WAVE OPTICS

12th Standard CBSE

Date : 17-Nov-22

Physics

Reg.No. :

Exam Time : 02:00:00 Hrs

Total Marks : 100

208 x 5 = 1040

1) Answer the following questions:
(a) In a single-slit diffraction experiment, the width of the slit is made double the original width. How does this affect the size and intensity of the central diffraction band?
(b) In what way is diffraction from each slit related to the interference pattern in a double slit experiment?
(c) When a tiny circular obstacle is placed in the path of light from a distant sources, a bright spot is seen at the centre of the shadow of the obstacle. Explain why?
(d) Two students are separated by a 7 m partition wall in a room 10 m high. If both light and sound waves can bend around obstacles, how is it that the students are unable to see each other even though they can converse easily.
(e) Ray optics is based on the assumption that light travels in a straight line. Diffraction effects(observed when light propagates through small apertures/slits or around small obstacles) disprove this assumption. Yet the ray optics assumption is so commonly used in understanding location and several other properties of images in optical instruments. What is the justification?

2) Two towers on top of two hills are 40 km apart. The line joining them passes 50 m above a hill half way between the towers. What is the longest wavelength of radio waves, which can be sent between the towers without appreciable diffraction effects?

3) Explain the terms interference of light and define constructive and destructive interference. Is law of conservation of energy obeyed?

4) What is sustained interference? What are necessary conditions for producing stationary or sustained interference.

5) Distinguish between interference and diffraction.

6) Show that at polarising angle, the reflected and refracted beams of light are at { 90 }^{ \circ } to each other.

7) What should the width of each slit be to obtain 10 maxima of the double slit pattern within the central maxima of the single slit pattern ?

8) The mixture a pure liquid and a solution in a long vertical column (i.e., horizontal dimensions < < vertical dimensions) produces diffusion of solute particles and hence a refractive index gradient

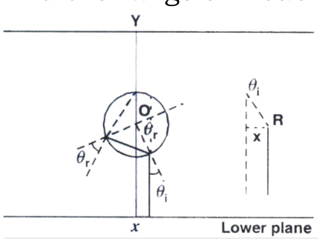
along the vertical dimension. A ray of light entering the column at right angles to the vertical deviates from its original path. find the deviation in travelling a horizontal distance d<

9) If light passes near a massive object, the gravitational interaction causes a bending of the ray. This can be thought of as happening due to a change in the effective refractive index of the medium given by

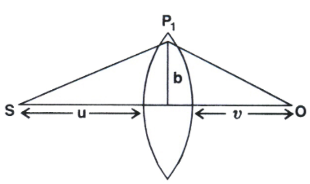
$n(r)=\frac { 1+2GM }{ { rc }^{ 2 } }$

where r is the distance of the point of consideration from the centre of the mass of the massive body. G is the universal gravitational constant, M the mass of the body and c the speed of light in vacuum. considering a spherical object find the deviation of the ray from the original path as it grazes the object

10) An infinitely long cylinder of radius R is made of an unusual exotic material with refractive index -1. The cylinder is placed between two planes whose normals are along the y direction. The centre of the cylinder O lies along the y-axis. A narrow laser beam is directed along the y direction from the lower plate. The laser source is at a horizontal distance x from the diameter in the y direction. find the range of x such that light emitted from the lower plane does not reach the upper plane



11) (i) Consider a thin lens placed between a source (S) and an observer (O). Let the thickness of the lens vary as $\omega (b)={ \omega }_{ 0 }-\frac { { b }^{ 2 } }{ a }$, where b is the vertical distance from the pole. ${ \omega }_{ 0 }$ is a constant. using Fermat's principle i.e., the time of transit for a ray between the source and observer is an extremum, find the condition that all paraxial rays starting from the source will converge at a point O on the axis. find the focal length



(ii) A gravitational lens may be assumed to have a varying width of the form show that an observer will see an image of a point object as a ring about the centre of the lens with an angular radius $\beta =\sqrt { \frac { (n-1){ k }_{ 1 }\frac { u }{ v } }{ u+v } }$

12) The magnifying power of an astronomical telescope in the normal adjustment position is 100.The distance between the objective and eye piece is 101cm.Calculate the focal lengths of objective and eye piece.

13) An astronomical telescope is designed to have a magnifying power of 50 in normal adjustment.If the length pf the tube is 120cm, find the powers of objective and eye piece.

14) A refracting telescope has an objective of focal length 1m and an eye of the sun 10cm in diameter is formed at a distance of 24cm from eye piece.what angle does the sun subtend at the

objective?

15) Light of wavelength $5000\overset { \circ }{ A }$ falls on a plane reflecting surface. What are the wavelength and frequency of reflected light? For what angle of incidence is the reflected ray normal to the incident ray?

16) When an object is placed at a distance of 60 cm from a convex spherical mirror, the magnification produced is 1/2. Where should the object be placed to get a magnification of 1/3?

17) A 5 cm long needle is placed 10 cm from a convex mirror of focal length 40 cm. Find the position, nature and size of image of the needle. What happens to the size of image when needle is moved farther away from the mirror?

18) An object of height h is held before a spherical mirror of focal length $\left| f \right| =40\ cm$ The image of the object produced by the mirror has same orientation as the object and has height=0.2h. Is the image real or virtual? Is the image on the same side of the mirror as the object? Is the mirror convex or concave? What is focal length of mirror with proper sign?

19) Light of wavelength $5\times { 10 }^{ -7 }$m is diffracted by an aperture of width.$2\times { 10 }^{ -3 }$m For what distance traveled by the diffracted beam does the spreading due to diffraction becomes greater than width of the aperture?

20) A slit of width 'd' is illuminated by light of wavelength $5000\mathring { A }$. For what value of 'd' will the first maximum fall at an angle of diffraction of 30°

21) A parallel beam of light of 600nm falls on a narrow slit and the resulting diffraction patterns are observed on a screen 1.2m away. It is observed that the first minimum is at a distance of 3mm from the center of the screen. Calculate the width of the slit.

22) A screen is placed 2m away from the single narrow slit. Calculate the slit width if the first minimum lies 5mm on either side of the central maximum. Incident plane waves have a wavelength of $5000\mathring { A }$

23) Light of wavelength $6000 \ \overset { \circ }{ A }$ in air enters a medium of refractive index 1.5. What are the wavelength and frequency of light in that medium?

24) What is the speed of light in glass of refractive index 1.5? Given speed of light in water is $2.25\times 10^{ 8 }\ m/s$ and refractive index of water is 1.3.

25) Two spectral lines of sodium ${ D }_{ 1 }$and${ D }_{ 2 }$have wavelengths of approximately.$5890\mathring { A } \ and \ 5896\mathring { A }$ A sodium lamp sends incident plane wave onto a slit of width 2 micrometer. A screen is located 2m from the slit. Find the spacing between first maxima of two sodium lines as measured of two sodium lines as measured on the screen.

26) A ray of light is incident at an angle of 45° on one face of a rectangular glass slab of thickness 10 cm and refractive index 1.5. Calculate the lateral shift produced.

27) Refractive indices of water and glass are 4/3 and 3/2 respectively. A ray of light travelling in water is incident on the water glass interface at 30°. Calculate the angle of refraction.

28) In a single-slit diffraction experiment, the first minimum for red light coincides with the first maximum of some other wavelength. λ' Calculate λ'

29) What should be the width of each slit to obtain 10 maxima of the double slit interference pattern within the central maximum of single slit diffraction pattern?

30) The critical angle of incidence in a glass slab placed in air is 45°. What will be the critical angle when the glass slab is immersed in water of refractive index 1.33?

31) A slit width d is illuminated by white light. For what value of d is the first minimum, for red light of $\lambda = 650nm$, located at point P at 30° . For what value of the wavelength of light will the first diffraction maxima also fall at P?

32) Calculate the resolving power of a microscope if its numerical aperture is 0.12 and wavelength of light used is $6000\mathring{A}$.

33) Determine the critical angle for a glass air interface, if a ray of light, which is incident in air on the surface is deviated through 15°, when its angle of incidence is 40° .

34) A telescope is used to resolve two stars separated by $4.6\times{10}^{-6}$rad. If wavelength of light used is $5460\mathring{A}$, what should be the aperture of the objective of telescope?

35) Calculate the separation of two points on the moon that can be resolved using 600 cm telescope. Given distance of moon from earth=$3.8\times{10}^{10}$cm The wavelength most sensitive to eye is $5.5\times{10}^{-5}$cm

36) Calculate the critical angle for total internal reflection of light travelling from (i) water into air (ii) glass into water. Given, ${}^{a}{\mu}_{w}=1.33$ and ${}^{a}{\mu}_{g}=1.5$

37) A telescope has an objective of diameter 60 cm. The focal lengths of the objective and eyepiece are 2.0m and 1.0cm. respectively. The telescope is directed to view two distant almost point sources of light. The sources are roughly at the same distance along the line of sight, but separated transverse to the line of sight by a distance of ${10}^{10}$m Will the telescope resolve the two ?bjects.

38) A mark placed on the surface of a sphere is viewed through glass from a position directly opposite. If the diameter of the sphere is 10 cm and refractive index of glass is 1.5, Find the position of the image.

39) Calculate the resolving power of a microscope with cone angle of light falling on the objective equal to 60°.Take $\ \lambda =600nm \ and \ \mu \ for \ air=1$.

40) Light from a point source in air falls on a spherical glass of $\mu =1.5$ and R=0.2 m. The image is formed at a distance of 100 cm from the glass surface in the direction of incident light. Calculate the object distance from the centre of curvature of the spherical surface.

41) The diameter of the pupil of the human eye is about 2mm. The human eye is most sensitive to the wavelength 555nm. Find the limit of resolution of human eye.

42) A laser beam has a wavelength of $7\times { 10 }^{ -7 }$mand aperture ${ 10 }^{ -2 }$mThe beam is sent to moon, the distance of which from earth is $4\times { 10 }^{ 5 }$km Find the angular spread and areal spread of the beam when it reaches the moon.

43) Light from a point source in air falls on a spherical glass surface. If $\mu =1.5$, and radius of curvature=20 cm, the distance of light source from the glass surface is 100 cm ; at what position will the image be formed?

44) A biconvex lens has focal length $\frac { 2 }{ 3 }$ times the radius of curvature of either surface. Calculate refractive index of material of the lens.

45) A double convex lens made of glass of refractive index 1.56 has both radii of curvature of magnitude 20 cm. If an object is placed at a distance of 10 cm from this lens, find the position of image formed.

46) Find the radius of curvature of convex surface of a plano convex lens, whose focal length is 0.3m and $\mu =1.5$.

47) Earth is moving towards a fixed star with a velocity of 30km${ s }^{ -1 }$. An observer on earth observes a shift of $0.58\mathring { A }$ in wavelength of light coming from the star. What is the actual wavelength of light emitted by star?

48) A radar wave has a frequency of.$8.1\times { 10 }^{ 9 }$Hz The reflected wave from an airplane shows a frequency difference of $2.7\times { 10 }^{ 3 }$Hzon the higher side. Calculate the velocity of an airplane in the line of sight.

49) The spectral line for a given element in light received from a distant star is shifted towards the longer wavelength by 0.032%. Deduce the velocity of star in the line of sight.

50) With what speed should a galaxy move with respect to us so that the sodium line at 589.0 nm is observed at 589.6 nm?

51) At what angle θ above the horizon should the sun be situated so that its light reflected from the surface of the still water in a pond is completely polarized. Take $\mu =1.327 and \ \tan \ 53°=1.327$

52) Two Nichols are so oriented that the maximum amount of light is transmitted. To what fraction of its maximum value is the intensity of transmitted light reduced when the analyzer is rotated when the analyzer is rotated through (i)$30°$(ii) $60°$?

53) A magician during a show makes a glass lens $\mu =1.5$ disappear in a trough of liquid. What is the refractive index of the liquid? Is the liquid water?

54) The refractive index of a medium is $\sqrt{3}$. what is the angle of refraction, if the unpolarized light is incident on it at the polarizing angle of the medium.

55) The focal length of an equiconvex lens is equal to radius of curvature of either surface. What is the refractive index of the material of the prism?

56) At what distance should an object be placed from a convex lens of focal length 15 cm to obtain an image three times the size of the object?

57) An unpolarized beam of light is incident on a group of four polarizing sheets, which are arranged in such a way that the characteristic direction of each polarizing sheet makes an angle of with$30°$ that of the preceding sheet. What fraction of the incident is unpolarized light transmitted?

58) The image obtained with a convex lens is erect and its length is 4 times the length of the object. If the focal length of lens is 20 cm, calculate the object and image distances.

59) An illuminated object and a screen are placed 90 cm apart. What is the focal length and nature of the lens required to produce a clear image on the screen twice the size of the object?

60) A converging lens of focal length 50 cm is placed co-axially in contact with another lens of unknown focal length. If the combination behaves like a diverging lens of focal length 50 cm, find the power and nature of second lens.

61) The objective of an astronomical telescope has a diameter of 150mm and focal length of 4.0m. The eyepiece has a focal length of 25.0mm. Calculate the magnifying power and resolving power of the telescope. What is the distance between objective and eyepiece?
Take $\lambda =6000\mathring{A}$

62) Two lenses of power +15 D and -5 D are in contact with each other. What is the focal length of the combination? What would be the position of image formed by the combination for an object at 30 cm?

63) The refractive index of water is 4/3 and that of glass is 3/2. A beam of light enters glass from the water. For what angle of incidence will the reflected light be completely polarized?

64) A convex lens of focal length 10 cm is placed co-axially 5 cm away from a concave lens of focal length 10 cm. If an object is placed 30 cm in front of the convex lens, find the position of final

image formed by the combined system.

65) The critical angle between a given transparent medium and air is denoted by C. A ray of light in air enters this transparent medium at an angle of incidence equal to polarizing angle p. Deduce a relation for the angle of refraction in terms of C.

66) A concave lens is placed in contact with a convex lens of focal length 25 cm. The combination produces a real image at a distance of 80 cm, when an object is at a distance of 40 cm. What is the focal length of concave lens?

67) Two polaroids are placed at 90° to each other and the transmitted intensity is zero. What happens when one more polaroid is placed between these two bisecting the angle between them? What will be the direction of polarizing of the outcoming beam?

68) A real image of an object is formed at a distance of 20 cm from a lens. On putting another lens in contact with it, the image is shifted 10 cm towards the combination. Determine the power of the second lens.

69) The polarizing angle for a piece of glass for a piece glass for green light is 60°Find the angle of minimum deviation for green light for its passage through 60° prism, made of the same glass.

70) A convex lens of focal length 30 cm and a concave lens of focal length 60 cm are placed in combination. If an object is placed 40 cm away from the combination, find the position of the image.

71) A double convex lens of +5 D is made of glass of refractive index 1.5 with both faces of equal radii of curvature. Find the value of curvature.

72) A convex lens of focal length 25 cm is placed co-axially in contact with a concave lens of focal length 20 cm. Determine the power of the combination. Will the system be converging or diverging in nature?

73) An object is placed 15 cm in front of a convex lens of focal length 10 cm. Find the nature and position of image formed. Where should a concave mirror of radius of curvature 20 cm be placed so that the final image is formed on the position of the object itself?

74) The Radius of curvature of an equiconvex lens is 0.2 m. Its refractive index is 1.5. Calculate its focal length. If two such lenses are kept separated with common principal axis by a distance of 0.2 m, what will be the effective focal length of the combination?

75) A ray of light passing through an equilateral triangular glass prism from air undergoes minimum deviation when angle of incidence is \frac { 3 }{ 4 } th of the angle of prism. Calculate speed of light in prism

76) A ray of light incident on an equilateral triangular glass prism of $\mu =\sqrt{3}$ moves parallel to the base of the prism inside it. What is the angle of incidence for this ray?

77) The angle of minimum deviation for prism of angle $\pi /3$is $\pi /6$. Calculate the velocity of light in the material of the prism, if the velocity of light in vacuum is $3\times 10^{8} ms^{-1}$.

78) A ray of light passes through an equilateral prism (refractive index 1.5) such that angle of incidence is equal to angle of emergence and the latter is equal to 3/4th of the angle of prism. Calculate the angle of deviation.

79) A prism of refractive index 1.53 is placed in water of refractive index 1.33. If the angle of prism is 60°, calculate the angle of minimum deviation in water.

80) White light passed through a prism of 5° . If refractive indices for red and blue rays are 1.641 and 1.659 respectively, calculate the angular dispersion of the prism.

81) Calculate the dispersive power of crown and flint glass prisms from the following data : For crown glass, $\mu_{b}=1.522,\ \mu_{r}=1.514$. For crown glass, $\mu'_{b}=1.662,\ \mu'_{r}=1.644$

82) In a certain spectrum produced by a glass prism of dispersive power 0.031, it was found that $\mu_{r}=1.645$ and $\mu_{b}=1.665$. What is the refractive index for yellow colour?

83) A person wears glasses of power-2.5 D. Is the person short sighted or long sighted? What is the far point of the person without glasses?

84) The near point of a hypermetropic person is 50 cm from the eye. What is the power of the lens required to enable him to read clearly a book held at 25 cm from the eye?

85) The far point of a myopic person is 150 cm in front of the eye. Calculate the focal length and power of a lens required to enable him to see distant objects clearly.

86) A person wears eye glasses with a power of -5.5 D for distance viewing. His doctor prescribes a correction of +1.5 D for his near vision. What is the focal length of his distance viewing part of the lens and also for near vision section of the lens?

87) A hypermetropic person whose near point is at 100 cm wants to read a book at 25 cm. Find the nature and power of the lens needed.

88) A short sighted person can see objects most distinctly at a distance of 16 cm. If he wears spectacles at a distance of 1 cm from the eye, what focal length should he have so as to enable him to see distinctly at a distance of 26 cm?

89) A simple microscope is a combination of two lenses of powers + 15 D and +5 D in contact. Calculate magnifying power of microscope, if final image is formed at 25 cm from the eye.

90) A child has near point at 10 cm. What is the maximum angular magnification the child can have with a convex lens of focal length 10 cm?

91) The focal lengths of objective and eye piece of a microscope are 1.25 cm and 5 cm respectively. Find the position of the object relative to the objective in order to obtain an angular magnification of 30 in normal adjustment.

92) Monochromatic light of wavelength 589 nm is incident from air on a water surface. What are the wavelength, frequency, and speed of
(a) reflected and
(b) refracted light? Refractive index of water is 1.33 ?

93) A compound microscope with an objective of 1.0 cm focal length and an eye piece of 2.0 cm focal length has a tube length of 20 cm. Calculate the magnifying power of microscope if final image is formed at the near point of eye.

94) You are given two converging lenses of focal lengths 1.25 cm and 5 cm to design a compound microscope. If it is desired to have a magnification of 30, find out separation between the objective and eye piece.

95) A person uses +1.5 D glasses to have normal vision from 25 cm onwards. He uses a 20 D lens as a simple microscope to see an object. Calculate the maximum magnifying power, if he uses the microscope (a) together with his glasses (b) without the glasses.

96) (a) The refractive index of glass is 1.5. What is the speed of light in glass?
(b) Is the speed of light in glass independent of the color of light? If not, which of the two colors, red and violet travels slower in a glass prism?

97) A compound microscope has an objective of focal length 1 cm and an eye piece of focal length 2.5 cm. An object has to be placed at a distance of 1.2 cm away from the objective for normal adjustment. Find the angular magnification and length of the microscope tube.

98) The total magnification produced by a compound microscope is 20. The magnification produced by the eye piece is 5. The microscope is focussed on a certain object, The distance between the objective and eye piece is observed to be 14 cm. If least distance of distinct vision is 20 cm, calculate the focal length of objective and eye piece.

99) In Young's double slit experiment using the monochromatic light of wavelength,\lambda the intensity of light at a point on the screen where path difference is \lambda is K units. What is the intensity of light at a point where the path difference is \lambda /3?

100) An astronomical telescope consists of the thin lenses, 36 cm apart and has a magnifying power 8. Calculate the focal length of lenses. Two stars have an actual separation of one minute of arc. Find the angle of separation as seen through the telescope.

101) A small telescope has an objective lens of focal length 150 cm and an eye piece of focal length 5 cm. If his telescope is used to view a 100 m high tower 3 km away, find the height of the final image when it is formed 25 cm away from the eye piece.

102) A beam of light consisting of two wavelengths 650 nm and 520 nm, is used to obtain interference fringes in Young's double-slit experiment. (a) Find the distance of the third bright fringe on the screen from the central maximum for wavelength 650 nm.
(b) What is the least distance from the central maximum, where the bright fringes due to both the wavelengths coincide?

103) The diameter of the moon is $3.5\times 10^{3}\ km$ and its distance from the earth is $3.5\times 10^{5}\ km$. It is viewed by a telescope which consists of two lenses of focal lengths 4 m and 10 cm. Find the angle subtended at the eye by the final image.

