PRAYAS

JEE 2025

Lecture - 05

Physics

Wave Optics

By- Saleem Ahmed Sir

Topics *to be covered*

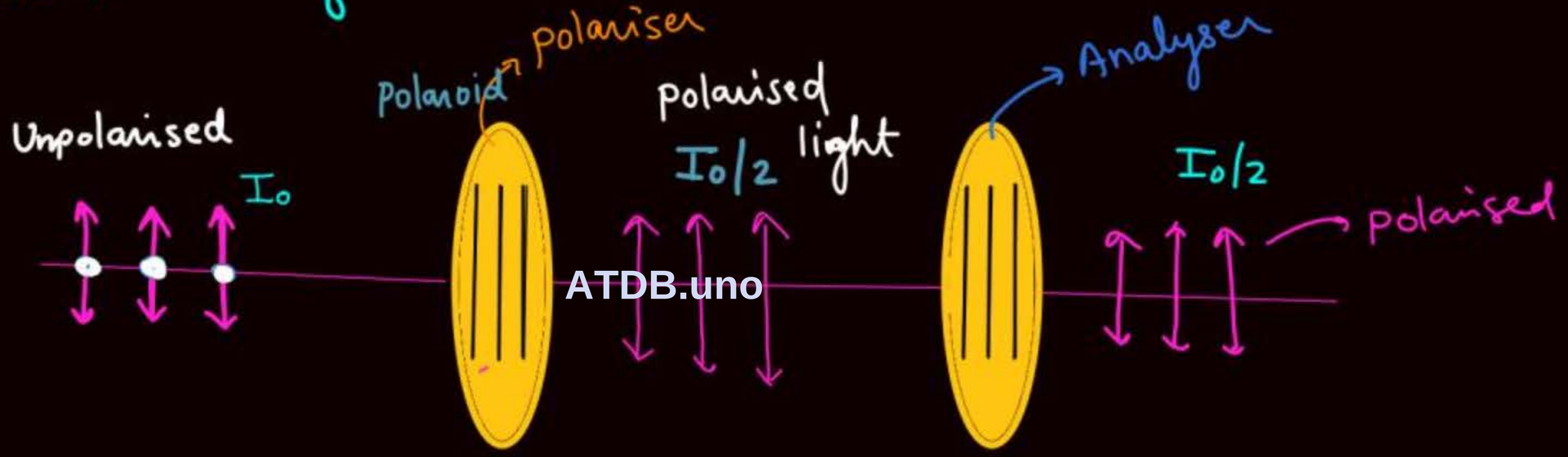
1. Polarisation
2. Questions Practice
3.
4.

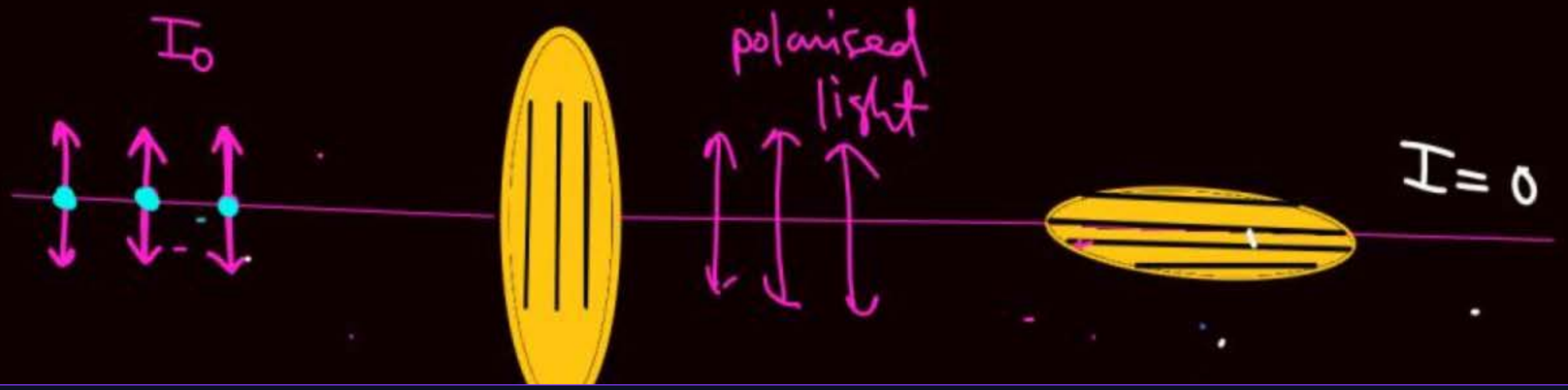
- Rosolving power of M-scole telescope
- " " " eye
- " " " eye
- Rayligh Griterion

⟹ JEE mains ✗ Removed

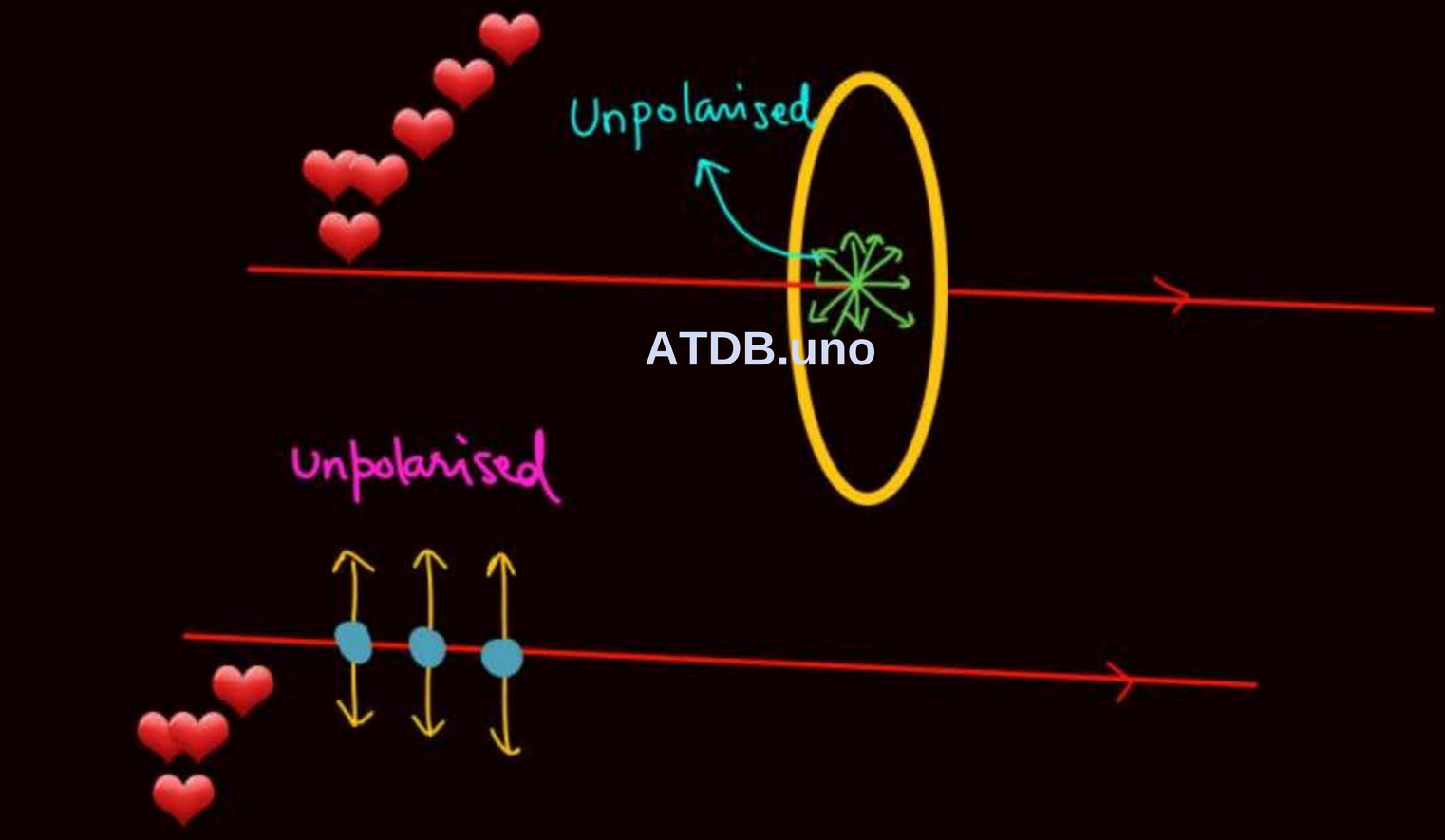
- Loyd's mirror ⟶ ✓
- Diffeaction Derivation ⟶
- Biprism YDSE ⟶

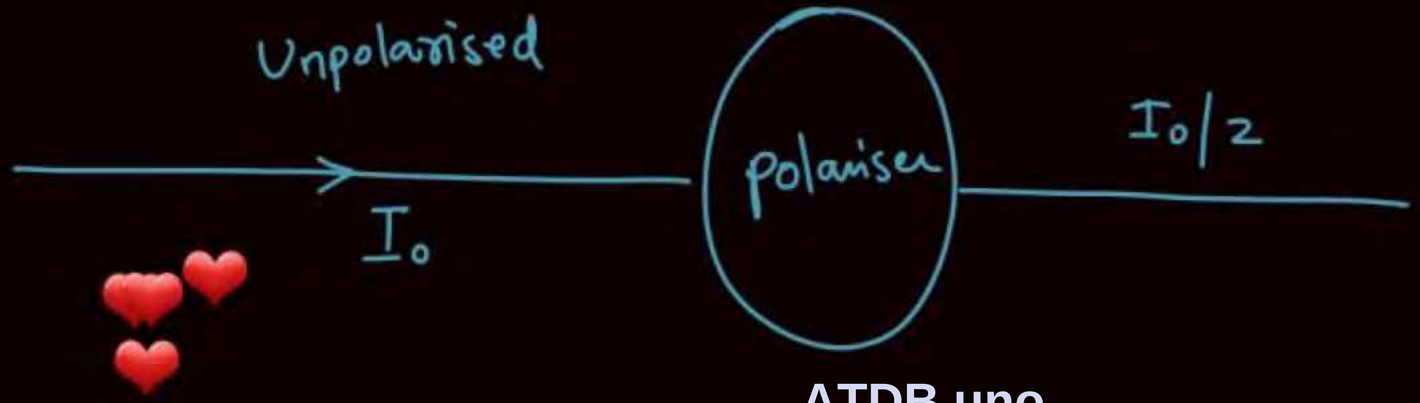
Polarisation → Restriction of vibrations of Electric field vector in a particular direction, perpendicular to the dirⁿ of wave motion is called polarisation of light.



