will be

$$x_n' = \frac{n\lambda_2 D}{a}$$
$$= \frac{nD}{a} \times \frac{\mu_1 \lambda_1}{\mu_2}$$
$$= \frac{nD\lambda_1}{a} \times \frac{\mu_1}{\mu_2}$$
$$= x_n \times \frac{\mu_1}{\mu_2}$$

$\mu_1 = 1$ & $\mu_2 = 1.33$

As $\mu_1 \neq \mu_2$

So, $x_n \neq x_n'$

That's value of x_n won't remain same.

So, the observation is correct.

Ques. ▶ 7 In young's double slit experiment the distance of the 4th maxima from the central maxima is 0.25×10^{-3}m, the separation between the slits 1 mm and distance of screen from the slits 1m. *[Viqarunnisa Noon School & College, Dhaka]*

a. What is wave front? 1
b. The power of a spectacle is 5D. What does this mean? 2
c. What will be the wave length of the incident light? 3
d. At 6.02×10^{-3}m away from central maxima will we get maxima or minima? Explain it? 4

Answer to the question no. 7

a The wave front at any instant is the locus of all points in the medium over which the waves pass and at which the particles are in the same phase of vibration.

b Power of a spectacle is 5D' Means the spectacle is convex & it converges the light rays parallel to the principal axis at point at $\frac{1}{5}$ m distance from the center of the lens, i.e, the focus length is $\frac{1}{5}$ m.

c If the wave length of the light is λ and the distance to 4th maxima is X_4 then

$$x_4 = 4\frac{\lambda D}{a}$$
$$\Rightarrow \lambda = \frac{ax_4}{4D}$$

Here,
Width of slits, a = 1mm
$= 1 \times 10^{-3}$ m
Distance from slit to screen, D = 1m
Distance of 4th maximum, $X_4 = 0.25 \times 10^{-3}$m

$$= \frac{1 \times 10^{-3} \times 0.25 \times 10^{-3}}{4 \times 1}$$
$$= 62.5 \times 10^{-9} \text{m (Ans.)}$$

d If the point is, at distance of $\frac{m\lambda}{2}$ from the central bright fringe, then

$$x = \frac{m\lambda D}{2a}$$

$$\therefore m = \frac{2ax}{\lambda D}$$

$$= \frac{2 \times 1 \times 10^{-3} \times 6.02 \times 10^{-3}}{62.5 \times 10^{-9} \times 1}$$

$$= 192.64$$

Here,
Width of the slit, $a = 1 \times 10^{-3}$ m
Distance from slit to screen, D = 1m
From 'C', the wavelength, $\lambda = 62.5 \times 10^{-9}$m

$\therefore$ The point is at distance 192.64 multiple of $\frac{\lambda}{2}$.

As the point is nearer to the 193th multiple of $\frac{\lambda}{2}$ than 192, the point is in the dark fringe region.

Ques. ▶ 8 Riad was performing young's double slit experiment with sodium light of wavelength 5800 Å. He was observing the change in frings due to the change of position of the screen from lm to 1.5 m. Distance between the slits 0.2 mm. *[Ideal School and College Motijheel, Dhaka]*

a. Define Dopant. 1
b. The base of a transistor is very thin and dopped slightly, explain why? 2
c. Determine the angular distance between two successive bright fringes. 3
d. After the change of position of the screen, what necessary steps should be taken to remain the nature of fringes unchanged ? - Justify with your mathematical opinion. 4

Answer to the question no. 8

a The element which is used to dope the semi-conductors is called Dopant.

b Transistor is used to amplify the electric signal. The active region of the transister is its base. The thinner the base. The stronger the electric field in emitter & collector. As a result a small current in base would infulence a lot on the emitter & collector, hence β will be larger. That's why base is made thinner & doped lightly.

c If the angular distance of two consecutive bright fringes is θ, then,

$$\tan\frac{\theta}{2} = \frac{\lambda}{2a}D$$

$$\therefore \theta = 2\tan^{-1}\left(\frac{\lambda}{2a}D\right)$$

Here,
Wavelength of light,
$\lambda = 5800\text{Å} = 5800 \times 10^{-10}$ m
Distance between slit and scereen
D = 1 m
Distance between two slits,
$a = 0.2$ mm $= 0.2 \times 10^{-3}$ m

$$= 2\tan^{-1}\left(\frac{5800 \times 10^{-10} \times 1}{2 \times 0.2 \times 10^{-3}}\right)$$

$$= 0.166° \textbf{ (Ans.)}$$

d We know, $\Delta x = \frac{\lambda D}{2a}$

So, to get the same fringe with after moving the screen 0.5m further away from D_1 = 1m to D_2 = 1.5m, either the distance between slits should be reduced or light to smaller wave length should be used.