104) An astronomical telescope has a magnifying power of 10. In normal adjustment, distance between the objective and eye piece is 22 cm. Calculate focal length of objective lens.

105) A telescope has an objective of focal length 30 cm and an eye piece of focal length 3.0 cm. It is focussed on a scale distant 2.0 m. For seeing with relaxed eye, calculate the separation between the objective and eye piece.

106) The refractive index of diamond is 2.47 and that of windows glass is 1.51. Find the ratio of speeds of light in glass and diamond.

107) The absolute refractive index of air is 1.0003 and wavelength of yellow light in vacuum is $6000\quad \overset{\circ}{A}$. Find the thickness of air column which will contain one more wavelength of yellow light than in the same thickness of vacuum.

108) A light wave has a frequency of $5\times 10^{14}\ Hz$. Find the difference in its wavelengths in alcohol of refractive index 1.35 and glass of refractive index 1.5.

109) Two plane monochromatic waves propagating in the same direction with amplitudes A and 2 A and differing in phase by $\pi/3$ superimpose. Calculate the amplitude of the resulting wave.

110) Two coherent monochromatic light beams of intensities I and 4 I are superposed. What will be in maximum and minimum possible intensities?

111) If the two slits in young's experiment have width ratio 1:4, deduce the ratio of intensity at maxima and minima in the interference pattern.

112) Find the ratio of intensities at the two points X and Y on a screen in Young's double slit experiment, where waves from the two sources S_{1} and S_{2} have path differences of zero and $\lambda/4$ respectively.

113) In Young's double slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path diff. is λ is K units. Find the intensity of light at a point where path difference is $\lambda/3$.

114) The ratio of intensities of minima to maxima in young's double slit experiment is 9:25. Find the ratio of width of two slits.

115) Laser light of wavelength 630 nm incident on a pair of slits produces an interference pattern in which the bright fringes are separated by 7.2 mm. Calculate the wavelength of another source of laser light which produce interference fringes separated by 8.1 mm using same pair of slits.

116) In Young's double slit experiment, the light has a frequency of $6\times 10^{14}\ Hzx = {-b \pm \sqrt{b^2-4ac} \over 2a}$ and the distance between the centres of adjacent fringes 0.75 nm. If the screen is 1.5 m away, what is the distance between the slits?

117) In Young's experiment, two slits are 0.2 mm apart. The interference fringes for light of wavelength $6000\ \overset{\circ}{A}$ are formed on a screen 80 cm away.
(a) How far is the second bright fringe from the central image?
(b) How far is the second dark fringe from the central fringe?

118) In Young's double slit experiment, the two slits 0.15 mm apart are illuminated by light of wavelength 450 nm. The screen is 1.0 m away from the slits. Find the distance of second bright fringe and second and second dark fringe from the central maximum. How will the fringe pattern change if the screen is moved away from the slits?

119) A beam of light consisting of two wavelengths 800 nm and 600 nm is used to obtain the interference fringes in YDSE on a screen held 1.4 m away. If the two slits are separated by 0.28 mm, calculate the last distance from the central bright maximum, where the bright fringes of the two wavelengths coincide.

120) In YDSE with monochromatic light, fringes are obtained on a screen placed at some distance D from slits. If the screen is moved 5×10^{-2}m towards the slits, the change in fringe width is 3×10^{-5}m. If the distance between the slits is 10^{-3}m, calculate the wavelength of light used.

121) In a Young's double slit experiment, λ=500nm, d=1.0mm and D=1.0m. Find the minimum distance from the central maximum for which the intensity is half of the maximum intensity.

122) Suppose while sitting in a parked car, you notice a jogger approaching towards you in the rear view mirror having R=2m. If the Jogger is running at a speed of 5m/s, how fast is the image of

Jogger moving. When the Jogger is (i) 39m (ii) 29m (iii) 19 m and (iv) 9 m away?

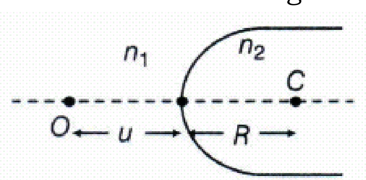
123) (i) State Huygens' principle.Using this principle,draw a diagram to show how a plane wavefront incident at the interference of the two media gets refracted when it propagates from a rarer to a denser medium. Hence,verify Snell's law of reflection.
(ii) Is the frequent of reflected and refracted light same as the frequency of incident light?

124) Use the mirror equation to deduce that,
The virtual image produced by a convax mirror is always diminished in size and is located between the focus and the pole.

125) An angular magnification (mafnifying power) of 30 is desired using an objective of focal length 1.25cm and an eyepiece of focal length 5cm. How will you set up the compound microscope?

126) Define magnifying power of a telescope. Write its expression. A small telscope has an objective lens of focal length 150cm and an eyepiece of focal length 5cm. If this telescope is used to view a 100m high tower 3Km away, find the height of the final image, when it is formed 25cm away from the eyepiece.

127) (i) A point object O is kept in amedium of refractive index n_1, in front of a convex spherical surface of radius of curvature R which separates the second medium of refractive index n_2 from the first one, as shown in the figure.
Draw the ray diagram showing the image formation and deduce the relationship between the object distance and the image distance in term of n_1, n_2 and R.



(ii) When the image formed above acts as a virtual object for a concave spherical surface separating the medium n_2 from $n_1(n_2 > n_1)$, draw this ray diagram and write the similar [similar to (i)] relation. Hence, obtain the expression for lens maker's formula.

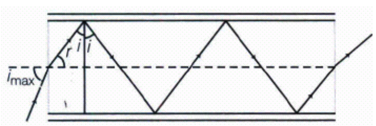
128) How is the working of telescope different from that of a microscope?
The focal lengths of the objective and eyepiece o a microscope are 1.25cm and 5 cm, respectively. Find the position of the object relative to the objective in order to obtain an angular magnification of 30 in normal adjustment.

129) Mr.Vishwanathan, a retired professor of physics was walking with his grandson. It was last week of December and it was drk aruond 5.30 pm. The streetlights were on and the yellow light flooded the area around. The boy asked professor why yellow lights were used when light was beighter. The professor answered that during foggy days the tiny droplets act as prisms splitting white light light into its constituwnt colours and thus reducing the clarity.
Read the above passage and give the answer of the following questions:
(i) What phenomenon was the professor referring to? Why does it happen?

(ii) Give one application of prism.
(iii) What values of the boy are being reflected from the conversation?

130) Kanchan while driving her scooty sees a woman behind driving a moped through his rear view mirror. She sees that her saree is almost touching the wheels of the vehicle. She stops her and alert that it may cause a severe accident.
Read the above passage and answer the folllowing questions:
(i) What values do you observe in Kanchan?
(ii) Name the mirror used in rear view in scooty. Draw a ray diagram for the same.

131) (i) Figure shows a cross-section of a light pipe made of a glass fiber of refractive index 1.68. The outer of refractive index 1.44. What is the range of the angles of the incident rays with the axis of the pipe for which total reflection inside the pipe take place as shown in the figure.



(ii) What is the answer, if there is no outer covering of the pipe?

132) Kritika's mom is finding difficult to cook in the kitchen as there was power-cut and she told the same to Kritika. She immediately took a plane mirror from her shelf made it stand against a wall such that sun rays were focussed into the Kitchen due to the reflection of the mirror. There was some lighting and her mother was able to finish her work.
Read the above passage and answer the following question:
(i) What are the values shown by Kritika?
(ii) Name the types of mirror used in periscope.
(iii) Give the nature of image in case of plane mirror.

133) One day, Chetan's mother developed a sever stomach ache all of a sudden. She immediately rushed to the doctor, who suggested for an immediate endoscopy test and gave an estimate of expenditure for the same. Chetan immediately contacted his class teacher and shared the information with her. The class teacher arranged the money and reached to the hospital. On realising that Chetan belonged to a below average incom group of family, even the doctor offered concession for the test fee.The test was conducted successfully.
Read the above passage and answer the following questions:
(i) Which principle of optics is used in endoscopy?
(ii) Briefly explain the values reflected in the action taken by the teacher.
(iii) In what way do you appreciate the response of the doctor on the given situations?

134) Answer the following questions.
(i) You have learnt that plane and convex mirrors produce virtual images of objects. Can they produce real images under some circumstances? Expalin.
(ii) A virtual image, we always say, cannot be caught on a screen. Yet when we see a virtual image, we are obviously bringing it on to the screen (i.e. the retina) of our eye. Is there a contradiction?
(iii) A diver under water, looks obliquely at a fisherman standing on the bank of a lake. Would the fisherman look taller or shorter to the diver than what he actually is?

(iv) Does the apparent depth of a tank of water change, if viewed obliquely? If so, does the apparent depth increase or decrease?

135) Ravi wanted to buy a gift for his sister and so he entered inside a gift shop. The gift shop had many glass items. On looking closely, he found many of the beverage glasses used for cold drinks had big thick glass walls. He decided not to buy these glasses because he knows that this gives a false impression that there is more amount of liquid inside the glass.
Read the above passage and answer the following questions:
(i) How does Ravi know about the false impression given by the beverage glasses made with very thick glass walls?
(ii) What values can you associate with Ravi decision?

136) A teacher has given three lenses of power 0.5D, 4D and 10D to a studet. He is not sure as to which lens should he use for constructing a good astronomical telescope. So, he consults his seniors and the teacher, and then constructs a telescope. Later, he shows this telescope to the junior classes and ex[plains about the choice of lenses.
Read the above passage and give the answer of the following questions:
(i) What values has he shown by doing these?
(ii) Which lenses are used as objective and which one as eyepiece?

137) In Young's double slit experiment, the slits are separated by 0.28 mm and the screen is placed 1.4 m away.The distance between the central bright fringe and the fourth bright fringe is measured to be 1.2 cm, determine the wavelength of light used in the experiment.

138) Jimmy and John were both creating a series of circular waves by catching the fish in water.The waves form a pattern similar to the diagram as shown.Their friend Anita advised Jimmy and John not to catch the fishes for a long time.She then not to catch the fishes for a long time.She then observed beautiful patterns of ripples which became colourful when her friend Lata poured oil drops on it.Lata, a 12th standard girl, then explained Anita the cause for colourful ripple patterns.

Read the above passage and answer the following questions:
(i) Identify any two values that could be related with Anita and Lata.
(ii) Define wavefront

139) Shyam's sister was watching coloured soap bubbles and was excited to know, why it happens? She asked her elder brother Shyam, who is preparing for engineering entrance examination.Shyam explained everything to his sister, why soap bubbles appear to be of different colour patterns.
Read the above passage and answer the following questions:
(i) What are the values displayed by the Shyam?

(ii) What do you mean by interference.

(iii) Give the condition for bright fringe in Young's double slit experiment.

140) A child is observing a thin film such as a layer of oil on water showing beautiful colours, when illuminated by white light. He feels happy and surprised to see this.His teacher explains him example of spreading of kerosene oil on water to prevent malaria and dengue.

Read the above passage and answer the following questions:

(i) What values are displayed by his teacher?

(ii) Name the phenomenon involved.

141) Ram and Rahim were returning home from the cricket field, on their way they found a new 500 rupee note on the road.Rahim advised Ram to handover the money to the cashier of the charity home. They did so and the cashier of the charity home. They did so and the cashier checked to see whether the currency was genuine or fake.He appreciated the boys and showed them how to check the currency. The number 500 at the centre of the note appears green when looked straight and blue when tilted at an angle. The cashier also explained that the colour shift on tilting is due to constructive interference of blue light produced by the variation of thickness of chemical layers specially added in the printing ink.

Read the above passage and answer the following questions:

(i) state one value each that you can identify from Rahim and cashier.

(ii) Draw the intensity distribution pattern of interference.

142) Ravi is using yellow light in a single slit diffraction experiment with slit width of 06. mm.The teacher replaces yellow light by X-ray.

Now, he is not able to observe the diffraction pattern, he feels sad. Again the teacher replaces X-rays with yellow light and the diffraction pattern appears again.The teacher now explains the facts about the diffraction.

Read the above passage and answer the following questions:

(i) What values are displayed by the teacher?

(ii) Give the necessary condition for the diffraction.

143) (i) Describe briefly how a diffraction pattern is obtained on a screen due to a single narrow slit illuminated by a monochromatic source of light. Hence, obtain the conditions for angular width of secondary minima.

(ii) Two wavelength of solution light of 590nm and 596nm are used in turn to study the diffraction taking place at a single slit of aperture 2\times { 10 }^{ -6 }m. The distance between the slit and the screen is 1.5m. Calculate the separation between the position of first maxima of the diffraction pattern obtained in the two cases.

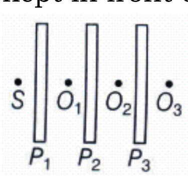
144) (i) Obtain the conditions for the bright and dark fringes in diffraction pattern due to a single narrow slit illuminated by a monochromatic source. Explain clearly, why the secondary maxima go on becoming weaker with increasing of their order?

(ii) When the width of the slit is made double, how would this affect the size and intensity of the central diffraction band? Justify your answer.

145) (i) In a double slit experiment using light of wavelength 600 nm, the angular width of the fringe formed on a distant screen is 0.1^o . Find the spacing between the two slits.
(ii) Light of wavelength $5000\dot{A}$ propagating in air gets partly reflected from the surface of water. How will the wavelengths and frequencies of the reflected and refracted light be affected?

146) Two independent monochromatic sources of light cannot produce a sustained interference pattern.Give reason.
Light waves each of amplitude a and frequency ω , emanating from two coherent light sources superpose at a point. If the displacements due to these waves is given by $y_1=a\cos\omega t$ and $y_2=a\cos(\omega t+\phi)$, where ϕ is the phase difference between the two, obtain the expression for the resultant intensity at the point.
In Young's double slit experiment, using monochromatic light of wavelength λ is K units.Find out the intensity of light at a point where path difference is $\lambda /3$

147) (i) Describe briefly how an unpolarised light gets linearly polarised, when it passes through a polaroid.
(ii) Three identical polaroid sheets ${P}_{1}$,${P}_{2}$and${P}_{3}$ are oriented, so that the pass axis of ${P}_{2}$and${P}_{3}$ are inclined at angles of ${60}^{\circ}$and${90}^{\circ}$ respectively with respect to the pass axis of ${P}_{1}$ A monochromatic source S of unpolarised light of intensity I is kept in front of the polaroid sheet ${P}_{1}$ as shown in the figure.



Determine the intensities of light as observed by the observers${O}_{1}$,${O}_{2}$and${O}_{3}$ as shown in the figure.

148) (i) How does one demonstrate, using a suitable diagram, that unpolarised light when passed through a polaroid gets polarised?
(ii) A beam of unpolarised light is incident on a glass-air interface. Show, using a suitable ray diagram, that light reflected from the interface is totally polarised, when $\mu =\tan{i}_{B}$ where μ is the refractive index of glass with respect to air and ${i}_{B}$ is the Brewster's angle.

149) Rahul was driving a car and suddenly became aware of a loud sound coming from behind. He looked through his rear-view and saw an ambulance.He recalled reading that such emergency vehicles often have their name written in the mirror writing.
He Quickly made way for the ambulance murmuring a quick prayer for the speedy recovery of the patient inside the ambulance
(a) What type of mirror is as a rear view mirror and why ?
(b) What Values did rahul exhibit ?

150) Ajay thought a virtual image, We always say, cannot be found on a screen. yet when we see a virtual image we are obvisously bringing it on the screen such as retina of our eye. How It can be possible? He had no answer.so he approached his friend vijay, Who explained him ts proper reason

(a) What we the values displayed by Vijay ?
(b) How did vijay explain ajay properly ? Describe briefly.

151) A glass window has been broken into tiny particles of glass in a robbery case. Some of these tiny particles are found at the scene of crime and some in the robbers clothing. If the police can prove that both particles found from both the places are similar, they have a stonge case. Being a responsible person Ganesh helped the police to prove such case.
(a) Which values are displayed by Ganesh in proving such case ?
(b) Which phenoemenon is responsible for proving such case ?
(c) How do you prove such case ?

152) Ravi goes to visit a museum. A special mirror is kying there. When he stands in front of the mirror he finds his image having a very small head, a fat body and legs of normail size. He becomes frightened and comes to his friens Shiva to konw the facts. Being a science student Shive explains the reason behind it.
(a) What values are shown by Shiva ?
(b) Name the Kinds of mirror.
(c) How do you explain such a thing proberly ?

153) (a) Write three characteristic features to distinguish between the interference fringes in Young's double slit experiment and the diffraction pattern obtained due to a narrow single slit.
(b) A parallel beam of light wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. it is observed that the first minimum is at distance of 2.5 mm away from the center. Find the width of the slit.

154) When puja, a student of 10th class, watched her mother washing clothes in the open, she observed coloured soap bubbles and was curious to know why the soap bubbles appear coloured. In the evening when her father, an engineer by profession, came home, she asked him this question.Her father explained to her basic phenomenon of physics due to which bubbles appear coloured.
(a) What according to you are the values are the displayed by puja and her father?
(b) State the phenomenon of light involved in the formation of coloured soap bubbles.

155) Amit's uncle was finding great difficulty in reading abook placed at normal position. He was not going to the doctor because he could not afford the cost.When amit came to know of it, he tool his uncle to the doctor, after throughhly checking his eyes, the doctor prescribed the proper lenses for him. Amit bought the spectacles he should now read with great ease, for this, he expressed his gratitude to his nephew. Based on the above paragraph. Answer the follwing :
(a) (i) Why does the least distance of distinct vision increase with age ?
(ii) What type of lens is required to correct this defect ?
(b) What, according to yoy, are the two values displayed by amit towards his uncle ?

156) The whole class was excited as they were on theirway to kavalur in Tamilnadu, an observatory, housing the largest telescope in India. The teacher was explaining the type of telescope, the diameter of the objective (2.34 m) and other details. The children were looking forward to see

through the telescope
(a) What type of telescope is the teacher referring to ?
(b) Mention any two advantages of this telescope.
(c) Why are such a field trips important ?

157) Nisha was working on a physics project. In This she has to construct a good astronomical telescope, while three lenses of power 0.5 D, 4 D, and 10 D are available for her project.She was not sure as to which lenses would she use for constucting such telescope.So she consulted her friend Rani for her problem. Rani explained details and significance of a telescope, which helped Nisha to a choose the lenses for her project.
(a) What are the values displayed by rani ?
(b) What do you understand by normal adjustment of a telescope ?
(c) Which lenses will be used as objective and which one as eyepieces from given above lenses ?

158) State Huygen's principle. Show, with the help of a suitable diagram, how the principle is used to obtain the diffraction pattern by a single slit.
Draw a plot of intensity distribution and explain clearly why the secondary maxima become weaker with increasing order (n) of the secondary maxima.

159) Anil is using yellow light in a single slit diffraction experiment with of 0.6 mm. When his friend replaced yellow light by X-rays then diffraction pattern is not visible.they became surprised and asked the teacher about such thing.The teacher replaces X-rays by yellow light and diffraction pattern appears again. The teacher explained all the facts about diffraction properly.
(a) What are the values noticed in both the students?
(b) Give the necessary condition for the diffraction?
(c) Why is diffraction pattern not visible by using X-rays in such case?

160) Two students are situated in a room 10 m high, they are separated by 7 m high partition wall. the students are unable to see each other even though they can converse easily. But they know that both light and sound waves can bend around the obstacles. So they were phenomena. Then they went to their friend Neelam who convinced them with basic facts.
(a) what are the values shown by Neelam?
(b) How did Neelam convince them such basic facts?

161) Draw a ray diagram to show the working of a compound microscope. Deduce an expression for the total magnification when the final image is formed at the near point.
In mpound microscope, an object is place at a distance of 1.5 cm from the objective of focal length 1.25 cm. If the eye piece has a focal length of 5 cm and the final image is formed at the near point, estimate the magnifying power of the microscope.

162) (a) Draw a labelled ray diagram of an astronomical telescope to show the image formation of a distant object. Write the main considerations required in selecting the objective and eyepiece lenses in order to have large magnifying power and high resolution of the telescope.
(b) A compound microscope has an objective of focal length 1.25 em and eyepiece of focal length 5

cm. A small object is kept at 2.5 cm from the objective. If the final image formed is at infinity, find the I distance between the objective and the eyepiece.

163) (a) Distinguish between linearly polarised and unpolarized light.
(b) Show that the light waves are transverse in nature.
(c)Why does light from a clear blue portion of the sky show a rise and fall of intensity when viewed through a Polaroid which is rotated? Explain by drawing the necessary diagram.

