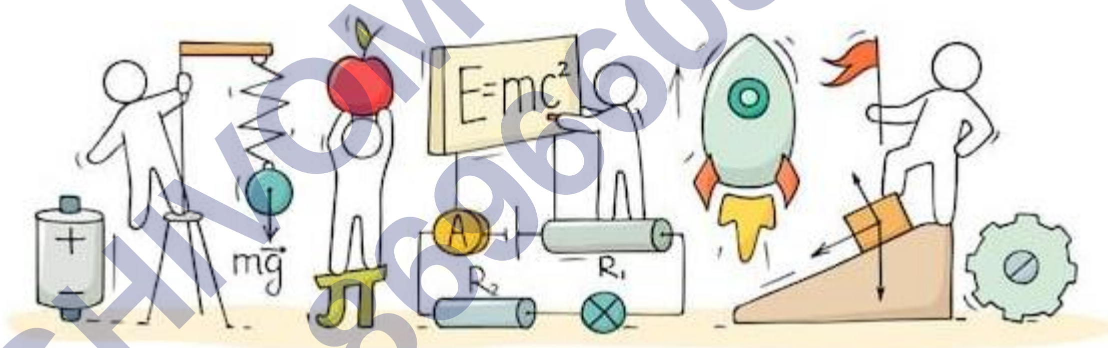
PHYSICS

CHAPTER 10: WAVE OPTICS



SHIVOM CLASSES 8696608541

WAVE OPTICS

Wave Optics:

Wave optics also called Physical optics deals with the study of various phenomena such as polarization, diffraction, interference, and other occurrences where ray approximation of geometric optics cannot be done. Thus, the section of optics that deals with the behaviour of light and its wave characteristics is said to be wave optics.

Wave Front:

The locus of all those particles which are vibrating in the same phase at any instant is called wave front. Thus, wave front is a surface having same phase of vibrating particles at any instant at every point on it.

These are three types:

- Spherical wavefront
- Cylindrical wavefront
- Plane wavefront

Models of Light:

Corpuscular model: According to this model, a luminous body emits a stream of particles in all directions. The particles are assumed to be very-very tiny. It explained the laws of reflection and refraction of light at an interface using concepts of elastic collisions and momentum conservation. Although this law could explain reflection and refraction, this law could not satisfactorily explain phenomenon like interference, polarization, and diffraction. In 1637, Descartes gave the corpuscular model of light.

Wave model: The wave theory of light was first put forward by Christian Huygen in 1678. On the basis of his wave theory, Huygen explained satisfactorily the phenomenon of reflection, refraction and total internal reflection.

Huygens's Principle:

Huygens's principle is a geometrical construction, which can be used to obtain new position of a wave front at a later time from its given position at any instant. Or we can quote that this principle gives a method gives an idea about how light spreads out in the medium.

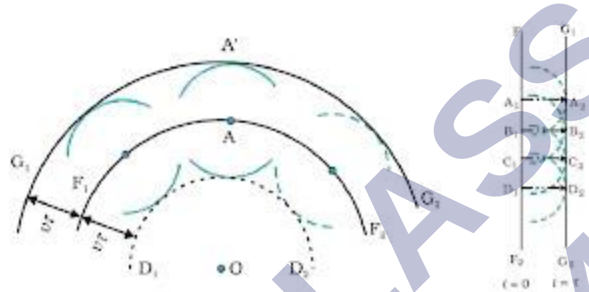
SHIVOM CLASSES 8696608541

It is developed on the following assumptions:

- All the points on a given or primary wave front acts as a source of secondary wavelets, which sends out disturbance in all directions in a similar manner as the primary light source.

- The new position of the wave front at any instant (called secondary wave front) is the envelope of the secondary wavelets at that instant.

  These two assumptions are known as Huygens principle or Huygens' construction.



Maxwell's Electromagnetic Wave Theory:

- Light waves are electromagnetic waves which do not require a material medium for their propagation.
- Due to transverse nature, light wave undergo polarization.
- The velocity of electromagnetic wave in vacuum is $c = \frac{1}{\mu_0 \varepsilon_0}$
- The velocity of electromagnetic waves in medium is less than that of light, v < c
  $v = \frac{1}{\sqrt{\mu_0 \varepsilon_0 \varepsilon_r \mu_r}} = \frac{c}{\sqrt{\mu_0 \varepsilon_r}}$
- The velocity of electromagnetic waves in a medium depend upon the electric and magnetic properties of the medium.

  where, μ_o = absolute magnetic permeability and

  ε_o = absolute electrical permittivity of free space.
- It failed to explain the phenomenon of photoelectric effect, Compton effect and Raman effect.

Max Planck's Quantum Theory:

- Light emits from a source in the form of packets of energy called quanta or photon.
- The energy of a photon is E = hv, where h is Planck's constant and v is the

SHIVOM CLASSES 8696608541

frequency of light.

- Quantum theory could explain photoelectric effect, Compton effect and Raman effect.
- Quantum theory failed to explain interference, diffraction and polarization of light.

The Doppler's Effect:

When light producing source moves away from the observer the frequency as measured by the observer will be smaller than that is actually generated by the source. Astronomers call the increase in wavelength due to Doppler effect as red shift.

When observer moves towards the source or the source moves towards observer, then apparent wavelength decreases, and visible spectrum appear to be shifted towards shorter wavelength. Hence, we call this as blue shift.