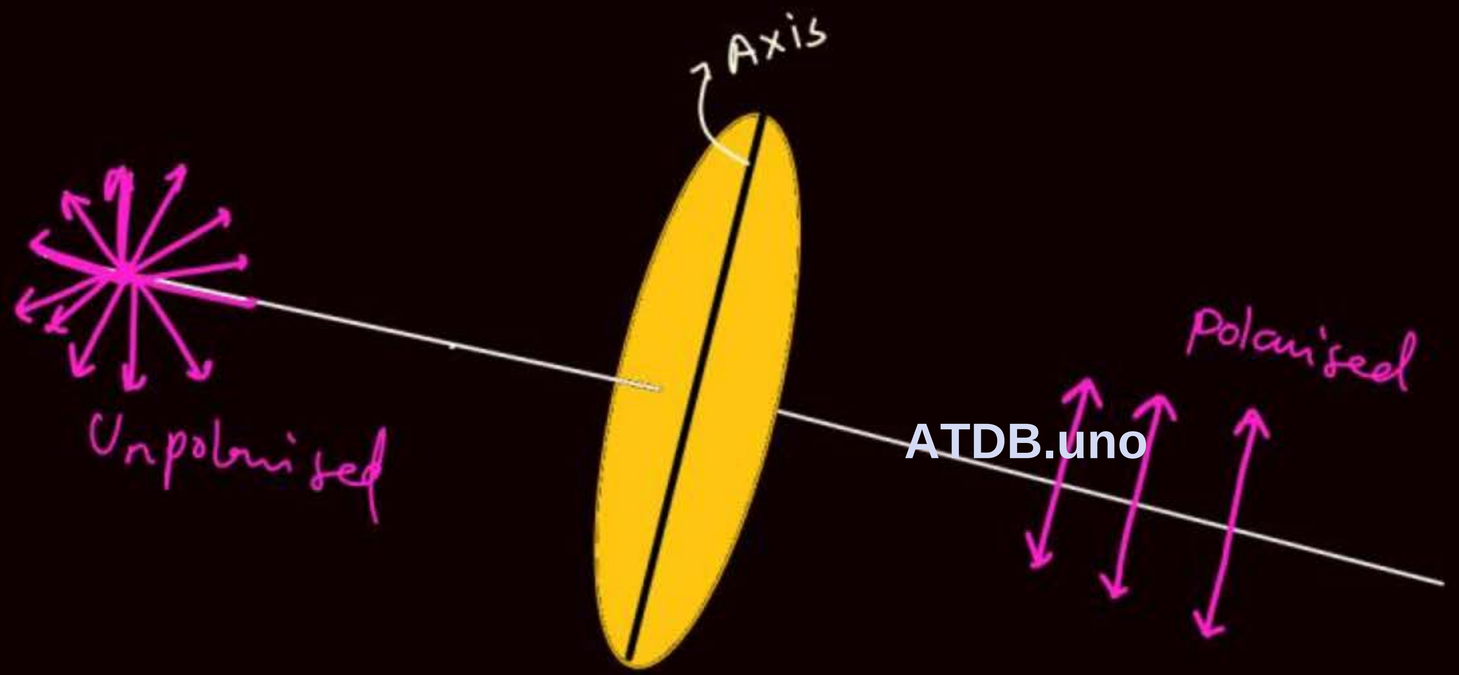


Polarisation



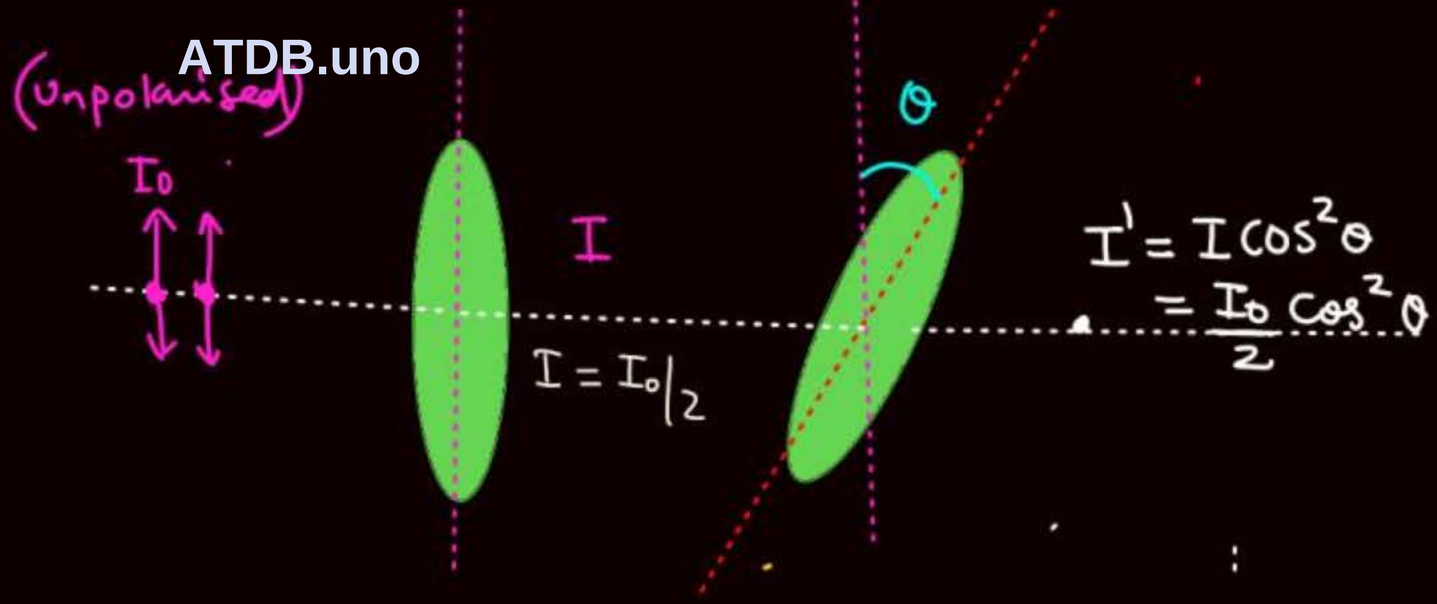


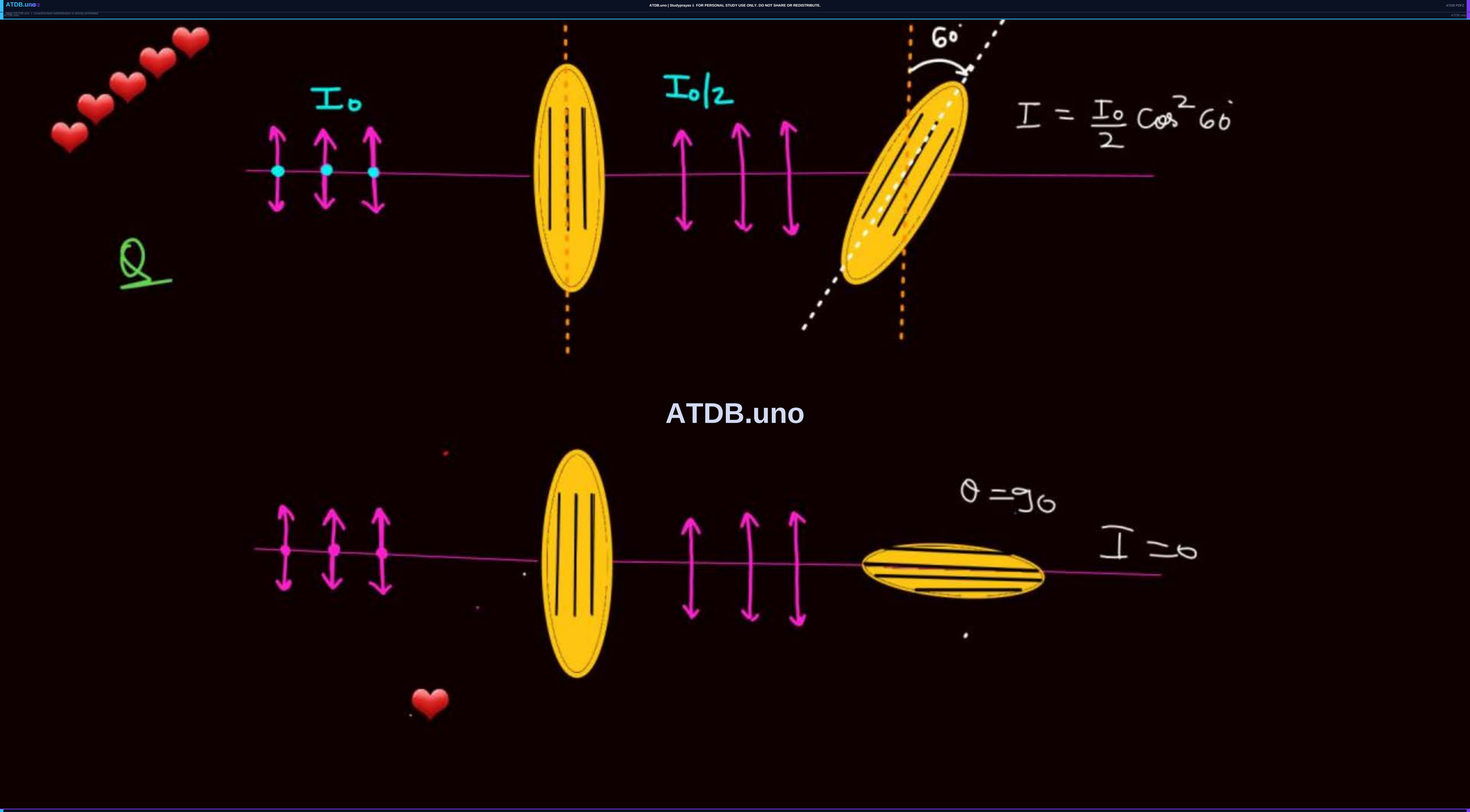
ATDB.uno



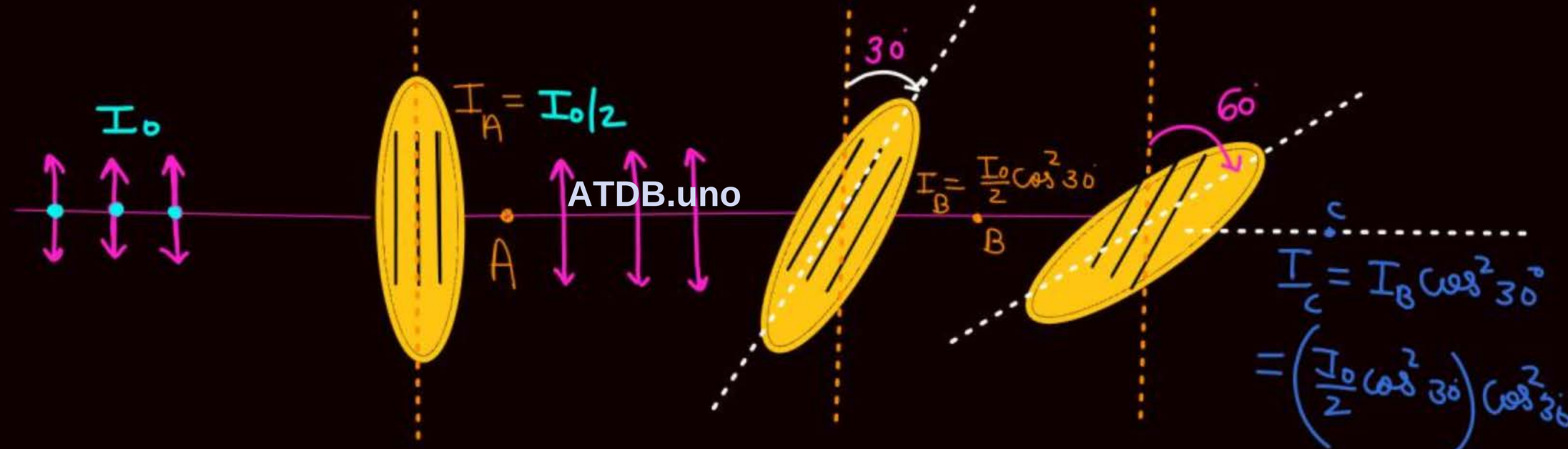
Malus Law

when a Completely polarised light is incident on analyser, intensity of emergent light Varies as square of cosine of the angle between the plane of transmission of the analyser & polariser.





Q If three polaroid are placed such that angle b/w their axis is 30° to the preceading polaroid. find Intensity coming out from last polaroid.



$$I = I_0 \cos^2\theta$$

I_0 → polariser पर गिरने वाली Intensity है

$$I \propto A^2 \propto (\text{Amplitude})^2$$

$$E_0 \cos\theta$$

$$I \propto (E_0 \cos\theta)^2$$

ATDB.uno

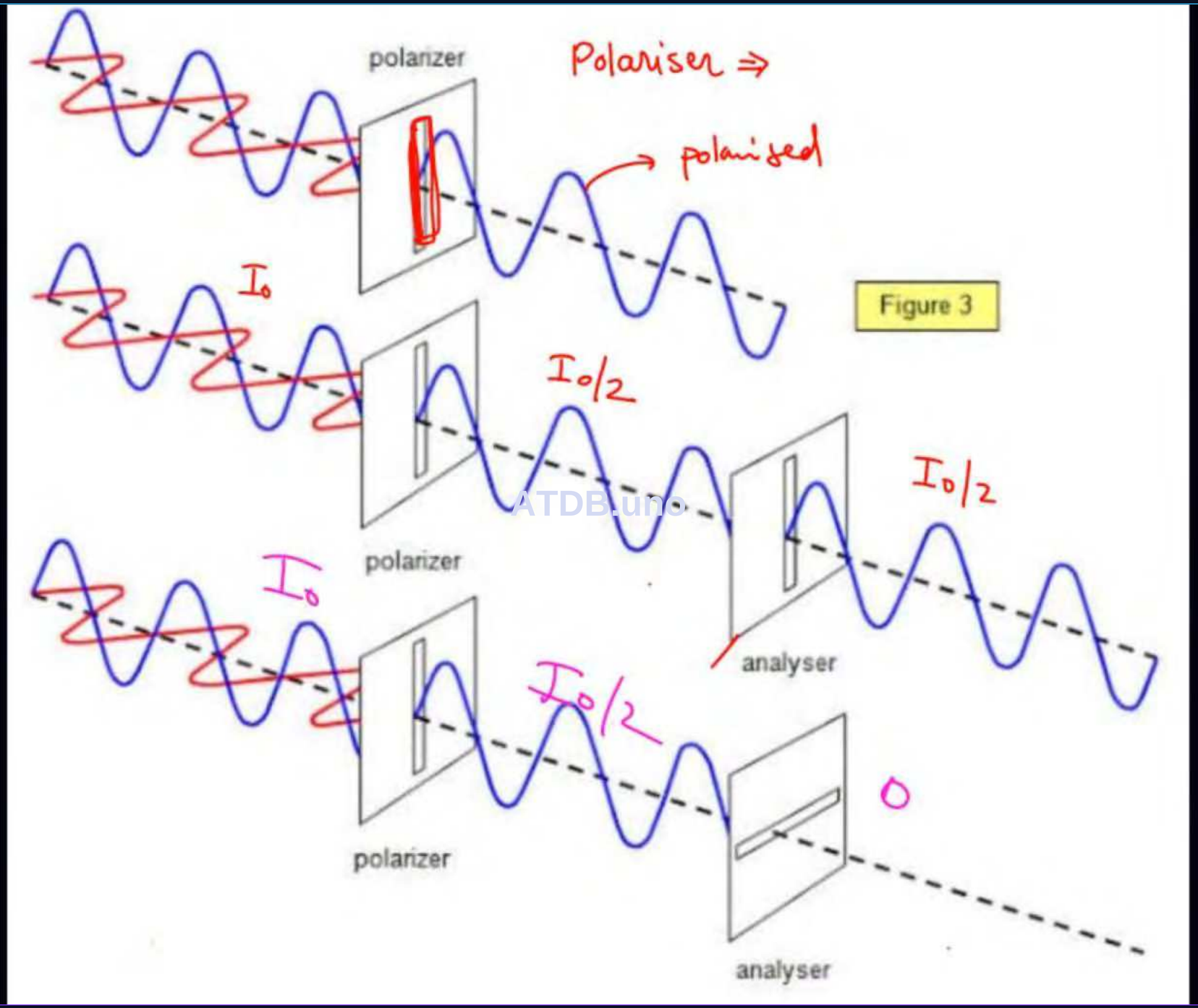
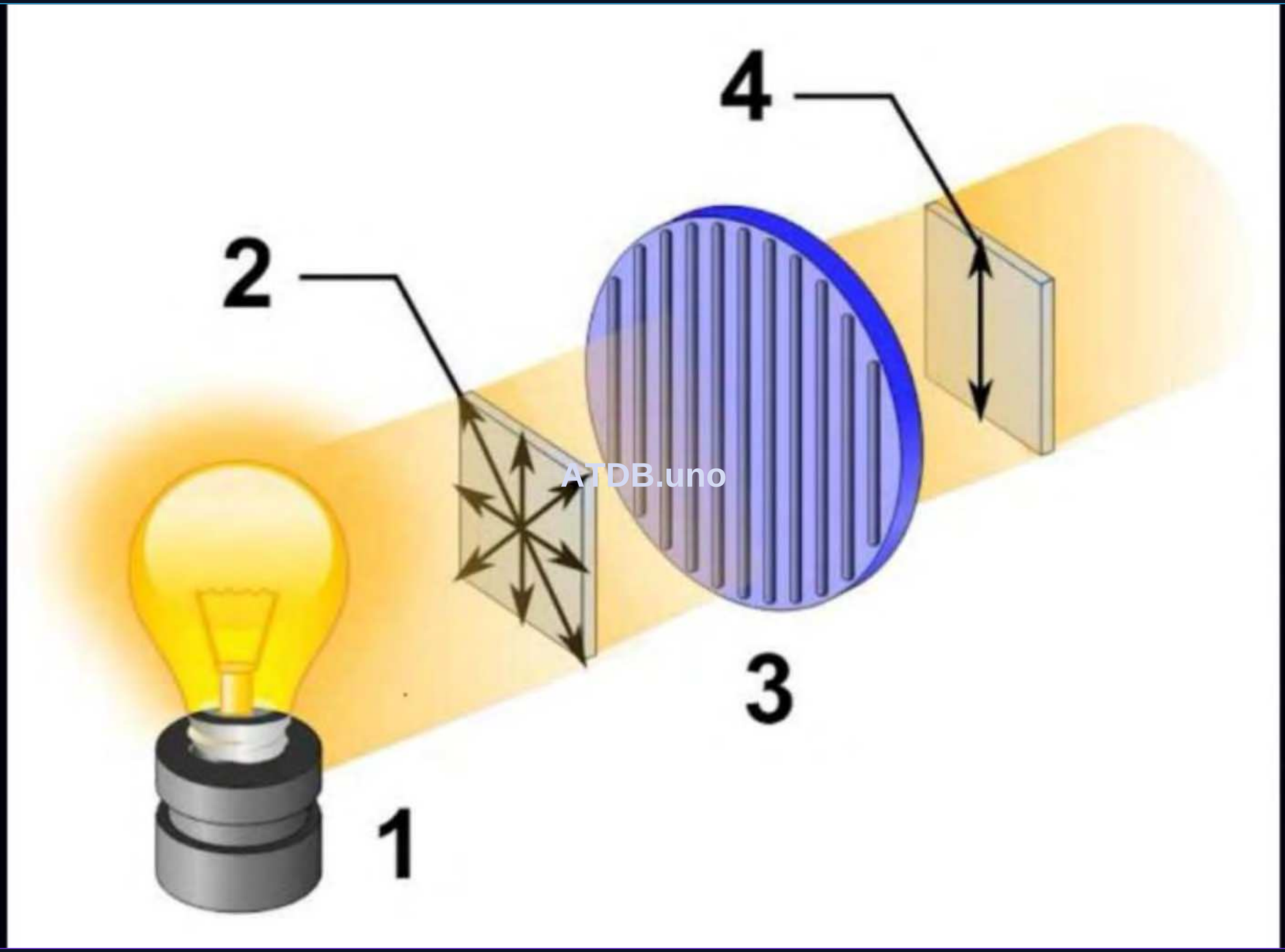
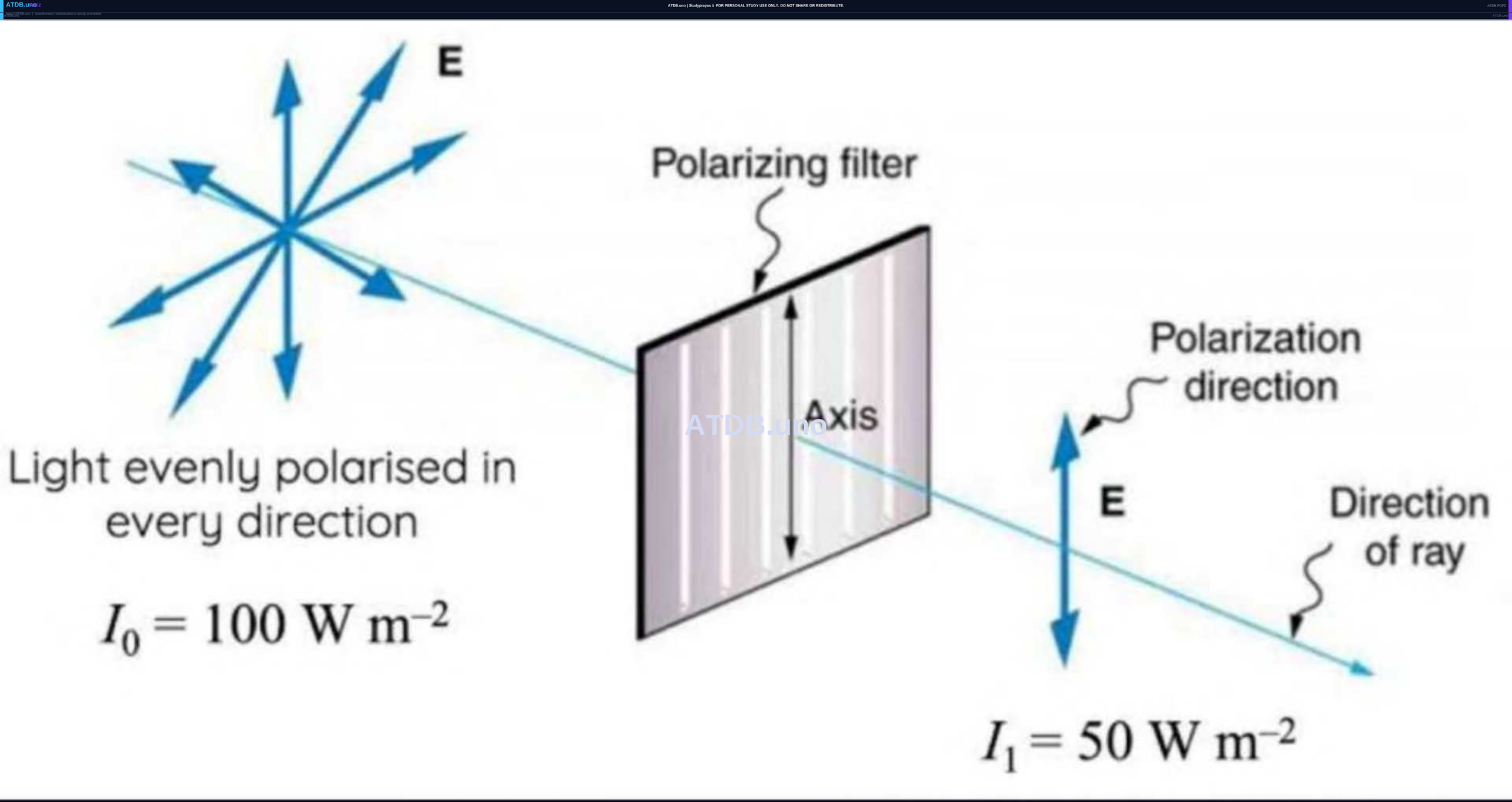
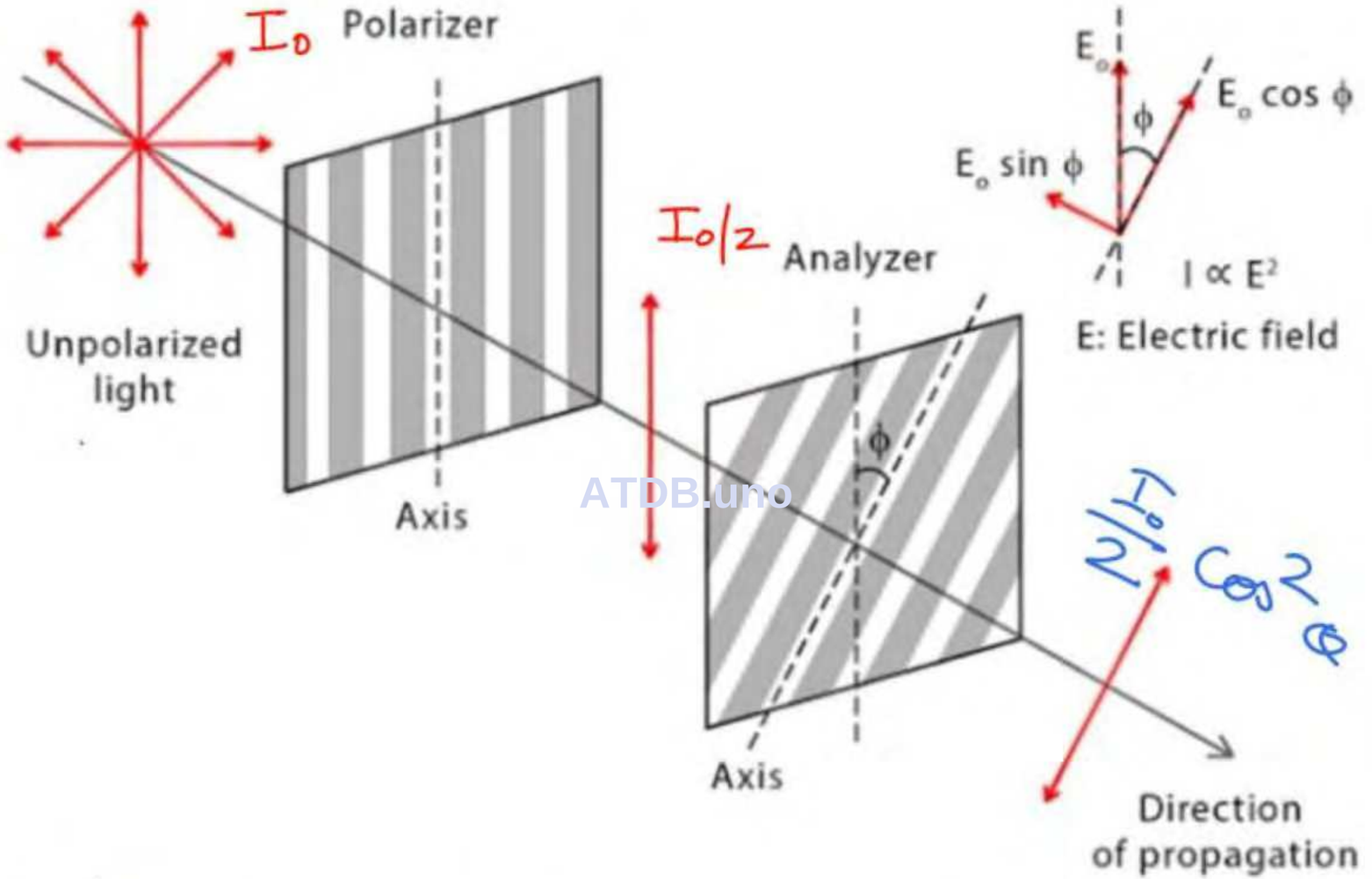