164) (a) How does an unpolarized light incident on a Polaroid get polarized? Describe briefly, with the help of a necessary diagram, the polarization of light by reflection from a transparent medium.
(b) Two polaroids 'A' and 'B' are kept in crossed position. How should a third Polaroid 'C' be placed between them so that the intensity of polarized light transmitted by Polaroid B reduces to $1/8^{th}$ of the intensity of unpolarized light incident on A?

165) During summer vacation Radha and Rani decided to go for a 3· FILM. They have heard about this film through their friends. They were asked to buy special glasses to view the film. Before they go for a movie, they approached their Physics teacher to know about these glasses. Physics teacher explained when two polarizer's are kept perpendicular to each other (crossed polarizer's), the left eye sees only the image from the left end of the projector and the right eye sees only the image from the right lens. The two images have the approximate perspectives that the left and right eyes would see in reality the brain combine the image to produce a realistic 3-D effect
(a) What qualities do these girls possess?
(b) What do you mean by polarization?
(c) Mention the other applications of polarization.

166) Draw a ray diagram showing the formation of the image by a point object on the principal axis of a spherical convex surface separating two media of refractive indices n_1 and n_2, when a point source is kept in rarer of refractive index n_1. Derive the relation between object and image distance in terms of refractive of the medium and radius of curvature of the surface. Hence obtain the expression for lens maker's formula in the case of thin convex lens.

167) (a) A point object is placed in front of a double convex lens (of refractive index n $=n_2/n_1$ with respect air) with its spherical faces of radii of curvature R_1 and R_2. Show the path of rays due to surface to obtain the formation of the real image of the object.
Hence obtain the lens maker's formula for a thin lens.
(b) A double convex lens having both faces of the same radius of curvature has refractive index 1.55. Find out the radius of curvature of the lens required to get the focal length of 20 cm.

168) (a) Draw a labelled ray diagram showing the image formation of a distant object by a refracting telescope.
Deduce the expression for its magnifying power when the final image is formed at infinity.
(b) The sum of focal lengths of the two lenses of the two lenses of a refracting telescope is 105 cm. The focal length of one lens is 20times that of the other. Determine the total magnification of the telescope when the final image is formed at infinity.

169) (a) Obtain Lens Maker's formula using the expression

$$\frac { { n }_{ 2 } }{ v } -\frac { { n }_{ 1 } }{ u } =\frac { \left({ n }_{ 2 }-{ n }_{ 1 } \right) }{ R }$$

Here the ray of light propagating from a rarer medium of refractive index (n_1)to a denser medium of refractive index (n_2) is incident on the convex side of spherical refracting surface of radius of curvature R.

(b) Draw a ray diagram t show the image formation by a concave mirror when the object is kept between its focus and the pole. Using this diagram, derive the magnification formula for the image formed.

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170) Define wavefront. Use Huygens' principle to verify the laws of refraction.

How is linearly polarised light obtained by the process of scattering of light? Find the Brewster angle for air-glass interface, when the refractive index of glass = 1.5.

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171) Define a wavefront. How is it different from a ray?

Depict the shape of a wavefront in each of the following cases.

Light diverging from point source.

Light emerging out of a convex lens when a point source is placed at its focus.

Using Huygen's construction of secondary wavelets, draw a diagram showing the passage of a plane wavefront from a denser into a rarer medium.

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172) State Huygens' principle. Using this principle draw a diagram to show how a plane wavefront incident at the interface of the two media gets refracted when it propagates from a rarer to a denser medium. Hence, verify Snell's law of refraction.

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173) A beam of light consisting of two wavelengths 560 nm and 420 nm is used to obtain interference fringes in a Young's double slit experiment.

Find the least distance from the central maximum, where the bright fringes, due to both the wavelengths coincide. The distance between the two slits is 4.0 mm and the screen is at a distance of 1.0 m from the slits.

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174) In Young's double slit experiment, monochromatic light of wavelength 630 nm illuminates the pair of slits and produces an interference pattern in which two consecutive bright fringes are separated by 8.1 mm.

Another source of monochromatic light produces the interference pattern in which the two consecutive bright fringes are separated by 7.2 mm. Find the wavelength of light from the second source. What is the effect on the interference fringes, is when monochromatic source is replaced by a source of white light?

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175) What is the effect on the interference fringes in a Young's double-slit experiment due to each of the following operations:

(a) the screen is moved away from the plane of the slits;

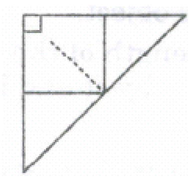
(b) the (monochromatic) source is replaced by another (monochromatic) source of shorter wavelength;

(c) the separation between the two slits is increased;

(d) the source slit is moved closer to the double-slit plane;

(e) the width of the source slit is increased;
(f) the monochromatic source is replaced by a source of white light?
(In each operation, take all parameters, other than the one specified, to remain unchanged.)

176) i) Plot a graph to show variation of the angle of deviation as a function of angle of incidence for light passing through a prism. Derive in expression for refractive index of the prism in terms of angle of minimum deviation and angle of the prism.
ii) What is dispersion of light? What is its cause?
(iii) A ray of light incident normally on one face of a right isosceles prism is totally reflected as shown in figure. What must be the minimum value of refractive index of glass? Give relevant calculations.



177) (i) A point object is placed in front of a double convex lens (or refractive index \mu =\frac { n_{ 2 } }{ n_{ 1 } } with respect to air) n1 with its spherical faces of radii of curvature and R2. Show the path of rays due to refraction at first and subsequently at the second surface to obtain the formation of the real image of the object. Hence, obtain the lens maker's formula for a thin lens.
(ii) A double convex lens having both faces of the same radius of curvature has refractive index 1.55 Find out the radius of curvature of the lens required to get the focal length of 20 cm

178) Distinguish between unpolarised light and linearly polarised light. How does one get linearly polarised light with the help of a polarised?
A narrow beam of unpolarised light of intensity I_0 is incident on a polaroid P_1. The light transmitted by it is then incident on a second polaroid P_2 with its pass axis making an angle of 60° relative to the pass axis of P_1 Find the intensity of the light transmitted by P_2.

179) Explain two features to distinguish between the interference pattern in Young's double slit experiment with the diffraction pattern obtained due to a single slit.
A monochromatic light of wavelength 500 nm is incident normally on a single slit of width 0.2 mm to produce a diffraction pattern. Find the angular width of the central maximum obtained on the screen, Estimate the number of fringes obtained in Young's double slit experiment with fringe width 0.5 mm, which can be accommodated within the region of total angular spread of the central maximum due to single slit.

180) (i) Draw a ray diagram for formation of image of a point object by a thin double convex lens having radii of curvatures R_1 and R_2 and hence, derive lens maker's formula. Define power of a lens and give its 81 unit. If a convex lens of length 50 cm is placed in contact coaxially with a concave lens of focal length 20 cm, what is the power of the combination?

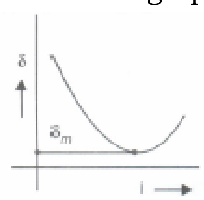
181) (i) Draw the ray diagram for the formation of image of an object by a convex mirror and use it (along with the sign convention) to derive the mirror formula.

(ii) Use the mirror formula to show that for an object kept between the pole and focus of a concave mirror the image appears to 'be formed behind the mirror

182) (i) Draw a labelled ray diagram to obtain the real image formed by an astronomical telescope in normal adjustment position. Define its magnifying power
(ii) You are given three lenses of power 0.5 D, 4 D and 10 D to design a telescope.
(a) Which lenses should be used as objective and eyepiece? Justify your answer.
(b) Why is the aperture of the objective preferred to be large?

183) Draw the labelled ray diagram for the formation of image by an astronomical telescope. Derive the expression for its magnifying power in normal adjustment. Write two basic features which can distinguish between a telescope and a compound microscope.

184) (a) The relation, between the angle of incidence (i) and the corresponding, angle of deviation (\delta), for a certain optical device, is represented by the graph shown in the figure. Identify this device.
Draw a ray diagram for this device and use it for obtaining an expression for the refractive index of the material of this device in terms of an angle characteristic of the device and the angle, marked as 8m' in the graph.



(b) Based on Huygen's contructuion, draw the shape of a plane wavefront as it gets refracted on passing through a convex lens.

185) (i) Derive the mathematical relation between refractive indices $n_1$and n_2 of two radii and radius of c curvature R for refraction at a convex spherical surface. Consider the object to be a point since lying on the principle axis in rarer medium of refractive index n1 and a virtual image formed in the rarer medium of refractive index n_1 Hence, derive lens maker's formula.

186) (i) A point object, 0 is on the principle axis of a spherical surface having a radius of curvature, R. Draw a diagram to obtain the relation between the object and image distances, the refractive indices of the media and the radius of curvature
of the spherical surface.

187) (a) State the conditions for total internal reflection to occur.
(b) A right angled prism of refractive index n has a plate of refractive index n_1 so that $n_1 < n$, cemented to its diagonal face. The assembly is in air. A ray is incident on AB.
(i) Calculate the angle of incidence at ABfor which the ray strikes the diagonal face at the critical angle.
(ii) Assuming n = 1.352, calculate the angle of incidence at AB for which the refracted ray passes through the diagonal face undeviated.

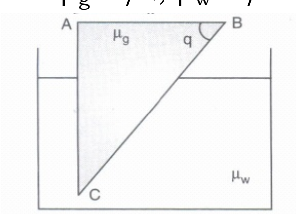
188) (i) Draw a diagram showing the 'Young's arrangement' for producing 'a sustained interference pattern'. Hence obtained the expression for the width of the interference fringes obtained in this pattern.
(ii) If the principal source point S were to be moved a little upwards, towards the slit SI from its usual symmetrical position, with respect to the two slits S_1 and S_2, discuss how the interference pattern, obtained on the screen, would get affected

189) (a) In Young's double slit experiment, describe briefly how bright and dark fringes are obtained on the screen kept in front of a double slit. Hence obtain the expression for the fringe width.
(b) The ratio of the intensities at minima to the maxima in the Young's double slit experiment is 9 : 25. Find the ratio of the width of the slits

190) Ravi is a student of mechanical engineering studying in one of the engineering colleges. The other day he saw an old man who suddenly collapsed as he walked out of the house in his neighbourhood. Ravi rushed towards him immediately made a call to the nearby hospital, asked for the ambulance and took him to the emergency ward of the hospital. On getting the medical aid, the old man soon got recovered. he did not forget to thank Ravi for the timely help he rendered. He was wondering that in his times to get the telephone connection, one had to wait for years whereas these days it takes no time to get the connection. Ravi told him it was all because of the technological progress/development due to which the simple phenomenon in physics could be easily used.
Answer the following questions based on the above:
(i) To which phenomenon in physics was Ravi referring to, which made the land line links so easily accessible?
(ii) What are the essential conditions required to observe this phenomenon?
(iii) Write two values displayed by Ravi and the old man in this episode.

191) While driving his car, Rahul suddenly heard loud sound coming from behind. He happed to look through his rear view mirror and saw that an ambulance is approaching. He recollect that mostly emergency vehicles have their names written
in mirror script. He quickly give the way for the ambulance. murmuring a prayer for fast recovery of patient who is inside the ambulance.
(a) What type of mirror is as a rear-view mirror and why?
(b) What values did Rahul exhibit?

192) (i) Calculate the value of θ, for which light incident normally on face AB grazes along the face BC. $\mu_g=3/2$, $\mu_w=4/3$



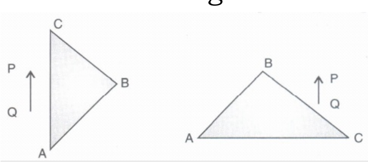
(ii) Draw a graph showing the variation of angle of deviation 'δ' with that of angle of incidence 'i' for a monochromatic ray of light passing through a glass prism of refracting angle 'A'. What do you interpret from the graph? Write a relation showing the dependence of angle of deviation on angle of

incidence and hence derive the
expression for refractive index of the prism.

193) School arrange an educational trip to Kavalur in Tamil Nadu where an observatory having Indias largest telescope. On hearing this, the whole class got excited and left for their way to kavalur. In the observatory, the physics teacher' was explaining about the type of telescope, with diameter of objective (2.34 m) and several other details. Everyone was ready to look through the telescope.
(i) What type of telescope is the teacher referring to?
(ii) Mention any two advantages of this telescope
(iii) Why are such a field trips important?

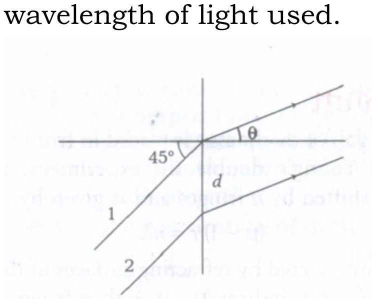
194) (a) Draw a ray diagram showing the image formation by a compound microscope. Obtain expression for total magnification when the image is formed at infinity.
(b) How does the resolving power of a compound microscope get affected, when
(i) focal length of the objective is decreased.
(ii) the wavelength of light is increased? Give reasons to justify your answer.

195) (i) Draw a ray diagram to show the formation of the real image of a point object due to a convex spherical refracting surface, when a ray of light is travelling from a rarer medium of refractive index μ_1 to a denser medium of refractive index μ_2, Hence derive the relation between object distance, image distance and radius of curvature of the spherical surface.
(ii) An object is placed in front of right angled prism ABC in two positions as shown. The prism is made of crown glass with critical angle of 42°. Trace the path of the two rays from P & Q.



196) What is the shape of the wavefront in each of the following cases:
(a) Light diverging from a point source.
(b) Light emerging out of a convex lens when a point source is placed at its focus.
(c) The portion of the wavefront of light from a distant star intercepted by the Earth.

197) Distance between the slits, in YDSE, shown in figure is d = 20 \lambda, where \lambda is the wavelength of light used.



Find the angle \theta, where
(i) central maxima (where path difference is zero) is obtained. .
(ii) third order maxima is obtained.

198) (i) What is the effect on the interference fringes to a Young's double slit experiment when
(a) the width of the source slit is increased?
(b) the monochromatic source is replaced by a source of white light? Justify your answer in each case.

199) Consider two coherent sources S_1 and S_2 producing monochromatic waves to produce Interference pattern.
Let the displacement of the wave produced by S_1 be given by $Y_{1}=a \cos \omega t$ and the displacement by $S_{2} \text { be } Y_{2}=a \cos (\omega t+\phi)$. Find out the expression for the amplitude of the resultant displacement at a point and show that the intensity at that point will be $I=4 a^{2} \cos ^{2} \frac{\phi}{2}$ Hence, establish the conditions for constructive and destructive interference.

200) (a) In Young's double slit experiment, deduce the conditions for obtaining constructive and destructive interference fringes. Hence deduce the expression for the fringe width.
(b) Show that the fringe pattern on the screen is actually a superposition of single slit diffraction from each slit.
(c) What should be the width of each slit to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern, for green light of wavelength 500 nm, if the separation between two slits is 1mm?

201) (a) What are coherent sources of light? Two slits in young's double slit experiment are illuminated by two different sodium lamps emitting light of the same wavelength. Why is no interference pattern observed?
(b) Obtain the conditions for getting dark and bright fringes in young's experiment. Hence write the expression for the fringe width.
(c) If s is the size of the source and d its distance from, the plane of the two slits. What should be the criterion for the interference fringes to be seen?

202) A monochromatic light of wavelength λ is incident normally on a narrow slit of width 'a' to produce a diffraction pattern on the screen placed at a distance D from the slit. With the help of a relevant diagram, deduce the conditions for obtaining maxima and minima on the screen. Use these conditions to show that angular width of central maximum is twice the angular width of secondary maximum.

203) (a) A monochromatic source of light of wavelength λ illuminates a narrow slit of width d to produce a diffraction pattern on the screen. Obtain the conditions when secondary wavelets originating from the slit interfere to produce maxima and minima on the screen.
(b) How would the diffraction pattern be affected when
(i) the width of the slit is decreased?
(ii) the monochromatic source of light is replaced by white light?

204) State the essential condition for diffraction of light to take place.
Use Huygen's principle to explain diffraction of light due to a narrow single slit and the formation of

a pattern of fringes obtained on the screen. Sketch the pattern of fringes formed due to diffraction at a single slit showing variation of intensity with angle θ.

205) Red colour of light of wavelength Ie is passed from two narrow slits which are distance d apart and interference pattern is obtained on the screen distance D apart from the plane of two slits. Then find the answer to following parts assuming that slit widths are equal to produce intensity I_0 from each slit.

(a) Intensity at a point on the screen, situated at a distance \frac{1}{4} \mathrm{th} of fringe separation from centre.

(b) Intensity in the screen, if the sources become incoherent by using two different lamps behind lamps S_1 and S_2

(c) Angular position of loth maxima, and the angular width of that fringe.

(d) Find the distance between 5th maxima and 3rd minima, at same side of central maxima.

(e) If the phase difference between the two waves reaching two slits from the source slit is (i) 5π and (ii) 2π, then what will be the colour of central fringe?

206) (a) In Young's double slit experiment, derive the condition for (i) constructive interference, and (ii) destructive interference at a point on the screen.

(b) A beam of light consisting of two wavelengths, 800 nm and 600 nm is used to obtain the interference fringes in a Young's double slit experiment on a screen placed 1.4 m away. If the two slits are separated by 0.28 mm, calculate the least distance from the central bright maximum where the bright fringes of the two wavelengths coincide.

207) What is meant by a linearly polarised light? Which type of waves can be polarised? Briefly explain a method for producing polarised light.

Two polaroids are placed at 90° to each other and the intensity of transmitted light is zero. What will be the intensity of transmitted light when one more polaroid is placed between these two bisecting the angle between them? Take intensity of unpolarised light as I_0

208) (a) Define a wavefront. Using Huygens' principle, verify the laws of reflection at a plane surface.

(b) In a single slit diffraction experiment, the width of the slit is made double the original width. How does this affect the size and intensity of the central diffraction band? Explain.

(c) When a tiny circular obstacle is placed in the path of light from a distant source, a bright spot is seen at the centre of the obstacle. Explain why.

****

208 x 5 = 1040

1)

(a) The size of central diffraction band reduces by half according to the relation: size λ /d. Intensity increases four fold.
(b) The intensity of interference fringes in a double slit arrangement is modulated by different pattern of each slit.
(c) Waves diffracted from the edge of the circular obstacle interface constructive at the centre of the shadow producing a bright spot.
(d) For diffraction the size of the obstacle should be comparable to wavelength. If the size of the obstacle is much too large compared to wavelength, diffraction is by small angle. Here the size partition of wall is of the order of a few meters. The wavelength of light is about $5\times{ 10 }^{ -7 }$ m, while sound waves of say I kHz frequency have wavelength of about 0.3 m.Thus sound waves can bend around the partition while light waves cannot.
(e) Typical sizes of apertures involved in ordinary optical instruments are much larger the wavelength.

2) Distance between the towers, d = 40 km
Height of the line joining the hills, d = 50 m.
Thus, the radial spread of the radio waves should not exceed 50 km.
Since the hill is located halfway between the towers, Fresnel’s distance can be obtained as:
$Z_P = 20$ km $= 2 \times 10^4$ m
Aperture can be taken as:
a = d = 50 m
Fresnel’s distance is given by the relation,
$Z_{p}=\frac{a^{2}}{\lambda}$
Where,
λ = Wavelength of radio waves
$\therefore \lambda=\frac{a^{2}}{Z_{p}}$
$=\frac{(50)^{2}}{2 \times 10^{4}}=-1250 \times 10^{-4}=0.1250 \mathrm{~m}=12.5 \mathrm{~cm}$
Therefore, the wavelength of the radio waves is 12.5 cm.

3)

Interference of Light. The phenomenon of redistribution of energy in a medium due to superimposition of waves from two coherent source of light is called Interference of Light. **Constructive Interference.** At points, where the crest of one wave falls the crest of the other or a through of one falls on the through of the other, the amplitude of the resulting wave becomes maximum. Hence the energy or the intensity of light at such points becomes maximum. This is called **Constructive Interference.** **Destructive Interference.** At some other points where the through of one falls on the crest of the other or crest of one falls on the through of the other, the amplitude of the resulting waves becomes minimum. Hence the energy or intensity becomes minimum. This is called Destructive Interference. Law of conservation of energy is obeyed. It should be clearly understood that in interference of light no light energy is destroyed. The loss of energy at the points of destructive interference appears as the increase of energy at the points of constructive interference.

4)

Sustained interference. The interference in which the position of maxima and minima of light remains fixed all along the screen is called sustained interference.

Conditions for sustained interference. To produce sustained (or stationary) interference following conditions should be fulfilled:

1. Two sources must be coherent, so the sources emit continues waves of the same phase or constant phase difference.

2. The waves should be preferably of the same amplitude to get complete darkness in case of destructive interference.

3. Two sources must be very close to each other, if it is not so, the path difference at particular point of observation will be large and the maximas will be very close to each other and may overlap.