$\therefore$ If tringe width in both case are respectively Δx_1 and Δx_2, then,

$$\frac{\Delta x_1}{\Delta x_2} = \frac{\frac{\lambda_1 D_1}{2a_1}}{\frac{\lambda_2 D_2}{2a_2}}$$

or, $$1 = \frac{\lambda_1 D_1}{\lambda_2 D_2} \times \frac{a_2}{a_1}$$

or, $$\frac{\lambda_1}{\lambda_2} \times \frac{a_2}{a_1} = \frac{D_2}{D_1} = \frac{1.5}{1} = \frac{3}{2}$$

or, $$\frac{a_2}{a_1} = \frac{3}{2}\frac{\lambda_2}{\lambda_1}$$

Now if light of equal wave length is used.

$$\lambda_1 = \lambda_2$$

$$\therefore \frac{a_2}{a_1} = \frac{3}{2} \times 1 = \frac{3}{2}$$

$$\therefore a_2 = \frac{3}{2}a_1 = \frac{3}{2} \times 0.2 = 0.3 \text{ mm}$$

If distance between slits is constant kept,

$$a_1 = a_2$$

$$\therefore \frac{3}{2}\frac{\lambda_2}{\lambda_1} = 1$$

or, $$\lambda_2 = \frac{2}{3}\lambda_1 = \frac{2}{3} \times 5800 = 3866.67\text{Å}$$

So, to get the same fringe with distance between slits should be made 0.3 mm from 0.2 mm. Or a light of wave length of 3866.67Å should be used in place of 5800Å.

Ques. ▶ 9

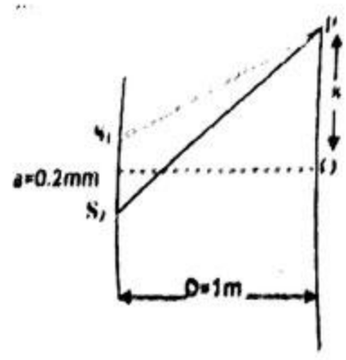


Figure shows the Young's double slit experiment. At point P, 10th bright has been created. The wavelength of the light is 6500Å. *[Adamjee Cantonment College, Dhaka]*

a. What is coherent source? 1
b. Magnitude is different but the direction of electromagnetic wave and pointing vector are same-explain. 2
c. Find out the distance X. 3
d. Distance between 5th bright and 5th dark is equal to the width of single bright explain mathematically. 4

Answer to the question no. 9

a If light-waves of the same wavelength are emitted from two sources with a particular phase difference and if that phase difference is maintained all along during propagation then those sources are called coherent sources.

b If electric field is $\vec{E}$ and magnetic field is $\vec{B}$, then pointing vector, $\vec{S} = \frac{1}{\mu_0}(\vec{E} \times \vec{B})$

With the same electric field $\vec{E}$ and magnetic field $\vec{B}$, the direction of electromagnetic wave is in the dicrection of $\vec{E} \times \vec{B}$ which is the same direction of $\vec{S}$.

So both have same direction but the magnitude of $\vec{S}$ is $\frac{1}{\mu_0}$ times of $\vec{E} \times \vec{B}$.

c Similar as Q. No. 1(c); **Ans.** 0.0325 m

d If the distance between the center of 5th maxima and 5th minima is respectively x_5 and x_5' then,

$$x_5' - x_5 = \frac{(2n+1)}{2a}\lambda D - \frac{n\lambda D}{a}$$
$$= \frac{(2\times 5+1)}{2a}\lambda D - \frac{5\lambda D}{a}$$
$$= \frac{11\,\lambda D - 10\,\lambda D}{2a}$$
$$= \frac{\lambda D}{2a}$$

Which is equal to any width of maxima by young's double slit experiment.

Ques. ▶ 10 In double slit experiment the distance between the two slit is 0.1 mm and the slits are illuminated by a monochromatic light of Wavelength 5000Å. Bright and darks fringe are found on the screen. The screend from the slits is 2m. *[BAF Shaheen College, Dhaka]*

a. What is decay constant? 1
b. Working function of any metal is 2.31 ev what do you mean? 2
c. What is the distance from the central bright fringe to the 8th bright fringe? 3
d. Compare the angular position of 8th bright fringe and 8th dark fringe. 4

Answer to the question no. 10

a **Decay constant:** The probability of decay of one atom of a radioactive substance in unit time is called the radioactive decay constant of that substance.

b "Working function of metal is 2.31 eV" means the incident photon should have the minimum energy of 2.31 eV to emit electron from the metal surface. Any photon having energy less than 2.31 eV work emit any electron from metal surface.

c Similar as 1(c); **Ans.** 8 cm

d Similar as 1(d); **Ans.** 17′14.44″

Ques. ▶ 11 A monochromatic light of 5710Å is refracted by a bi-convex lens of radii 15cm and 30cm respectively. Then the refracted light is used in a fraunh offer class of diffraction for single slit. The width of slit be 2×10^{-5}m and refractive index of lens be 1.5. *[Dhaka City College, Dhaka]*

a. What is black hole? 1
b. How can OR gate be formed from NAND gate? 2
c. Calculate the optical power of the lens according to above stimulus. 3
d. How many maxima can be observed in the diffraction pattern according to above experiment? Explain by mathematical analysis. 4

Answer to the question no. 11

a If the mass of a star just before the onset of death is more than $3M_0$, then contraction within the star due to gravitational attraction becomes so intense that contraction of the core continues until it reaches to a point of zero radius and infinite mass. This attractive force is so strong that nothing from the surrounding space of the point can come out, not even light. This region is called black hole.

b See Chapter-4, Q. No: 14(b)

c Given that,
Radio of curvature of lens, $r_1 = 15$ cm, $r_2 = -30$ cm
Refractive index of lens, $\mu = 1.5$
Optical power of lens, $P = ?$