Figure 3





Malus' Law

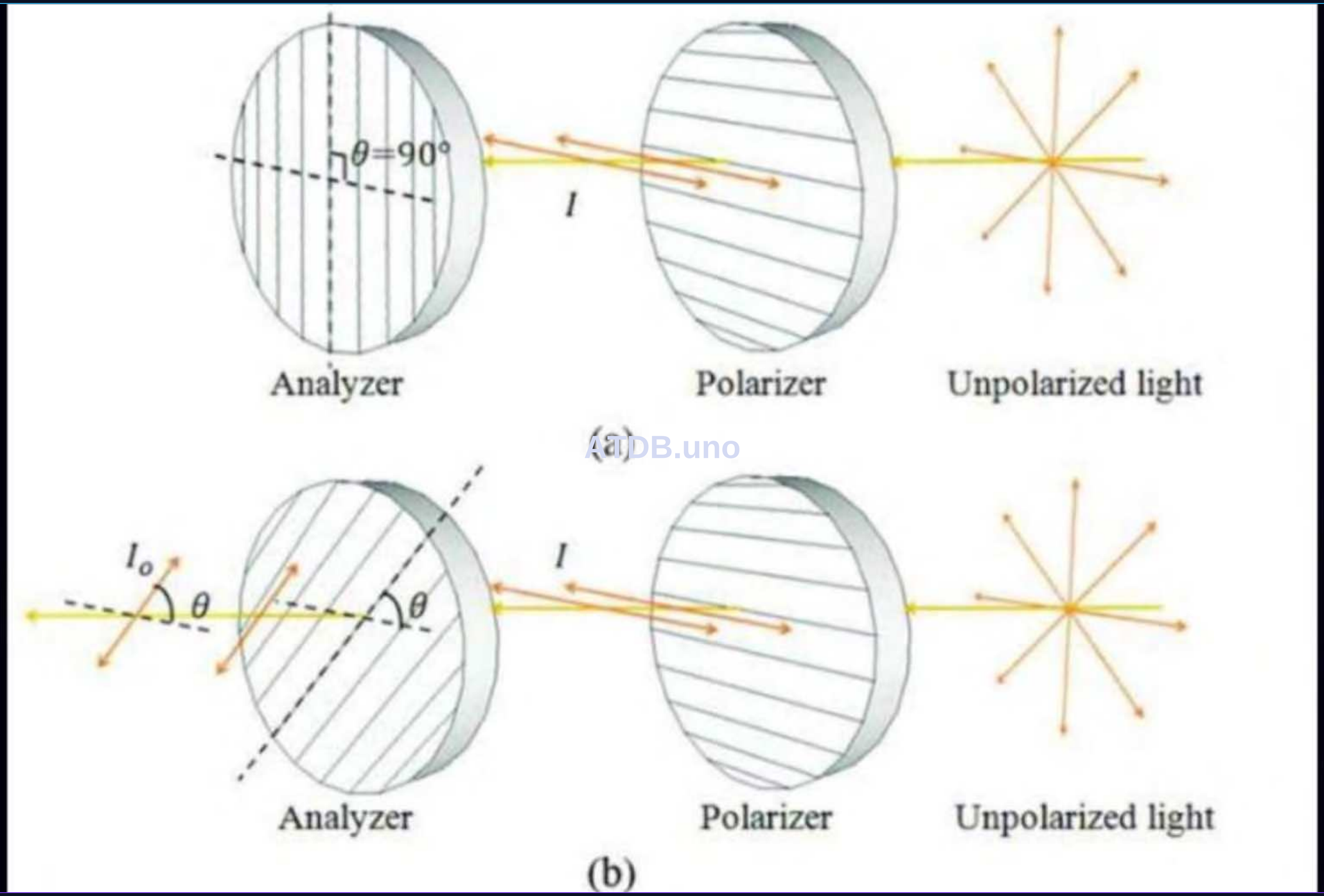


$I = I_0 \cos^2 \phi$

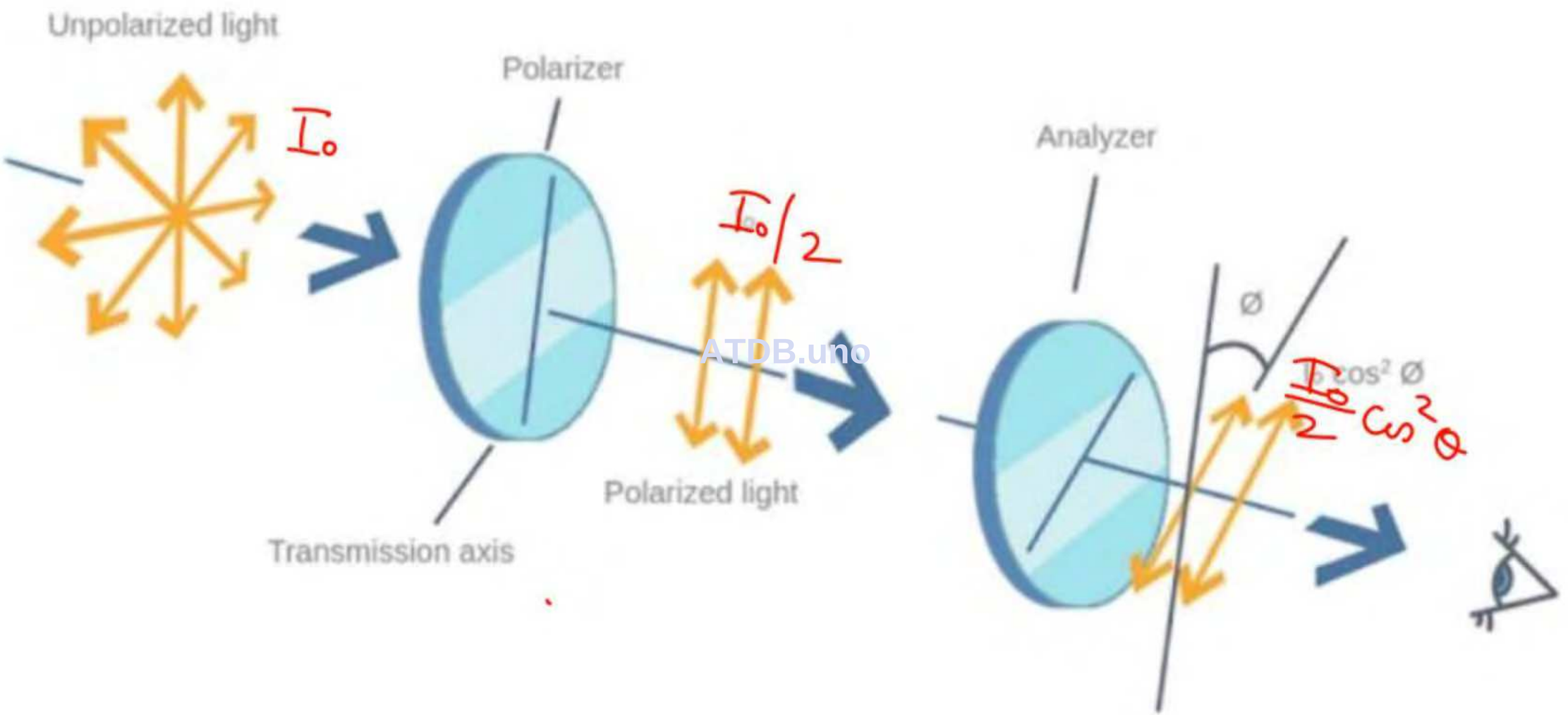
I : Intensity of light after pasing through the analyzer

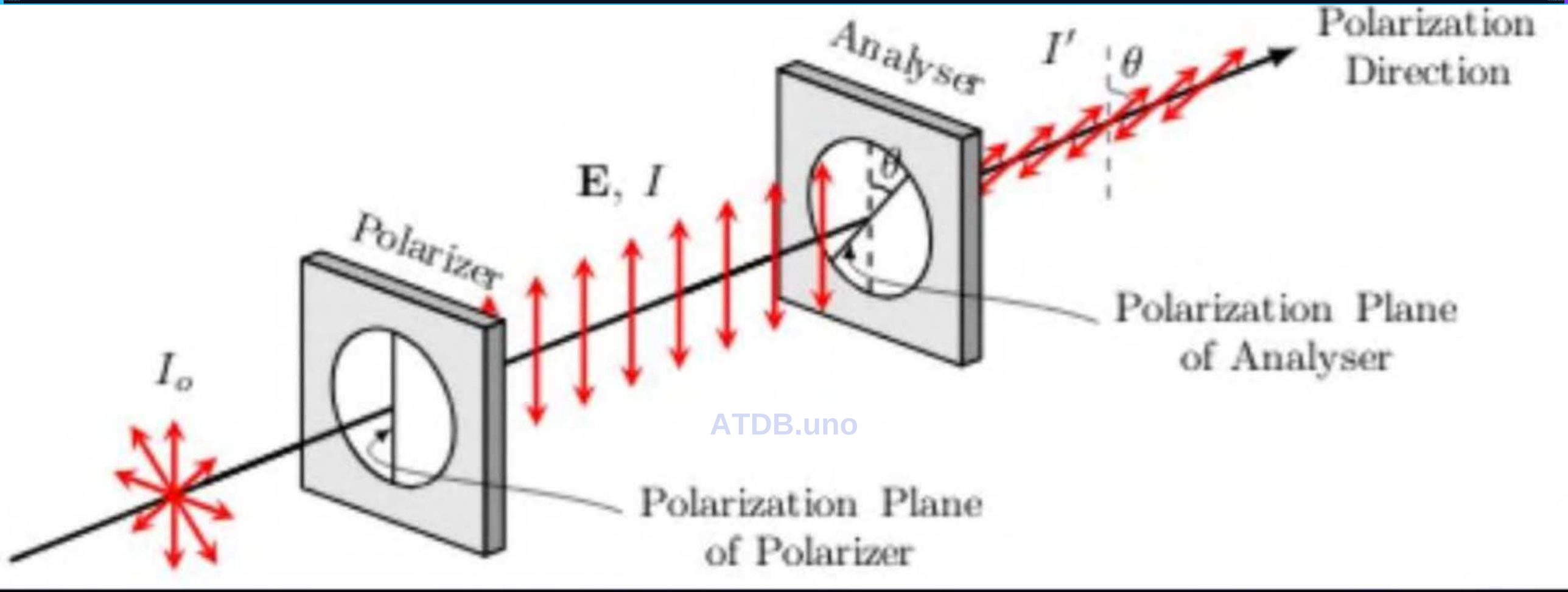
I_0 : Intensity of light after pasing through the polarizer

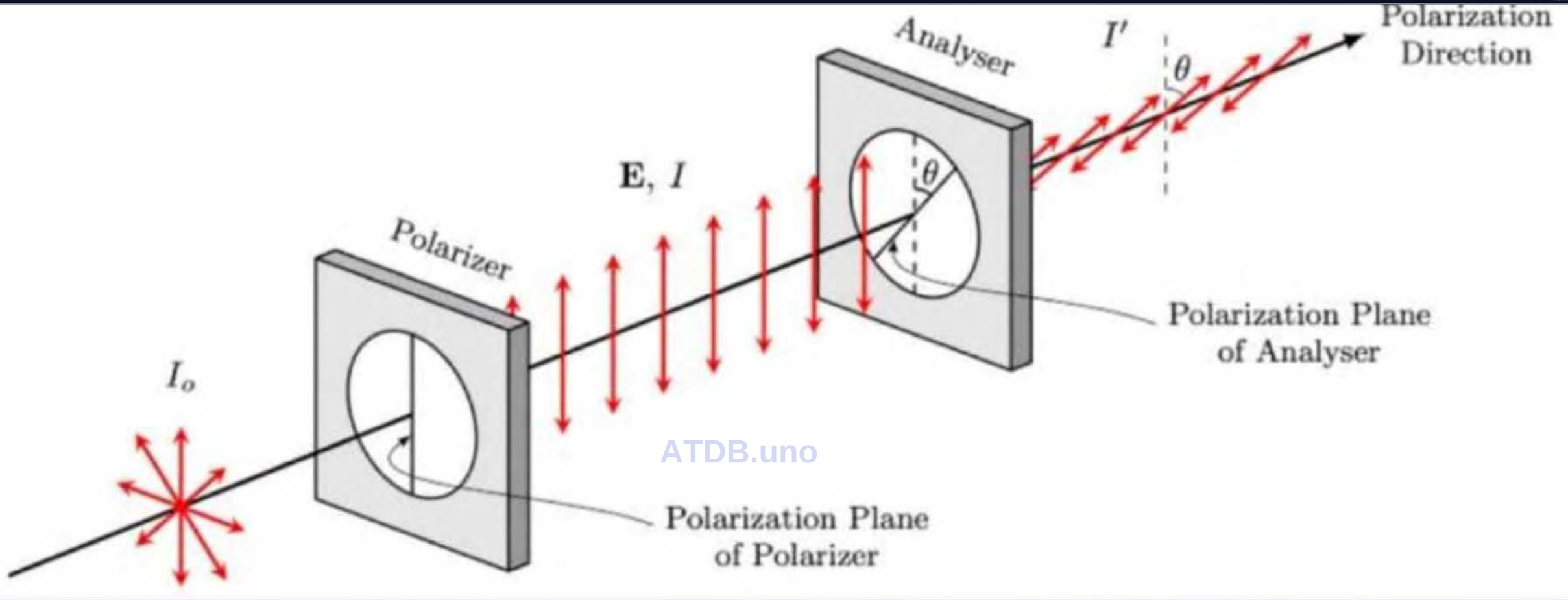
ϕ : Angle between the axes of the polarizer and analyzer