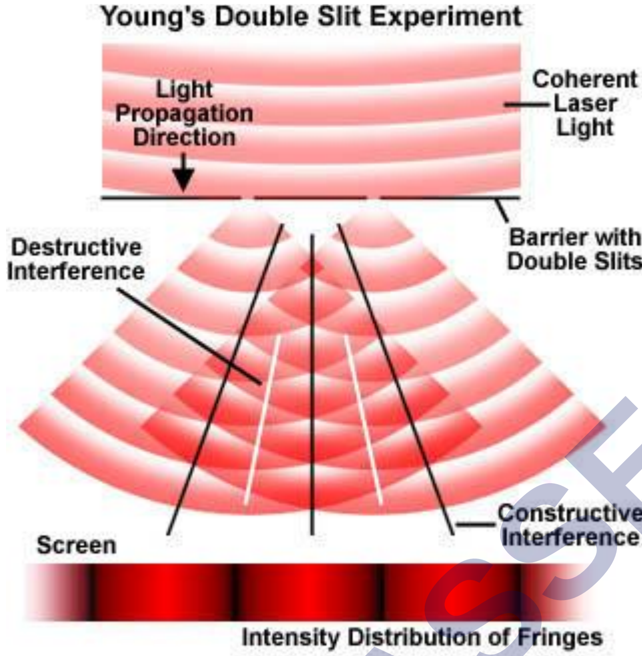
Coherent and Incoherent Sources of Light:

- **Coherent sources:** Two sources of light which continuously emit light waves of same frequency (or wavelength) with a zero or constant phase difference between them, are called coherent sources. Ex- LASER.
- **Incoherent sources:** Two sources of light which do not emit light waves with a constant phase difference are called incoherent sources. Ex- Two different light sources produce incoherent waves.

Interference of Light Wave:

Interference is the phenomenon in which two waves superpose to form the resultant wave of the lower, higher or same amplitude. When the crest of one wave falls on the crest of another wave such that the amplitude is maximum then interference is called constructive interference. When the crest of one wave falls on the trough of another wave such that the amplitude is minimum then interference is called destructive interference.

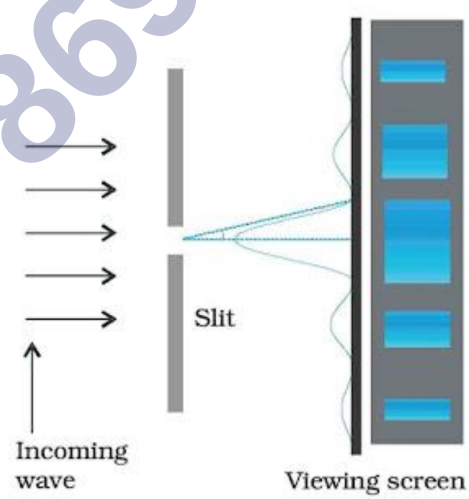
SHIVOM CLASSES 8696608541



Conditions for sustained interference:

- Two sources of light must be coherent.
- The frequencies (or wavelength) of the two waves should be equal.
- The light must be monochromatic.
- The amplitudes of the interfering waves must be equal or nearly equal.
- The two sources must be narrow.

Diffraction: The phenomenon of bending of light around the corners of an obstacle is called the diffraction of light.



Difference between Diffraction and Interference:

SHIVOM CLASSES 8696608541

S. No.	Interference	Diffraction
1.	Interference may be defined as waves emerging from two different sources, producing different wavefronts.	Diffraction, on the other hand, can be termed as secondary waves that emerge from the different parts of the same wave.
2.	The intensity of all the points on maxima is of similar intensity in interference.	In diffraction, there is a variance of the intensity of positions.
3.	It is absolutely dark in the region of minimum intensity, in the case of interference.	We see a variance in the intensity of interference in diffraction.
4.	The width of the fringes in interference is equal in interference.	The width of the fringes is not equal in interference.
5.	The sources are referred to as interference sources if the number of sources is as few as two sources.	If the number of sources is more than to the sources are referred to as diffraction sources.

SHIVOM CLASSES 8696608541

Polarization: If the vibrations of a wave are present in just one direction in a plane perpendicular to the direction of propagation, the wave is said to be polarized or plane polarised. The phenomenon of restricting the oscillations of a wave to just one direction in the transverse plane is called polarization of waves.

Malus' Law: It states that the intensity of plane-polarized light that passes through an analyzer varies directly with the square of the cosine of the angle between the plane of the polarizer and the transmission axes of the analyzer.

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

Polarizer: A device that polarizes the unpolarized light passed through it is called a polarizer.

Optical Activity: When plane polarized light passes through a certain substances, the plane of polarization of the light is rotated about the direction of propagation of light through a certain angle. This phenomenon is called optical activity or optical rotation and the substances optically active.

Brewster's Law:

According to Brewster's law, when an unpolarized light is incident on a transparent substance surface, it experiences maximum plan polarization at the angle of incidence whose tangent is the refractive index of the substance for the wavelength.

n = tan i (where, i = incident angle)

Double Refraction:

When unpolarized light is incident on a calcite or quartz crystal it splits up into two refracted rays. one of which follows laws of refraction. called ordinary ray (O-ray) and other do not follow laws of refraction. called extraordinary ray (E-ray). This phenomenon is called double refraction.

Dichroism:

Few double refracting crystals have a property of absorbing one of the two refracted rays and allowing the other to emerge out. This property of crystal is called dichroism.

Polaroid:

It is a polarizing film mounted between two glass plates. It is used to produce polarized light.

A polaroid is used to avoid glare of light in spectacles.

Uses of Polaroid:

- Polaroids are used in sunglasses. They protect the eyes from glare.
- The polaroid's are used in window panes of a train and especially of an aero plane. They help to control the light entering through the window.
- The windshield of an automobile is made of polaroid. Such a mind shield protects the eyes of the driver of the automobile from the dazzling light of the approaching vehicles.
- The pictures taken by a stereoscopic camera. When seen with the help of polarized spectacles, create three-dimensional effect.

Nicol Prism: A Nicol prism is an optical device which is used for producing plane polarised light and analyzing light the same.

The Nicol prism consists of two calcite crystal cut at 68° with its principal axis joined by a glue called Canada balsam.

Validity of Ray Optics: By diffraction of light travels, a parallel beam of light travels up to distances as large as few meters can be broadened.

SHIVOM CLASSES 8696608541

Fresnel Distance: The minimum distance a beam of light can travel before its deviation from straight line path becomes significant/ noticeable is known as Fresnel distance.

$$Z_F = \frac{a^2}{\lambda}$$

As the wavelength of light is very small, the deviation will be also very small, and light can be assumed as travelling in a straight line.

So, we can neglect broadening of beam due to diffraction up to distances as large as a few meters, i.e., we can assume that light travels along straight lines and ray optics can be taken as a limiting case of wave optics.

Therefore, Ray optics can be considered as a limiting case of wave optics.