$(\because \beta \propto \frac{1}{(distance \ between \ the \ sources)})$

4. Two sources must be very narrow, a broad source of light is equivalent to a large number of narrow sources and each set of two sources will give its own interference pattern and their overlap will result in general illumination.

5. The distance between two sources and the screen should be large, so that the dark and bright fringes are of large width $[\because \ \beta \ \propto \ D \ (distance \ between \ two \ sources \ and \ screen)]$

5) **Differences between interference and diffraction**

Interference	**Diffraction**
1. Interference takes place when light from two different wavefronts coming from two coherent sources superimpose on each other.	1. Diffraction is due to superposition of secondary wavelets from various points on the same wave-front.
2. Bright fringes are of the same intensity.	2. Intensity of secondary maximas goes on decreasing.
3. Fringes are equispaced	3. Fringes are not equispaced.
4. Intensity of light is zero at minima.	4. Intensity of light at minima is not zero.

6)

Let μ be refractive index of the transparent surface. If ${i}_{p}$ is polarising angle r is the angle of refraction as shown in Fig. then from Snell law, we have

$\mu =\frac{\sin{{i}_{p}}}{\sin{{r}}}$ ....(1)

From Breester' law, we have

$\mu =\tan{{i}_{p}} =\frac{\sin{{i}_{p}}}{\sin{{i}_{p}}}$ ....(2)

From Eqs. (1) (2), we have

$\frac{\sin{{i}_{p}}}{\sin{r}} =\frac{\sin{{i}_{p}}}{{\cos{{i}_{p}}}}$

or $\ \sin{r} =\cos{{i}_{p}}$

or $\ \sin{r} =\sin{({90}^{\circ}-{i}_{p})}$

or $\ r ={90}^{\circ}-{i}_{p}$

or $\ {i}_{p}+r={90}^{\circ}$

i.e. the reflected and refracted beams of light at polarising angle are perpendicular to each other.

7)

We want a $\theta=\lambda, \theta=\frac{\lambda}{a}$

$10 \frac{\lambda}{d}=2 \frac{\lambda}{a}$ $a=\frac{d}{5}=0.2 \mathrm{~mm}$

Notice that the wavelength of light and distance of the screen do not enter in the calculation of a.

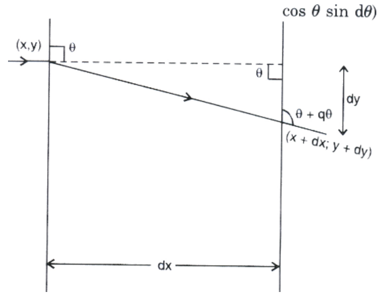
8)

Here ray of light at (x, y) enters at 90°. consider a portion of the ray between x and x+dx inside the liquid. the ray deviates at an angle d\theta between x and x+dx. emerging at (x+dx, y+dy) at an angle \theta +d\theta while entering at \theta , at height ay and y + dy. from snell's law

\mu (y) \ sin \ \theta \ = \ \mu (y+dy) \ sin \ (\theta +d\theta)

or\ \mu (y) \ sin\ = \ \left(\mu (y)+\frac { d\mu }{ dy } dy \right) (sin \ \theta \ cos \ d\theta +cos \ \theta \ sin \ d\theta)

$\cos \theta \sin d\theta)$



As d\theta is small, cos d\theta = 1 and sin d\theta = d\theta

\therefore \mu (y) \ sin \ \theta \ = \mu (y) \ sin \ \theta + \ \mu (y) \ cos \ \theta \ d\theta +\frac { d\mu }{ dy } dy \ sin \ \theta

(the fourth term is negligibly small hence neglected)

or \ \mu (y) \ cos \ \theta d\theta \ =-\frac { d\mu }{ dy } dy \ sin \ \theta

o d\theta \ =-\frac { 1 }{ \mu } \frac { d\mu }{ dy } dy \ tan \ \theta

but from the figure, we find tan \ \theta =\frac { dx }{ dy }

\Rightarrow \ dy \ tan \ \theta =dx

sod\theta =-\frac { 1 }{ \mu } \frac { d\mu }{ dy } dx

or\theta =-\frac { 1 }{ \mu } \frac { d\mu }{ dy } \int _{ 0 }^{ d }{ dx } =-\frac { 1 }{ \mu } \frac { d\mu }{ dy } (d)

This is the deviation in travelling a horizontal distance d.

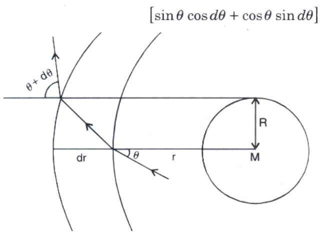
9)

Let the light be incident at the angle \theta at the plane at r and leave r+dr at an angle \theta +d\theta

From snell's law

n(r)sin \ \theta \ = \ n(r+dr) \ sin(\theta +d\theta)

=\left[n(r)+\frac { dn }{ dr } dr \right] \ \left[sin\theta \ cos \ d\theta +cos\theta \ sind\theta \right]



As d\theta is small, so cos \ d\theta = \ 1 and sind\theta =d\theta and neglecting the product of differentiates, we get

n(r)sin \ \theta \ = \ n(r) \ sin\theta +n(r) \ cos \ d\theta +\frac { dn }{ dr } dr \ sin\theta

-\frac { dn }{ dr } dr \ sin\theta \ = \ n(r)cos\theta \ d\theta

-\frac { dn }{ dr } dr \ tan\theta \ = \ n(r)\frac { d\theta }{ dr }

As n(r) \ =\ 1+\frac { 2GM }{ { rc }^{ 2 } }

\\ \therefore \frac { dn }{ dr } \ = \ \frac { -2GM }{ { r }^{ 2 }{ c }^{ 2 } }

Putting in eq, we get

\frac { -2GM }{ { r }^{ 2 }{ c }^{ 2 } } tan\theta \ = \ \left(1+\frac { 2GM }{ { rc }^{ 2 } } \right) \frac { d\theta }{ dr } =\frac { d\theta }{ dr }

or d\theta \ =\ \frac { 2GM }{ { c }^{ 2 } } \frac { tan\theta }{ { r }^{ 2 } } dr

Integrating both sides, we get

\int _{ 0 }^{ { \theta }_{ 0 } }{ d\theta } \ = \ \frac { 2GM }{ { c }^{ 2 } } \int _{ -\infty }^{ \infty }{ \frac { tan\theta \ dr }{ { r }^{ 2 } } }

=\frac { 2GM }{ { c }^{ 2 } } \int _{ -\infty }^{ \infty }{ \frac { tan\theta \ dr }{ { r }^{ 3 } } } .r

As \ { r }^{ 2 }={ x }^{ 2 }+{ R }^{ 2 } \ and \ tan\theta =\frac { R }{ X } ,\ we \ get

2r \ dr=2xdx

\therefore \int _{ 0 }^{ { \theta }_{ 0 } }{ d\theta } =\frac { 2GM }{ { c }^{ 2 } } \int _{ -\infty }^{ \infty }{ \frac { R }{ x } \frac { x\quad dx }{ ({ { X }^{ 2 }+{ R }^{ 2 } })^{ 3/2 } } }

let\ x=R \ tan \ \phi

\therefore dx=R\quad { sec }^{ 2 }\phi \ d\phi

\therefore{ \theta }_{ 0 }=\frac { 2GMR }{ { c }^{ 2 } } \int _{ -\pi /2 }^{ \pi /2 }{ \frac { R{ sec }^{ 2 }\phi \ d\phi }{ { R }^{ 3 }{ sec }^{ 3 }\phi } }

=\frac { 2GMR }{ { c }^{ 2 } } \int _{ -\pi /2 }^{ \pi /2 }{ cos\phi \quad d\phi } =\frac { 4GM }{ { Rc }^{ 2 } }

---

10) As the material is of refractive index-1. { \theta }_{ 2 } is negative and { \theta ' }_{ 2 } is positive

Now \left| { \theta }_{ i } \right| =\left| { \theta }_{ r } \right| =\left| { \theta ' }_{ r } \right|

The total deviation of the out coming ray from the incoming ray is { 4\theta }_{ i }

The ray shall not reach the receiving plate if

\frac { \pi }{ 2 } \le { 4\theta }_{ i }\le \frac { 3\pi }{ 2 }

(Angles measured clockwise from the y-axis)

or \ \frac { \pi }{ 8 } \le { \theta }_{ i }\le \frac { 3\pi }{ 8 }

From the figure

sin{ \theta }_{ i }=\frac { \pi }{ R }

\therefore \frac { \pi }{ 8 } \le { sin }^{ -1 }\frac { \pi }{ R } \le \frac { 3\pi }{ 8 }

orfrac { \pi }{ 8 } \le \frac { \pi }{ R } \le \frac { 3\pi }{ 8 }

Thus for \frac { R\pi }{ 8 } \le x\le \frac { 3R\pi }{ 8 } light emitted from the source shall not reach the receiving plate

---

11)

(i) The time elapsed to travel from S to $\{ P \}_{ 1 }$

$i_{ 1 }=\frac { { SP }_{ 1 } }{ C } =\frac { \sqrt { { u }^{ 2 }+{ b }^{ 2 } } }{ c }$

$or \ \frac { u }{ c } \left(1+\frac { 1 }{ 2 } \frac { { b }^{ 2 } }{ { u }^{ 2 } } \right) \ assuming \ b< < { u }_{ o }$

Time required to travel from $\{ p \}_{ 1 }$ to O is

$t_{ 2 }=\frac { { p }_{ 1 }o }{ c } =\frac { \sqrt { { v }^{ 2 }+{ b }^{ 2 } } }{ c } =\frac { v }{ c } \left(1+\frac { 1 }{ 2 } \frac { { b }^{ 2 } }{ { v }^{ 2 } } \right)$

Time required to travel through the lens is

$t_{ 1 }=\frac { { \left(n-1 \right) \omega (b) } }{ c }$

where n is the refractive index

Thus, the total time is

$t=\frac { { 1 } }{ c } u+v+\frac { 1 }{ 2 } { b }^{ 2 }\left(\frac { 1 }{ u } +\frac { 1 }{ v } \right) +(n-1)w(b)$

$put\ \frac { 1 }{ D } =\frac { 1 }{ u } +\frac { 1 }{ v }$

Then, $t=\frac { { 1 } }{ c } \left(u+v+\frac { 1 }{ 2 } \frac { { b }^{ 2 } }{ D } +(n-1)\left({ \omega }_{ 0 }+\frac { { b }^{ 2 } }{ \alpha } \right) \right)$

Fermat's principle gives the time taken should be minimum

For that first derivative should be zero.

$\frac { dt }{ db } =0=\frac { b }{ CD } -\frac { 2(n-1)b }{ c\alpha }$

$\\ \ \alpha \ =\ 2(n-1)D$

Thus, a convergent lens is formed if $\alpha \ =\ 2(n-1)D$

This is independent of and hence, all paraxial rays from S will converge at O i.e., for rays and (b<

since,$\ \frac { 1 }{ D } =\frac { 1 }{ u } +\frac { 1 }{ v } ,\quad$ the focal length is D

(ii) In this case, differentiating the expression of time taken t w,r,t,b.

$t=\frac { 1 }{ c } \left(u+v+\frac { 1 }{ 2 } \frac { { b }^{ 2 } }{ D } +(n-1){ k }_{ 1 }In\left(\frac { { k }_{ 2 } }{ b } \right) \right)$

$\frac { dt }{ db } =0=\frac { b }{ D } -(n-1)\frac { { k }_{ 2 } }{ b }$

${ b }^{ 2 }=(n-1){ k }_{ 1 }D$

$\therefore \quad b=\sqrt { (n-1){ k }_{ 1 }D }$

Thus, all rays passing at a height b shall contribute to the image. The ray paths make an angle

$\beta =\frac { b }{ v } =\sqrt { \frac { (n-1){ k }D }{ { v }^{ 2 } } }$

$={ \left[\frac { (n-1) \ { k }_{ 1 }uv }{ { v }^{ 2 }(u+v) } \right] }^{ 1/2 }$

i.e., $\beta ={ \left[\frac { (n-1)ku }{ (u+v)\theta } \right] }^{ 1/2 }$

---

12)

$m=-100$, $f_0+f_e=101cm$, $f_0=?$, $f_e=?$

$m=-{f_0\over f_e}=-100\ \ \therefore f_0=100 f_3$

Now $f_0+f_e=101$

$100 f_e+f_e=101$,

$f_e=$**1cm**,

$f_0=100 f_e=100cm$

---

13) Here $m=-50$, $L= 102cm$

As $m=-{f_0\over f_e}=-50, f_0=50f_e$

Also, $L = f_0 + f_e= 102$;

$50f_0 + f_e= 102$, $f_e = 2$ cm

$f_0 = 50 f_e= 50 \times 2= 100$ cm

$P_o={100\over f_0}={100\over100}=1D$,

$P_e={100\over f_e}={100\over2}=50D$

14) here, $f_0=1$ m=100cm, $f_e=20$cm.

If h_1=size of image formed by objective lens and

h_2=size of image formed by eye piece

$tan\alpha={h_1\over f_0}={h_1\over 100}$

$m_e={h_2\over h_1}=1+{d\over f_e}$

${10\over h_1}=1+{24\over14}={44\over20}\ \ h_1={200\over44}={50\over11}cm$

$\alpha\simeq tan\ \alpha ={h_1\over100}={50\over1100}={1\over22}rad$

= 0.0455 rad

15) Here, $\lambda =5000\quad \overset { \circ }{ A } =5\times 10^{ -7 }m$

$v=\frac { c }{ \lambda } =\frac { 3\times 10^{ 8 } }{ 5\times 10^{ -7 } } =6\times 10^{ 14 }$ hertz

On reflection, there is no change in wavelength or frequency. Therefore,

$\lambda '=\lambda =5000\quad \overset { \circ }{ A } \quad ;\quad v'=v=6\times 10^{ 14 }Hz.$

For reflected ray to be normal to incident ray,

$i+r=90^\circ$ or $i+i=90^\circ$ $(\because r=i)$

$\therefore$ $i=90/2=45^\circ$

16)

Here,

$u_{ 1 }=-60\ cm,\ m_{ 1 }=\frac { 1 }{ 2 }$

$u_{ 2 }=?,\ m_{ 2 }=\frac { 1 }{ 3 }$

As $m_{ 1 }=-\frac { \upsilon _{ 1 } }{ u_{ 1 } } \therefore \frac { 1 }{ 2 } =-\frac { \upsilon _{ 1 } }{ -(-60) } ,\upsilon _{ 1 }=30\quad cm$

From $\frac { 1 }{ f } =\frac { 1 }{ \upsilon _{ 1 } } +\frac { 1 }{ u_{ 1 } } =\frac { 1 }{ 30 } -\frac { 1 }{ 60 } =\frac { 1 }{ 60 }$

$f=60\ cm$

Again, $m_{ 2 }=-\frac { \upsilon _{ 2 } }{ u_{ 2 } } =\frac { 1 }{ 3 } ,\ \upsilon _{ 2 }=-\frac { u_{ 2 } }{ 3 }$

From

$\frac { 1 }{ \upsilon _{ 2 } } +\frac { 1 }{ u_{ 2 } } =\frac { 1 }{ f }$

$\frac { 1 }{ u_{ 2 } } =\frac { 1 }{ f } -\frac { 1 }{ \upsilon _{ 2 } } =\frac { 1 }{ 60 } +\frac { 3 }{ u_{ 2 } }$

or $\frac { 1 }{ u_{ 2 } } -\frac { 3 }{ u_{ 2 } } =\frac { 1 }{ 60 } ,\ u_{ 2 }=-120 \ cm$

17) Here,

$h_{ 1 }=5 \ cm, \ u=-10 \ cm$

$f=40 \ cm$

From

$\frac { 1 }{ \upsilon } =\frac { 1 }{ f } -\frac { 1 }{ u } =\frac { 1 }{ 40 } -\frac { 1 }{ -10 } =\frac { 5 }{ 40 } =\frac { 1 }{ 8 }$

$\upsilon =8\ cm$

Image is virtual, erect and is formed 8 cm behind the mirror.

Magnification,

$m=\frac { h_{ 2 } }{ h_{ 1 } } =\frac { -\upsilon }{ u } =\frac { -8 }{ -10 } =\frac { 4 }{ 5 }$

$h_{ 2 }=\frac { 4 }{ 5 } h_{ 1 }=\frac { 4 }{ 5 } \times 5=4\ cm$

As needle is moved farther away from the mirror, image shifts towards the focus and its size goes on decreasing.

18)

As the image of the object has the same orientation as the object, the image must be virtual, and on the opposite side of the object.

Now, $m=\frac { h_{ 2 } }{ h_{ 1 } } =-\frac { \upsilon }{ u } =0.2$

$\therefore \quad \upsilon =-0.2\quad u$

From $\frac { 1 }{ f } =\frac { 1 }{ \upsilon } +\frac { 1 }{ u } \ ; \ \frac { 1 }{ f } =\frac { 1 }{ -0.2u } +\frac { 1 }{ u } =-\frac { -4 }{ u }$

$f=-\frac { u }{ 4 }$. As u is negative, f must be positive, i.e., f=+40 cm. The mirror must be convex.

19)

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

$\alpha =2\times { 10 }^{ -3 }m$

$Fresnel \ Distance,\ { Z }_{ F }=\frac { { a }^{ 2 } }{ \lambda } =\frac { { \left(2\times { 10 }^{ -3 } \right) }^{ 2 } }{ 5\times { 10 }^{ -7 } }$

20) Here, $\ \lambda =5000\mathring { A } =5\times { 10 }^{ -7 }m,$

$d=?,\ n=1, \ \theta =30°$

$For\ maxima \ of \ diffraction$

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

$d=\frac { (2n+1)\lambda }{ 2sin\theta } =\frac { 3\times 5\times { 10 }^{ -7 } }{ 2sin30° } =1.5\times { 10 }^{ -6 }m$

21) Here, $\ \lambda =600nm=6\times { 10 }^{ -7 }m,$

$D=1.2m,\ n=1,\ x=3mm=3\times { 10 }^{ -3 }m,\ a=?\$

$For \ first \ minimum, \ a \ sin\theta =n\lambda$

$a.\left(\frac { x }{ D } \right) =1\lambda$

$\\ a=\frac { \lambda D }{ x } =\frac { 6\times { 10 }^{ -7 }\times 1.2 }{ 3\times { 10 }^{ -3 } } =2.4\times { 10 }^{ -4 }m=0.24mm$

22) Here, distance of the screen from the slit, D=2m,

$a=?, x=5mm=5\times { 10 }^{ -3 }m,$

$\lambda =5000\mathring { A } =5000\times { 10 }^{ -10 }m$

$For \ the \ first \ secondary \ minima,$

$sin\theta =\frac { \lambda }{ a } =\frac { x }{ D }$

$a=\frac { D\lambda }{ x } =\frac { 2\times 5000\times { 10 }^{ -10 } }{ 5\times { 10 }^{ -3 } } =2\times { 10 }^{ -4 }m$

23) Here, $\lambda =6000\quad \overset { \circ }{ A } =6\times 10^{ -7 }\ m$,

$\mu =1.5, \ \lambda '=?,\ v'=?$

$\lambda '=\frac { \lambda }{ \mu } =\frac { 6000 }{ 1.5 } =4000 \ \overset { \circ }{ A }$

$v'=v=\frac { c }{ \lambda } =\frac { 3\times 10^{ 8 } }{ 6\times 10^{ -7 } } =5\times 10^{ 14 }Hz$

24) Here,

$\mu _{ g }=1.5,\quad \upsilon _{ g }=?\mu _{ w }=1.3,$

$\upsilon _{ w }=2.25\times 10^{ 8 } \ m/s$

As $\frac { \upsilon _{ g } }{ \upsilon _{ w } } =\frac { \mu _{ w } }{ \mu _{ g } } =\frac { 1.3 }{ 1.5 }$

$\therefore \upsilon _{ g }=\frac { 1.3 }{ 1.5 } \upsilon _{ w }=\frac { 1.3\times 2.25\times 10^{ 8 } }{ 1.5 }$

$=1.95\times 10^{ 8 }m/s$

25) Here,

${ \lambda }_{ 1 }=5890\mathring { A } =5890\times { 10 }^{ -10 }m$

$a=2\mu m=2\times { 10 }^{ -6 }m$

${ \lambda }_{ 2 }=5896\mathring { A } =5896\times { 10 }^{ -10 }m,D=2m$

$For \ the \ first \ secondary \ maxima,$

$sin\theta =\frac { 3{ \lambda }_{ 1 } }{ 2a } =\frac { { x }_{ 1 } }{ D }$

$or \ { x }_{ 1 }=\frac { 3{ \lambda }_{ 1 }D }{ 2a }$ and $\ { x }_{ 2 }=\frac { 3{ \lambda }_{ 2 }D }{ 2a }$

Spacing between the first secondary maxima of two sodium lines

$={ x }_{ 2 }-{ x }_{ 1 }=\frac { 3D }{ 2a } ({ \lambda }_{ 2 }-{ \lambda }_{ 1 })$

$=\frac { 3\times 2(5896-5890)\times { 10 }^{ -10 } }{ 2\times 2\times { 10 }^{ -6 } } =9\times { 10 }^{ -4 }m$

26) Here, $i_{ 1 }=45°, \ t=10 \ cm=0.1 \ m$

$\mu =1.5$, lateral shift=?