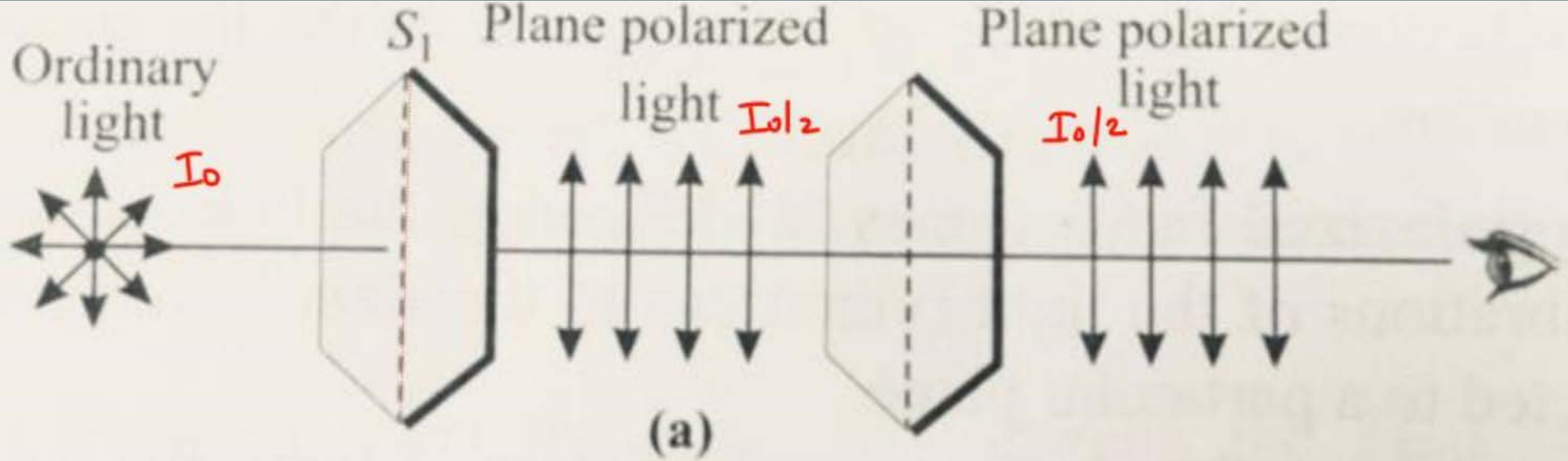


The Law of Malus

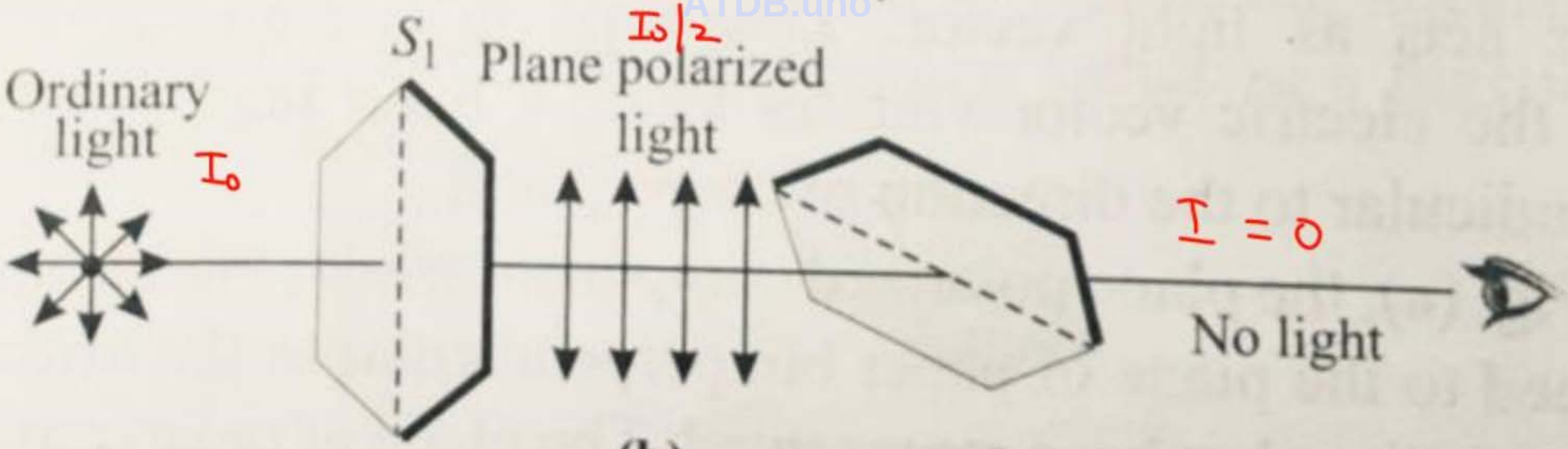




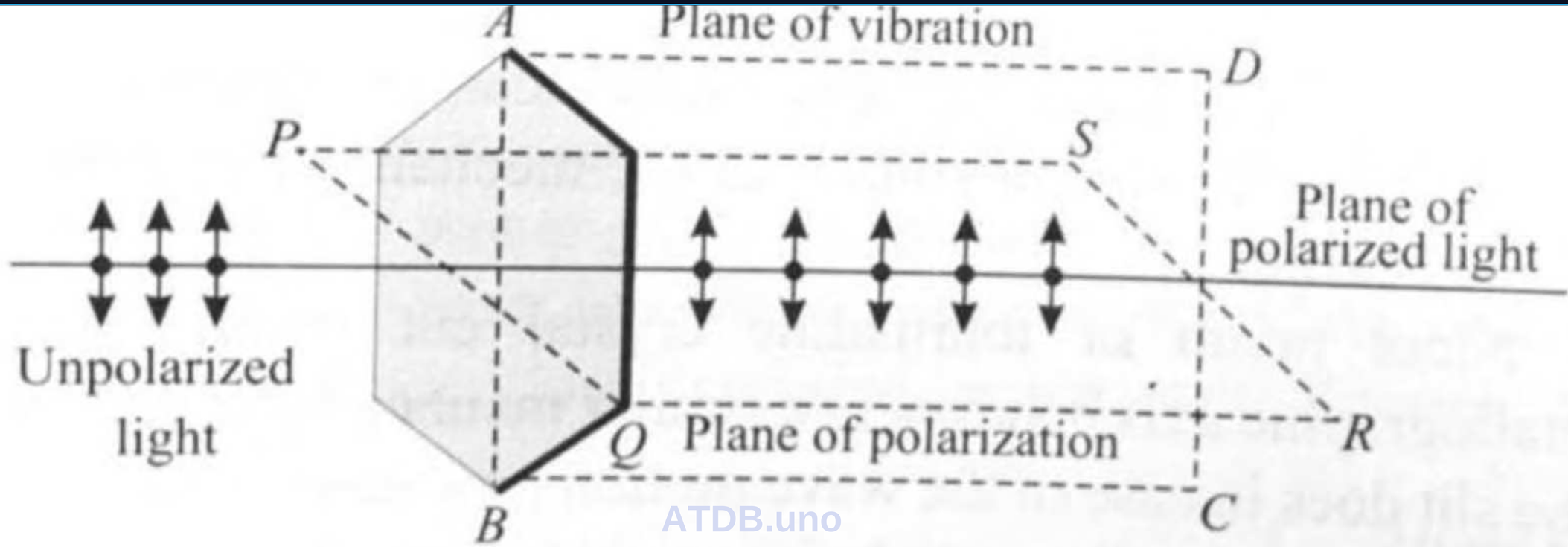


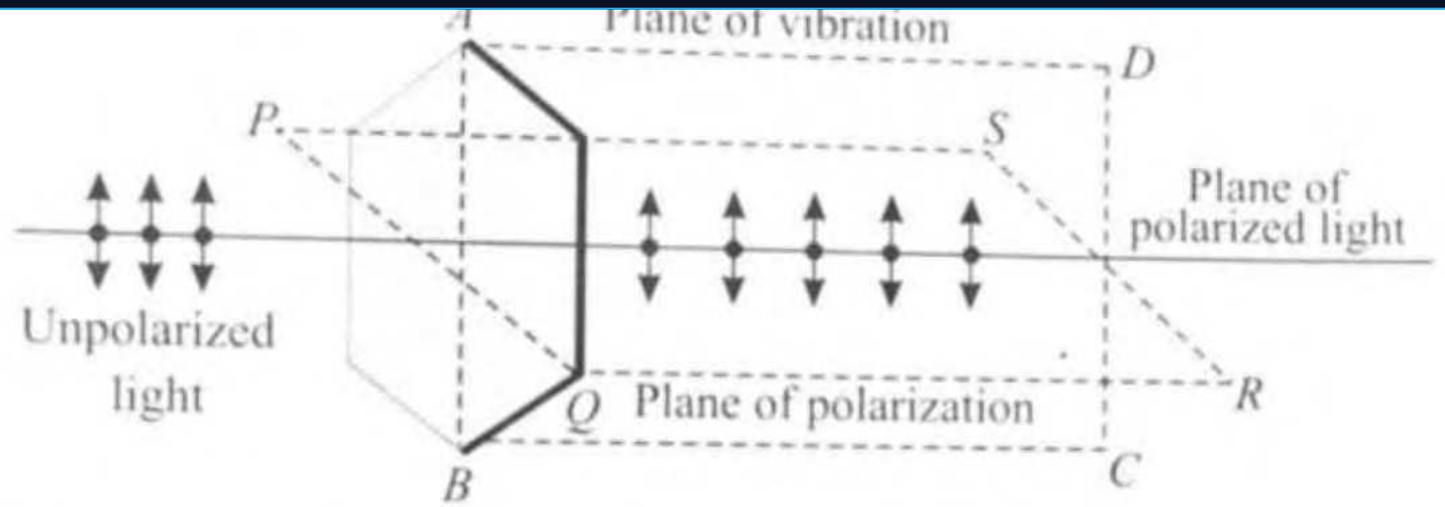


(a)



(b)





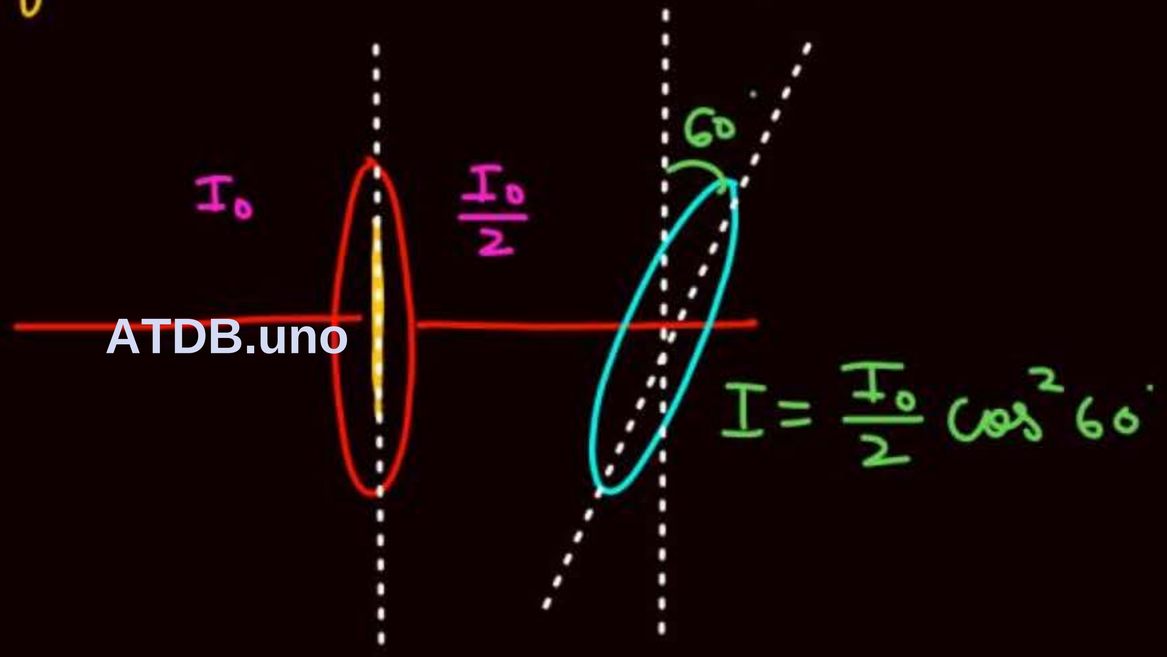
Plane of vibration: The plane within which the vibrations of the polarized light are confined is known as the **plane of vibration**. It is represented by the plane (*ABCD*) in figure.

Plane of polarization: It is the plane at right angles to the plane of vibration and passing through the direction of propagation of light is known as the **plane of polarization**. The plane (*PQRS*) perpendicular to the plane of vibrations is called the plane of polarization.

Plane polarized light: It may be defined as the light, in which the vibrations of the light (vibrations of the electric vector) are restricted to a particular plane.

Q Two polaroids cross each other. Now if one polaroid is rotated by angle 30°. what % of incident Unpolarised light is transmitted finally.

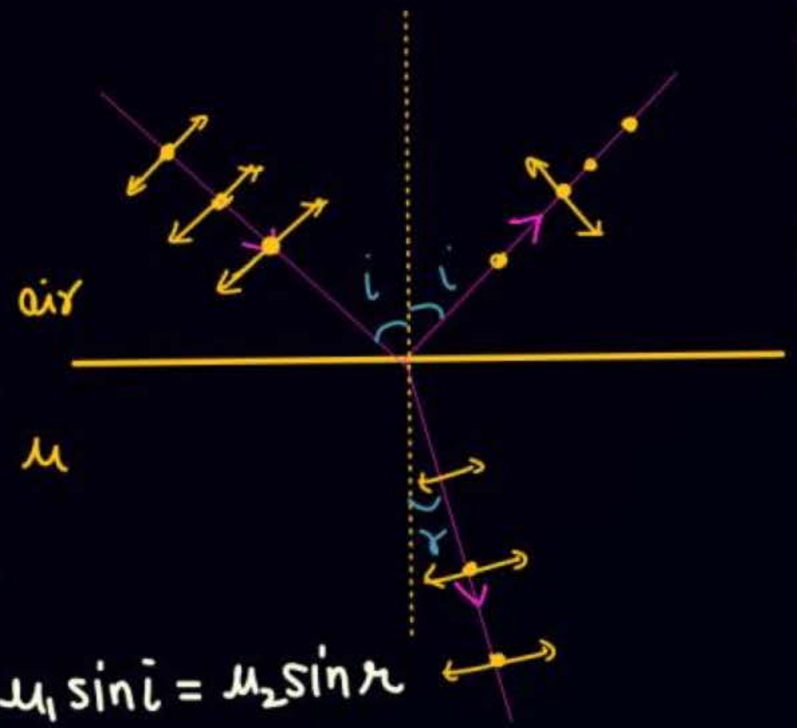
Soln



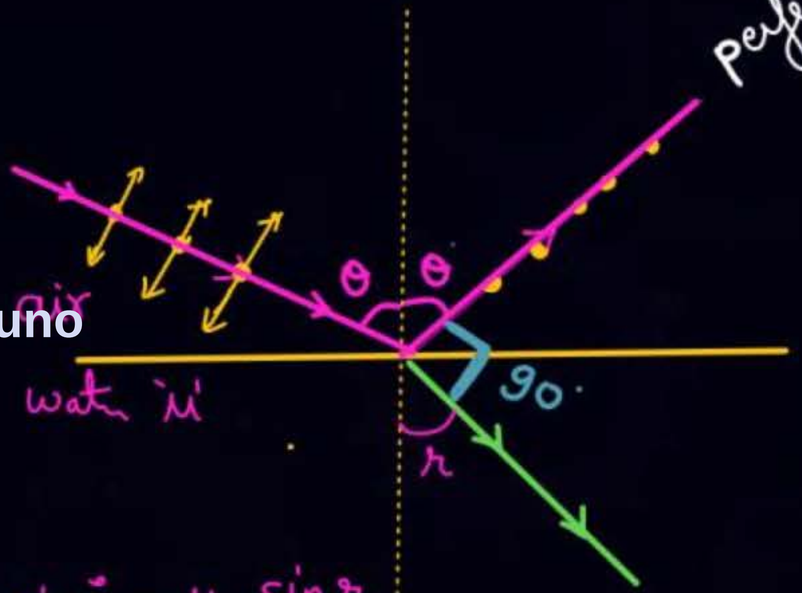
$$I = \frac{I_0}{2}\cos^2 60$$

Polarisation by reflection

Brewster's Law



$\mu_1 \sin i = \mu_2 \sin r$



$\mu_1 \sin i = \mu_2 \sin r$

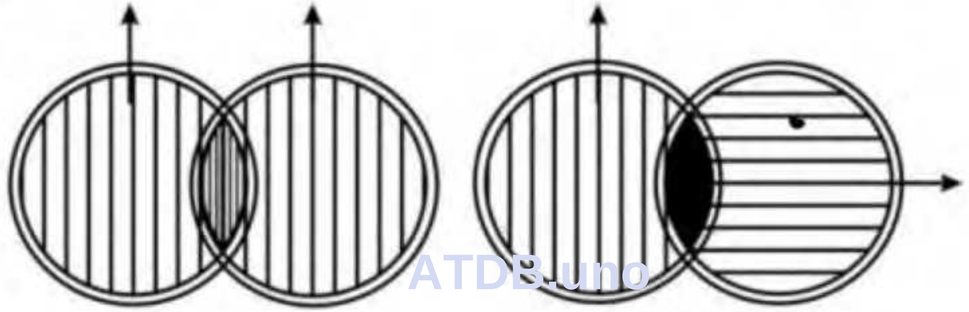
$1 \cdot \sin\theta = \mu_2 \sin(90 - \theta)$

$\tan\theta = \mu$

$\theta = \tan^{-1}(\mu)$

polariser is incident on a second polaroid (usually called **analyser**) the intensity of the light emerging from the second polaroid in accordance with Malus law will be given by $I_2 = I_1 \cos^2\theta'$

where θ' is the angle between the transmission axis of the two polaroids.