Resolving Power:

If two point objects are close to each other, images diffraction patterns of those objects will also be close and overlap each other.

Limit of resolution of the instrument is the minimum distance between two objects which can be seen separately by the object instrument.

Resolving Power (R.P) = $\frac{1}{\text{Limit of Revolution}}$

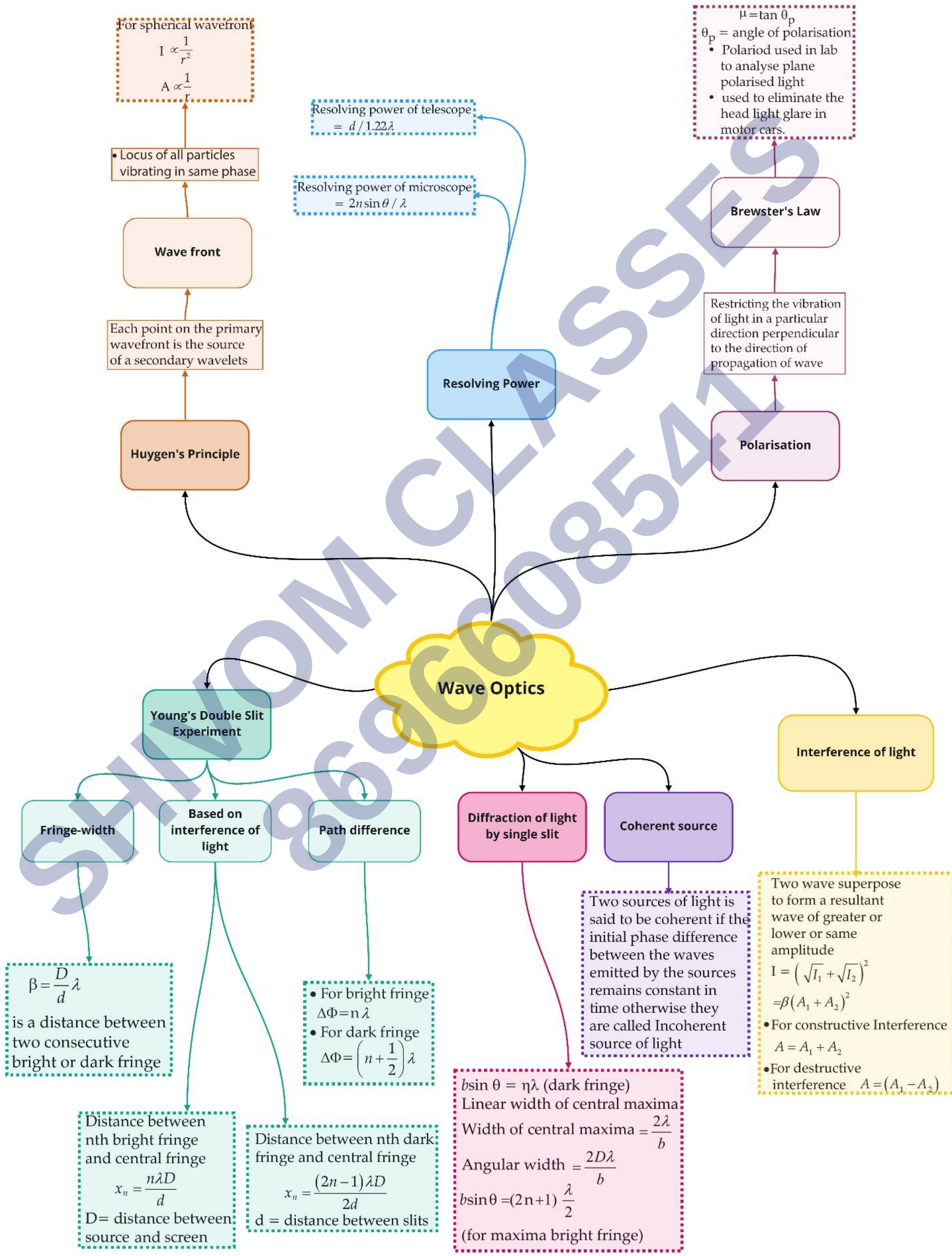
Resolving power of Microscope:

R.P. of microscope = $\frac{2\mu \sin\theta}{\lambda}$

Where D is the aperture of the telescope.

SHIVOM CLASSES 8696608541

Class : 12th Physics
Chapter- 10 : Wave Optics



SHIVOM CLASSES 8696608541

Important Questions

Multiple Choice questions-

1. The idea of secondary wavelets for the. propagation of a wave was first given by

(a) Newton
(b) Huygens
(c) Maxwell
(d) Fresnel

2. Light propagates rectilinearly, due to

(a) wave nature
(b) wavelengths
(c) velocity
(d) frequency

3. Which of the following is correct for light diverging from a point source?

(a) The intensity decreases in proportion with the distance squared.
(b) The wavefront is parabolic.
(c) The intensity at the wavelength does not depend on the distance.
(d) None of these.

4. The refractive index of glass is 1.5 for light waves of X = 6000 A in vacuum. Its wavelength in glass is

(a) 2000 Å
(b) 4000 Å
(c) 1000 Å
(d) 3000 Å

5. The phenomena which is not explained by Huygen's construction of wavefront

(a) reflection
(b) diffraction
(c) refraction
(d) origin of spectra

6. A laser beam is used for locating distant objects because

(a) it is monochromatic
(b) it is not chromatic
(c) it is not observed
(d) it has small angular spread.

7. Two slits in Young's double slit experiment have widths in the ratio 81 :1. The ratio of the amplitudes of light waves is

SHIVOM CLASSES 8696608541

(a) 3 :1
(b) 3 : 2
(c) 9 :1
(d) 6:1

8. When interference of light takes place

(a) energy is created in the region of maximum intensity
(b) energy is destroyed in the region of maximum intensity
(c) conservation of energy holds good and energy is redistributed
(d) conservation of energy does not hold good

9. In a double slit interference pattern, the first maxima for infrared light would be

(a) at the same place as the first maxima for green light
(b) closer to the center than the first maxima for green light
(c) farther from the center than the first maxima for green light
(d) infrared light does not produce an interference pattern

10. To observe diffraction, the size of the obstacle

(a) should be X/2, where X is the wavelength.
(b) should be of the order of wavelength.
(c) has no relation to wavelength.
(d) should be much larger than the wavelength.