We know, $P = \frac{1}{f} = (\mu-1)\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$
$$= (1.5-1)\left(\frac{1}{15\text{ cm}}-\frac{1}{-30\text{cm}}\right)$$
$$= 0.5\times\frac{2+1}{30\text{ cm}}$$
$$= \frac{0.5\times3}{0.3\text{m}} = +5\text{D}$$

d For bright fringe in fraunhofer diffraction,

$a\sin\theta = (2n+1)\frac{\lambda}{2}$

Here, width of slit, $a = 2\times10^{-6}$ m

Wavelength of light, $\lambda = 5710\text{Å} = 5.71\times10^{-7}$ m

for n = 1, $(2\times10^{-6}\text{ m})\sin\theta = \frac{3}{2}\times5.71\times10^{-7}$ m

$= 8.565\times10^{-7}$ m

$\therefore \sin\theta = \frac{8.565\times10^{-7}\text{ m}}{2\times10^{-6}\text{ m}} = 0.428$

$\therefore \theta = \sin^{-1}(0.428) = 25.3°$

For 2nd maxima, n = 2

$(2\times10^{-6}\text{ m})\sin\theta = \frac{5}{2}\times5.71\times10^{-7}$ m

or, $\sin\theta = 0.714$

or, $\theta = \sin^{-1}(0.714) = 45.56°$

For 3rd maxima n = 3

$(2\times10^{-6}\text{m})\sin\theta = \frac{7}{2}\times5.71\times10^{-7}$ m

or, $\sin\theta = 0.99925$

or, $\theta = 87.78° \approx 90°$

Here, it is possible to get 3rd maxima but can't get 4th maxima. So there will be get 7 maxima include center maxima.

Ques. ▶ 12 On Young's double slit experiment a light of wave length 5000Å is exposed to the slits which are 0.1 mm apart. The screen is placed 2 m away from the slits. *[Square High School & College, Pabna]*

a. What is molar heat capacity? 1
b. What is the qualitative difference of first and second law of thermodynamics? 2
c. Find the distance of the 10th maximum from the central maxima. 3
d. Compare with mathematical analysis between the angular position of 10th maximum and 10th minimum. 4

Answer to the question no. 12

a Molar heat capacity or molar specific heat capacity is the amount of heat energy required to raise the temperature of 1 mole of a substance.

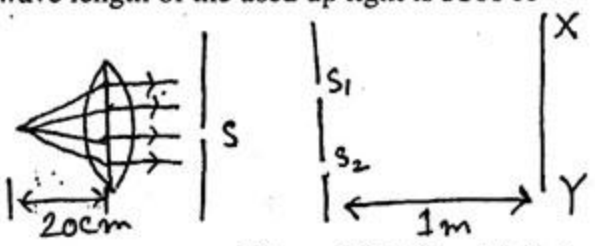
b The first law of thermodynamics is, essentially, a reiteration of the law of the conservation of energy. "The increment in the internal energy of the system is equal to the increment of the heat supply to the system".

The second law of thermodynamics speaks about the entropy in a system. A closed system is usually the main example (That which allows for the entering and exiting of heat and energy but not matter). The entire energy of a system cannot be converted into work without energy loss. Furthermore, any spontaneous process will actively increase the entropy.

c See creative question 1(c).

d See creative question 1(d).

Ques. ▶ 13 In the following figure, young's double slit experiment is shown; where s_1 and s_2 are two coherent source and the wave length of the used up light is 5800 Å



[Square High School & College, Pabna]

a. Which thing is used as high speed switch? 1

b. Why current is not available in reverse bias of a p-n junction? 2

c. Calculate the power of the lens. 3

d. It it possible to get the fringe having the same width by increasing the distance of the screen 20 cm than before? 4

Answer to the question no. 13

a Transistor.

b In reverse biased condition, the positive terminal of the battery is connected to the n-type semiconductor and negative terminal of the battery is connected to the p-type semiconductor. When we apply reverse voltage, the large number of free electrons in the n-type semiconductor experience an attractive force from the positive electric field or positive terminal and move towards the positive terminal of the battery. Hence, large number of atoms lose electrons and become positive ions. We know that depletion region is nothing but group of motionless charges or ions. Therefore, the width of depletion region increases at n-side. In the similar way, due to pulling holes away from the depletion region at p-side, the depletion width increases at p-side. In reverse biased condition, thus the depletion width is very wide. Hence, it is very difficult for the free electrons and holes to overcome the strong opposite electric field from the depletion region and cross the depletion region. Therefore, no electric current flows in the reverse biased condition.

c See creative question 5(c).

d See creative question 5(d).

Ques. ▶ 14 Young's double slite experiment, a monochromic ray falls on screen. From optima a bright fringe found of width 2.95×10^{-4}m. The distance between two slites is 0.03m and the screen from source is 30cm.