As $\mu =\frac { sin \ i_{ 1 } }{ sin \ r_{ 1 } }$

$\therefore sin \ r_{ 1 }=\frac { sin \ i_{ 1 } }{ \mu } =\frac { sin \ 45° }{ 1.5 } =\frac { 0.707 }{ 1.5 } =0.4713$

$r_{ 1 }=sin^{ -1 }(0.4713)=28.14°$

lateral shift$=\frac { t \ sin(i_{ 1 }-r_{ 1 }) }{ cos \ r_{ 1 } }$

$=\frac { 0.1 \ sin \ (45°-28.14°) }{ cos \ 28.14° }$

$=\frac { 0.1 \ sin \ 16.86° }{ cos\quad 28.14° } =\frac { 0.1\times 0.2900 }{ 0.8818 } =0.033 \ m$

27) Here,

$^{ a }{ \mu }_{ w }=\frac { 4 }{ 3 } ,\ ^{ a }{ \mu }_{ g }=\frac { 3 }{ 2 }$

$^{ w }{ \mu }_{ g }=\frac { ^{ a }{ \mu }_{ g } }{ ^{ a }{ \mu }_{ w } } =\frac { 3/2 }{ 4/3 } =\frac { 9 }{ 8 }$

Angle of incidence in water, $i=30°$, $r=?$

$\frac { sin\quad i }{ sin\quad r } =^{ w }{ \mu }_{ g }=\frac { 9 }{ 8 }$

$sin\quad r=\frac { 8 }{ 9 } sin\quad i=\frac { 8 }{ 9 } sin30°=\frac { 8 }{ 9 } \times \frac { 1 }{ 2 }$

$sin \ r=0.4444$

$r=sin^{ -1 }0.4444=26.38°$

28) Here,\quad { \lambda }_{ r }=660nm;\lambda '=?

For \ diffraction \ minima,

a \ sin\theta =n\lambda , \ sin\theta =\frac { n\lambda }{ a }

For \ first \ minima \ of \ red \ light, \ sin\theta =\frac { 1{ \lambda }_{ r } }{ a }

For \ diffraction \ maxima,\ asin\theta =(2n+1)\frac { \lambda }{ 2 }

for \ first \ maxima \ of \ \lambda ',

a \ sin\theta '=\frac { 3\lambda ' }{ 2 } ; \ sin\theta '=\frac { 3\lambda ' }{ 2a } ;

As \ the \ two \ coincide, \ therefore, \ sin\theta '=sin\theta

\\ \frac { 3\lambda ' }{ 2a } =\frac { { \lambda }_{ r } }{ a } or\lambda '=\frac { 2 }{ 3 } { \lambda }_{ r }

or \ \lambda '=\frac { 2 }{ 3 } (660)=440nm

29) As, the path difference is \lambda

So, a \theta=\lambda \Rightarrow \theta=\lambda \mid a

\Rightarrow \frac{10 \lambda}{d}=\frac{2 \lambda}{a} \Rightarrow a=\frac{d}{5}=\frac{10}{5}=2 \mathrm{~m}

30) Here,

^{ a }{ \mu }_{ g }=\frac { 1 }{ sin \ C } =\frac { 1 }{ sin \ 45° \ } =\sqrt { 2 } =1.414

Refractive index of glass w.r.t. water

^{ w }{ \mu }_{ g }=\frac { ^{ a }{ \mu }_{ g } }{ ^{ a }{ \mu }_{ w } } =\frac { 1.414 }{ 1.33 }

When glass slab is immersed in water.

sin\quad C'=\frac { 1 }{ ^{ w }{ \mu }_{ g } } =\frac { 1.33 }{ 1.414 } =0.9434

C'=sin^{ -1 }(0.9432)=70° \ 36'

31) Here,\lambda =650nm \ d=?

For \ first \ minimum, \ n=1, \ \theta =30°

d \ sin\theta =n\lambda

d=\frac { n\lambda }{ sin\theta } =\frac { 1\times 650 }{ sin30° } =1300nm

For \ first \ maximum \ to \ lie \ at \ P, \ we \ have

d \ sin\theta =(2n+1)\frac { \lambda ' }{ 2 } =\frac { 3\lambda ' }{ 2 }

\lambda '=\frac { 2 }{ 3 } d \ sin\theta =\frac { 2 }{ 3 } \times 1300\times \frac { 1 }{ 2 } =433.3nm

32)

Here,\quad N.A.=\mu \quad sin\theta =0.12,

\lambda =6000\mathring { A } =6\times { 10 }^{ -7 }m

R.P. \ of \ microscope,

\frac { 1 }{ d } =\frac { 2\mu sin\theta }{ \lambda } =\frac { 2\times 0.12 }{ 6\times { 10 }^{ -7 } } =4\times { 10 }^{ 5 }{ m }^{ -1 }

33)

Here, $C=?,\quad i=40°$

deviation, $\delta =15°$

As ray deviates towards normal, therefore,

$r=i-\delta =40°-15°=25°$

As $\mu =\frac { sin\quad i }{ sin\quad r } =\frac { 1 }{ sin\quad C }$

$\therefore sin\quad C=\frac { sin\quad r }{ sin\quad i } =\frac { sin\quad 25° }{ sin\quad 40° } =\frac { 0.4226 }{ 0.6428 }$

$=0.6574$

$C=sin^{ -1 }(0.6574)=41.1°$

34) Here, $\quad d\theta =4.6\times { 10 }^{ -6 }rad,$

$\lambda =5460\mathring { A } =546\times { 10 }^{ -9 }m$

$D=?\quad As\quad d\theta =\frac { 1.22\lambda }{ D }$

$D=\frac { 1.22\lambda }{ d\theta } =\frac { 1.22\times 546\times { 10 }^{ -9 } }{ 4.6\times { 10 }^{ -6 } } =0.1488m$

35)

Here, $\ x=?\quad D=600cm,$

$\lambda =5.5\times { 10 }^{ -5 }cm$

Limit of resolution,

$d\theta =\frac { 1.22\lambda }{ D } =\frac { 1.22\times 5.5\times { 10 }^{ -5 } }{ 600 } =1.1\times { 10 }^{ -7 }rad$

If x is separation of two points on the moon that can be resolved and d is distance of moon from objective of telescope, then

$d\theta =\frac { x }{ d }$

$x=(d\theta)d=1.1\times { 10 }^{ -7 }\times 3.8\times { 10 }^{ 10 }cm$

$=4180cm.$

36) (i) When light travels from water to air,

$^{ a }{ \mu }_{ w }=\frac { 1 }{ sin\quad C }$

$sin\quad C=\frac { 1 }{ ^{ a }{ \mu }_{ w } } =\frac { 1 }{ 1.33 } =0.7518$

$\therefore \quad C=sin^{ -1 }(0.7518)=48° \ 44'$

(ii) When light travels from glass into water

$^{ w }{ \mu }_{ g }=\frac { 1 }{ sin \ C' } , \ i.e., \ \frac { ^{ a }{ \mu }_{ g } }{ ^{ a }{ \mu }_{ w } } =\frac { 1 }{ sin \ C' }$

or $\frac { 1.5 }{ 1.33 } =\frac { 1 }{ sin\quad C' }$

or $sin\quad C'=\frac { 1.33 }{ 1.5 } =0.8866$

$\therefore \quad C'=sin^{ -1 }\quad (0.8866)$

$=62° \ 27'$

37)

Here, $D=60\ cm=0.6\ m$

${f}_{0}=2.0m,\ {f}_{e}=1.0cm$

$Distance\ between\ stars={10}^{4}light\ years$

$={10}^{4}\times (9.46\times {10}^{15}m)=9.46\times {10}^{19}m$

$Transverse\ separation\ of\ stars={10}^{10}m$

$Angle\ subtended\ by\ transverse\ separation\ of\ stars$

$=\frac{{10}^{10}}{9.46\times {10}^{19}} \approx {10}^{-10}radian$

Smallest angular separation between two objects that can be resolved by the telescope=limit of resolution of telescope,

$d\theta =\frac{1.22\lambda}{D} =\frac{1.22\times (6\times {10}^{-7})}{0.6}$

$=1.22\times {10}^{-6}rad$

As the angle subtended by transverse separation of stars is much too small compared to the limit of resolution of the telescope, therefore, the two stars of the binary cannot be resolved by the telescope.

---

38) Here, $u=-10\ cm,\ R=-5\ cm,$

$u_{2}=1.5,\ u_{1}=1, \upsilon =?$

In present case, refraction occurs from denser to rarer medium.

$\therefore \frac{\mu_{2}}{-u} +\frac{\mu_{1}}{\upsilon} =\frac{\mu_{1}-\mu_{2}}{R}$

$\frac{1.5}{10} +\frac{1}{\upsilon} =\frac{1-1.5}{-5} =\frac{1}{10}$

or $\frac{1}{\upsilon} =\frac{1}{10} -\frac{3}{20} =-\frac{1}{20}$

$\therefore \upsilon =-20\quad cm$

---

39) Here, $\quad 2\theta =60°,\quad \theta =30°,$

$\lambda =600nm=6\times {10}^{-7}m;\mu =1$

$R.P=\frac{1}{d} =\frac{2\mu sin\theta}{\lambda}$

$R.P=\frac{2\times 1\times sin30°}{600\times {10}^{-9}} =\frac{10}{6} \times {10}^{6}=1.67\times {10}^{6}$

---

40) Here,

$\mu_{1}=1,\quad \mu_{2}=1.5,$

$R=0.2\ m=20\ cm,\ \upsilon =100\ cm,\ u=?$

As refraction occurs from rarer to denser medium,

$\frac{\mu_{1}}{-u} +\frac{\mu_{2}}{\upsilon} =\frac{\mu_{2}-\mu_{1}}{R}$

$\frac{1}{-u} +\frac{1.5}{100} =\frac{1.5-1}{20} =\frac{1}{40}$

$-\frac{1}{u} =\frac{1}{40} -\frac{3}{200} =\frac{2}{200} =\frac{1}{100} =-100\quad cm$

$\therefore$ Distance of object from pole of spherical surface is 100 cm

Distance of object from the centre of spherical surface=100+20=120 cm

---

41) Here, $\quad D=2mm=2\times {10}^{-3}m$

$\lambda =555nm=555\times {10}^{-9}m$

$Limit\ of\ resolution,$

$d\theta =\frac{1.22\lambda}{D} =\frac{1.22\times 555\times {10}^{-9}}{2\times {10}^{-3}}$

$=3.39\times {10}^{-4}\times {\left(\frac{180}{\pi} \right)}^{0}$

$=0.0194°=0.0194\times 60\ min=1.2min$

---

42) Here, $\lambda =7\times { 10 }^{ -7 }m, \ a={ 10 }^{ -2 }m$

$D=4\times { 10 }^{ 8 }m$

For the circular aperture, angular spread

$\theta =\frac { 1.22\lambda }{ a } =\frac { 1.22\times 7\times { 10 }^{ -7 } }{ { 10 }^{ -2 } } =8.54\times { 10 }^{ -5 }rad$

Area l spread $={ \left(D\theta \right) }^{ 2 }$

$={ \left(4\times { 10 }^{ 8 }\times 8.54\times { 10 }^{ -5 } \right) }^{ 2 }$

$=1.97\times { 10 }^{ 9 }{ m }^{ 2 }$

43) Here,

$\mu _{ 2 }=1.5, \ \mu _{ 1 }=1 \ ; \ R=20 \ cm \ ;$

$u=-100 \ cm, \ \upsilon =?$

As light goes from air (rarer medium) to glass (denser medium), therefore,

$-\frac { \mu _{ 1 } }{ u } +\frac { \mu _{ 2 } }{ \upsilon } =\frac { \mu _{ 2 }-\mu _{ 1 } }{ R }$

$-\frac { 1 }{ -100 } +\frac { 1.5 }{ \upsilon } =\frac { 1.5-1 }{ 20 } =\frac { 1 }{ 40 }$

$\frac { 3 }{ 2\upsilon } =\frac { 1 }{ 40 } -\frac { 1 }{ 100 } =\frac { 5-2 }{ 200 } =\frac { 3 }{ 200 } =100 \ cm$

$\therefore$ The image is formed at a distance of 100 cm from the glass surface, in the direction of incident light.

44) Here, $R_{ 1 }=R,R_{ 2 }=-R,$

$f=\frac { 2 }{ 3 } R,$

$\mu =?$

$\frac { 1 }{ f } =(\mu -1)\left(\frac { 1 }{ R_{ 1 } } -\frac { 1 }{ R_{ 2 } } \right)$

$\frac { 3 }{ 2R } =(\mu -1)\left(\frac { 1 }{ R } +\frac { 1 }{ R } \right) =(\mu -1)\frac { 2 }{ R }$

$\therefore \mu -1=\frac { 3 }{ 4 } =0.75,\ \mu =0.75+1=1.75$

45)

Here, $\mu =1.56, \ R_{ 1 }=20 \ cm,$

$R_{ 2 }=-20 \ cm, \ u=-10 \ cm, \ \upsilon =?$

As $\frac { 1 }{ f } =(\mu -1)\left(\frac { 1 }{ R_{ 1 } } -\frac { 1 }{ R_{ 2 } } \right)$

$\frac { 1 }{ f } =(1.56-1)\left(\frac { 1 }{ 20 } +\frac { 1 }{ 20 } \right) =0.56\times \frac { 1 }{ 10 }$

$f=\frac { 10 }{ 0.56 } =17.86 \ cm$

As $\frac { 1 }{ \upsilon } -\frac { 1 }{ u } =\frac { 1 }{ f } \therefore \frac { 1 }{ \upsilon } =\frac { 1 }{ f } +\frac { 1 }{ u } =\frac { 1 }{ 17.86 } +\frac { 1 }{ -10 }$

$\upsilon =-22.72\quad cm$

46) Here,

$R_{ 1 }=\infty ,\ R_{ 2 }=?$

$f=0.3m,\ \mu =1.5$

From

$\frac { 1 }{ f } =(\mu -1)\left(\frac { 1 }{ R_{ 1 } } -\frac { 1 }{ R_{ 2 } } \right)$

$\frac { 1 }{ 0.3 } =(1.5-1)\left(\frac { 1 }{ \infty } -\frac { 1 }{ R_{ 2 } } \right)$

$-\frac { 1 }{ R_{ 2 } } =\frac { 1 }{ 0.3\times 0.5 } =\frac { 100 }{ 15 } ;$

$R_{ 2 }=-\frac { 15 }{ 100 } =-0.15m$

47) Here,$\quad v=30km{ s }^{ -1 }=3\times { 10 }^{ 4 }{ ms }^{ -1 }$

$\Delta \lambda =0.58\mathring { A } ,\lambda =?$

As, $\ \Delta \lambda =\frac { v }{ x } \lambda$

$\lambda =\frac { c }{ v } \Delta \lambda =\frac { 3\times { 10 }^{ 8 } }{ 3\times { 10 }^{ 4 } } (0.58)=5800\mathring { A }$

48) Here, $\ v=8.1\times { 10 }^{ 9 }Hz$

$\Delta v=2.7\times { 10 }^{ 3 }Hz$

Velocity $\ of \ aeroplane, \ v=\frac { 1 }{ 2 } \frac { \Delta v }{ v } \times c$

$=\frac { 1 }{ 2 } \times \frac { 2.7\times { 10 }^{ 3 } }{ 8.1\times { 10 }^{ 9 } } \times 3\times { 10 }^{ 8 }=50m/s$

49)

Here,$\quad \frac { \Delta \lambda }{ \lambda } =\frac { 0.032 }{ 100 } ,v=?$

Since the wavelength of light from a star is shifting towards longer wavelength side, therefore $\Delta \lambda$ is positive, hence star is moving away from the earth i.e., v is negative.

$v=\frac { \Delta \lambda }{ \lambda } c=-\frac { 0.032 }{ 100 } \times 3\times { 10 }^{ 8 }$

$=-9.6\times { 10 }^{ 4 }m{ s }^{ -1 }$

50) Since, $v \lambda=c, \ \frac{\Delta v}{v}=-\frac{\Delta \lambda}{\lambda}$ for small changes in + and λ). For

$\triangle \lambda = 589.6 – 589.0 = + 0.6$ nm

we get,

$\frac{\Delta v}{v}=-\frac{\Delta \lambda}{\lambda}=-\frac{v_{\text {radial }}}{c}$

or, $v_{\text {radial }} \cong+c\left(\frac{0.6}{589.0}\right)=+3.06 \times 10^{5} \mathrm{~m} \mathrm{~s}^{-1}$

= 306 km/s

Therefore, the galaxy is moving away from us.

51) The reflected light will be completely polarized, when

$\theta \ \mu =1.327and \ tan \ 53°=1.327$

$i={ i }_{ p },\ so \ that \ \theta =(90-{ i }_{ p })$

As $\ \mu =tan{ i }_{ p }$

$1.327=tan{ i }_{ p }:{ i }_{ p }={ tan }^{ -1 }(1.327)=53°$

$\\ \theta =90°-{ i }_{ p }=90°-53°=37°$

52) Net intensity transmitted is

$I={ I }_{ 0 }{ cos }^{ 2 }\theta$

(i) $\ Here, \ \theta =30°$

$I={ I }_{ 0 }{ \left(cos30° \right) }^{ 2 }={ I }_{ 0 }{ \left(\frac { \sqrt { 3 } }{ 2 } \right) }^{ 2 }$

$I=\frac { 3 }{ 4 } { I }_{ 0 }=0.75{ I }_{ 0 }=75\%{ I }_{ 0 }$

Intensity transmitted is reduced to 75% of the maximum intensity.

(ii) $\ Here,\ \theta =60°$

$I={ I }_{ 0 }{ cos }^{ 2 }\theta ={ I }_{ 0 }{ \left(cos60° \right) }^{ 2 }$

$\frac { { I }_{ 0 } }{ 4 } =0.25{ I }_{ 0 }=25\%{ I }_{ 0 }$

Intensity transmitted is reduced to 25% of the maximum intensity.

53)

From lens maker's formula,

$\frac { 1 }{ f } =(\mu -1)\left(\frac { 1 }{ R_{ 1 } } -\frac { 1 }{ R_{ 2 } } \right)$

where $\mu =\frac { \mu _{ 2 } }{ \mu _{ 1 } }$

If $\mu _{ 2 }=\mu _{ 1 }, \ \frac { 1 }{ f } =0 \ or \ f=\infty$

$\therefore$ The lens in the liquid will act like a plane sheet of glass, when refractive index of the lens and the surrounding medium is the same. Therefore, refractive index of surrounding medium,

$\mu _{ 2 }=\mu _{ 1 }=1.5$

This liquid medium is not water because refractive index of water=1.33.

---

54) Here, $\ \mu =\sqrt { 3 } ;\quad r=?$

As $\ tan{ i }_{ p }=\mu =\sqrt { 3 }$

${ i }_{ p }={ tan }^{ -1 }(\sqrt { 3 })=60°$

$r=90-{ i }_{ p }$

$r=90°-60°=30°$

---

55) Here, $R_{ 1 }=R,R_{ 2 }=-R \ ; \ f=R, \ \mu =?$

From $\frac { 1 }{ f } =(\mu -1)\left(\frac { 1 }{ R_{ 1 } } -\frac { 1 }{ R_{ 2 } } \right)$

$\frac { 1 }{ R } =(\mu -1)\left(\frac { 1 }{ R } +\frac { 1 }{ R } \right) =(\mu -1)\frac { 2 }{ R }$

$\mu -1=\frac { 1 }{ 2 } \quad or\quad \mu =3/2=1.5$

---

56) Here, $\mu =?, \ f=15 \ cm, \ m=\underset { - }{ + } 3=\frac { \upsilon }{ u }$

$\therefore \upsilon =\underset { - }{ + } 3u$

From

$\frac { 1 }{ \upsilon } -\frac { 1 }{ u } =\frac { 1 }{ f }$

$\frac { 1 }{ \underset { - }{ + } 3u } -\frac { 1 }{ u } =\frac { 1 }{ 15 }$

$\therefore$ u=20 cm, when m is negative,

u=10 cm, when m is positive,

i.e., for virtual image, u=10 cm and for real image, u=20 cm

---

57)

If ${ I }_{ 0 }$ is intensity of unpolarized light, then intensity of light transmitted from 1st polarizing sheet $=\frac { { I }_{ 0 } }{ 2 }$

Intensity of light from 2nd polarizing sheet

$I'=\frac { { I }_{ 0 } }{ 2 } { \left(cos30° \right) }^{ 2 }=\frac { { I }_{ 0 } }{ 2 } { \left(\frac { \sqrt { 3 } }{ 2 } \right) }^{ 2 }=\frac { { I }_{ 0 } }{ 2 } \left(\frac { 3 }{ 4 } \right)$

Intensity of light from 3rd polarizing sheet

$I''=I'{ \left(cos30° \right) }^{ 2 }=\frac { { I }_{ 0 } }{ 2 } \left(\frac { 3 }{ 4 } \right) { \left(\frac { \sqrt { 3 } }{ 2 } \right) }^{ 2 }=\frac { { I }_{ 0 } }{ 2 } { \left(\frac { 3 }{ 4 } \right) }^{ 2 }$

Intensity of light from 4th polarizing sheet

$I'''=I''{ \left(cos30° \right) }^{ 2 }$

$=\frac { { I }_{ 0 } }{ 2 } { \left(\frac { 3 }{ 4 } \right) }^{ 2 }{ \left(\frac { \sqrt { 3 } }{ 2 } \right) }^{ 2 }={ I }_{ 0 }\times \frac { 27 }{ 128 }$

$\frac { I''' }{ { I }_{ 0 } } =\frac { 27 }{ 128 }$

58) Here, $f=20$ cm, $m=+4$, for erect image.