Very Short:

1. Sketch the refracted wavefront emerging from convex tens, If a plane wavefront is an incident normally on it.
2. How would you explain the propagation of light on the basis of Huygen's wave theory?
3. Draw the shape of the reflected wavefront when a plane wavefront is an incident on a concave mirror.
4. Draw the shape of the refracted wavefront when a plane wavefront is an incident on a prism.
5. Draw the type of wavefront that corresponds to a beam of light diverging from a point source.
6. Draw the type of wavefront that corresponds to a beam of light coming from a very far off source.
7. Name two phenomena that establish the wave nature of light.
8. State the conditions which must be satisfied for two light sources to be coherent.

SHIVOM CLASSES 8696608541

9. Draw an intensity distribution graph for diffraction due to a single slit.
10. Name one device for producing plane polarised light. Draw the graph showing the variation of intensity of polarised light transmitted by an analyser.

Short Questions:

1. How can one distinguish between an unpolarised and linearly polarised light beam using polaroid? (CBSE Delhi 2019)
2. What is meant by plane polarised light? What type of waves shows the property of polarisation? Describe a method of producing a beam of plane polarised light?
3. Write the Important characteristic features by which the Interference can be distinguished from the observed diffraction pattern. (CBSE AI 2015)
4. State Brewster's law. The value of Brewster's angle for the transparent medium is different for the light of different colours. Give reason. (CBSE Delhi 2016)
5. Discuss the intensity of transmitted light when a polaroid sheet is rotated between two crossed polaroid's.
6. Is energy conserved in interference? Explain.
7. An incident beam of light of intensity Io is made to fall on a polaroid A. Another polaroid B is so oriented with respect to A that there is no light emerging out of B. A third polaroid C is now introduced midway between A and B and is so oriented that its axis bisects the angle between the axis of A and B. What is the intensity of light now between (i) A and C (ii) C and B? Give reasons for your answers.
8. One of the slits of Young's double-slit experiment is covered with a semi-transparent paper so that it transmits lesser light. What will be the effect on the interference pattern?

Long Questions:

1. Define the term wavefront. Using Huygen's wave theory, verify the law of reflection.

Or

Define the term, "refractive index" of a medium. Verify Snell's law of refraction when a plane wavefront is propagating from a denser to a rarer medium. (CBSE Delhi 2019)

2.

(a) Sketch the refracted wavefront for the incident plane wavefront of the light from a distant object passing through a convex lens.

(b) Using Huygens's principle, verify the laws of refraction when light from a denser medium is incident on a rarer medium.

SHIVOM CLASSES 8696608541

(c) For yellow light of wavelength 590 nm incident on a glass slab, the refractive index of glass Is 1.5. Estimate the speed and wavelength of yellow light Inside the glass slab. (CBSE 2019C)

Assertion and Reason Questions-

1. For question two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is NOT the correct explanation of A.

c) A is true but R is false.

d) A is false and R is also false.

Assertion (A): When tiny circular obstacle is placed in the path of light from some distance, a bright spot is seen at the centre of the shadow of the obstacle.

Reason (R): Destructive interference occurs at the centre of the shadow.

2. For question two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is NOT the correct explanation of A.

c) A is true but R is false.

d) A is false and R is also false.

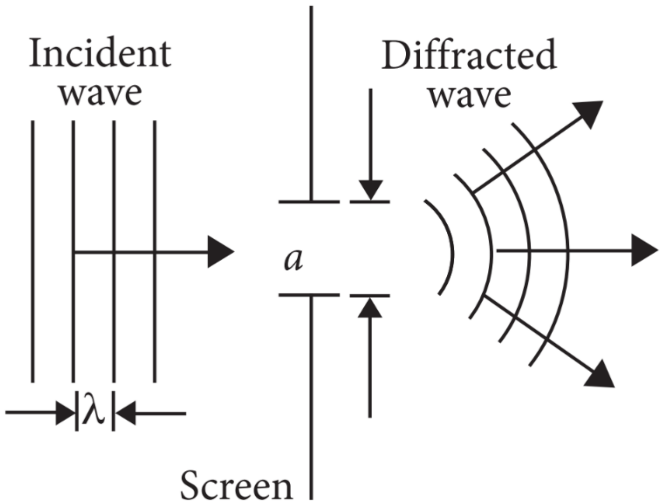
Assertion (A): One of the condition for interference is that the two source should be very narrow.

Reason (R): One broad source is equal to large number of narrow sources.

Case Study Questions-

1. The phenomenon of bending of light around the sharp corners and the spreading of light within the geometrical shadow of the opaque obstacles is called diffraction of light. The light thus deviates from its linear path. The deviation becomes much more pronounced, when the dimensions of the aperture or the obstacle are comparable to the wavelength of light.

SHIVOM CLASSES 8696608541



(i) Light seems to propagate in rectilinear path because.

a) Its spread is very large.
b) Its wavelength is very small.
c) Reflected from the upper surface of atmosphere.
d) It is not absorbed by atmosphere.

(ii) In diffraction from a single slit the angular width of the central maxima does not depends on:

a) λ of light used.
b) Width of slit.
c) Distance of slits from the screen.
d) Ratio of λ and slit width.

(iii) For a diffraction from a single slit, the intensity of the central point is:

a) Infinite.
b) Finite and same magnitude as the surrounding maxima.
c) Finite but much larger than the surrounding maxima.
d) Finite and substantially smaller than the surrounding maxima.

(iv) Resolving power of telescope increases when:

a) Wavelength of light decreases.
b) Wavelength of light increases.
c) Focal length of eye-piece increases.
d) Focal length of eye-piece decreases.