[The Millennium Stars School & College ...]

a. What is stopping voltage? 1

b. At the top of mobile tower red colour bulb is used-why? 2

c. Find the wave length of the light ray. 3

d. If you use a ray of wave light of 8000Å , what should be changed position of the screen. 4

Answer to the question no. 14

a The stopping voltage is defined as the voltage necessary to stop any electron (or, in, other, words, to stop even the electron with the most kinetic energy) from reaching the other side.

b As red color is scattered less than that of other colors. It can reach long without much attenuation & scattering. So red color bulb is used warning to reach long without much avoid collision from helicopters & planes etc.

c If wavelength of the incident photon is λ, then,

$$\Delta x = \frac{\lambda D}{a}$$

$$\therefore \lambda = \frac{a\Delta X}{D}$$

$$= \frac{0.03 \times 2.95 \times 10^{-4}}{0.3}$$

$$= 2.95 \times 10^{-3} \text{ m (Ans.)}$$

Here,

Distance between two slits,

$a = 0.03$m

Screen to source distance,

$D = 30$cm

$= 0.3$m

Width of bright fringe from optima,

$\Delta x = 2.95 \times 10^{-4}$m

d If a wave of wavelength 8000Å is used & to keep the fringe width constant,

$$\frac{\Delta x}{\Delta x'} = 1$$

$$\Rightarrow \frac{\frac{\lambda D}{a}}{\frac{\lambda' D'}{a}} = 1$$

$$\therefore D' = \frac{\lambda D}{\lambda'}$$

$$= \frac{2.95 \times 10^{-3} \times 0.3}{8000 \times 10^{-10}}$$

$$= 1106.25\text{cm}$$

$$= 11.06\text{m}$$

Here,

From 'c'

$x = 2.95 \times 10^{-3}$m

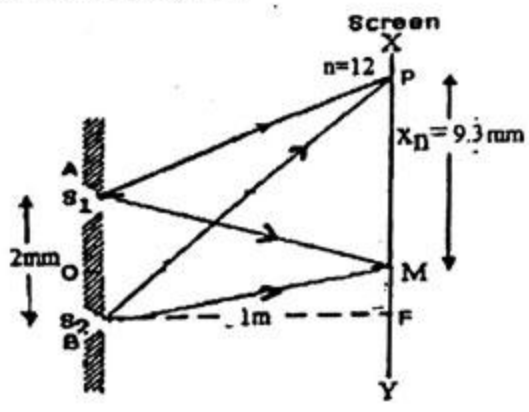
$D = 0.3$m

$\lambda' = 8000$Å

$= 8000 \times 10^{-10}$

The screen should be at 11.06 distance from the source to keep fringe width constant.

Ques. ▶ 15 Young's double slit experiment is shown in figure where p is the nth bright point.



[Cantonment English School & College, Chattogram]

a. What is diffraction of light?

b. 'Grating constant of a plane transmission grating is 0.2mm'-what does it mean? 2

c. Calculate the frequency of the light. 3

d. Will the value of X_n remains same if experiment is done in water of refractive index 1.33? Explain mathematically. 4

Answer to the question no. 15

a The bending of light waves around the corners of an obstacle on aperture into the region of geometrical shadow of the obstacle.

b Grating constant 0.2mm means the total width of a slit and an apaque portion of grating in that plane transmission grating is 0.2mm.

c If frequence at light is f, then distance of n = 12th bright point from central bright point is,

$$x_n = \frac{\eta\lambda D}{a}$$

$$\Rightarrow x_n = \frac{\eta c D}{a x_\eta}$$

$$= \frac{12 \times 3 \times 10^8 \times 1}{2 \times 10^{-3} \times 9.3 \times 10^{-3}}$$

$$= 1.94 \times 1014 \text{ Hz } \textbf{(Ans.)}$$

Here,
$x_n = 9.3$ mm
$= 9.3 \times 10^{-3}$m
Distance between screen & slit,
D = 1m
Width of slits,
$a = 2mm = 2 \times 10^{-3}$m
Order of bright point,
n = 12

d It same light wave is used in the new medium, then the wavelength of the light will change. And if changed wavelength, λ_2,

$$\lambda_2 = \frac{\mu_1\lambda_1}{\mu_2}$$

So, value of X_n will be

$$X'_n = \frac{n\lambda_2 D}{a}$$

$$= \frac{nD}{a} \times \frac{\mu_1\lambda_1}{\mu_2}$$

$$= \frac{nD\lambda_1}{a} \times \frac{\mu_1}{\mu_2}$$

$$= X_n \times \frac{\mu_1}{\mu_2}$$

$\mu_1 = 1$ & $\mu_2 = 1.33$

As, $\mu_1 \neq \mu_2$

So, $X'_n \neq X_n$

That's value of X_n won't remain same.

Ques. ▶ 16 In Young's double slit experiment the distance between two slits 0.3 mm. The distance of the screen from the slits is 1m. In an experiment in air medium the distance of the 8th bright fringe from the central bright fringe is 6.2mm.

[Mymensingh Girls' Cadet College, Mymensingh]

a. What is called polarization of light? 1
b. No sources in nature are coherent— explain. 2
c. Find the wavelength light used in the experiment. 3
d. Analyse what change in the fringe will take place when the arrangement of the stem is kept into water. 4

Answer to the question no. 16

a the fact of remaining the vibration of wave unidirection always under certain condition is called polarization.

b If light-waves of the same wavelength are emitted from two sources with a particular phase difference and if that phase difference is maintained all along during propagation then those sources are called coherent sources.

Light emitted from two completely independent identical sources or light emitted from different parts of the same source will not form coherent sources i.e, same particular phase difference does not exist all along.

So, we do not get any coherent source in nature.

c Similar as Creative Question No.: 7(c) [Ans. : 2325 Å]

d Similar as Chatper-6, Question No.: 17(d)

[Ans. : Fringe will decrease by 25%]

Ques. ▶ 17 In young double slit experiment, the distance between two slits in 2 mm. The separation between two consecutive fringes at distance 1m from the slit is found to be 0.295 mm.