From $m=\frac{f}{u+f}$

$4=\frac{20}{u+20}\ ;\ u=-15\ cm$

From $m=\frac{f-\upsilon}{f}$

$4=\frac{20-\upsilon}{20}\ ;\ \upsilon=-60\ cm$

59)

As image is real, the lens must be convex and it should be placed between the object and screen. Let x be distance between the object and convex lens.

$\therefore \upsilon=-x,\ \upsilon=90-x\ ;\ m=-2$

As $m=\frac{\upsilon}{u}$,

$\therefore -2=\frac{90-x}{-x}\ x=30\quad cm$

$\therefore u=-x=-30\ cm$

$\upsilon=90-x=90-30=60\ cm$

$\\ \frac{1}{f}=\frac{1}{\upsilon}-\frac{1}{u}=\frac{1}{60}-\frac{1}{-30}=\frac{3}{60}=\frac{1}{20}$

$f=20\ cm$

60) Here, $f_{1}=50\ cm$,

$P_{1}=\frac{100}{f_{1}}=\frac{100}{50}=2D$

$F=-50\ cm,\ P=\frac{100}{F}=\frac{100}{-50}=-2D$

As $P_{1}+P_{2}=P$

$\therefore P_{2}=P-P_{1}=-2D-2D=-4D$

As power is negative, lens must be concave.

61) Here $D=150mm=150\times{10}^{-3}$

${f}_{0}=4.0m,{f}_{e}=25.0mm=25\times{10}^{-3}m$

$\lambda=6000\mathring{A}=6\times{10}^{-7}m$

If we assume that final image is formed at infinity, then magnifying power,

$m=\frac{{f}_{0}}{{f}_{e}}=\frac{4.0}{25\times{10}^{-3}}=160$

$Resolving\ power=\frac{D}{1.22\lambda}=\frac{150\times{10}^{-3}}{1.22\times 6\times{10}^{-7}}$

$=2.05\times{10}^{5}$

$Distance\ between\ objective\ and\ eyepiece$

$={f}_{0}+{f}_{e}=4.0+25\times{10}^{-3}=4.025m$

62) Here, $P_{1}=15\quad D,\quad P_{2}=-5\quad D$

$P=P_{1}+P_{2}=15-5=10\quad D$

$F=\frac{100}{P}=\frac{100}{10}=10\quad cm$

Now, $u=-30$ cm, $v=?$

from $\frac{1}{\upsilon}=\frac{1}{F}+\frac{1}{u}=\frac{1}{10}-\frac{1}{30}=\frac{1}{15}$

$\upsilon=15\ cm$

63) Here $\ ^{a}{\mu}_{w}=4/3, ^{a}{\mu}_{g}=3/2$

$^{w}{\mu}_{g}=\frac{^{a}{\mu}_{g}}{^{a}{\mu}_{g}}=\frac{3/2}{4/3}=\frac{9}{8}=1.125$

$For\ beam\ travelling\ from\ water\ to\ glass,$

$\tan{i}_{p}=^{w}{\mu}_{g}=1.125$

${i}_{p}={\tan}^{-1}(1.125)=48°22'$

64)

For the convex lens,

f=10 cm, u=-30 cm

$\frac{1}{\upsilon}=\frac{1}{f}+\frac{1}{u}=\frac{1}{10}-\frac{1}{30}=\frac{1}{15},\upsilon=15\ cm$

As concave lens is at 5 cm from convex lens, therefore image formed by convex lens is at (15-5) cm=10 cm beyond concave lens.

For concave lens

u=+10 cm, f=-10 cm

$\frac{1}{\upsilon}=\frac{1}{f}+\frac{1}{u}=-\frac{1}{10}+\frac{1}{10}=0\ \therefore\ \upsilon=\infty$

i.e., final image is formed at infinity.

65) According to Brewster's law,

$\mu=tanp....(i)$

$Also\ \mu=\frac{1}{sin\quad C}.....(ii)$

$From\ (i)\ and\ (ii),\ tanp=\frac{1}{sin\ C}$

$If\ r\ is\ angle\ of\ refraction,\ then\ p=90°-r$

$or\ tan\ r=sin\ C\ r={\tan}^{-1}(sin\ C)$

66) Here, $f_{1}=25\ cm,\ f_{2}=?$

For the combination of focal length F,

U=-40 cm, v=+80 cm.

As $\frac{1}{F}=\frac{1}{\upsilon}-\frac{1}{u}$

$\therefore \frac{1}{F}=\frac{1}{80}-\frac{1}{-40}=\frac{1+2}{80}=\frac{3}{80}$

As $\frac{1}{f_{1}}+\frac{1}{f_{2}}=\frac{1}{F}$

$\therefore \frac{1}{f_{2}}=\frac{1}{F}-\frac{1}{f_{1}}=\frac{3}{80}-\frac{1}{25}=\frac{15-16}{400}$

$\frac{1}{f_{2}}=-\frac{1}{400},\ \therefore\ f_{2}=-400\ cm$

67)

If E is amplitude of electric field component emanating from 1st polaroid, then from 2nd polaroid at 45° , the amplitude of electric field component is

$E'=E\cos45°=E/\sqrt{2}$

Again amplitude of electric field component coming from 3rd polaroid at 45° to 2nd polaroid would be

$E''=E'\cos45°=\frac{E}{\sqrt{2}}\times\frac{1}{\sqrt{2}}=\frac{E}{2}\rightarrow half\ of\ E$

As $Intensity\ \alpha{\ E}^{2}$

Intensity transmitted from three polaroids will be 1/4th of the intensity transmitted from the first polaroid. The direction of polarization of the outcoming beam will be same as that coming from the first polaroid.

68)

Here, as image formed by the lens is real, the lens must be convex, $v=20$ cm If f_{1} is focal length of this lens, them from

$\frac{1}{\upsilon}-\frac{1}{u}=\frac{1}{f_{1}}$

$\frac{1}{20}-\frac{1}{u}=\frac{1}{f_{1}}$

For the combination (of focal length f),

$v=(20-10)$ cm$=10$ cm

$\therefore \quad \frac{1}{10}-\frac{1}{u}=\frac{1}{f}=\frac{1}{f_{1}}+\frac{1}{f_{2}}$

using (i), $\frac{1}{10}-\frac{1}{u}=\frac{1}{f}=\left(\frac{1}{20}-\frac{1}{u}\right)+\frac{1}{f_{2}}$

or $\frac{1}{10}-\frac{1}{20}=\frac{1}{f_{2}}$

or $f_{2}=20\ cm$

$P=\frac{100}{20}=5\ dioptre$

---

69) Here, $\ {i}_{p}=60°,\delta m=?\ A=60°$

$\mu=\tan{i}_{p}=\tan60°=\sqrt{3}$

$For\ prism\ formula,\ \mu=\frac{\sin(A+\delta m)/2}{\sin\ A/2}$

$\sqrt{3}=\frac{\sin(60°+\delta m)/2}{\sin30°}$

$\frac{\sin(60°+\delta m)}{2}=\sqrt{3}\times\frac{1}{2}=\sin60°$

$\frac{60°+\delta m}{2}=60°\ \delta m=2\times 60°-60°=60°$

---

70) Here, $f_{1}=30\ cm,\ f_{2}=-60\ cm$

$u=-40\ cm,\ \upsilon=?$

$\frac{1}{F}=\frac{1}{f_{1}}+\frac{1}{f_{2}}=\frac{1}{30}-\frac{1}{60}=\frac{1}{60}$

From $\frac{-1}{u}+\frac{1}{\upsilon}=\frac{1}{F}$

$\frac{1}{\upsilon}=\frac{1}{F}+\frac{1}{u}=\frac{1}{60}-\frac{1}{40}=\frac{-1}{120}$

$\upsilon=-120\ cm$

which is the position of the image.

---

71) $P=+5\ D,\ \mu=1.5$

$R_{1}=R, R_{2}=-R$

From $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_{1}}-\frac{1}{R_{2}}\right)$

$5=(1.5-1)\left(\frac{1}{R}+\frac{1}{R}\right)=\frac{1}{R}$

$R=\frac{1}{5}m=20cm$

---

72) Here, $f_{1}=25\ cm$

$f_{2}=-20\ cm,\ P=?$

$P_{1}=\frac{100}{f_{1}}=\frac{100}{20}=4D$

$P_{2}=\frac{100}{f_{2}}=\frac{100}{-20}=-5\ D$

$P=P_{1}+P_{2}=4-5=-1\ D\ ;\ diverging$

---

73)

Here, u=-15 cm, f=10 cm, v=?

From $\frac { 1 }{ \upsilon } -\frac { 1 }{ u } =\frac { 1 }{ f }$

$\frac { 1 }{ \upsilon } =\frac { 1 }{ f } +\frac { 1 }{ u } =\frac { 1 }{ 10 } -\frac { 1 }{ 15 } =\frac { 1 }{ 30 }$

$\upsilon =30\quad cm,\quad m=\frac { \upsilon }{ u } =\frac { 30 }{ -15 } =-2$

Image is real, inverted and magnified formed at a distance of 30 cm from lens.

Now, the final image formed by concave mirror will be at the position of the object itself only if image formed by the lens lies at the centre of curvature of the mirror.

$\therefore$ Distance of mirror from the lens

=30+R(30+20) cm=50 cm

74) Here, $R_{ 1 }=0.2 \ m=20 \ cm$,

$R_{ 2 }=-20cm,\ \mu =1.5 \ ; \ f=? \ d=0.2 \ m=20 \ cm$

F=?

As, $\frac { 1 }{ f } =(\mu -1)\left(\frac { 1 }{ R_{ 1 } } -\frac { 1 }{ R_{ 2 } } \right)$

$\therefore \frac { 1 }{ f } =(1.5-1)\left(\frac { 1 }{ 20 } +\frac { 1 }{ 20 } \right) =0.5\times \frac { 1 }{ 10 } =\frac { 1 }{ 20 }$

$\therefore$ f=20 cm

Now, $f_{ 1 }=f_{ 2 }=20 \ cm$

As $\frac { 1 }{ F } =\frac { 1 }{ f_{ 1 } } +\frac { 1 }{ f_{ 2 } } -\frac { d }{ f_{ 1 }f_{ 2 } }$

$\therefore \frac { 1 }{ F } =\frac { 1 }{ 20 } +\frac { 1 }{ 20 } -\frac { 20 }{ 20\times 20 } =\frac { 1 }{ 20 } ,\ F=20 \ cm$

75)

Here, $A=60°,\quad i=\frac { 3 }{ 4 } A=\frac { 3 }{ 4 } \times 60°=45°$

In the position of minimum deviation,

$r=\frac { A }{ 2 } =30°,\ \mu =\frac { sin \ i }{ sin \ r } =\frac { sin \ 45° }{ sin \ 30° } =\frac { 1\sqrt { 2 } }{ 1/2 } =\sqrt { 2 }$

As $\mu =\frac { c }{ \upsilon } ,\quad \upsilon =\frac { c }{ \mu } =\frac { 3\times 10^{ 8 } }{ \sqrt { 2 } } =2.12\times 10^{ 8 }m/s$

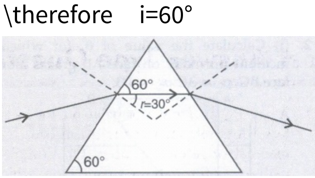
76) When refracted ray is parallel to the base of the prism, deviation is minimum.

$\therefore$ r=A/2=60/2=30°

From $\mu =\frac { sin\quad i }{ sin\quad r }$

$sin \ i=\mu \ sin\quad r=\sqrt { 3 } \ sin \ 30°=\sqrt { 3/2 }$

$\therefore$ i=60°



77)

Here, $A=\frac { \pi }{ 3 } =60°;\delta _{ m }=\frac { \pi }{ 6 } =30°$,

$c=3\times 10^{ 8 }ms^{ -1 } ; \upsilon =?$

We know, $\mu =\frac { sin(A+\delta _{ m })/2 }{ sin\quad A/2 }$

$=\frac { 0.7071 }{ 0.50 } =1.414$

$=\frac { 0.7071 }{ 0.50 } =1.414$

From $\mu =\frac { c }{ \upsilon } ,\quad \upsilon =\frac { c }{ \mu } =\frac { 3\times 10^{ 8 } }{ 1.414 } =2.12\times 10^{ 8 }m/s$

78) Here, $A=60°,\ \mu =1.5,$

$i_{ 1 }=i_{ 2 }=\frac { 3 }{ 4 } \times 60°=45°,\delta =?$

As $A+\delta =i_{ 1 }+i_{ 2 }$

$\therefore 60°+\delta =45°+45°$, or $\delta =90°-60°=30°$

79) Here, $^{ a }{ \mu _{ g } }=1.53,$

$^{ a }{ \mu _{ w } }=1.33,\ A=60°,\ \delta _{ m }=?$

$^{ w }{ \mu _{ g } }=\frac { ^{ a }{ \mu _{ g } } }{ ^{ a }{ \mu _{ w } } } =\frac { 1.53 }{ 1.33 } =1.15$

As $^{ w }{ \mu _{ g } }=\frac { sin\quad (A+\delta)/2 }{ sin\quad A/2 }$

$\therefore \frac { sin\quad (A+\delta _{ m }) }{ 2 } =^{ w }{ \mu _{ g } }\times sin\frac { A }{ 2 }$

$=1.15\quad sin\frac { 60° }{ 2 } =0.575$

$\frac { A+\delta _{ m } }{ 2 } =sin^{ -1 }(0.575)=35.1°$

$\therefore \delta _{ m }=35.1\times 2-60=10.2°$

80) Here, $A=5°,\ \mu _{ r }=1.641,\ \mu _{ b }=1.659$

Angular dispersion$=(\mu _{ b }-\mu _{ r })A$

$=(1.659-1.641)\times 5°$

$=0.09°$

81) For crown glass,

$\mu _{ b }=1.522,\ \mu _{ r }=1.514$

$\mu =\frac { \mu _{ b }+\mu _{ r } }{ 2 } =\frac { 1.522+1.514 }{ 2 } =1.518$

$\omega =\frac { \mu _{ b }+\mu _{ r } }{ \mu -1 } =\frac { 1.522-1.514 }{ 1.518-1 } =\frac { 0.008 }{ 0.518 }$

$=0.01544$

For flint glass,

$\mu '=\frac { \mu '_{ b }+\mu '_{ r } }{ 2 } =\frac { 1.662+1.644 }{ 2 } =1.653$

$\omega '=\frac { \mu _{ b }-\mu _{ r } }{ \mu -1 } =\frac { 1.662-1.644 }{ 1.653-1 } =\frac { 0.018 }{ 0.653 }$

$=0.0276$

82) Here, $\omega =0.031$

$\mu _{ r }=1.645,\ \mu _{ b }=1.665,\ \mu =?$

As $\omega =\frac { \mu _{ b }-\mu _{ r } }{ \mu -1 }$

$\therefore \mu -1=\frac { \mu _{ b }-\mu _{ r } }{ \omega } =\frac { 1.665-1.645 }{ 0.031 } =\frac { 0.020 }{ 0.031 }$

$=0.645$

$\therefore \mu =0.645+1=1.645$

83) Here, $P=-2.5$ D

As P negative, the person is short sighted

$f=\frac { 100 }{ P } =\frac { 100 }{ 2.5 } =-40cm$

An object at infinity from the corrective lens must produce the virtual image at the far point, i.e., at 40 cm from the eye.

From $\frac { 1 }{ \upsilon } =\frac { 1 }{ f } +\frac { 1 }{ u } =\frac { 1 }{ -40 } +\frac { 1 }{ \infty }$

$\upsilon =-40cm$

84) Here, $u=-25$ cm, $v=-50$ cm, $f=?$

$\frac{1}{f}=\frac{1}{\upsilon}-\frac{1}{u}=\frac{1}{-50}+\frac{1}{25}=\frac{1}{50}$

$f=50cm,\ P=\frac{100}{50}=+2D$

85) Here, $x=150$ cm, $f=?$, $P=?$

To see distant objects clearly,

$f=-x=150\ cm=-1.5\ m$

$P=\frac{100}{P}=\frac{100}{-150}=-0.67D$

86) (a) For distance viewing,

$P_{1}=-5.5 \ D$

$\therefore f_{1}=\frac{100}{P_{1}}=\frac{100}{-5.5}=-18.73\ cm$

(b) As power of near vision part is measured relative to the main part of lens of power-5.5 D, therefore,

$P_{1}+P_{2}=P\\ -5.5+P_{2}=1.5$

$P_{2}=1.5+5.5=7.0 \ D$

$f_{2}=\frac{100}{P_{2}}=\frac{100}{7.0}=14.3 \ cm$

87) Here, $u=-25$ cm, $v=-100$ cm,

$f=?$

As $\frac{1}{f}=\frac{-1}{u}+\frac{1}{\upsilon}$

$\therefore \frac{1}{f}=\frac{1}{25}-\frac{1}{100}=\frac{4-1}{100}=\frac{3}{100}$

$f=\frac{100}{3}$ cm=33.3cm

$P=\frac{100}{f}=\frac{100}{100/3}=3\ dioptre$

The lens must be converging.

88) As the person wears spectacles at a distance of 1 cm. from the eyes.

$\therefore u=-(26-1)$ cm=-25 cm,

and $v=-(16-1)cm=-15cm;f=?$

As $\frac{1}{f}=\frac{1}{\upsilon}-\frac{1}{u}$

$\therefore \frac{1}{f}=\frac{-1}{15}+\frac{1}{25}=\frac{5+3}{75}=-\frac{2}{75}$

$f=\frac{75}{2}$ cm=-37.5cm

$\therefore$ A concave lens of focal length 37.5 cm. is to be used.

89) Here, $P=P_{1}+P_{2}=15+5=20 \ D$

Focal length of combination,

$f=\frac{100}{P}=\frac{100}{20}=5 \ cm$

Magnifying power, $m=1+\frac{d}{f}=1+\frac{25}{5}=6$

90)

For maximum angular magnification,

$v=-d=-10cm$

From $\frac{1}{\upsilon}-\frac{1}{u}=\frac{1}{f},\quad \frac{1}{u}=\frac{1}{\upsilon}-\frac{1}{f}=\frac{1}{10}-\frac{1}{10}=-\frac{1}{5}$

$u=-5\quad cm$

Maximum angular magnification,

$m=\frac{\upsilon}{u}=\frac{-10}{-5}=2$

---

91)

Here, $f_{0}=1.25\quad cm,\quad f_{e}=5\quad cm,\quad u_{0}=?$ $m=30$

In normal adjustment, magnification produced by the eye piece,

$m_{e}=\frac{d}{f_{e}}=\frac{25}{5}=5$

As $m=m_{0}\times m_{e}\ \therefore\ m_{0}=\frac{m}{m_{e}}=\frac{30}{5}=6$

As real image is formed by objective lens, therefore, $m_{0}=\frac{\upsilon_{0}}{u_{0}}=-6,\quad \upsilon_{0}=-6\quad u_{0}$

From $\frac{1}{\upsilon_{0}}-\frac{1}{u_{0}}=\frac{1}{f_{0}}$

$\frac{1}{-6u_{0}}-\frac{1}{u_{0}}=\frac{1}{1.25}$ or $u_{0}=\frac{-7\times 1.25}{6}$

$=-1.46$ cm

$\therefore$ Object must be held 1.46 cm in front of objective lens.