(v) In a single diffraction pattern observed on a screen placed at D metre di stance from the slit of width d metre, the ratio of the width of the central maxima to the width of other secondary maxima is:

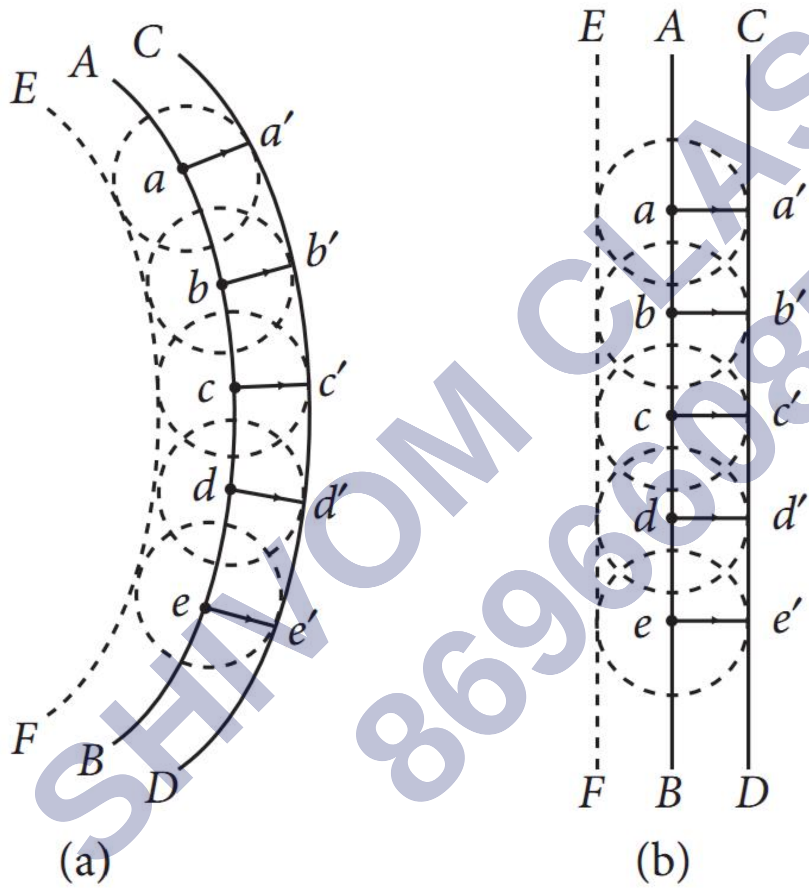
a) 2 : 1
b) 1 : 2

SHIVOM CLASSES 8696608541

c) 1 : 1
d) 3 : 1

2. Huygen's principle is the basis of wave theory of light. Each point on a wavefront acts as a fresh source of new disturbance, called secondary waves or wavelets. The secondary wavelets spread out in all directions with the speed light in the given medium.

An initially parallel cylindrical beam travels in a medium of refractive index $\mu(\mathrm{I}) = \mu_0 + \mu_2\mathrm{I}$, where μ_0 and μ_2 are positive constants and I is the intensity of the light beam. The intensity of the beam is decreasing with increasing radius.



SHIVOM CLASSES 8696608541

(i) The initial shape of the wavefront of the beam is:

a) Planar.
b) Convex.
c) Concave.
d) Convex near the axis and concave near the periphery.

(ii) According to Huygens Principle, the surface of constant phase is:

a) Called an optical ray.
b) Called a wave.
c) Called a wavefront.

d) Always linear in shape.

(iii) As the beam enters the medium, it will:

a) Travel as a cylindrical beam.
b) Diverge.
c) Converge.
d) Diverge near the axis and converge near the periphery.

(iv) Two plane wavefronts of light, one incident on a thin convex lens and another on the refracting face of a thin prism. After refraction at them, the emerging wavefronts respectively become.

a) Plane wavefront and plane wavefront.
b) Plane wavefront and spherical wavefront.
c) Spherical wavefront and plane wavefront.
d) Spherical wavefront and spherical wavefront.

(v) Which of the following phenomena support the wave theory of light?

1. Scattering.
2. Interference.
3. Diffraction.
4. Velocity of light in a denser medium is less than the velocity of light in the rarer medium.

a) 1, 2, 3
b) 1, 2, 4
c) 2, 3, 4
d) 1, 3, 4

✓ Answer Key:

Multiple Choice Answers-

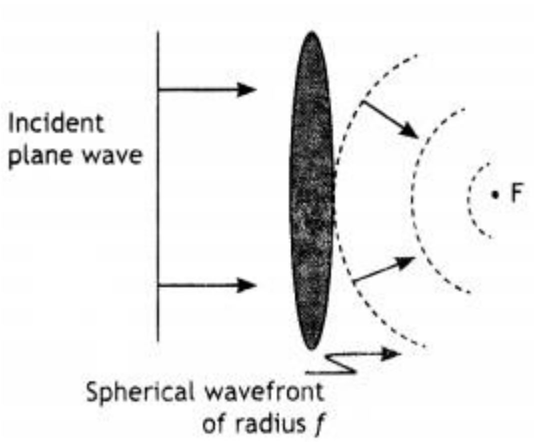
1. Answer: b
2. Answer: a
3. Answer: a
4. Answer: b
5. Answer: d
6. Answer: d
7. Answer: c
8. Answer: c
9. Answer: c

SHIVOM CLASSES 8696608541

10.Answer: b

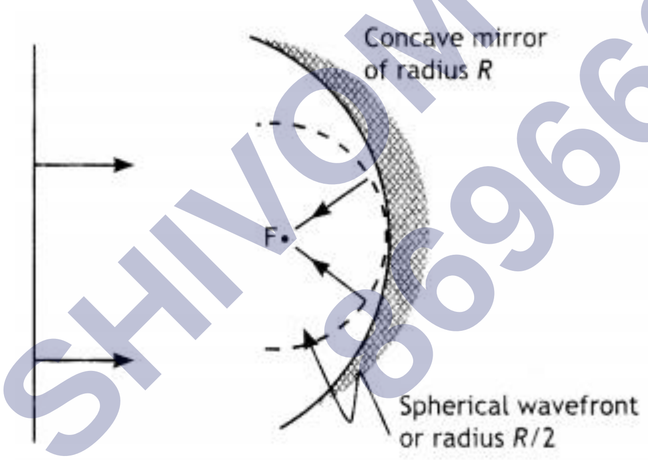
Very Short Answers:

1. Answer: The figure is as shown.

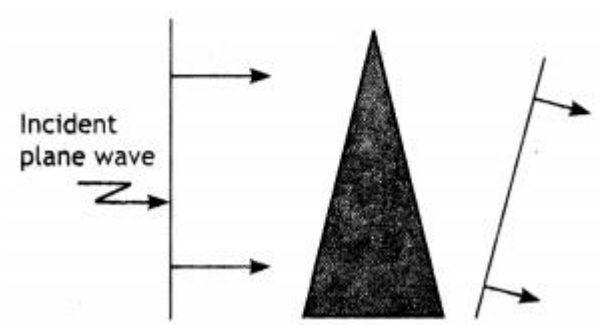


2. Answer: To explain the propagation of light we have to draw a wavefront at a later instant when a wavefront at an earlier instant is known. This can be drawn by the use of Huygen's principle.