Parallel polaroids Crossed polaroids

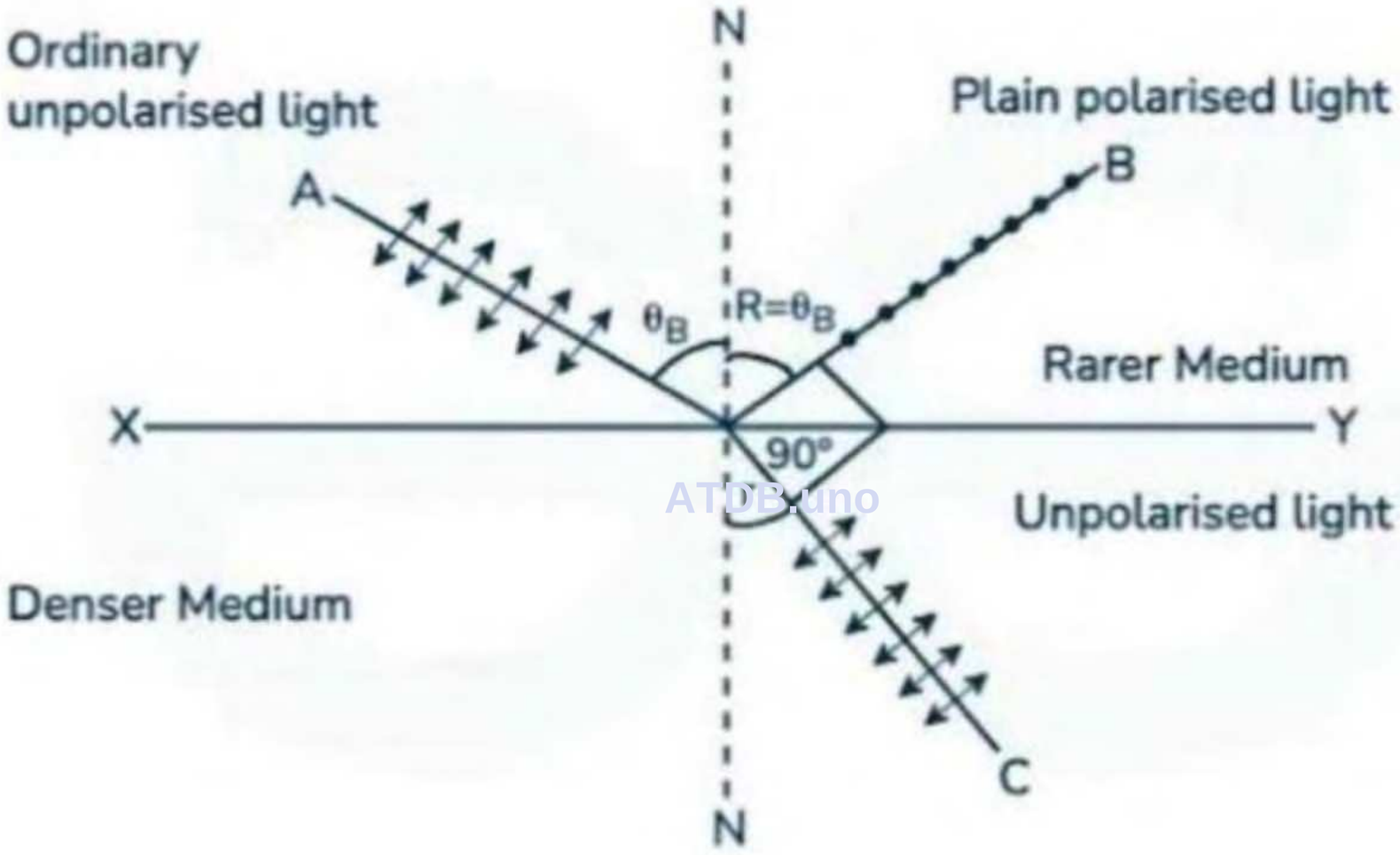
So if the two polaroids have their transmission axes parallel to each other, i.e., $\theta' = 0^\circ$,

$$I_2 = I_1 \cos^2 0^\circ = I_1$$

and if the two polaroids are crossed, *i.e.*, have their transmission axes perpendicular to each other, $\theta' = 90^\circ$.

$$I_2 = I_1 \cos^2 90^\circ = 0$$

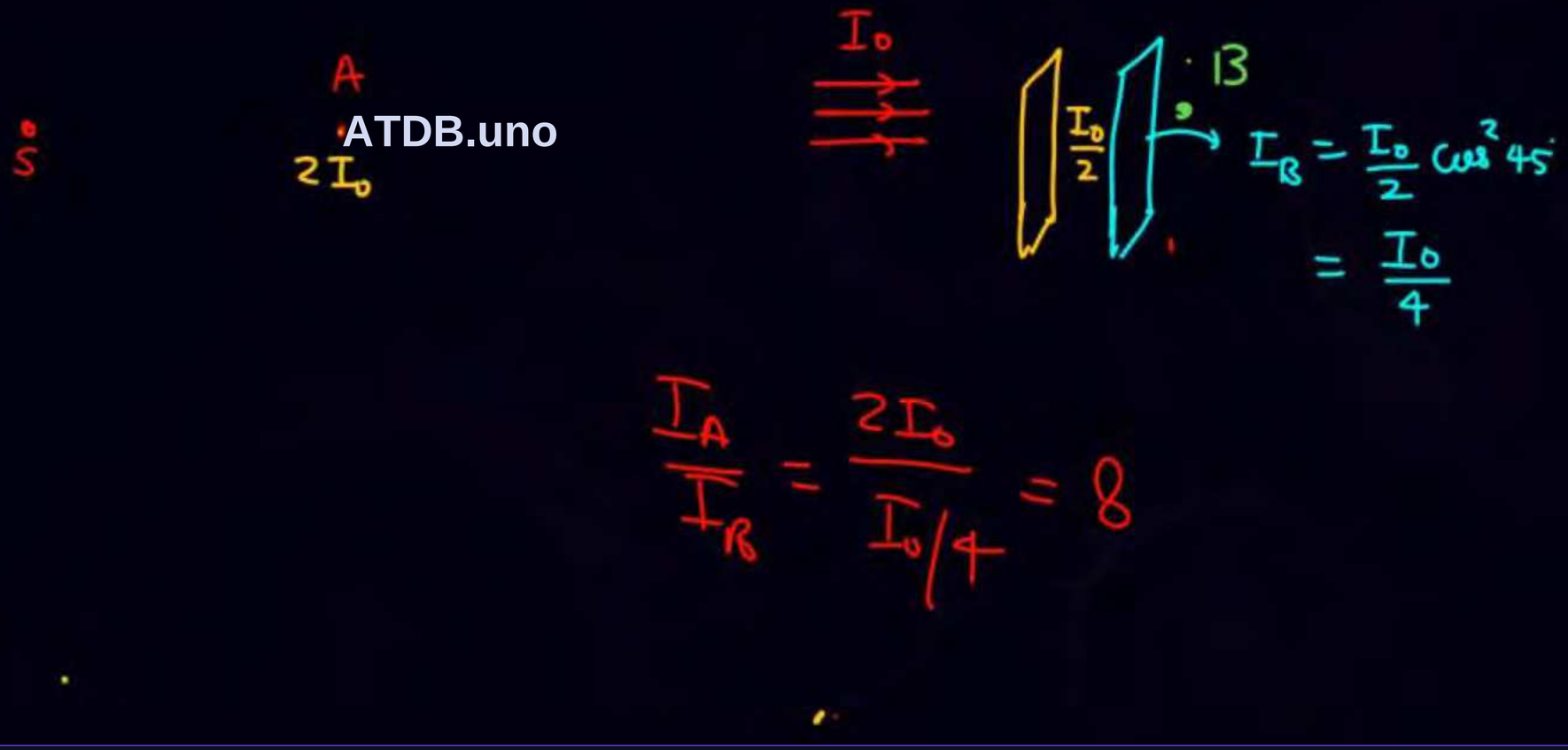
So, if an analyser is rotated from 0° to 90° with respect to polariser, the intensity of emergent light changes from



Q.10 A point source S emits unpolarized light uniformly in all directions. At two points A and B, the ratio $r = I_A/I_B$ of the intensities of light is 2. If a set of two polaroids having 45° angle between their pass-axes is placed just before point B, then the new value of r will be _____.

JEE 2024

$\frac{I_A}{I_B} = 2$ $\quad I_B = I_0$ $\quad I_A = 2I_0$



QUESTION

Orange light of wavelength 6000×10^{-10} m illuminates a single slit of width 0.6×10^{-4} m. The maximum possible number of diffraction minima produced on both sides of the central maximum is _____.

[JEE Mains 2020]

Ans. 200

QUESTION

An unpolarized light beam is incident on the polarizer of a polarization experiment and the intensity of light beam emerging from the analyser is measured as 100 Lumens. Now, if the analyser is rotated around the horizontal axis (direction of light) by 30° in clockwise direction, the intensity of emerging light will be _____ Lumens.

[JEE Mains 2021]

Ans. 75

QUESTION

A source of light is placed in front of a screen. Intensity of light on the screen is I. Two Polaroids P_1 and P_2 are so placed in between the source of light and screen that the intensity of light on screen is I/2. P_2 should be rotated by an angle of _____ (degrees) so that the intensity of light on the screen becomes $\frac{3I}{8}$. [JEE Mains 2021]

Ans. 30

QUESTION

An unpolarized light beam of intensity $2I_0$ is passed through a polaroid P and then through another polaroid Q which is oriented in such a way that its passing axis makes an angle of 30° relative to that of P. The intensity of the emergent light is:

[JEE Mains 2022]

1. $\frac{I_0}{4}$
2. $\frac{I_0}{2}$
3. $\frac{3I_0}{4}$
4. $\frac{3I_0}{2}$

Ans. (3)

QUESTION

Given below are two statements :

Statement I: If the Brewster's angle for the light propagating from air to glass is θ_B, then Brewster's angle for the light propagating from glass to air is $\frac{\pi}{2} - \theta_B$.

Statement II: The Brewster's angle for the light propagating from glass to air is $\tan^{-1}(\mu_g)$ where μ_g is the refractive index of glass.

In the light of the above statements, choose the correct answer from the options given below:

[24 January 2023 - Shift 1]

1. Both Statements I and Statement II are true.
2. Statement I is true but Statement II is false.
3. Both Statement I and Statement II are false.
4. Statement I is false but Statement II is true.

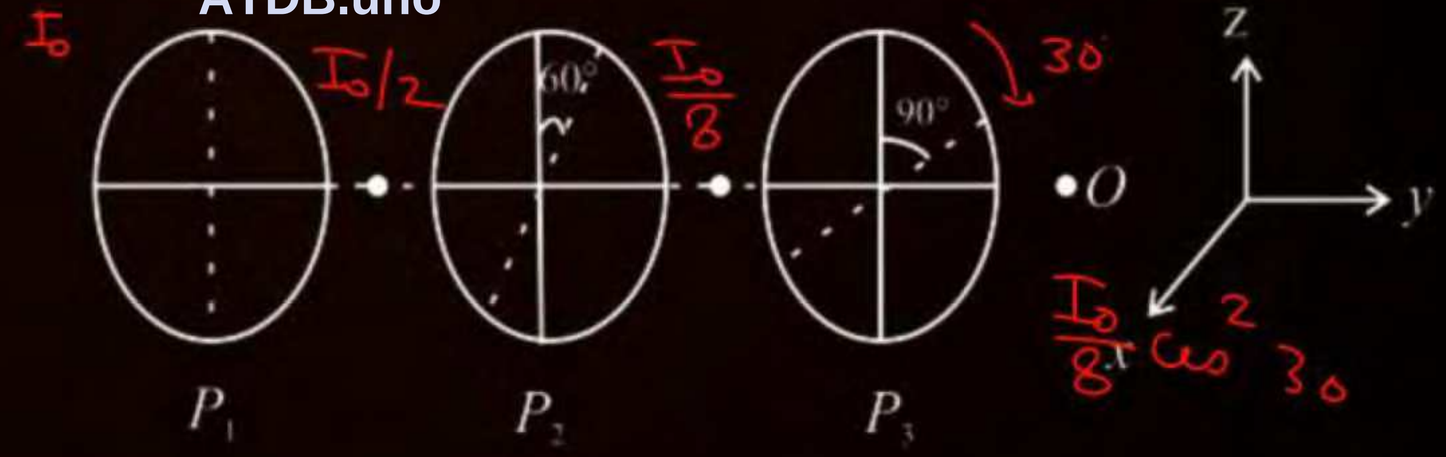
Ans : (2)

QUESTION

As shown in figures, three identical polaroids P_1, P_2 and P_3 are placed one after another. The pass axis of P_2 and P_3 are inclined at angle of 60° and 90° with respect to axis of P_1. The source S has an intensity of 256 $\frac{W}{m^2}$. The intensity of light at point O is 24 $\frac{W}{m^2}$.

$\frac{256}{8} \times \frac{3}{4}$

[29 January 2023 - Shift 1]



Ans : (24)

QUESTION

Two polaroide A and B are placed in such a way that the pass-axis of polaroids are perpendicular to each other. Now, another polaroid C is placed between A and B bisecting angle between them. If intensity of unpolarised light is I_0 then intensity of transmitted light after passing through polaroid B will be:

(31 January 2023 - Shift 1)

1. $\frac{I_0}{4}$
2. $\frac{I_0}{2}$
3. $\frac{I_0}{8}$
4. Zero

Ans : (3)

QUESTION

'n' polarizing sheets are arranged such that each makes an angle 45° with the proceeding sheet. An unpolarized light of intensity I is incident into this arrangement. The output intensity is found to be $\frac{I}{64}$. The value of n will be:

[01 February 2023 - Shift 1]

1. 3
2. 6
3. 5
4. 4

Ans : (2)

QUESTION

Unpolarised light of intensity 32 Wm^{-2} passes through the combination of three polaroids such that the pass axis of the last polaroids is perpendicular to that of the pass axis of first polaroids. If intensity of emerging light is 3 Wm^{-2}, then the angle between pass axis of first two polaroids is _____°.

[10 April 2023 - Shift 1]

Ans : (30)

QUESTION

A beam of unpolarised light of intensity I_0 is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A. The intensity of emergent light is:

[30 Jan. 2024 - Shift 1]

1. $I_0/4$
2. I_0
3. $I_0/2$
4. $I_0/8$

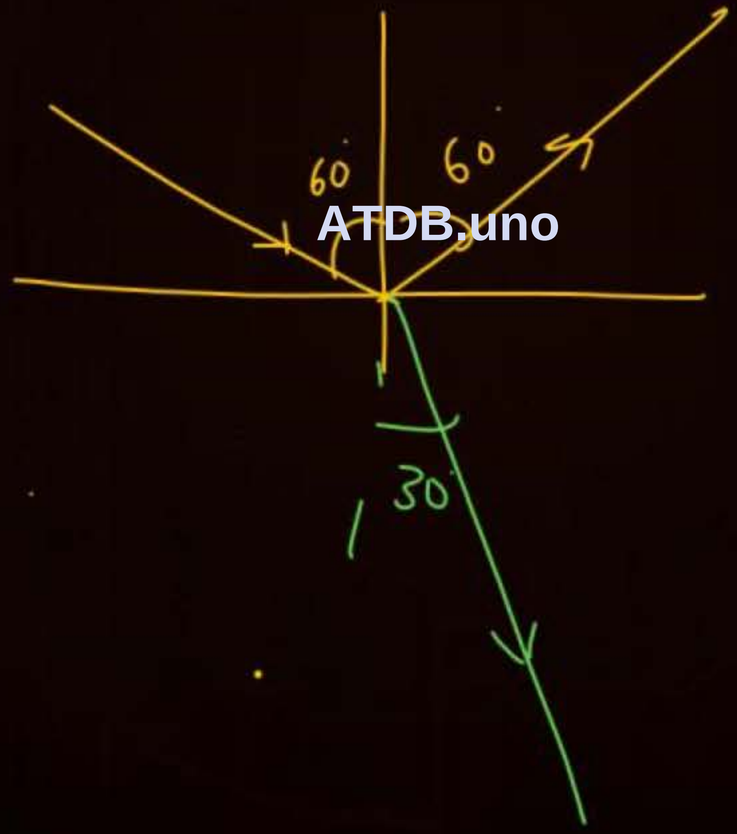
Ans. (1)

QUESTION

When unpolarized light is incident at an angle of 60° on a transparent medium from air. The reflected ray is completely polarized. The angle of refraction in the medium is:

[31 Jan. 2024 - Shift 2]

1. 30°
2. 60°
3. 90°
4. 45°



Ans. (1)

Q. **2.** In Young's double slit experiment the slits are 0.5 mm apart and the interference is observed on a screen at a distance of 100 cm from the slit. It is found that the 9th bright fringe is at a distance of 7.5mm from the second dark fringe from the centre of the fringe pattern on same side. Find the wavelength of the light used.