[Rajshahi Cadet College, Rajshahi]

a. Define coherent source. 1
b. What do you mean by visible light? 2
c. Calculate the wavelength of light. 3
d. How is the distance between two slits changed so that the wavelength of light is 7800 Å. Explain with mathematical logic. 4

Answer to the question no. 17

a If light-waves of the same wavelength are emitted from two sources with a particular phase difference and if that phase difference is maintained all along during propagation then those sources are called coherent sources.

b Visible light waves are the only electromagnetic waves we can see. We see these waves as the colors of the rainbow. A typical human eye will respond to wavelengths from about 390 to 700 nanometers. In terms of frequency, this corresponds to a band in the vicinity of 430–770 THz. Each color has a different wavelength. Red has the longest wavelength and violet has the shortest wavelength. When all the waves are seen together, they make white light. When white light shines through a prism or through water vapor like rainbow, the white light is broken apart into the colors of the visible light spectrum.

c Here,

Distance between two slits, $a = 2mm = 2 \times 10^{-3}$ m

Distance of screen from slits D = 1m

Separation of corsecutive tringes, $\Delta x = 0.295$ mm
$= 0.295 \times 10^{-3}$m

Wave length of light, x = ?

We know,

$$\Delta x = \frac{\lambda D}{a}$$

$$\therefore x = \frac{a\Delta x}{D}$$

$$= \frac{2 \times 10^{-3} \times 0.295 - 10^{-3}}{1}$$

$$= 5.9 \times 10^{-7}$$

$$= 5900\text{Å } \textbf{(Ans.)}$$

d If wavelength of light is changed to $\lambda' = 7800$Å & fringe width is to keep constant, then the distance between the slits should be changed to a'.

If fringe width remains unchanged, then,

$$\Delta x' = \Delta x$$

$$\text{or, } \frac{\lambda' D}{a'} = \frac{\lambda D}{a}$$

$$\therefore a' = \frac{\lambda'}{\lambda} a$$

$$= \frac{7800}{5900} \times 2$$

$$= 2.644 \text{ mm}$$

So, the distance between slits should be 2.644 mm.

Ques. ▶ 18 In Young double slit experiment Razib used indigo light having frequency 6×10^{14} Hz. He observe 15 fringes at a distance 1.55m from the slits is found to be 22.5mm. Then he proceed the experiment by single slit of slit width 6×10^{-4}cm in a liquid having refractive index 1.33.

[Pabna Cadet College, Pabna]

a. What is diffraction of light? 1
b. What are the characteristics of Coherent sources? 2
c. What was the distance between two slits in Young double slit experiment? 3
d. Razib found the same angular position for two bright fringes and two dark fringes when experiment was proceed in the liquid, give your opinion. 4

Answer to the question no. 18

a When an obstacle is placed in front of a source, it is seen that a shadow is formed, but a careful observation shows that the shadow is not distinct and perfectly dark but the light gradually fades away continuously. From this it is clear that light does not pass in straight line at the edge-it exhibits a bending slightly. This bending of light waves round a corner or the edge of an obstacle causing a rapid diminution in the intensity of light within the geometrical shadow is known as diffraction.

b Coherent sources have the following characteristics :

1. The waves generated have a constant phase difference
2. The waves are of a single frequency

c If the distance between two slits is a then the distance between 15 slits is, $15 \times \frac{\lambda D}{a}$

$\therefore$ According to the question,

$$\frac{15\lambda D}{a} = 22.5 \text{ mm} = 22.5 \times 10^{-3}$$

$$\therefore a = \frac{15 \times D}{22.5 \times 10^{-3}}$$

$$= \frac{15cD}{22.5 \times 10^{-3} f}$$

$$= \frac{15 \times 3 \times 10^8 \times 1.55}{22.5 \times 10^{-3} \times 6 \times 10^{14}}$$

$$= 516.7 \times 10^{-6} \text{m}.$$

$$= 516.7 \ \mu\text{m}$$ **(Ans.)**

Here,
Frequency,
$f = 6 \times 10^{14}$ Hz
Distance from slit to screen,
D = 1.55 m

d Changed wavelength,

$$\lambda' = \frac{\lambda}{\mu}$$

$$= \frac{5 \times 10^{-7}}{1.33} \text{ m}$$

$$= 3.7593 \times 10^{-7} \text{m}$$

Here,
Width of slit,
$a = 6 \times 10^{-4}$cm
$= 6 \times 10^{-6}$m
Refractive index of medium,
$\mu = 1.33$

Condition of maxima : $a \sin\theta = \frac{2n+1}{2}\lambda$; n = 1, 2, 3 ...

Conditoin of minima : $a \sin\theta = n\lambda$; n = 1, 2, 3 ...