3. Answer: The reflected wavefront is as shown.



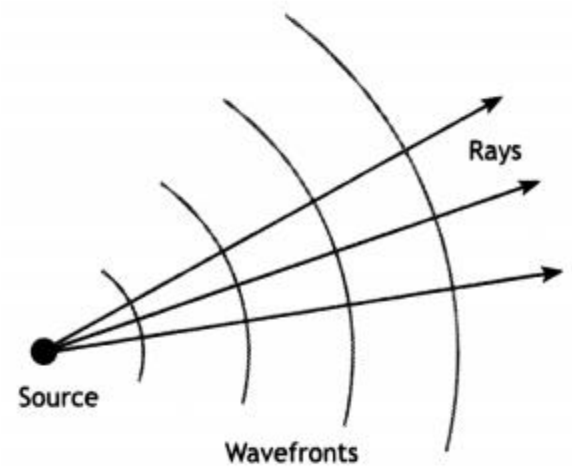
4. Answer: The shape of the wavefront is as shown.



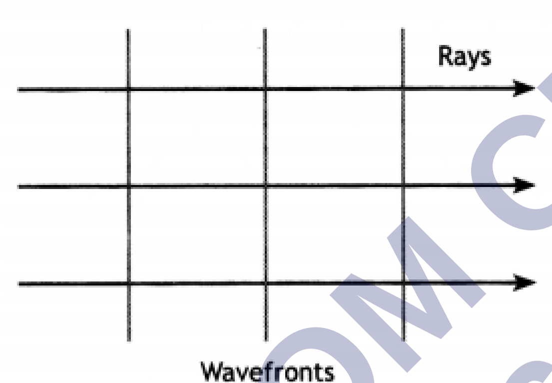
5. Answer: The wavefront formed by the light coming from a very far off source is a

SHIVOM CLASSES 8696608541

plane and for a beam of light diverging from a point, a wavefront is a number of concentric circles.



6. Answer: The wavefront is as shown.



7. Answer: Interference and diffraction of light.

8. Answer:

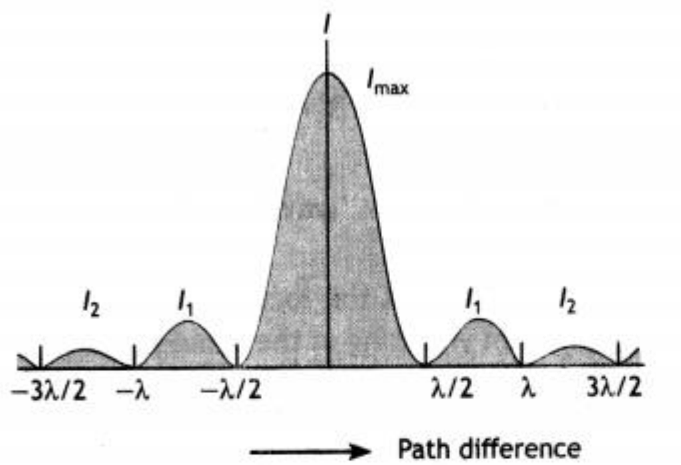
   (a) Two sources must emit light of the same wavelength (or frequency).

   (b) The two light sources must be either in-phase or have a constant phase difference.

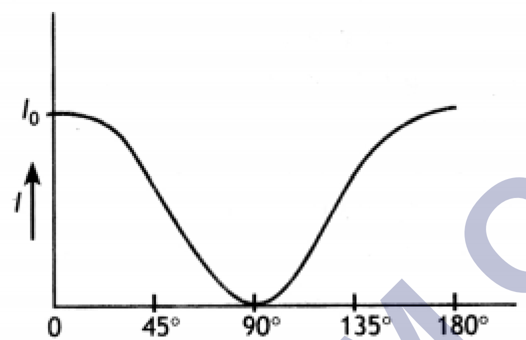
9. Answer:

   The intensity distribution for a single-slit diffraction pattern is as shown.

SHIVOM CLASSES 8696608541



10. Answer: Nicol prism can be used to produce plane polarised light. The graph is as shown.



Short Questions Answers:

1. Answer: The two lights will be allowed to pass through a polariser. When the polarizer is rotated in the path of these two light beams, the intensity of light remains the same in all the orientations of the polariser, then the light is unpolarised. But if the intensity of light varies from maximum to minimum then the light beam is a polarised light beam.

2. Answer:

   - The light that has its vibrations restricted in only one plane is called plane polarised light.
   - Transverse waves show the phenomenon of polarization.

     Light is allowed to pass through a polaroid. The polaroid absorbs those vibrations which are not parallel to its axis and allows only those vibrations to pass which are parallel to its axis.

3. Answer:

   (a) In the interference pattern the bright fringes are of the same width, whereas in the diffraction pattern they are not of the same width.

SHIVOM CLASSES 8696608541

(b) In interference all bright fringes are equally bright while in diffraction they are not equally bright.

4. Answer:

When the reflected ray and the refracted ray are perpendicular then $\mu = \tan i_p$ where i_p is the polarising angle or Brewster angle.

Brewster's angle depends upon the refractive index of the two media in contact. The refractive index in turn depends upon the wavelength of light used (different colours) hence Brewster's angle is different for different colours.