---

92)

Here, $\lambda=589\ nm,\ c=3\times{10}^{8}m/s,\ \mu=1.33$

(a) For reflected light

wavelength, $\lambda=589\quad nm=589\times{10}^{-9}m,\quad v=\frac{c}{\lambda}=\frac{3\times{10}^{8}}{589\times{10}^{-9}}=5.09\times{10}^{14}hertz$

speed, $v=c=3\times{10}^{8}m/s$

(b) For refracted light $\quad \lambda'=\frac{\lambda}{\mu}=\frac{589\times{10}^{-9}}{1.33}=4.42\times{10}^{-7}m$

As frequency remains unaffected on entering another medium,

therefore, $\quad v'=v=5.09\times{10}^{14}hertz$

speed, $v'=\frac{c}{\mu}=\frac{3\times{10}^{8}}{1.33}=2.25\times{10}^{8}m/s$

---

93)

Here, $f_{0}=1.0\ cm,\ f_{e}=2.0\ cm,$

$L=20\ cm,\ d=25\ cm$

When final image is formed at the near point of the eye (at least distance d of distinct vision), then

$m=\frac{L}{f_{0}}\left(1+\frac{d}{f_{e}}\right)=\frac{20}{1.0}\left(1+\frac{25}{2}\right)=270$

---

94)

Here, $f_{0}=1.25\ cm,\ f_{e}=5\ cm,\ d=25\ cm,\ L=?,\ M=30$

When final image is formed at the near point of eye, the magnifying power of compound microscope is given by

$M=\frac{L}{f_{0}}\left(1+\frac{d}{f_{e}}\right)$

$30=\frac{L}{1.25}\left(1+\frac{25}{5}\right)=\frac{6L}{1.25}$

$L=\frac{30\times 1.25}{6}=6.25\ cm$

---

95)

Here, $P_{ 1 }=1.5 D\ :\ d=25\ cm,P_{ 2 }=20\ D$

(a) With glasses on

$M=1+\frac { d }{ f_{ 2 } } =1+\frac { 25 }{ 100/20 } =6$

(b) Without glasses, Focal length of glasses,

$f_{ 1 }=\frac { 100 }{ P_{ 1 } } =\frac { 100 }{ 1.5 } =\frac { 200 }{ 3 }$ cm

$u=-25cm,\ \upsilon =?$

As $\frac { 1 }{ \upsilon } -\frac { 1 }{ u } =\frac { 1 }{ f_{ 1 } }$

$\therefore \frac { 1 }{ \upsilon } =\frac { 1 }{ f_{ 1 } } +\frac { 1 }{ u } =\frac { 3 }{ 200 } -\frac { 1 }{ 25 } =\frac { 3-8 }{ 200 } =\frac { -5 }{ 200 }$

$\upsilon =-40cm$

$M=1+\frac { \upsilon }{ f_{ 2 } } =1+\frac { 4 }{ 100/20 } =9$

96)

(a) Refractive index of glass, $\mu = 1.5$

Speed of light, $c = 3 \times 10^8$ m/s

Speed of light in glass is given by the relation

$v=\frac{c}{\mu}$

$=\frac{3 \times 10^{8}}{1.5}=2 \times 10^{8} \mathrm{~m} / \mathrm{s}$

Hence, the speed of light in glass is 2×10^8 m/s.

(b) The speed of light in glass is not independent of the colour of light

The refractive index of a violet component of white light is greater than the refractive index of a red component. Hence, the speed of violet light is less than the speed of red light in glass. Hence, violet light travels slower than red light in a glass prism.

97)

Here, $f_{ 0 }=1\ cm,\ f_{ e }=2.5\ cm.\ u_{ 0 }=-1.2\ cm.,\ m=?\ L=?$

As $\frac { 1 }{ \upsilon _{ 0 } } -\frac { 1 }{ u_{ 0 } } =\frac { 1 }{ f_{ 0 } }$

$\therefore \frac { 1 }{ \upsilon _{ 0 } } =\frac { 1 }{ f_{ 0 } } +\frac { 1 }{ u_{ 0 } } =\frac { 1 }{ 1 } -\frac { 1 }{ 1.2 } =\frac { 0.2 }{ 1.2 }$

$\upsilon _{ 0 }=1.2/00.2=6\ cm.$

As $m=\frac { \upsilon _{ 0 } }{ \left| u_{ 0 } \right| } \left(1+\frac { d }{ f_{ e } } \right)$

$\therefore m=\frac { 6 }{ 1.2 } \left(1+\frac { 25 }{ 2.5 } \right) =55$

$L=\upsilon _{ 0 }+f_{ e }=6+2.5=8.5 \ cm$

98)

From $m=m_{ 0 }\times m_{ e }$

$m_{ 0 }=\frac { m }{ m_{ e } } =\frac { 20 }{ 5 } =4$

Now, $m_{ 0 }=\frac { \upsilon _{ 0 } }{ u_{ 0 } } =\frac { L }{ f_{ 0 } } =4,$

$f_{ 0 }=\frac { L }{ 4 } =\frac { 14 }{ 4 } =3.5 \ cm$

Also, $m_{ e }=1+\frac { d }{ f_{ e } } =5$

$\frac { d }{ f_{ e } } =5-1=4, \ f_{ e }=\frac { d }{ 4 } =\frac { 20 }{ 4 } =5 \ cm$

99) Let $I_1 = I_2 = I$. If ϕ is phase difference between the two light waves, then resultant intensity,

$I_1 = I_2 = I \quad \phi \quad$

$I_R = I_1 + 2\sqrt{I_1 I_2} \cos\theta$

When path difference $= \lambda$, d phase difference $\phi = 0°$

When path difference $= \frac{\lambda}{3}$, phase difference $\phi = \frac{2\pi}{3}$

$I_R = I + I + 2\sqrt{I \quad I} \cos 0° = 4I = K$

$I'_R = I + I + 2\sqrt{I \quad I} \cos\frac{2\pi}{3}$

$I'_R = 2I + 2I\left(-\frac{1}{2}\right) = I = K/4$

---

100) Here, $L = 36\ cm,\ m = 8,\ f_0 = ?\ f_e = ?$

As $m = \frac{f_0}{f_e} = 8\ \therefore\ f_0 = 8f_e$

Now $L = f_0 + f_e = 8f_e + f_e = 9f_e = 36$

$f_e = \frac{36}{9} = 4\ cm f_0 = 36 - f_e = 36 - 4 = 32 cm$

Angle of separation as seen through telescope

$= m \times$ actual separation

$= 8 \times 1' = 8'$

---

101) Here, $f_0 = 150\ cm,\ f_e = 5\ cm$

Angle subtended by 100 m tall tower at 3 km away is

$\alpha \simeq \tan\quad \alpha = \frac{100}{3 \times 10^3} = \frac{1}{30}$ radian

If h is the height of image of tower, then angle subtended by the image must also be α.

$\therefore \quad \alpha \simeq \tan\quad \alpha = \frac{h}{f_0} = \frac{h}{150}$

From (i) and (ii), $\frac{h}{150} = \frac{1}{30}$, $h = 5\ cm$.

Magnification produced by eye piece

$m_e = \left(1 + \frac{d}{f_e}\right) = 1 + \frac{25}{5} = 6$

$\therefore$ Height of final image, $h' = h \times m_e = 5 \times 6$

$= 30$ cm

---

102)

(a) Wavelength of the light beam, $\lambda 1$ = 650 nm

Wavelength of another light beam, $\lambda 2$ = 520 nm

Distance of the slits from the screen = D

Distance between the two slits = d

Distance of the n^{th} bright fringe on the screen from the central maximum is given by the relation,

$x=n \lambda_{1}\left(\frac{D}{d}\right)$

For third bright fringe n = 3

$\therefore x=3 \times 650 \frac{D}{d}=1950\left(\frac{D}{d}\right) n m$

(b) Wavelength of the light beam, lambda_1 = 650 nm

Wavelength of another light beam, $\lambda 2$ = 520 nm

Distance of the slits from the screen = D

Distance between the two slits = d

Let the n^{th} bright fringe due to wavelength $\lambda 2$ and $(n - 1)^{th}$ bright fringe due to wavelength lambda coincide on the screen. We can equate the conditions for bright fringes as:

$n \lambda_{2}=(n-1) \lambda_{1}$

520 n= 650 n -650

650 = 130 n

$\therefore n = 5$

Hence, the least distance from the central maximum can be obtained by the relation:

$x=n \lambda_{2} \frac{D}{d}$

$=5 \times 582 \frac{D}{d}=2600 \frac{D}{d} n m$

---

103)

Here, $l=3.5\times 10^{ 3 }km=3.5\times 10^{ 6 }m$,

$r=3.8\times 10^{ 5 }\ km=3.8\times 10^{ 8 }m$

$f_{ 0 }=4 \ m=400 \ cm,\ f_{ e }=10 \ cm, \ \beta =?$

$m=\frac { f_{ 0 } }{ f_{ e } } =\frac { 400 }{ 10 } =40$

Also, $m=\frac { \beta }{ \alpha }$

$\therefore \beta =m\alpha =40\times \left(\frac { 1 }{ r } \right) =40\times \frac { 3.5\times 10^{ 6 } }{ 3.8\times 10^{ 8 } }$ rad

$=36.84\times 10^{ -2 }\times \frac { 180° }{ \pi } =21.1°$

---

104) Here, $m=-10, \ L=22 \ cm., \ f_{ 0 }=?$

As $m=-\frac { f_{ 0 } }{ f_{ e } } \ \therefore \ -10=--\frac { f_{ 0 } }{ f_{ e } }$ or $f_{ 0 }=10f_{ e }$

As $L=f_{ 0 }+f_{ e }$

$\therefore 22=10f_{ e }+f_{ e }=11f_{ e }$

or $f_{ e }=\frac { 22 }{ 11 } =2\ cm.$

$f_{ 0 }=10f_{ e }=10\times 2=20 \ cm$

---

105)

Here, $f_{0}=30\ cm,\ f_{e}=-3.0\ cm,$

$u_{0}=-2.0m=-200\ cm$

$\frac{1}{\upsilon_{0}}=\frac{1}{f_{0}}+\frac{1}{u_{0}}=\frac{1}{30}-\frac{1}{200}=\frac{17}{600}$

$\upsilon_{0}=\frac{17}{600}=35.3cm$

For seeing the scale with relaxed eye, final image should be formed at infinity. This would happen when image formed by the objective lens lies at the focus of eye piece.

$\therefore$ Distance between the objective and eye piece

$=\upsilon_{0}+f_{e}=35.3+3.0=38.3\ cm$

106)

Here, $\mu_{d}=2.47$ and $\mu_{g}=1.51$

As $\mu=c/\upsilon\ \therefore\ \frac{\upsilon_{g}}{\upsilon_{d}}=\frac{\mu_{d}}{\mu_{g}}=\frac{2.47}{1.51}$

$=1.63$

107) Let thickness t of vacuum contain n waves and same thickness of air contain (n+1) waves.

$\therefore\ n=\frac{t}{\lambda}=\frac{t}{6000}$, and

$n+1=\frac{t}{\lambda'}=\frac{t}{\lambda/\mu}=\frac{\mu t}{\lambda}=\frac{1.0003t}{6000}$

$\therefore\ \frac{t}{6000}+1=\frac{1.0003t}{6000}$

$t+6000=1.0003t$

$0.0003t=6000$

$t=\frac{6000}{0.0003}=2\times 10^{7}\quad \overset{\circ}{A}=2\ mm$

108)

Here, $v=5\times 10^{14}\quad Hz$

$\lambda_{a}=\frac{\upsilon_{a}}{v}=\frac{c}{\mu_{a}.v}=\frac{3\times 10^{8}}{1.35\times 5\times 10^{14}}$

$=4.445\times 10^{-7}m$

$\lambda_{g}=\frac{\upsilon_{g}}{v}=\frac{c}{\mu_{g}.v}=\frac{3\times 10^{8}}{1.5\times 5\times 10^{14}}$

$=4.0\times 10^{-7}m$

$\lambda_{a}-\lambda_{g}=(4.445\times 10^{-7}-4.0\times 10^{-7})m$

$=0.445\times 10^{-7}m=445\ \overset{\circ}{A}$

109) Here, $a=A\ and\ b=2\ A,\ \phi=\pi/3,$

$R=?$

$R=\sqrt{a^{2}+b^{2}+2ab\ \cos\ \phi}$

$=\sqrt{A^{2}+4A^{2}+2A.2A\cos\pi/3}$

$=\sqrt{5A^{2}+4A^{2}\times\frac{1}{2}\ }=A\sqrt{7}$

110) Here, $I_{1}=I\ and\ I_{2}=4I$

As sources are coherent,

$\therefore\quad I=I_{1}+I_{2}+2\sqrt{I_{1}I_{2}}\cos{\phi}$

$When\ \phi=0,\ intensity\ is\ maximum$

$\therefore\quad I=I_{1}+I_{2}+2\sqrt{I_{1}I_{2}}\cos{\phi}$

$When\ \phi=\pi,\ intensity\ is\ minimum$

$\therefore\quad I_{min}=I+4I+2\sqrt{I\times 4I}\cos\pi$

$=5I-4I=I$

111) As, Intensity $\propto$ width of slit (w)

Also, Intensity $\propto$ square of amplitude

$\therefore \frac { w_{ 1 } }{ w_{ 2 } } =\frac { I_{ 1 } }{ I_{ 2 } } =\frac { a^{ 2 } }{ b^{ 2 } } =\frac { 1 }{ 4 }$

or $\frac { a }{ b } =\sqrt { \frac { 1 }{ 4 } } =\frac { 1 }{ 2 } \ or\ b=2a.$

$\therefore \frac { I_{ max } }{ I_{ min } } =\frac { (a+b)^{ 2 } }{ (a-b)^{ 2 } } =\frac { (a+2a)^{ 2 } }{ (a-2a)^{ 2 } } =\frac { 9 }{ 1 }$

112)

At X, when path diff. is zero, phase diff. $\phi =0$

$\therefore$ from $I=k\left[I_{ 1 }+I_{ 2 }+2\sqrt { I_{ 1 }I_{ 2 } } \cos { \phi } \right]$

$I_{ X }=k\left[a^{ 2 }+b^{ 2 }+2\sqrt { a^{ 2 }b^{ 2 } } cos\quad 0° \right]$

$=k\left[a^{ 2 }+b^{ 2 }+2ab \right]$

At Y, path diff.$=\frac { \lambda }{ 4 }$,

phase diff.$=\frac { 2\pi }{ 4 } =\frac { \pi }{ 2 }$ rad

$\therefore I_{ Y }=k\left[a^{ 2 }+b^{ 2 }+2\sqrt { \sqrt { a^{ 2 }b^{ 2 } } cos } \pi /2 \right]$

$=k\left[a^{ 2 }+b^{ 2 } \right]$

$\frac { I_{ X } }{ I_{ Y } } =\frac { k\left[a^{ 2 }+b^{ 2 }+2ab \right] }{ k\left[a^{ 2 }+b^{ 2 } \right] } =\frac { (a^{ 2 }+b^{ 2 })^{ 2 } }{ a^{ 2 }+b^{ 2 } }$

113) Here, $I_{ 0 }=K, \ where \ path \ diff. \ is \ \lambda$

$I=?, \ where \ path \ diff.=\lambda /3$

Phase diff., $\phi =\frac { 2\pi }{ 3 } =120$

From $I=I_{ 0 }cos^{ 2 }\phi /2$

$I=K\left(cos\frac { 120° }{ 2 } \right) =K\left(\frac { 1 }{ 2 } \right) ^{ 2 }=K/4$

114) Here, $\frac { I_{ max } }{ I_{ min } } =\frac { 9 }{ 25 } \frac { w_{ 1 } }{ w_{ 2 } } =?$

$\frac { I_{ max } }{ I_{ min } } =\frac { (a-b)^{ 2 } }{ (a+b)^{ 2 } } =\frac { 9 }{ 25 }$

$\therefore \frac { a-b }{ a+b } =\frac { 3 }{ 5 }$

$\frac { \frac { a }{ b } -1 }{ \frac { a }{ b } +1 } =\frac { 3 }{ 5 }$

$5\left(\frac { a }{ b } -1 \right) =3\left(\frac { a }{ b } +1 \right)$

$2\frac { a }{ b } =3+5=8, \ \frac { a }{ b } =4$

$\frac { w_{ 1 } }{ w_{ 2 } } =\frac { a^{ 2 } }{ b^{ 2 } } =(4)^{ 2 }=16$

115)

Here, $\lambda _{ 1 }=630 \ nm, \ \beta _{ 1 }=8.1 \ nm$

$\lambda _{ 2 }=?,\ \beta =7.2 \ nm$

As $\beta =\frac { \lambda \quad D }{ d } ,\ therefore, \ \frac { \lambda _{ 2 } }{ \lambda _{ 1 } } =\frac { \beta _{ 2 } }{ \beta _{ 1 } } =\frac { 7.2 }{ 8.1 } =\frac { 8 }{ 9 }$

$\lambda _{ 2 }=\frac { 8 }{ 9 } \lambda _{ 1 }=\frac { 8 }{ 9 } \times 630nm=560 \ nm$

116)

Here, $v=6\times 10^{ 14 }Hz,$

$\beta =0.75 \ mm=0.75\times 10^{ -3 }m, \ D=1.5m, \ d=?$

$\lambda =\frac { c }{ v } =\frac { 3\times 10^{ 8 } }{ 6\times 10^{ 14 } } =5\times 10^{ -7 }m$

As $\beta =\frac { \lambda \quad D }{ d } ,\quad d=\frac { \lambda \quad D }{ \beta } =\frac { 5\times 10^{ -7 }\times 1.5 }{ 0.75\times 10^{ -3 } }$

$=10^{ -3 } \ m$

117) Here, $d=0.2mm=2\times 10^{ 4 }m$

$\lambda =6000 \ \overset { \circ }{ A } =6\times 10^{ -7 }m, \ D=80 \ cm=0.8m$

(a) x=? n=2 (for second bright fringe)

$x=n\lambda \frac { D }{ d } =\frac { 2\times 6\times 10^{ -7 }\times 0.8 }{ 2\times 10^{ -4 } }$

$=4.8\times 10^{ -3 }m$

(b) x=? n=2 (for 2nd dark fringe)

$x=(2n-1)\frac { \lambda }{ 2 } .\frac { D }{ d } =\frac { 3\times 6\times 10^{ -7 }\times 0.8 }{ 2\times 2\times 10^{ -4 } }$

$=3.6\times 10^{ 3 }m$

---

118) Here, $d=0.15mm=1.5\times 10^{ -4 }m$

$\lambda =450nm=450\times 10^{ -9 }m, \ D=1.0m$

Distance of 2nd bright fringe

$x_{ 2 }=\frac { 2\lambda D }{ d } =\frac { 2\times 450\times 10^{ -9 }\times 1.0 }{ 1.5\times 10^{ -4 } }$

$=6\times 10^{ -3 }m=6mm$

Distance of 2nd dark fringe

$x'_{ 2 }=\frac { 3 }{ 2 } \frac { \lambda D }{ d } =4.5mm$

As D is increased, fringe width of each fringe $\left(\beta =\frac { \lambda D }{ d } \right)$ increases.