$\therefore$ Angular difference between first two maxima,

$$\Delta\theta_{max} = \sin^{-1}\left(\frac{5\lambda}{2a}\right) - \sin^{-1}\left(\frac{3\lambda}{2a}\right)$$

$$= \sin^{-1}\left(\frac{5 \times 3.7593 \times 10^{-7}}{2 \times 6 \times 10^{-6}}\right) - \sin^{-1}\left(\frac{3 \times 3.7593 \times 10^{-7}}{2 \times 6 \times 10^{-6}}\right)$$

$$= 3.56°$$

Angular difference between first two minima,

$$\Delta\theta_{min} = \sin^{-1}\left(\frac{2\lambda}{a}\right) - \sin^{-1}\left(\frac{\lambda}{a}\right)$$

$$= \sin^{-1}\left(\frac{2 \times 3.7593 \times 10^{-7}}{6 \times 10^{-6}}\right) - \sin^{-1}\left(\frac{3.7593 \times 10^{-7}}{6 \times 10^{-6}}\right)$$

$\Delta\theta_{min} = 3.61°$

$\Delta\theta_{max} \neq \Delta\theta_{min}$; Therefore, the statement is not correct.

Ques. ▶ 19 In a optics lab Rakib incident a color of light with 450nm wavelength perpendicularly on a diffraction grating with 6×10^5 number of lines on it.

[Rangpur Cadet College, Rangpur]

a. What is coherent source? 1
b. How does a shunt protect a galvanometer? 2
c. Calculate the diffractive angle of first order? 3
d. Is it possible of diffraction of forth order? Analyze. 4

Answer to the question no. 19

a If light-waves of the same wavelength are emitted from two sources with a particular phase difference and if that phase difference is maintained all along during propagation then those sources are called coherent sources.

b A resistance contains short quantity is connected as shunt with galvanometer in parallel combination as if the excess quantity of current could not be able to damage the galvanometer. As a result, main currents divided in 2 parts. And for being the resistance of shunt is less. More current flows through it and less current flows through the galvanometer. From this galvanometer stays safe from being damage.

c Given that,

Grating element, $d = \frac{1}{N} = \frac{1}{6 \times 10^5 \text{ m}^{-1}}$

Wavelength, $\lambda = 450 \text{ nm} = 450 \times 10^{-9}$m
Number of order, n = 1
Diffractive angle, θ = ?
We know, $d\sin\theta = n\lambda$

$$\therefore \sin\theta = \frac{n\lambda}{d} = 1 \times 450 \times 10^{-9}\text{m} \times 6 \times 10^5 \text{ m}^{-1} = 0.27$$

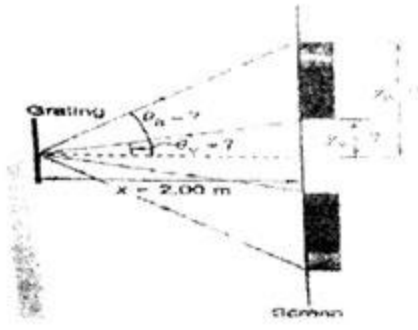
$\therefore \theta = \sin^{-1}(0.27) = 15.66°$ **(Ans.)**

d For diffraction of forth order n = 4. If there is any acceptable value can get for $\sin\theta$. Then it is possible to diffraction of forth order.
Again, $d\sin\theta = n\lambda$

$$\sin\theta = \frac{n\lambda}{d} = 4 \times 450 \times 10^{-9}\text{m} \times 6 \times 10^5 \text{ m}^{-1} = 1.08$$

But, the highest value of $\sin\theta$ can be 1.
So, it is not acceptable.
So, it is not possible to diffraction of forth order.

Ques. ▶ 20



Diffraction grating with 10000 lines per centimeter are ready available. Suppose you have one, and you send a beam of white light through it to screen 2m away. The shortest wavelength of visible light is 380nm. The longest wavelength of visible light is 760 nm) *[Cumilla Cadet College, Cumilla]*

a. What is called wave front? 1
b. How does the polarization occur in electromagnetic wave? 2
c. Find the angles for the first-order diffraction of the shortest wavelength of visible light? 3
d. For first order interference, what is the distance between the ends of the rainbow of visible light produced on the screen? Explain Mathematically. 4

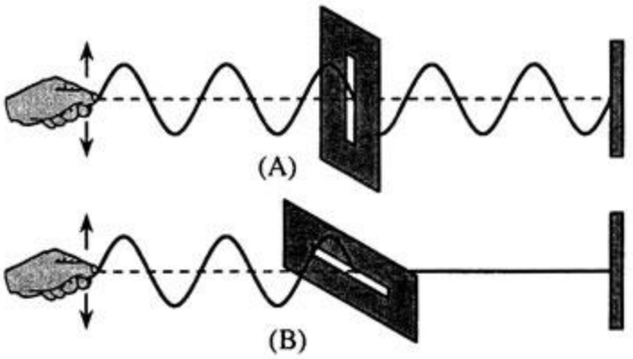
Answer to the question no. 20

a

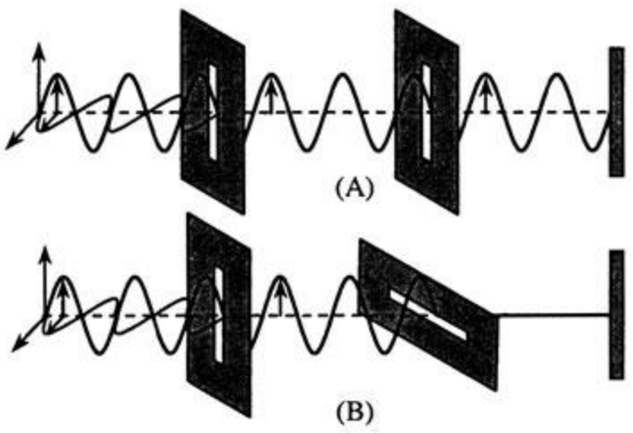
(i) The plane in which particles of a wave having same phase of oscillation remains is called the wave front of the generated wave.