5. Answer:

Let I_o be the intensity of polarised light after passing through the first polarizer P_1. Then the intensity of light after passing through the second polarizer P_2 will be $I = I_o \cos 2\theta$, where θ is the angle between pass axes of P_1 and P_2. Since P_1 and P_3 are crossed the angle between the pass axes of P_2 and P_3 will be $(\pi/2 - \theta)$. Hence the intensity of light emerging from P3 will be

$I = I_o \cos^2\theta \cos^2(90° - \theta) = I_o \cos^2\theta \sin^2\theta = (I_o/4)\sin^2 2\theta$

Therefore, the transmitted intensity will be maximum when $\theta = \pi/4$

6. Answer:

Yes, energy is conserved in interference. Energy from the dark fringes is accumulated in the bright fringes. If we take

$I = 4a^2\cos^2\frac{\phi}{2}$, then intensity at bright points is $I_{max} = 4a^2$ and intensity at the minima $I_{min} = 0$. Hence average intensity in the pattern of the fringes produced due to interference is given by

$\bar{I} = \frac{I_{max} + I_{min}}{2} = \frac{4a^2 + 0}{2} = 2a^2$

But if there is no interference then total intensity at every point on the screen will be $I = a^2 + a^2 = 2a^2$, which is the same as the average intensity in the interference pattern.

7. Answer: Polaroids A and B are oriented at an angle of 90°, so no light is emerging out of B. On placing polaroid C between A and B such that its axis bisects the angle between axes of A and B, then the angle between axes of polaroids A and B is 45° and that of C and B also 45°.

(a) Intensity of light on passing through Polaroid A or between A and C is $I_1 = \frac{I_0}{2}$

(b) On passing through polaroid C, intensity of light between C and B becomes

$I_2 = I_1 \cos^2\theta = \frac{I_0}{2} \times \cos^2 45° = \frac{I_0}{4}$

8. Answer: There will be an interference pattern whose fringe width is the same as that of the original. But there will be a decrease in the contrast between the

SHIVOM CLASSES 8696608541

maxima and the minima, i.e., the maxima will become less bright, and the minima will become brighter.

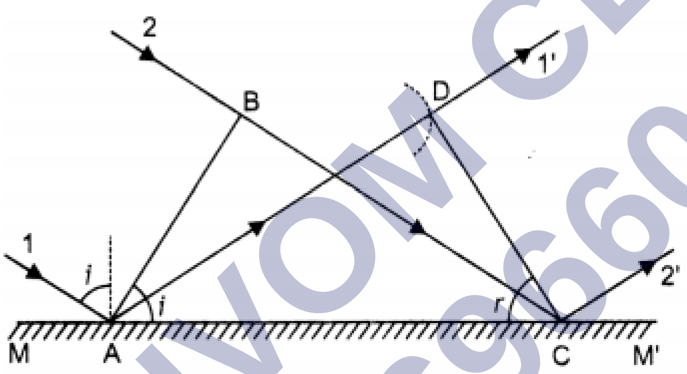
Long Questions Answers:

1. Answer:

The wavefront is a locus of points that oscillate in the same phase.

Consider a plane wavefront AB incident obliquely on a plane reflecting surface MM⁻. Let us consider the situation when one end A of was front strikes the mirror at an angle i but the other end B has still to cover distance BC. The time required for this will be t = BC/c.

According to Huygen's principle, point A starts emitting secondary wavelets and in time t, these will cover a distance c t = BC and spread. Hence, with point A as centre and BC as radius, draw a circular arc. Draw tangent CD on this arc from point C. Obviously, the CD is the reflected wavefront inclined at an angle 'r'. As incident wavefront and reflected wavefront, both are in the plane of the paper, the 1st law of reflection is proved.



To prove the second law of reflection, consider ΔABC and ΔADC. BC = AD (by construction),

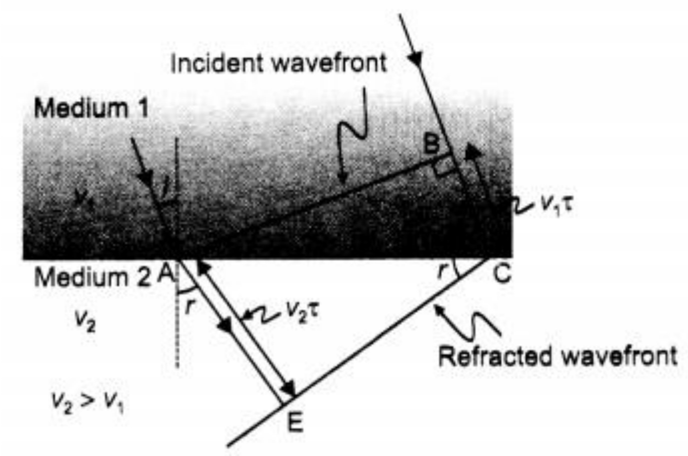
∠ABC = ∠ADC = 90° and AC is common.

Therefore, the two triangles are congruent and, hence, ∠BAC = ∠DCA or ∠i = ∠r, i.e. The angle of reflection is equal to the angle of incidence, which is the second law of reflection.

Or

The refractive index of medium 2, w.r.t. medium 1 equals the ratio of the sine of the angle of incidence (in medium 1) to the sine of the angle of refraction (in medium 2), The diagram is as shown.

SHIVOM CLASSES 8696608541



From the diagram

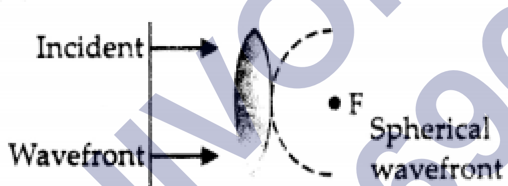
$$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC}$$

$$\text{And } \sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC}$$

$$\text{Therefore, } \frac{\sin i}{\sin r} = \frac{v_1}{v_2} = n_{12}$$

2. Answer:

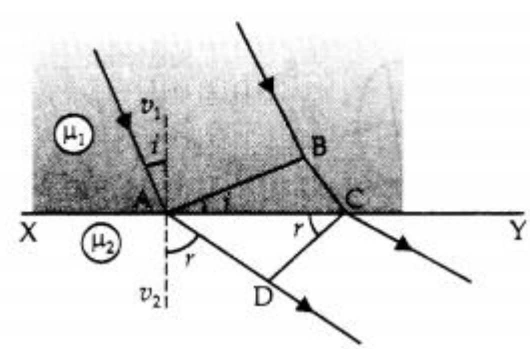
(a) Refracted wavefront



(b) Refraction from denser to the rarer medium: Let XY be plane refracting surface separating two media of refractive index μ_1 and μ_2 ($\mu_1 > \mu_2$)