$d = 5 \times 10^{-4}$

$D = 1$

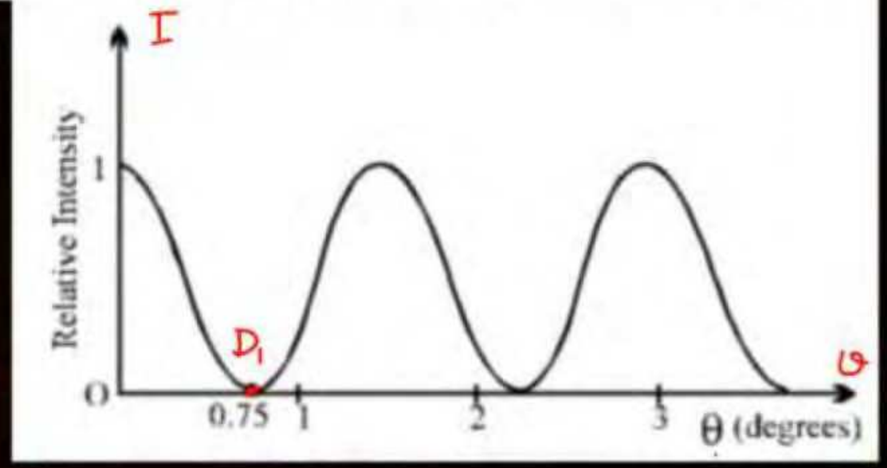
$9\beta - 1.5\beta = 7.5 \times 10^{-3}$

$$7.5 \times \frac{\lambda \times 1}{5 \times 10^{-4}} = 7.5 \times 10^{-3}$$

$\lambda = 5 \times 10^{-7}$

Ans : 5000Å

Q. 3. Light of wavelength 520 nm passing through a double slit, produces interference pattern of relative intensity versus angular position θ as shown in the figure. Find the separation d between the slits.



$$\Delta x = d \sin\theta$$

$$\frac{\lambda}{2} = dx \cdot 75 \times \frac{\pi}{180}$$

$$d = \frac{520 \times 10^{-9} \times 180}{2 \times 75 \times \text{[illegible]}} = \checkmark$$

Ans : 1.99×10^{-2} mm

Q. **5.** In a YDSE apparatus, $d = 1\text{mm}$, $\lambda = 600\text{ nm}$ and $D = 1\text{m}$. The slits individually produce same intensity on the screen. Find the minimum distance between two points on the screen having 75% intensity of the maximum intensity.

H|W

Ans : 0.2 mm

Q. One slit of a double slit experiment is covered by a thin glass plate of refractive index 1.4 and the other by a thin glass plate of refractive index 1.7. The point on the screen, where central bright fringe was formed before the introduction of the glass sheets, is now occupied by the 5^{th} bright fringe. Assuming that both the glass plates have same thickness and wavelength of light used is 4800 Å, find their thickness.

shift = 5β

$$\Delta x = \frac{d \cdot y}{D} - (\mu_1 - 1)t + (\mu_2 - 1)t$$

$$y = \left[(\mu_1 - 1)t - (\mu_2 - 1)t\right]\frac{D}{d}$$

$$5\lambda\frac{D}{d} = \left|(\cdot 4t - \cdot 7t)\frac{D}{d}\right|$$

$$5\lambda = \cdot 3t$$

$$t = \frac{5\lambda}{\cdot 3} = \frac{50}{3} \times 4800\,A^{\circ} = 80000 \times 10^{-10}$$

Ans : 8 μm

$$y = (\mu - 1)t \frac{D}{d}$$

$$y = \left[(\mu_1 - 1)t_1 + (\mu_2 - 1)t_2\right] \frac{D}{d}$$

Q. Two beams of light having intensities I and $4I$ interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\pi/2$ at point A and π at point B. Then the difference between the resultant intensities at A and B is : **[IIT-JEE (Scr.) 2001]**

(A) 2I (B) 4I (C) 5I (D) 7I

$$I_1 = I + 4I + 2\sqrt{I \cdot 4I}\cos\pi/2$$

$$I_2 = I + 4I + 2\sqrt{I \cdot 4I}\cos\pi$$

Ans : (B)

Q. A monochromatic light of $\lambda = 5000$ Å is incident on two slits separated by a distance of 5×10^{-4} m. The interference pattern is seen on a screen placed at a distance of 1 m from the slits. A thin glass plate of thickness 1.5×10^{-6} m & refractive index $\mu = 1.5$ is placed between one of the slits & the screen. Find the intensity at the centre of the screen, if the intensity there is I_0 in the absence of the plate. Also find the lateral shift of the central maximum.

$$y = \frac{(\mu-1)t\,D}{d}$$

$$= \frac{\cdot 5 \times 1.5 \times 10^{-6} \times 1}{5 \times 10^{-4}}$$

$$= \frac{75 \times 10^{-8}}{5 \times 10^{-4}} = 15 \times 10^{-4}$$

$$I = I_0 \omega^2 (3\pi/2) = 0$$

$I_{max} = I_0$

Individual intensity $\equiv I_0/4$

$$\Delta x = \frac{yd}{D} - (\mu-1)t$$

① $y=0$, $\Delta x = (\mu-1)t$ (magnitude)

$$= \cdot 5 \times 1.5 \times 10^{-6} = 75 \times 10^{-8}$$

$$\Delta\phi = \frac{\Delta x}{\lambda} \times 2\pi = \frac{75 \times 10^{-8}}{5000 \times 10^{-10}} \times 2\pi$$

$$= \frac{150\pi}{60} = 3\pi$$

Ans: 0, 1.5 mm

Q. When light is refracted into a denser medium,

(A) its wavelength and frequency both increase

(B) its wavelength increases but frequency remains unchanged

(C*) its wavelength decreases but frequency remains unchanged

(D) its wavelength and frequency both decrease.

Ans : (C)

Q. In a YDSE, the central bright fringe can be identified :

(A) as it has greater intensity than the other bright fringes.

(B) as it is wider than the other bright fringes.

(C) as it is narrower than the other bright fringes.

(D*) by using white light instead of single wavelength light.

Ans : (D)

Q. In a Young's double slit experiment, green light is incident on the two slits. The interference pattern is observed on a screen. Which of the following changes would cause the observed fringes to be more closely spaced?

$\beta \downarrow$

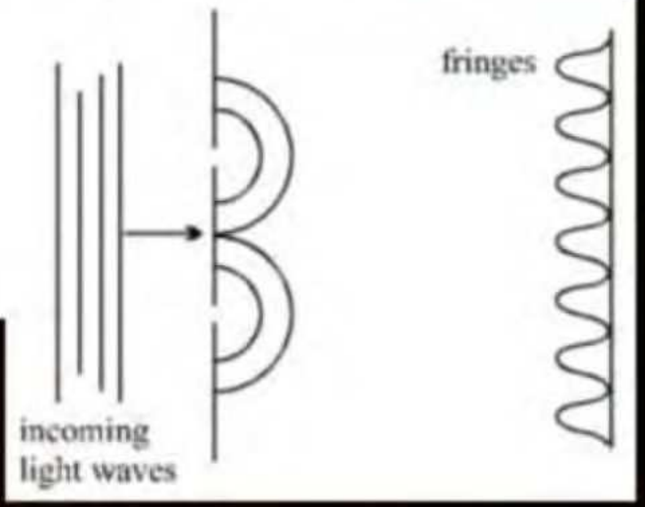
$\beta = \frac{\lambda D}{d}$

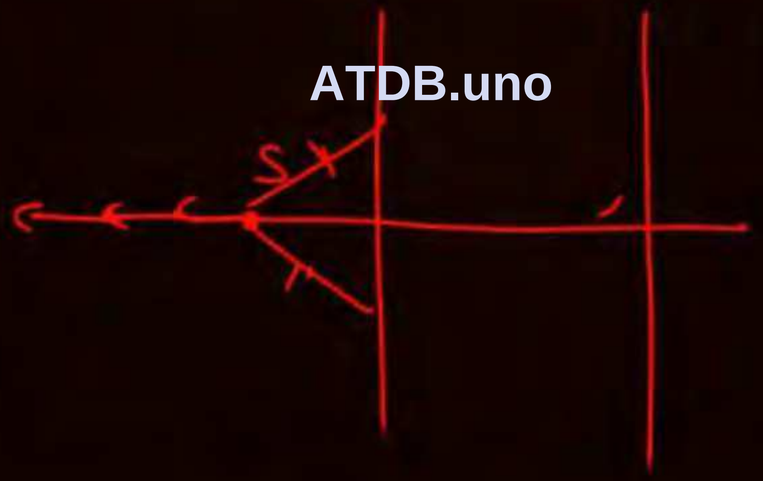
(A) Reducing the separation between the slits

(B*) Using blue light instead of green light

(C) Used red light instead of green light

(D) Moving the light source further away from the slits.





Ans : (B)

Q. In Young's double slit experiment, the wavelength of red light is 7800 Å and that of blue light is 5200 Å. The value of n for which n^{th} bright band due to red light coincides with $(n+1)^{th}$ bright band due to blue light, is :

(A) 1 (B*) 2 (C) 3 (D) 4

$$n\beta_{red} = (n+1)\beta_{blue}$$

Ans : (B)

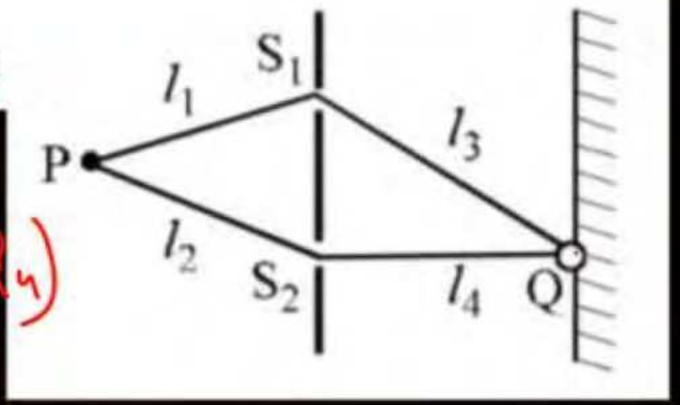
Q. Two identical narrow slits S_1 and S_2 are illuminated by light of wavelength λ from a point source P. If, as shown in the diagram, the light is then allowed to fall on a screen, and if n is a positive integer, the condition for destructive interference at Q is :-

(A) $(\ell_1 - \ell_2) = (2n + 1)\lambda/2$

(B) $(\ell_3 - \ell_4) = (2n + 1)\lambda/2$

(C) $(\ell_1 + \ell_2) - (\ell_3 + \ell_4) = n\lambda$

(D) $(\ell_1 + \ell_3) - (\ell_2 + \ell_4) = (2n + 1)\lambda/2$



$$(\text{odd})\frac{\lambda}{2} = \Delta x = (l_1 + l_3) - (l_2 + l_4)$$

Ans : (D)

$I_0 \rightarrow$ same

Q. In Young's double slit experiment, the two slits act as coherent sources of equal amplitude A and wavelength λ. In another experiment with the same setup the two slits are sources of equal amplitude A and wavelength λ but are incoherent. The ratio of the average intensity of light at the midpoint of the screen in the first case to that in the second case is :-

(A) 1 : 1 (B*) 2 : 1 (C) 4 : 1 (D) none of these

YDSE Coherent

$I_{net} = 4I_0$

Incoherent

$I_{net} = I_1 + I_2 = 2I_0$

Ans : (B)

Q. In a Young's double slit experiment, a small detector measures an intensity of illumination of I units at the centre of the fringe pattern. If one of the two (identical) slits is now covered, the measured intensity will be :-

(A) 2I (B) I (C*) I/4 (D) I/2

$4I_0 = I$

Avg $\Rightarrow$ $I_0 = I/4$

Ans : (C)

Q. In YDSE, the source placed symmetrically with respect to the slit is now moved parallel to the plane of the slits so that it is closer to the upper slit, as shown. Then,

(A) the fringe width will increase and fringe pattern will shift down.

(B) the fringe width will remain same but fringe pattern will shift up.

(C) the fringe width will decrease and fringe pattern will shift down.

(D*) the fringe width will remain same but fringe pattern will shift down.

Ans : (D)

Q. In the ideal double–slit experiment, when a glass–plate (refractive index 1.5) of thickness t is introduced in the path of one of the interfering beams (wavelength λ), the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass–plate is :– **[IIT-JEE 2002]**

(A) 2λ (B) $\frac{2\lambda}{3}$ (C) $\frac{\lambda}{4}$ 4λ (D) λ

Shift $= y = \frac{(\mu-1)t\,D}{d} = n\beta$

$(\mu-1)t\,\frac{D}{d} = n\lambda\,\frac{D}{d}$

$(1.5-1)t = n\lambda$

$t = 2n\lambda$

Ans : (A)

Q. In a Young's double-slit experiment, let A and B be the two slits. Films of thicknesses t_A and t_B and refractive indices μ_A and μ_B, are placed in front of A and B respectively. If $\mu_A t_A = \mu_B t_B$, the central maximum will :

(A) not shift

(B) shift towards A

(C) shift towards B

(D*) option (B), if $t_B > t_A$; option (C) if $t_B < t_A$

Ans : (D)

Q. In a double slit experiment, when the width of one slit is made twice as wide as the other in compared to normal YDSE having slits of equal width. Then, in the interference pattern **[IIT-JEE(Scr.) 2000]**

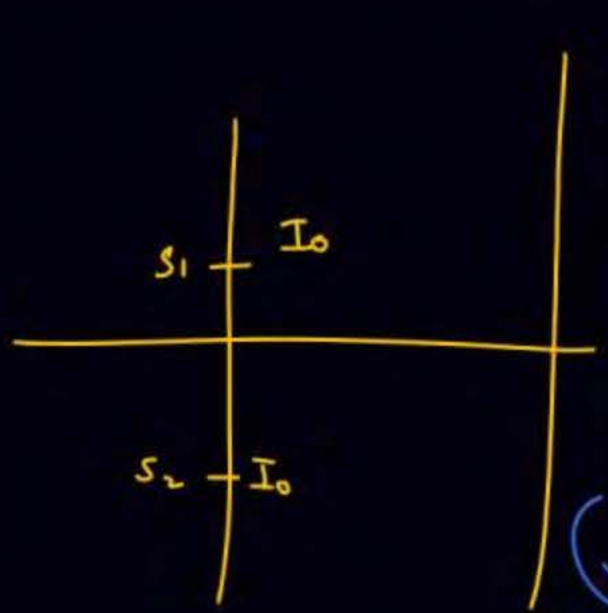
(A*) the intensities of both the maxima and the minima increase.

(B) the intensity of the maxima increases and the minima has zero intensity.

(C) the intensity of the maxima decreases and that of the minima increases.

(D) the intensity of the maxima decreases and the minima has zero intensity.

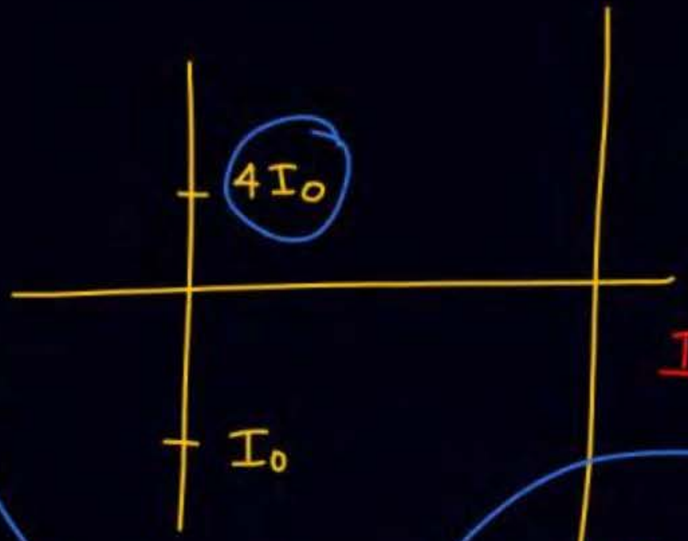
Ans : (A)



Bright $= 4I_0$

Dark $= 0$

$(\sqrt{I_0} - \sqrt{I_0})^2$



$I_{max} = (\sqrt{I_0} + \sqrt{4I_0})^2$

$= 9I_0$

$I_{min} = (\sqrt{I_0} - \sqrt{4I_0})^2$

$= I_0$

Q. If the source of light used in a Young's Double Slit Experiment is changed from red to blue, then

(A) the fringes will become brighter

(B*) consecutive fringes will come closer

(C*) the number of maxima formed on the screen increases

(D) the central bright fringe will become a dark fringe.