(ii) The locus of particles of a wave in an isotropic medium having same of oscillation is called the wave front.

b



One end of a rope is tied to the wall and placed horizontally. A transverse wave will be created if the rope is moved up and down vertically along its length, it will move forward along the length of the rope. The frequency of all the points of the rope is limited to this parallel vertical plane. Now, transverse wave created inserting the rope through a slit if the slit is located parallel to the frequency of the rope then the wave can cross the slit and go on to the other side, but if the slit is located right-angled to the frequency then the wave will not be able to cross the slit and go on the other side. This type of transverse wave whose frequency is limited to a plane is called a polarised wave.



Now if assumed that a lot of transverse waves are operating simultaneously on the rope whose plane of frequency is different that is unpolarized. However, with the help of only one slit, all the frequencies cannot be stopped simultaneously. No matter where the slit is placed, the frequency of any wave will be parallel to the slit and will cross it. But the frequency of the emitted wave will be limited to only one plane (parallel to the slit). That is after crossing the slit it turns into a polarised wave. If a second slit is placed parallelly to the first slit then the wave will also be able to cross the second slit. But if the second slit is placed right-angled to the first slit then the wave will not be able to cross the second slit.

c If the angles for the first order diffraction of the shortest wavelength is θ, then,

$d \sin\theta = \lambda$

or, $\sin\theta = \frac{\lambda}{d}$

or, $\theta = \sin^{-1}\left(\frac{\lambda}{d}\right)$

or, $\theta = \sin^{-1}\left[\frac{380\times10^{-9}}{10^{-6}}\right]$

$= 22.33°$ **(Ans.)**

Here,
Wavelength of light,
$\lambda = 380$ nm
$= 380\times10^{-9}$m
Grating constant,
$d = \frac{1}{N} = \frac{1}{10000}$ cm
$= 10^{-6}$ m

d In case of diffraction of white light in the grating the violet maxima will be at the first end of the rainbow and the red maxima will be at the last end of the rainbow. (Hence $\lambda_V < \lambda_R$)
$\therefore$ For violet colour if the diffraction angle of first order maxima is θ_v then,

$d \sin\theta_v = \lambda_v$

$\therefore \theta_v = \sin^{-1}\left(\frac{\lambda_v}{d}\right)$

$= \sin^{-1}(N\lambda_v)$

$= \sin^{-1}(10^6\times380\times10^{-9})$

$= 22.33°$

Here, Wave length of violet colour,
$\lambda_v = 380$ nm
$= 380\times10^{-9}$m
lines per unit length,
$N = 10^6 m^{-1}$

For red colour if the diffraction angle of first order maxima is θ_R then,

$d \sin\theta_R = \lambda_R$

$\therefore \theta_R = \sin^{-1}\left(\frac{\lambda_R}{d}\right)$

$= \sin^{-1}(N\lambda_R)$

$= \sin^{-1}(10^6\times760\times10^{-9})$

$= 49.46°$

Here,
Wave length of red colour,
$\lambda_R = 760$ nm
$= 760\times10^{-9}$m
lines per unit length,
$N = 10^6 m^{-1}$

$\therefore$ If the distance between two sides of rainbow of first order is θ, then, $\theta = \theta_R - \theta_V$
$= 49.46° - 22.33° = 27.13°$

Ques. ▶ 21 In Young's double slit experiment the distance between two slits 0.3 mm. The distance of the screen from the slits is 1 m. In an experiment in air medium the distance of the 4^{th} bright fringe from the central bright fringe is 6.2 mm. Keeping the arrangement into water the observation was taken $({}_a\mu_w = 4/3)$. *[Feni Girls' Cadet College, Feni]*

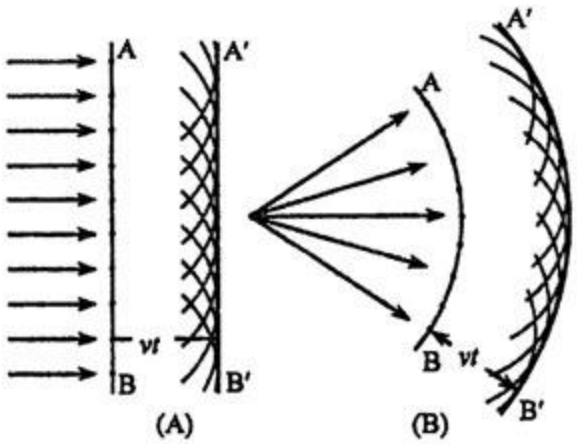
a. What is called electromagnetic wave? 1
b. Explain with diagram Huygene's principle. 2
c. Calculate the wavelength light used in the experiment. 3
d. Analyze what change in the fringe will take place when the arrangement of the stem is kept into water. 4

Answer to the question no. 21

a According to the theory of electromagnetic of Maxwell, if an alternating electric field and a magnetic field are oscillated at right angle to each other and in the same phase, then an wave traverse with a very high velocity and at right angle to both of them is called electro magnetic wave or radiation.

b Huygens describes wave a propagation principle by the following.