Let a plane wavefront AB incident at an angle i. According to Huygen's principle, each point on the wavefront becomes a source of secondary wavelets and

Time is taken by wavelets from B to C = Time taken by wavelets from A to D



SHIVOM CLASSES 8696608541

i.e. $t = \frac{BC}{v_1} = \frac{AD}{v_2}$

or $\frac{BC}{AD} = \frac{v_1}{v_2}$ ...(*i*)

In right angle ΔABC

$\frac{BC}{AC} = \sin i$

or BC = AC sin *i* ...(*ii*)

Similarly, in right angle ΔADC

AD = AC sin *r* ...(*iii*)

From (*ii*) and (*iii*)

$$\frac{BC}{AD} = \frac{\sin i}{\sin r}$$

From (*i*) and (*ii*), we have

$$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = {}^1\mu_2$$

(c)

Given λ = 590 nm, μ = 1.5

Velocity of light inside glass slab.

$\therefore v = \frac{C}{\mu} = \frac{3\times10^8}{1.5} = 2 \times 10^8\ ms^{-1}$

Wavelength of yellow light inside the glass slab.

$\lambda_1 = \frac{\lambda}{\mu} = \frac{290}{1.5} = 393.33$ nm

Assertion and Reason Answers-

1. (c) A is true but R is false.

Explanation:

The waves diffracted from the edges of circular obstacle, placed in the path of light, interfere constructively at the centre of the shadow resulting in the formation of a bright spot.

2. (a) Both A and R are true and R is the correct explanation of A.

Explanation:

As a broad source is equivalent to a large number of narrow sources lying side by side. Each set of these sources will produce an interference pattern of its own which will

SHIVOM CLASSES 8696608541

overlap on another to such an extent that all traces of a fringe system is lost and results in general illumination. Because of this reason, for interference a narrow slit should be used.

Case Study Answers-

1. Answer :

(i) (b) Its wavelength is very small.

Explanation:

The wavelength of visible light is very small, that is hardly shows diffraction, so it seems to propagate in rectilinear path,

(ii) (c) Distance of slits from the screen.

Explanation:

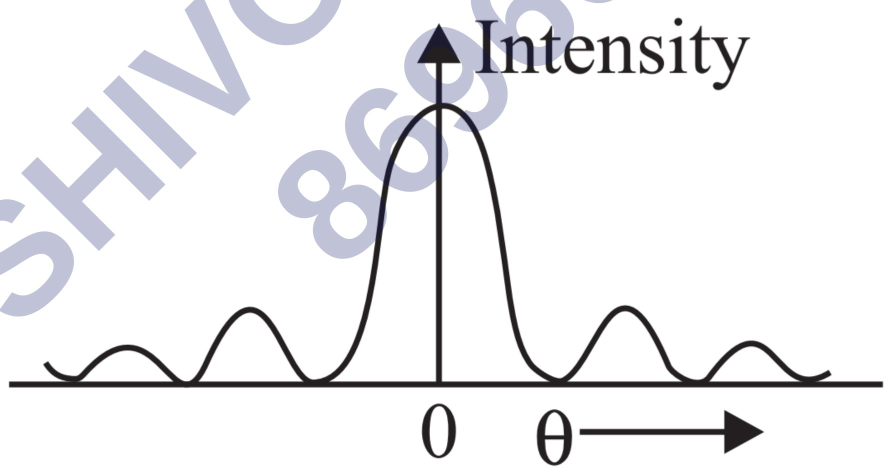
Angular width of central maxima, $2\theta = \frac{2\lambda}{e}$.

Thus, θ does not depend on screen i.e., distance between the slit and the screen.

(iii) (c) Finite but much larger than the surrounding maxima.

Explanation:

diffraction pattern is shown in the figure. From the graph it is clear that the intensity of the central point is finite but much larger than the surrounding maxima.



(iv) (a) Wavelength of light decreases.

Explanation:

Resolving power of telescope $= \frac{a}{1.22\lambda}$

∴ It increases when wavelength of light decreases and/or objective lens of greater diameter is used.

SHIVOM CLASSES 8696608541

(v) (a) 2 : 1

Explanation:

Width of central maxima $= \frac{2\lambda D}{e}$

width of other secondary maxima $= \frac{\lambda D}{e}$

∴ Width of central maxima: width of other secondary maxima

= 2 : 1

SHIVOM CLASSES 8696608541

2. Answer :

(i) (a) Planar.

Explanation:

As the beam is initially parallel, the shape of wavefront is planar.

(ii) (c) Called a wavefront.

Explanation:

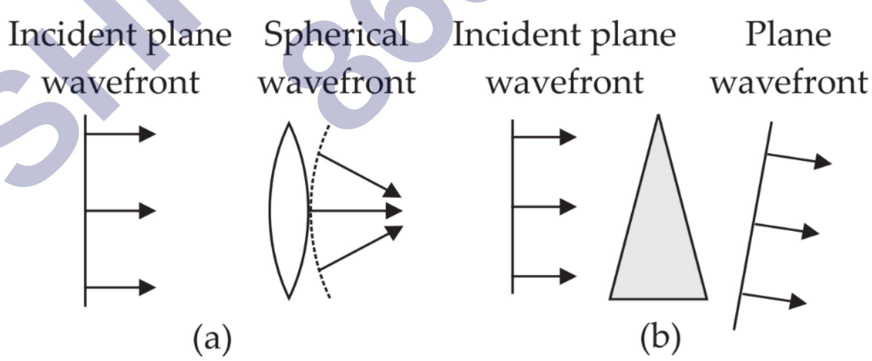
According to Huygens Principle, the surface of constant phase is called a wavefront.

(iii) (c) Converge.

(iv) (c) Spherical wavefront and plane wavefront.

Explanation:

After refraction, the emerging wavefronts respectively become spherical wavefront and plane wavefront as shown in figures (a) and (b).



(v) (c) 2, 3, 4