Ans : (B, C)

Q. In a Young's double slit experiment, the two slits act as coherent sources of waves of equal amplitude A and wavelength λ. In another experiment with the same arrangement the two slits are made to act as incoherent sources of waves of same amplitude and wavelength. If the intensity at the middle point of the screen in the first case is I_1 and in the second case I_2, then the ratio $\frac{I_1}{I_2}$ is :- **[AIEEE-2011]**

(1) 4 (2*) 2 (3) 1 (4) 0.5

Ans : (2)

Q. In Young's double slit experiment, one of the slit is wider than other, so that the amplitude of the light from one slit is double of that from other slit. If I_m be the maximum intensity, the resultant intensity I when they interfere at phase difference ϕ is given by : **[AIEEE-2012]**

(1*) $\frac{I_m}{9}(1+8\cos^2\frac{\phi}{2})$ (2) $\frac{I_m}{9}(4+5\cos\phi)$ (3) $\frac{I_m}{3}(1+2\cos^2\frac{\phi}{2})$ (4) $\frac{I_m}{5}(1+4\cos^2\frac{\phi}{2})$

I_0

$4I_0$

$I_m = (\sqrt{I_0}+\sqrt{4I_0})^2 = 9I_0$

$I = I_0 + 4I_0 + 2\sqrt{I_0 4I_0}\cos\phi$

$= 5I_0 + 4I_0\cos\phi$

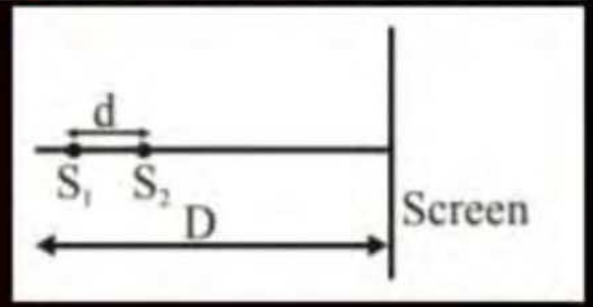
$= I_0(5+4\cos\phi) = \frac{I_0}{9}(1+8\cos^2\phi/2)$

$= \frac{I_m}{9}(5+4\cos\phi) = \frac{I_m}{9}(5+4(2\cos^2\phi/2-1))$

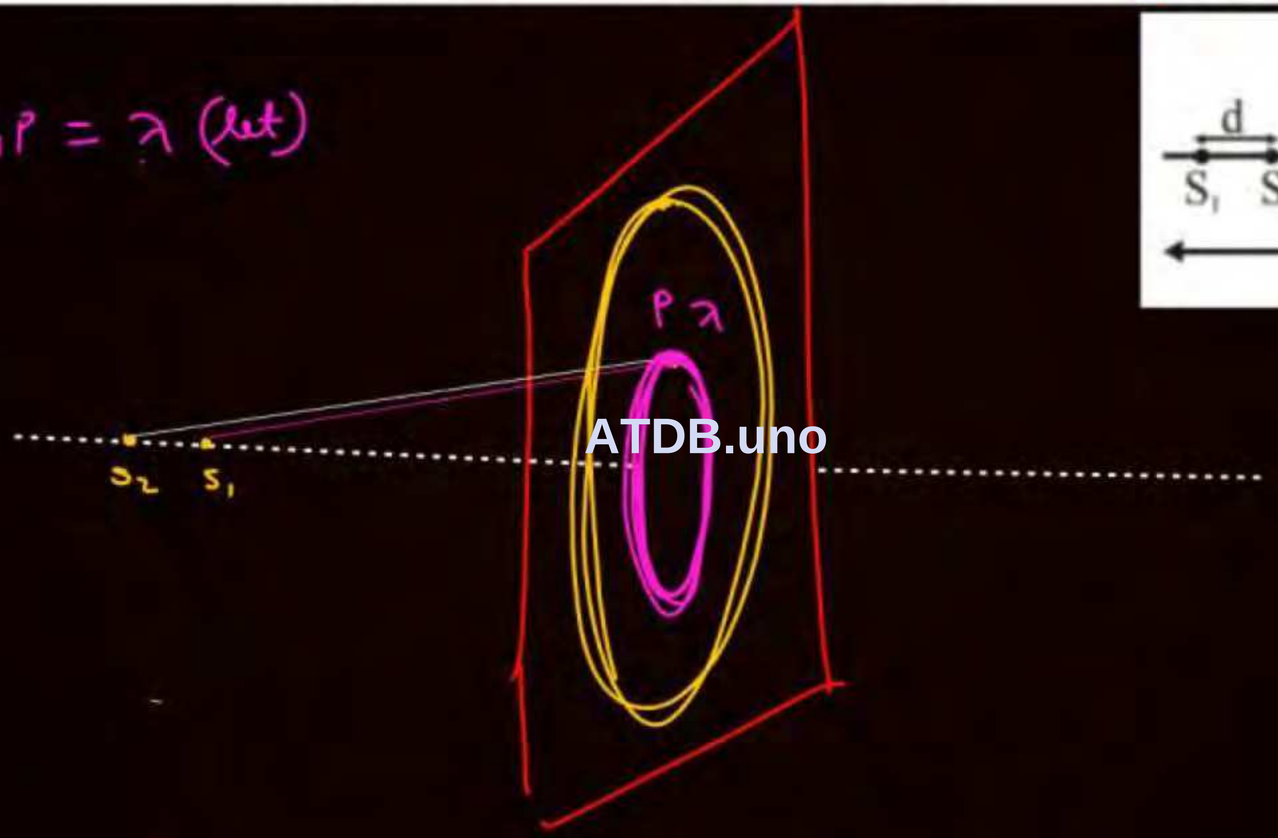
Ans : (1)

Q. Two coherent point sources S_1 and S_2 are separated by a small distance 'd' as shown. The fringes obtained on the screen will be : **[JEE-Mains 2013]**

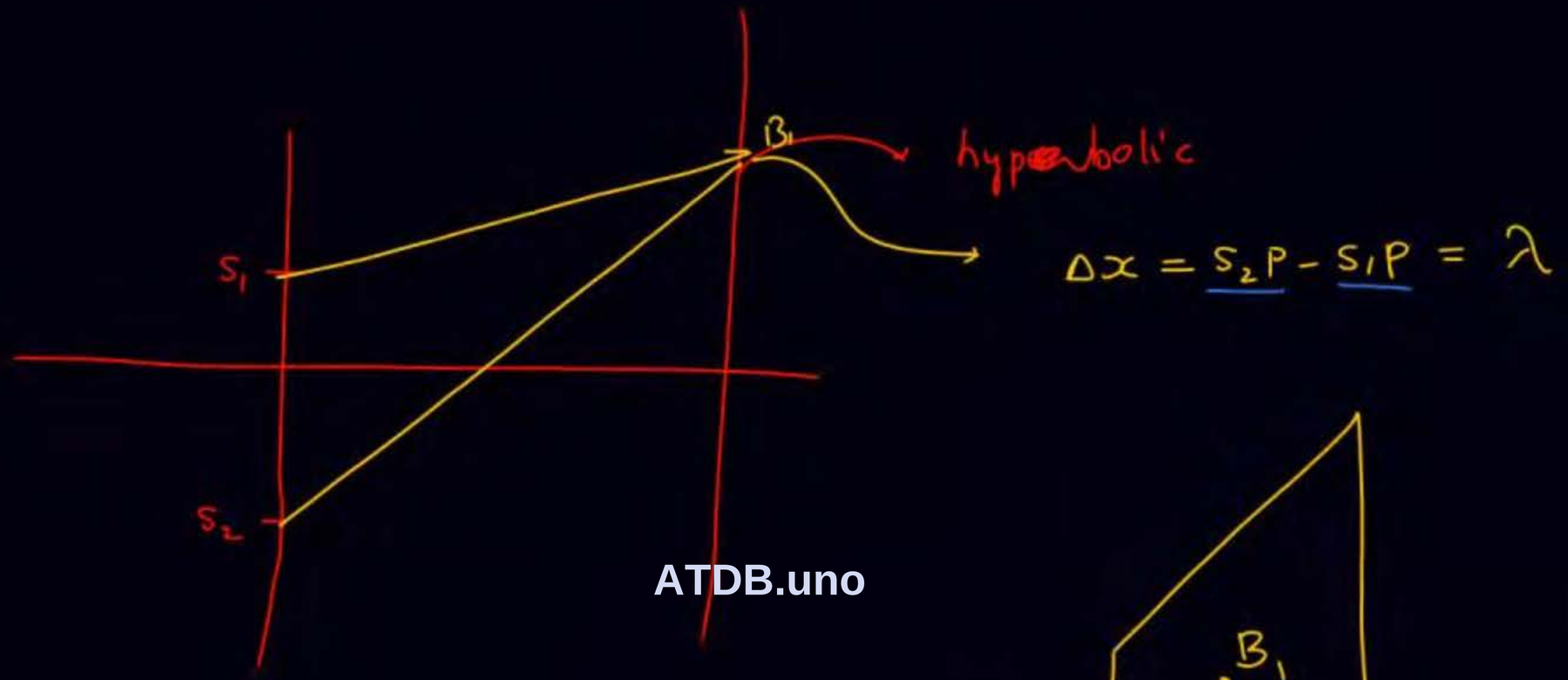
(1) points (2) straight lines (3) semicircles (4*) concentric circles

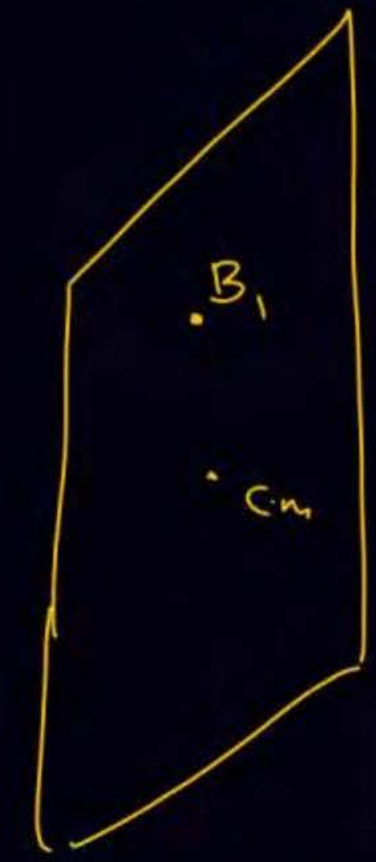


$S_2P - S_1P = \lambda$ (let)



Ans : (4)





Q. Young's double slit experiment is carried out by using green, red and blue light, one color at a time. The fringe widths recorded are β_G, β_R and β_B, respectively. Then

[IIT-JEE-2012]

(A) $\beta_G > \beta_B > \beta_R$ (B) $\beta_B > \beta_G > \beta_R$ (C) $\beta_R > \beta_B > \beta_G$ (D) $\beta_R > \beta_G > \beta_B$

$$\beta = \frac{\lambda D}{d}$$

Ans : (D)

Q. In the Young's double slit experiment using a monochromatic light of wavelength λ, the path difference (in terms of an integer n) corresponding to any point having half the peak intensity is :-

[JEE Advanced 2013]

(A) $(2n+1)\frac{\lambda}{2}$ (B) $(2n+1)\frac{\lambda}{4}$ (C) $(2n+1)\frac{\lambda}{8}$ (D) $(2n+1)\frac{\lambda}{16}$

$$\frac{\Delta x}{\lambda} = \frac{\Delta \phi}{\pi}$$

$$2I_0 = 4I_0 \cos^2 \phi/2$$

$$\cos^2 \phi/2 = \frac{1}{2}$$

$$\cos \frac{\phi}{2} = \pm \frac{1}{\sqrt{2}}$$

$$\frac{\phi}{2} = 45, 135 - - -$$

$$\phi = 90, 270 - - -$$

$$\phi = \pi/2, 3\pi/2 - - -$$

Ans : (B)

Q.

A light source, which emits two wavelengths $\lambda_1 = 400$ nm and $\lambda_2 = 600$ nm, is used in a Young's double slit experiment. If recorded fringe widths for λ_1 and λ_2 are β_1 and β_2 and the number of fringes for them within a distance y on one side of the central maximum are m_1 and m_2, respectively, then :-

[JEE Advanced 2014]

$$\beta = \frac{\lambda D}{d}$$

(A) $\beta_2 > \beta_1$

(B) $m_1 > m_2$

(C) From the central maximum, 3rd maximum of λ_2 overlaps with 5th minimum of λ_1

(D) The angular separation of fringes of λ_1 is greater than λ_2

$3 \times \lambda_2 \frac{D}{d} = 4.5\, \lambda_1 \frac{D}{d}$

3×600

4.5×400

Ans : (A, B, C)

Q. A Young's double slit interference arrangement with slits S_1 and S_2 is immersed in water (refractive index = 4/3) as shown in the figure. The positions of maxima on the surface of water are given by $x^2 = p^2m^2\lambda^2 - d^2$, where λ is the wavelength of light in air (refractive index = 1), 2d is the separation between the slits and m is an integer. The value of p is. = 3

[JEE Advanced 2015]

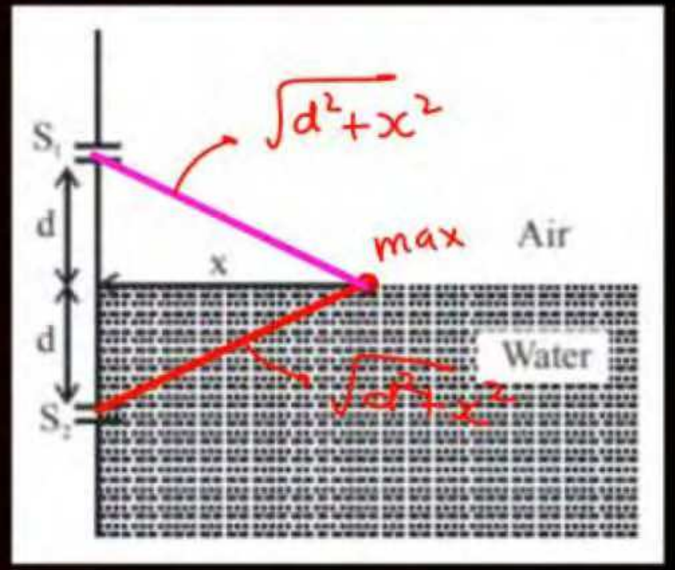
$$(S_2P)\mu_w - S_1P = n\lambda$$

$$\left(\sqrt{d^2+x^2}\right)\frac{4}{3} - \sqrt{d^2+x^2} = n\lambda$$

$$\frac{\sqrt{d^2+x^2}}{3} = n\lambda$$

$p^2 = 9$

$$x^2 = 9n^2\lambda^2 - d^2$$



Ans : (3)

Q. While conducting the Young's double slit experiment, a student replaced the two slits with a large opaque plate in the x-y plane containing two small holes that act as two coherent point sources (S_1, S_2) emitting light of wavelength 600 nm. The student mistakenly placed the screen parallel to the x-z plane (for $z > 0$) at a distance $D = 3$m from the mid-point of S_1S_2, as shown schematically in the figure. The distance between the sources $d = 0.6003$ mm. The origin O is at the intersection of the screen and the line joining S_1S_2. Which of the following is (are) true of the intensity pattern on the screen ?

[JEE Advanced 2016]

(A) Hyperbolic bright and dark bands with foci symmetrically placed about O in the x-direction

(B) Semi circular bright and dark bands centered at point O

(C) The region very close to the point O will be dark

(D) Straight bright and dark bands parallel to the x-axis

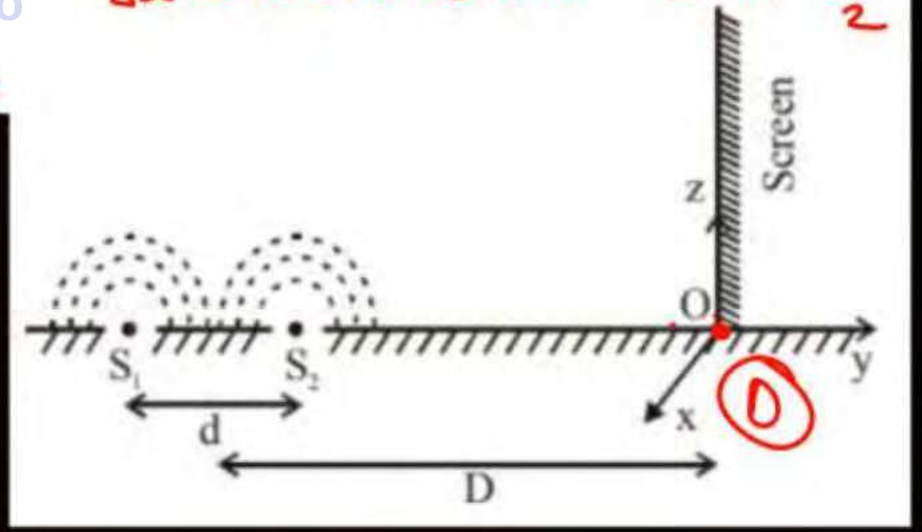
odd आनी चाहिए

$\Delta x = d = 6003 \times 10^{-7} = n \cdot \frac{\lambda}{2}$

$6003 \times 10^{-7} = n \times \frac{600 \times 10^{-9}}{2}$

$n = \frac{6003 \times 2 \times 10^{-2}}{6 \times 10^{-2}}$

$n = 2001$



Ans : (B, C)

Q. In a Young's double slit experiment, the slit separation d is 0.3 mm and the screen distance D is 1m. A parallel beam of light of wavelength 600nm is incident on the slits at angle α as shown in figure. On the screen, the point O is equidistant from the slits and distance PO is 11.0 mm. Which of the following statement(s) is/are correct ?