Each point on any wave front is considered as the source of oscillation or disturbance. The waves generated from those secondary sources (Secondary Wave) progress forward with the same velocity as the principal wave. If a surface is drawn by the tangents of those secondary waves at any time, then that surface will represent the new position of the wavefront at that time.



Let, AB be a plane or a spherical. Wavefront is moving toward the right from left. According to Huygens' principle, all the points above it will act as a source of secondary waves that means secondary waves will be generated from each point. If the velocity of the wave is v wavefront of secondary wave generated from each point in time t covering a distance of vt I the forward direction. Now taking radius vt an arc is drawn centered around each point AB on the top after time t will indicate the wavefront of secondary waves. The general relation of these arcs A'B' will be the new position of the wavefront at that time.

c Similar as Creative Question No.: 7(c)

[Ans : 4650 Å.]

d Similar as Chapter-6, Creative Question No.: 17(d)

[Ans : Fringe will decrease by 25%].

Ques. ▶ 22 In a Young's double silt experiment, a light of wavelength 4000Å is incident from a slit. The distance of the screen from the slit is 1.5m and fringe is formed on it. The width of 4 fringes is 3cm. *[Sylhet Cadet College, Sylhet]*

a. What is wave front? 1
b. Without two coherent sources, it is not possible to have interference of light. Explain. 2
c. Calculate the width of the slit. 3
d. If the distance of the screen from the slit becomes double, and the width of the slit becomes half, will the distance of the 4 fringes remain same? Explain mathematically. 4

Answer to the question no. 22

a (i) The plane in which particles of a wave having same phase of oscillation remains is called the wave front of the generated wave.

(ii) The locus of particles of a wave in an isotropic medium having same of oscillation is called the wave front.

b If light-waves of the same wavelength are emitted from two sources with a particular phase difference and if that phase difference is maintained all along during propagation then those sources are called coherent sources.

For interference of light the requirements can be fulfilled only by coherent source. So coherent source needed in interference of light.

c Similar as Creative Question No.: 18(c)

Ans. : 40 mm.

d Distance from slit to screen is doubled so, $D' = 2D$ and width of slit is halved so $a' = \frac{a}{2}$ then if fringe width is $\Delta x'$ then,

$$\Delta x' = \frac{\lambda D'}{2a'} = \frac{\lambda \times 2D}{2 \times \frac{a}{2}} = 4 \times \frac{\lambda D}{2a} = 4 \times \Delta x$$

Hence, the fringe width will not be the same, rather 4 times than before.

Ques. ▶ 23 A convex lens use in a Fraunhofer diffraction experiment. The power of the lens is 5D and the frequency of the light is 6×10^{14}Hz, between the first bands or maxima of the both the sides of the central maxima the angular difference is 8.627°. If this light use in another experiment like Young's double slit experiment, in this case the screen is at a distance of 1.55m from the slits and fringe width 0.75mm. *[Barishal Cadet College, Barishal]*

a. What is spectrometer? 2
b. Why is microwave used for cooking? 2
c. Determine the focal length of the lens. 3
d. The ratio of the slits separation is greater than 100. Verify this statement. 4

Answer to the question no. 23

a An spectrometer is an instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.

b The energy of electromagnetic wave with small wave length is more greater thats why microwave has higher energy than other spectrum wave length. Foods absorbs visible lights and inrared faster. Thats why the upper portion of food gets heated but lower portion doesn't. Due to low absorption microwave can enter to the inner layer of food. So microwave is used for cooking.

c Given that,
Power of the convex lens, $P = 5D = 5\ m^{-1}$
Focal length of lens, $f = ?$

We know, $f = \frac{1}{P} = \frac{1}{5\ m^{-1}} = 0.2\ m = 20\ cm$ **(Ans.)**

d For n^{th} magima in Fraumhofer diffraction,

$$a \sin\theta = (2n + 1)\frac{\lambda}{2}$$

If, $n = 1$ Here $\theta = \frac{8.627°}{2} = 4.3135°$

Wavelength, $\lambda = \frac{c}{f} = \frac{3 \times 10^8\ ms^{-1}}{6 \times 10^{14}\ Hz} = 5 \times 10^{-7}\ m$

$\therefore$ Width of slit in Fraumhofer diffraction,

$$a = \frac{(2n + 1)\frac{\lambda}{2}}{\sin\theta} = \frac{(2 \times 1 + 1)\frac{5 \times 10^{-7}\ m}{2}}{\sin 4.3135°} = 9.97 \times 10^{-6}\ m$$

In case of young's double slit experiment,
Wavelength, $\lambda = 5 \times 10^{-7}\ m$
Distance from slits to screen, $D = 1.55\ m$
Fringe width, $\Delta x = 0.75\ mm = 0.75 \times 10^{-3}\ m$
Distance between slits, $d = ?$

We know, $\Delta x = \frac{\lambda D}{2d}$

$$\therefore \quad d = \frac{\lambda D}{2\Delta x} = \frac{5 \times 10^{-7}\ m \times 1.55\ m}{2 \times 0.75 \times 10^{-3}\ m}$$
$$= 5.17 \times 10^{-4}\ m$$

$$\therefore \quad \text{Ratio} = \frac{d}{a} = \frac{5.17 \times 10^{-4}\ m}{9.97 \times 10^{-6}\ m}$$
$$= 51.86 < 100$$

So, ratio of distance between slits in Young's double slit experiment to slit with is not more than 100.