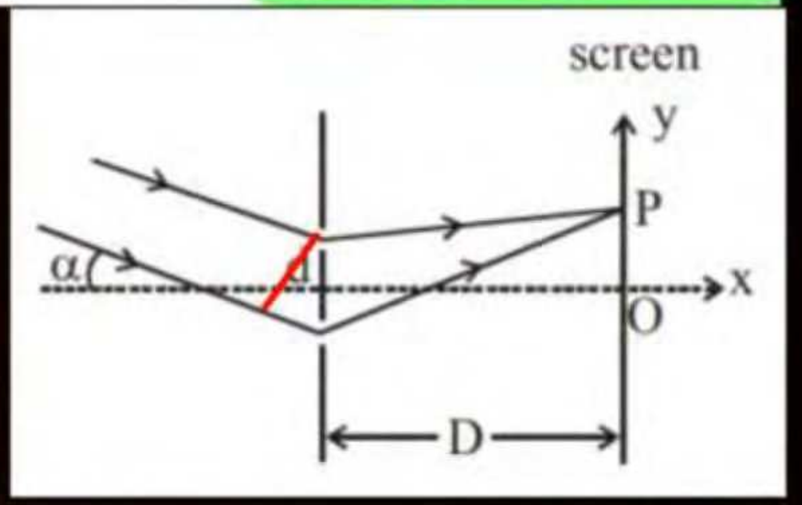
[JEE Advanced 2019]

(1) For $\alpha = \frac{0.36}{\pi}$ degree, there will be destructive interference at point O.

(2) Fringe spacing depends on α

(3) For $\alpha = \frac{0.36}{\pi}$ degree, there will be destructive interference at point P

(4) For $\alpha = 0$, there will be constructive interference at point P



Ans : (3)

Total geometric path difference for point P is

$$\Delta x = d\sin\alpha + \frac{yd}{D}$$

For option (A)

$$\alpha = \frac{0.36}{\pi} \text{ degree,}$$

then $\Delta x = 3900$ nm

or $(2n-1)\frac{\lambda}{2} = \Delta x$

(for destructive interference)

$\therefore \quad n = 7$

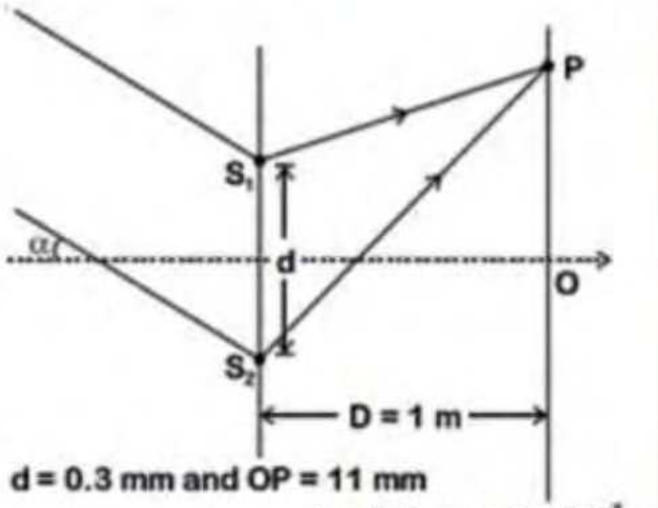
For option

If $\alpha = \frac{0.36}{\pi}$ degree

Then $\Delta x_0 = d\alpha = 600$ nm

or $\Delta x_0 = n\lambda$ (for $n = 1$)

(Constructive interference)



d = 0.3 mm and OP = 11 mm

$\lambda = 600$ nm $= 6 \times 10^{-7}$ m

For option

$\Delta x_0 = 0$ and $\frac{yd}{D} = 3300$ nm

as ($\alpha = 0$) (destructive interference at P)

Fringe width in all the above case remain unchanged

QUESTION

Monochromatic light of wavelength 500 nm is used in Young's double slit experiment. An interference pattern is obtained on a screen. When one of the slits is covered with a very thin glass plate (refractive index = 1.5), the central maximum is shifted to a position previously occupied by the 4^{th} bright fringe. The thickness of the glass-plate is _____ μm.

[09 Apr. 2024 - Shift 2]

$$y = (\mu - 1)t\frac{D}{d} = 4\beta = 4\frac{\lambda D}{d}$$

Ans. (4)

QUESTION

As shown in the figure, in Young's double slit experiment, a thin plate of thickness $t = 10\mu m$ and refractive index $\mu = 1.2$ is inserted infront of slit S_1. The experiment is conducted in air ($\mu = 1$) and uses a monochromatic light of wavelength $\lambda = 500$ nm. Due to the insertion of the plate, central maxima is shifted by a distance of $x\beta_0$. β_0 is the fringe-width before the insertion of the plate. The value of the x is _____.

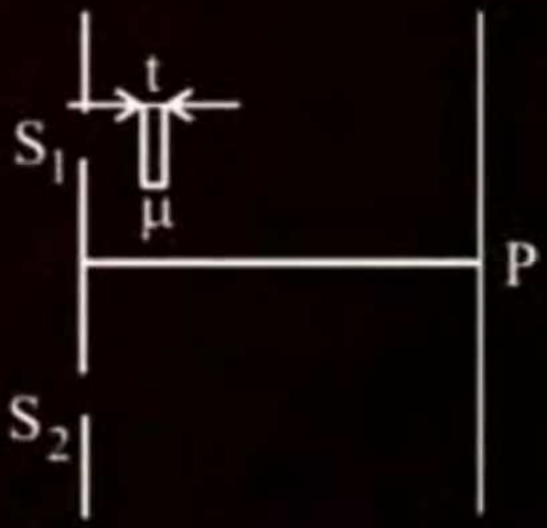
[01 February 2023 - Shift 2]

$$\frac{2 \times 1000^{2}}{500}$$

$$(\mu-1)t\frac{D}{d} = x\frac{\lambda D}{d}$$

$$\frac{(1.2-1)\times 10\times 10^{-6}}{500\times 10^{-9}} = x$$

④



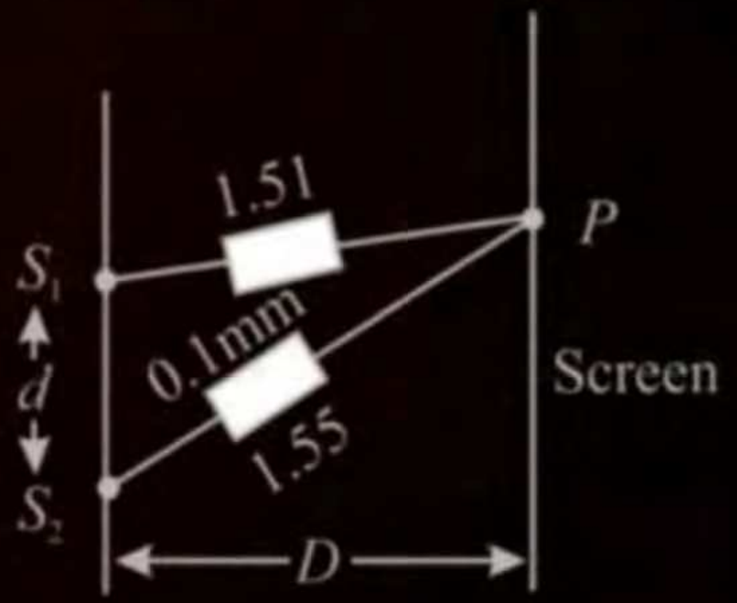
Ans : (4)

QUESTION

In Young's double slit experiment, two slits S_1 and S_2 are 'd' distance apart and the separation from slits to screen is D (as shown in figure). Now if two transparent slabs of equal thickness 0.1 mm but refractive index 1.51 and 1.55 are introduced in the path of beam (λ = 4000Å) from S_1 and S_2 respectively. The central bright fringe spot will shift by number of fringes.

[30 January 2023 - Shift 1]

$$n = \frac{[(\mu_1 - 1)t_1 - (\mu_2 - 1)t_2]}{\lambda} \frac{D}{d}$$



Ans : (10)

QUESTION

In young' s double slit experiment performed using a monochromatic light of wavelength λ, when a glass plate ($\mu = 1.5$) of thickness $x\lambda$ is introduced in the path of the one of the interfering beams, the intensity at the position where the central maximum occurred previously remains unchanged. The value of x will be:

[JEE Mains 2022]

$$n\lambda = \Delta x = \frac{dy}{D} + (\mu - 1)t$$

$$n\lambda = (\mu - 1) \cdot x\lambda$$

$$x = \frac{n}{\mu - 1} = \frac{n}{1.5 - 1} = 2n$$

1. 3
2. 2
3. 1.5
4. 0.5

Ans. (2)

QUESTION

In the Young's double slit experiment, the distance between the slits varies in time as $d(t) = d_0 + a_0 \sin\omega t$; where d_0, ω and a_0 are constants. The difference between the largest fringe width and the smallest fringe width obtained over time is given as:

[JEE Mains 2021]

1. $\frac{2\lambda D(d_0)}{(d_0^2 - a_0^2)}$
2. $\frac{2\lambda D a_0}{(d_0^2 - a_0^2)}$
3. $\frac{\lambda D}{d_0^2} a_0$
4. $\frac{\lambda D}{d_0 + a_0}$

$\beta = \frac{\lambda D}{d}$ $\quad \beta_{max} = \frac{\lambda D}{d_0 - a_0}$

$\beta_{min} = \frac{\lambda D}{d_0 + a_0}$

Ans $\frac{\lambda D}{d_0 - a_0} - \frac{\lambda D}{d_0 + a_0} = \lambda D \frac{(d_0 + a_0) - (d_0 - a_0)}{(d_0^2 - a_0^2)}$

$= \frac{\lambda D (2a_0)}{d_0^2 - a_0^2}$

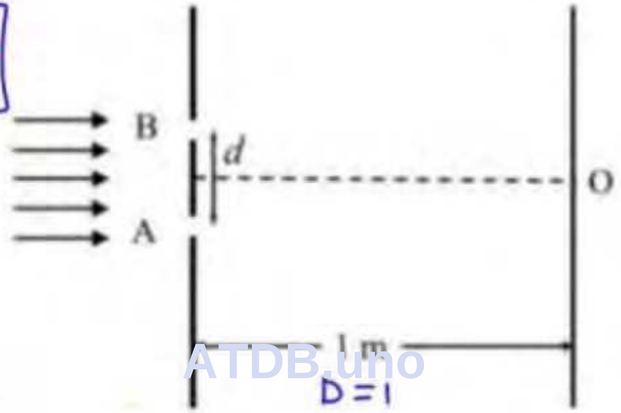
Ans. (2)

PARAGRAPH I

In a Young's double slit experiment, each of the two slits A and B, as shown in the figure, are oscillating about their fixed center and with a mean separation of 0.8 mm. The distance between the slits at time t is given by $d = (0.8 + 0.04 \sin \omega t)$ mm, where $\omega = 0.08$ rad s^{-1}. The distance of the screen from the slits is 1 m and the wavelength of the light used to illuminate the slits is 6000 Å. The interference pattern on the screen changes with time, while the central bright fringe (zeroth fringe) remains fixed at point O.

$d = .8 + .04 \sin \omega t$

$\lambda = 6000 A^{\circ}$



JEE Ad 2024

2024

$B_8 = 8\beta = 8\frac{\lambda D}{d}$

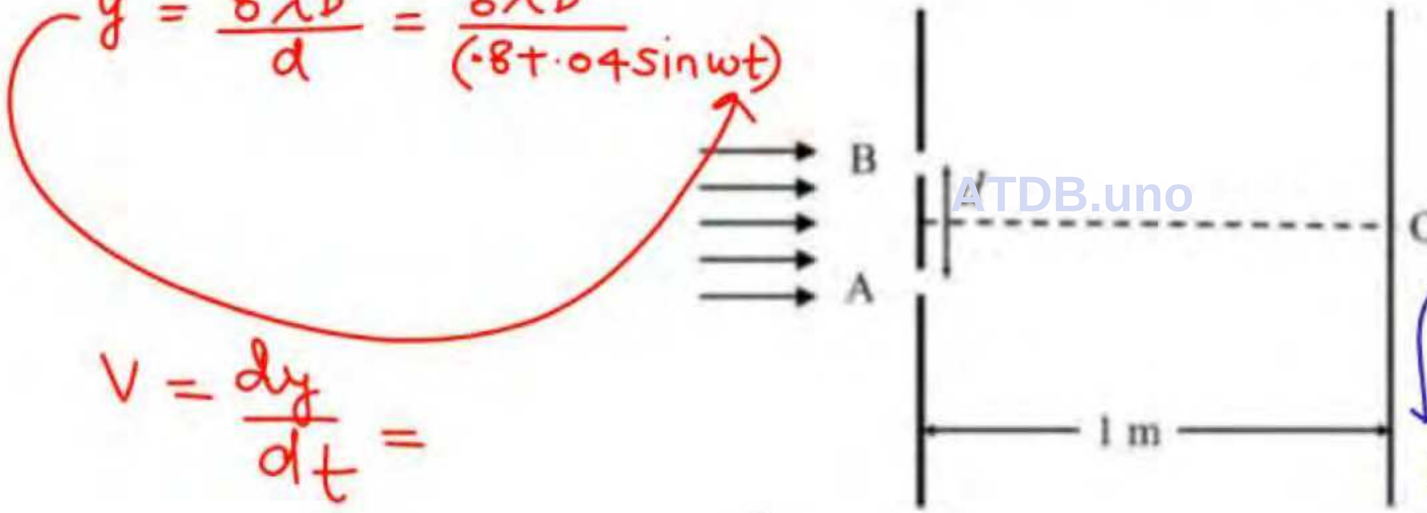
Q.14 The 8th bright fringe above the point O oscillates with time between two extreme positions. The separation between these two extreme positions, in micrometer (μm), is _____.

$(B_8)_{max} = \frac{8\lambda D}{(.8 - .04) \times 10^{-3}}$

$(B_8)_{min} = \frac{8\lambda D}{(.8 + .04) \times 10^{-3}}$

PARAGRAPH 1

In a Young's double slit experiment, each of the two slits A and B, as shown in the figure, are oscillating about their fixed center and with a mean separation of 0.8 mm. The distance between the slits at time t is given by $d = (0.8 + 0.04 \sin \omega t)$ mm, where $\omega = 0.08$ rad s^{-1}. The distance of the screen from the slits is 1 m and the wavelength of the light used to illuminate the slits is 6000 Å. The interference pattern on the screen changes with time, while the central bright fringe (zeroth fringe) remains fixed at point O.



$y = \frac{8\lambda D}{d} = \frac{8\lambda D}{(\cdot 8 + \cdot 04 \sin \omega t)}$

$V = \frac{dy}{dt} =$

$\frac{8\lambda D}{a + b \sin \omega t} = y$ (1)

$V = 8\lambda D \frac{b\omega \cos \omega t}{(a + b \sin \omega t)^2}$

max

0

$V = \frac{8\lambda D b \omega}{a^2}$

Q.15 The maximum speed (in μm/s) at which the 8th bright fringe will move is _____.

24

$b = .04\,mm$

$$y = y_8 = \frac{8\lambda D}{d} = \frac{8\lambda D}{.8 + .04\sin\omega t} = \frac{8\lambda D}{a + b\sin\omega t}$$

$\lambda = 6\times10^{-7}\,m$

$D = 1\,m$

$a = .8\times10^{-3}\,m$

$b = 4\times10^{-5}\,m$

$\omega = 8\times10^{-2}$

$$\frac{dy}{dt} = V = -\frac{8\lambda D \cdot b\omega(\cos\omega t)}{(a + b\sin\omega t)^2}$$

$$|V|_{max} = \frac{8\times6\times10^{-7}\times1\times4\times10^{-5}\times8\times10^{-2}\cos 0}{(.8\times10^{-3}+0)^2} = \frac{8\times6\times4\times8\times10^{-14}}{8\times8\times10^{-8}}$$

$$= 24\times10^{-6}$$

Homework

- module PYQ JEE mains + Adv
- Qus of this ppt

ATDB.uno