---

119) Here, $\lambda _{ 1 }=800nm$ and $\lambda _{ 1 }=800nm \ \lambda _{ 2 }=600 \ nm,$

$D=1.4m, \ d=0.28mm=0.28\times 10^{ -3 }m$

The bright fringes of two wavelengths will coincide at the least distance x from the central

maximum when $x=n\lambda _{ 1 }\frac { D }{ d } =(n+1)\lambda _{ 2 }\frac { D }{ d }$

$n\times 800=(n+1)600 \ or \ 4 \ n=3n+3;n=3$

$\therefore \quad x=3\times 800\times 10^{ -9 }\times \frac { 1.4 }{ 0.28\times 10^{ -3 } }$

$=12\times 10^{ -3 }m=12mm$

---

120) Here, $(D'-D)=5\times 10^{ -2 }m,$

$\beta '-\beta =3\times 10^{ -5 }m,\ d=10^{ -3 }m,\ \lambda =?$

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

$\therefore \quad \beta '-\beta =\frac { \lambda (D'-D) }{ d }$

$\lambda =\frac { (\beta '-\beta)d }{ (D'-D) } =\frac { 3\times 10^{ -5 }\times 10^{ -3 } }{ 5\times 10^{ -2 } }$

$=6\times 10^{ -7 }m=6000 \ \overset { \circ }{ A }$

---

121)

From $I_{ R }=4I_{ 0 }cos^{ 2 }\frac { \phi }{ 2 } =\frac { 1 }{ 2 } (4I_{ 0 })$

$cos^{ 2 }\frac { \phi }{ 2 } =\frac { 1 }{ 2 } ,\quad cos\frac { \phi }{ 2 } =\frac { 1 }{ \sqrt { 2 } } ;$

$\frac { \phi }{ 2 } =45°,\phi =90°$

Minimum distance from central maximum corresponding to $\phi =\pi /2$ would be :$\frac { \phi }{ 2\pi } \times \beta$

$x=\frac { \pi /2 }{ 2\pi } \times \left(\frac { \lambda D }{ d } \right) =\frac { 1 }{ 4 } \times \frac { 500\times 10^{ -9 }\times 1 }{ 1\times 10^{ -3 } } x$

$=125\times 10^{ -6 }m$

$=1.25\times 10^{ -4 }m$

---

122)

Here R=2m,

$f=\frac{R}{2}=\frac{2}{2}=1m$

Using morror formula, we have

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

$\Rightarrow \frac{1}{v}=\frac{u-f}{fu} \Rightarrow v=\frac{fu}{u-f}$

When Jogger is 39 m away, then u=-39m

$\Rightarrow$ we get

$v=\frac{fu}{u-f}=\frac{1\left(-39\right)}{-39-1}$ or $\ v=\frac{39}{40}$ m

As, the Jogger is running at a constant speed of 5 m/s, after 1 s, the positionof the image(v) for

u=-39+5

u=-34m

Again using the Equation we get

$\Rightarrow v=\frac{fu}{u-f}=\frac{1\left(-34\right)}{-34-1}$ or$\quad v=\frac{34}{35}$ m

Difference in apparent position of Jogger in 1s

$=\frac{39}{40}-\frac{34}{35}=\frac{1365-1360}{1400}=\frac{1}{280}$ m

Average speed of Joggers image $=\frac{1}{280}$ m/s

Similarly, for u=-29m, -19m and -9 m, average speed of Jogger image is $\frac{1}{150}$ m/s,$\frac{1}{60}$ m/s,$=\frac{1}{10}$ m/s respectively

The speed increases as the Jogger approaches the car >

This can be experienced by the person in the car.

---

123)

(ii)The frequency of reflected light remains same as the frequency of incident light because frequency only depends on the sourse of light.

---

124)

For convex mirror, $f > 0$, $u< 0$

From mirror formula, ($\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$,so$\frac{1}{v} > \frac{1}{f}$ orv

Also $\frac{1}{v} > \frac{-1}{u}$ or$\frac{-v}{u} < 1\quad$ i.e.$\quad m< 1$

Thus, image is always located between pole and focus of the mirror and is always dimished in size.

---

125)

Given, focal length of objective, $f = 1.25$cm

Focal length of eyepiece, $f_e = 5$cm

Least distance of distinct vision, D = 25cm

Angular magnification of lens,m = 30

The magnification produced by eyepiece

$m_e = 1+\cfrac{D}{f_e} = 1+\cfrac{25}{5} = 6$

The magnification produced by microscope,

$m = m_o \times m_e$

$30 = m_o \times 6$

Where, m_o is the magnification produced by objective lens.

$m_o = 5$

Again, we know that magnification of objective lens,

$\Rightarrow \quad 5=\cfrac{-v_0}{u_0}$

$\Rightarrow \quad v_0 = -5u_0$ ....(i)

Using lens formula for objective lens,

$\cfrac{1}{f_0}=\cfrac{1}{v_0}-\cfrac{1}{u_0}$

$\Rightarrow \cfrac{1}{1.25}=\cfrac{1}{-5u_0}-\cfrac{1}{u_0}=-\cfrac{6}{5u_0}$ [From Eq.(i)]

$u_0=-\cfrac{6}{5}\times 1.25=-1.5$cm

$v_0=-5u_0$

$=-5(-1.5)=7.5$cm

Thus, the objective should be placed at a distance of 1.5cm from the objective lens to get the desired magnification.(1)

Now, using the lens formula for eyepiece,

$\cfrac{1}{f_e}=\cfrac{1}{v_e}-\cfrac{1}{u_e}$

$\Rightarrow \quad \cfrac{1}{u_e}=\cfrac{1}{v_e}-\cfrac{1}{f_e}$

$=-\cfrac{1}{25}-\cfrac{1}{5}=-\cfrac{6}{25}$ $[\because \quad v_e=-25\text{cm}]$

$u_e=-4.17$cm

The separation between objective and eyepiece

$\left|v_0\right|+\left|u_e\right|=4.17+7.5=11.67$cm

Thus, the microscope is settled as the distance between eyepiece and objective is 11.67cm.

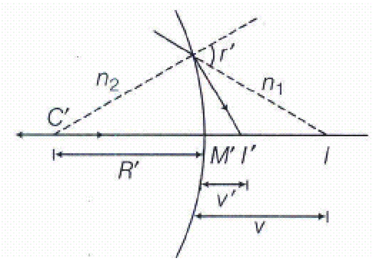
126)

The magnifying power of a telescope is equal to the ratio of the visual angle substended at the eye by final image formed at least distance of distinct vision to the visual angle subtended at naked eye by the object at infinity.

127)

(i) $\frac{n_1}{v}-\frac{n_2}{u}=\frac{n_2-n_1}{R}$ ....(i)

(ii) Now, the image I' acts as a virtual object for the second surface that will form a real at I. As, refraction takes place from denser to rarer medium,



$\therefore \quad \frac{-n_2}{v}+\frac{n_1}{v'}=\frac{n_2-n_1}{R'}$ ....(ii)

On adding Eqs. (i) and (ii), we get

$\frac{1}{f}=\left(n_{21}-1\right)\left(\frac{1}{R}-\frac{1}{R'}\right) \ \left[\therefore n_{21}=\frac{n_2}{n_1}, \frac{1}{f}=\frac{1}{v}-\frac{1}{u}\right]$

128) **For microscope f_0** =1.25cm, f_e =5cm

When final image forms at infinity, then mangnification produced by eye lens is given by

$m=-\cfrac{L}{f_0}.\cfrac{D}{f_e}$

$\Rightarrow -30=-\cfrac{L}{1.25}\times\cfrac{25}{5}$

$L=\cfrac{30\times 1.25}{5}$

$\Rightarrow$ L=7.50cm

For objective lens,v_0 = L = 7.5cm, f_0 = 1.25cm

Applying lens formula,

$\cfrac{1}{f_0}=\cfrac{1}{v_0}-\cfrac{1}{u_0}$

$\Rightarrow \cfrac{1}{1.25}=\cfrac{1}{7.5}-\cfrac{1}{u_0}$

$\cfrac{1}{u_0}=\cfrac{1}{7.5}-\cfrac{1}{1.25}$

$=\cfrac{1.25-7.5}{7.5\times 1.25}=-\cfrac{6.25}{7.5\times 1.25}$

$\Rightarrow u_0=\cfrac{7.5\times 1.25}{6.25}=-1.5$cm

The object must be at a distance of 1.5cm from objective lens.

129)

(i) He refers to the process of dispersion of light. Dispersion of light is due to the different velocities of light rays in a medium.

(ii) Studying and analysing the spectrum of distant light sources.

(iii) Curiosity, research mindedness and awareness.

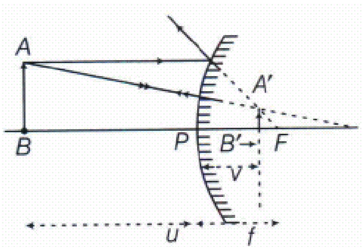
130) (i) The values we observe in Kanchan are as follows:

(a) Concern about others

(b) Observation of traffic rules

(c) Resposible citizen

(ii) Convex mirror is used in rear viwe in scooties. The ray diagram for convex mirror is



131)

The working of an optical fiber is based with respect to air, { \mu }_{ 2 }=^{ a }{ { \mu }_{ g }=1.68 }

Refractive index of outer coating material with respect to air, { \mu }_{ 1 }=^{ a }{ { \mu }_{ outer }=1.44 }

Let the critical angle be i_c .

So, \mu =\frac { { \mu }_{ 2 } }{ { \mu }_{ 1 } } =\frac { 1 }{ sin{ \ i }_{ c } }

\Rightarrow \ sin \ { i }_{ c }=\frac { { \mu }_{ 2 } }{ { \mu }_{ 1 } } =\frac { 1.44 }{ 1.68 } =0.8571

\Rightarrow \ { i }_{ c }{ =sin }^{ -1 }\left(0.8571 \right) \approx { 59 }^{ o }

The total internal reflection will take place when the angle of incidence i will be greater than the critical angle i_c , i.e. i > i_c = 59^o or when angle of reflection, rmax

where, r_{max} = 90^o-i_c=90^o-59^o=31^o So,

^{ a }{ { \mu }_{ g } }=\frac { sin \ { i }_{ max } }{ sin \ { r }_{ max } } =1.68 So,

or \ \ sin \ { i }_{ max }=1.68 \ sin \ { 31 }^{ o }=1.68\times 0.5150=0.8652

{ i }_{ max }={ sin }^{ -1 }(0.8652)\approx { 60 }^{ o }

Thus, all the rays which are incident in the range 0o , will suffer total internal reflection in the pipe (but i \neq 0).

(ii) If there is no outer covering of the pipe, then reflection inside the pipe shall place from the glass to air.

sin \ { i }_{ c }^{ ' }=\frac { { \mu }_{ 1 } }{ { \mu }_{ 2 } }

=\frac { 1 }{ 1.68 } =0.5952 \ [\because { \mu }_{ 1(air) }=1 \ and \ { \mu }_{ 2 }=1.68]

Critical angle, { i }_{ c }^{ ' }={ 36.5 }^{ o }

Now, \frac { { sin \ i }_{ max }^{ ' } }{ { sin \ r }_{ max }^{ ' } } =\mu =1.68

\Rightarrow \ sin \ { i }_{ max }^{ ' }=1.68\times { sin \ r }_{ max }^{ ' }

=1.68\times sin \ ({ 53.5 }^{ o })

=1.35 \ i.e \ > \ 1

So, for all values (i.e 0 to 90^o), total internal reflection inside the pipe would take place. Thus, all the rays incident at angles in the range zero to 90^o will suffer total internal reflection.

132) (i) Kritika is intelligent and has good knowledge of physics. She is helpful and can apply her mind at required time.

(ii) Plane mirror is used in periscope.

(iii) Nature of image in plane mirror is

(a) Virtual

(b) object distance = image distance

(c) same size as that of object.

133)

(i) Endoscopy is based on Total Internal Reflection (TIR) principle. It has tubes which are made up of optical fibres which are used for transmitting and receivingelectrical signals which are converted to light by suitable transducer.
(ii) Humanity and charity.
(iii) Doctor gave monetary help to Chetan by understanding his poor financial condition.

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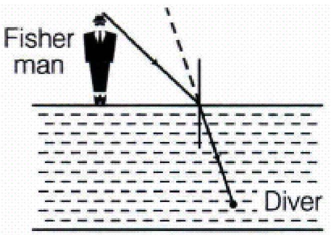
134)

(i) Yes, plane and convex mirrors can produce the real image, if the rays incident on the plane or convex mirror are converging to a point behind the mirror. A plane or convex mirror can produce a real image, if object is virtual.
(ii) No, there is no contradiction because virtual image formed by the spherical mirror acts as virtual object for eye lens. Our eye lens is convergent and it forms a real image of virtual object on retina.
(iii) As, the fisherman is in air, the rays of light travels from rarer to denser medium, so they bend towards the normal. Therefore, the fisherman appears taller.



(iv) Yes, the apparent depth decreases, further when water tank is viewed obliquely as compared to the depth when seen normally.

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135)

(i) Being a phtsics student, he knows that light rays from inside the glass bends away from the normal and appear to diverge. So, it gives false impression that ther is more amount of liquid in bottle.
(ii) Affection, patience and knowledge about refraction.

---

136) (i) The values shown by him are as follows:
(a) Consulting others in case of need
(b) Curosity
(c) Sharing knowledge.
(ii) From these three lenses, he will use a lens of power 0.5D for objective and lens of power 10D for eyepiece.

---

137) Here, slit width,d = 0.28 mm = $0.28\times { 10 }^{ -3 }m$
Distance between slit and screen, D = 1.4m
$y=1.2cm=1.2\times { 10 }^{ -2 }m,n=4,\lambda =?$
For constructive interference,
$y=\eta \lambda \frac { D }{ d }$ or $\lambda =\frac { yd }{ nD }$
$=\frac { 1.2\times { 10 }^{ -2 }\times 0.28\times { 10 }^{ -3 } }{ 4\times 1.4 } =6\times { 10 }^{ -7 }m$
= 600 nm
Hence, the wavelength of the light is 600 nm.

---

138) (i) The two values that can be related with Anita and Lata are helping nature and eagerness to share knowledge
(ii) It is defined as the locus of points having the same phase of oscillations.

---

139)

(i) Shyam is responsible, caring and intelligent.

(ii) It is the phenomena of redistribution of light energy in a medium due to the superposition of two coherent light waves.

(iii) For constructive interference or bright fringe, the phase difference between the two coherent light waves should be $2n\pi$

i.e $\phi =2n\pi$ (n=0,1,2,3)

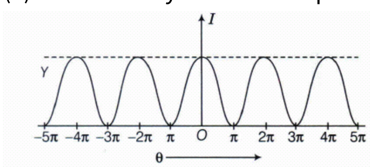
140)

(i) The teacher displays the qualities of deep knowledge of the phenomenon and eagerness to explain it to the child.

(ii) The phenomenon involved in a thin film is interference. Different colours of light interfere at different points in space and hence, child is able to see different colours.

141) (i) Rahim showed honesty and sincerity, while cashier had showed knowledge about the subject.

(ii) The intensity distribution pattern of interference is shown in the figure.



142)

(i) The teacher displays the quality of the knowledge of the phenomenon and the conditions under which it occurs.In producing the diffraction pattern again, he demonstrates with compassion, kindness towards the child and eagerness to share the knowledge.

(ii) The necessary condition for diffraction is that the slit width should be less than wavelength of light.

143) (ii) For $\lambda _{ 1 }=590nm$

Location of 1st maxima,$\lambda _{ 1 }=\left(2n+1 \right) \frac { D\lambda _{ 1 } }{ 2a }$

If $n=1 \ \Rightarrow \lambda _{ 1 }=\frac { 3D\lambda _{ 1 } }{ 2a }$

For $\lambda _{ 2 }=596nm$

Location of 2nd maxima,$\lambda _{ 2 }=\left(2n+1 \right) \frac { D\lambda _{ 1 } }{ 2a }$

If $\lambda _{ 2 }=\left(2n+1 \right) \frac { D\lambda _{ 1 } }{ 2a }$

Path difference $\lambda _{ 2 }-\lambda _{ 1 }=\frac { 3D }{ 2a } \left(\lambda _{ 2 }-\lambda _{ 1 } \right)$

$=\frac { 3\times 1.5 }{ 2\times 2\times { 10 }^{ -6 } } \left(596-590 \right) \times { 10 }^{ -9 }$

$=6.75\times { 10 }^{ -3 }m$

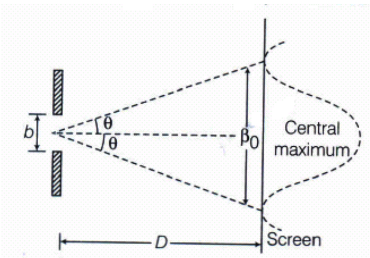
144)

(ii) As, the number of point sources increases, their contribution towards intensity also increases. Intensity varies as square of the slit width. Thus, when the width of the slit is made double the original width, intensity will get four times of its original value.

Width of central maximum is given by $\beta =\frac { 2D\lambda }{ b }$

Where, D = distance between screen and slit,

λ =wavelength of the light,b = size of slit.



So, with the increase in size of slit, the width of central maxima decreases. Hence, double the size of the slit would result as half the width of the central maxima.

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145)

(i) Here,

$\lambda =600 \ nm=600\times { 10 }^{ -9 }m=6\times { 10 }^{ -7 }m$

$\theta ={ 0.1 }^{ \circ }=\frac { 0.1\pi }{ 180 } rad,d=?$

From angular width, $\theta =\frac { \lambda }{ d }$

$\Rightarrow \ d=\frac { \lambda }{ \theta } =\frac { 6\times { 10 }^{ -7 } }{ \frac { \pi }{ 180 } \times 0.1 } =3.44\times { 10 }^{ -4 }m$

(ii) The frequency and wavelength of reflected wave will not change. The refracted wave will have same frequency. The velocity of light in water is given by $v=f\lambda$

where, v=velocity of light

f=frequency of light

λ =wavelength $\ of \ light$

If velocity will decrease, then wavelength(λ) will also decrease.

---

146)

Light waves, originating from two independent monochromatic sources, will not have a monochromatic source, will not have a constant phase difference. Therefore, these sources will not be coherent and, therefore, would not produce a sustained interface pattern.

$y = y_1 + y_2$

$= a \cos wt + a \cos (wt + \phi)$

$= 2a \cos{\phi\over2}.\cos(wt+{\phi\over2})$

Amplitude of resultant displacement is $2a \cos {\phi\over2}$

$\therefore$ Intensity,

$I = 4a^2 \cos2 {\phi\over2}$

A path difference of λ , corresponds to a phase difference of 2π

$\therefore$ The intensity, $K = 4a^2 \Rightarrow a^2 = {k\over4}$

A path difference of ${\lambda\over3}$, corresponds to a phase diference of ${2\pi\over3}$

$\therefore$ Intensity = 4a2 cos2 $\phi/2$

$= 4 \times a^2 \times \cos^2 {{2\pi/3}\over2}$

$= 4 \times {k\over4} \times { \left(\frac { 1 }{ 2 } \right) }^{ 2 }={k\over4}$

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147)

(ii) We know that, $I={ I }_{ \circ }cos^{ 2 }\theta$

Intensity at ${ O }_{ 1 }$,$I={ I }_{ \circ }cos^{ 2 }\theta$

Intensity at ${ O }_{ 2 }{ I }_{ 1 }={ I }cos^{ 2 }\theta _{ 1 }$

$={ I }_{ \circ }cos^{ 2 }\theta cos^{ 2 }{ 60 }^{ \circ } \ \left[\therefore \theta _{ 1 }={ 60 }^{ \circ } \right]$

${ I }_{ 1 }=\frac { { I }cos^{ 2 }\theta _{ 1 } }{ 4 }$

Intensity at ${ O }_{ 3 }$,${ I }_{ 2 }={ I }_{ 1 }cos^{ 2 }\theta _{ 2 }$

$=\frac { { I }_{ \circ }cos^{ 2 }\theta }{ 4 } \times cos^{ 2 }{ 90 }^{ \circ }\quad \left[\therefore \theta _{ 2 }={ 90 }^{ \circ } \right]$

$=0$

148)

The components of electric vector associated with light wave, along the direction of aligned molecules of a polaroid, get absorbed. As a result after passing through it, the components perpendicular to the direction of aligned molecules will be obtained in the form of plane polarised light.

(b) When unpolarised light is incident on the boundary between two transperent media, the reflected light is polarised, with electric vector perpendicular to the plane of incidence when the reflected and refracted light rays make a right angle, as shown in the figure below.

Since, $\angle CBQ+\angle QBD={ 90 }^{ o }$

$(90 - i_B) + (90 - r) = 90^o$

$i_B + r = 90$

$r = 90 - i_B$

Using Snell's law,

$\mu =\frac { sin{ i }_{ B } }{ sinr }$

$=\frac { sin{ i }_{ B } }{ sin\left(90-{ i }_{ B } \right) }$

$=\frac { sin{ i }_{ B } }{ { cosi }_{ B } }$

$\mu =tan{ i }_{ B }$.

149) (a) Convex mirror, to get a wide view of traffic behind

(b) Compassion courtesy concern for others knowledgeable

150)

(a) The values displayed by ajay are :

(i) Higher degree of general awarness

(ii) Ability to convince someone

(iii) Helping and caring nature

(b) The virtual image cannot be formed on the screen It is true.But when we use an approprate convex lens to coverage the rays, then these convegent rays can be focussed on the screen.The convex lens of eye serves this purpose. In that case the virtual image acts as a virtual object for the converging lens and thus forms a real image which can be formed on the screen.

151)

(a) The values displayed by ganesh are :

(i) High degree of general awareness

(ii) Presence of mind.

(iii) Social responsibility

(b) refraction

(c) Suspend the particles of glass in a special liquid and particles are viewed through a microscope.Change the temperature particles of glass disappear. Then they probably came from the same broken pane of glass.In thus case refractive index of liquid becomes equal to the refractive index of particles of the glass.

152) (a) The Values shown by Shown Shive are :

(i) Presence of mind

(ii) High degree of general awareness

(iii) Social responsibility

(b) Plane, concave and convex mirrors.

(c) The special mirror is the combination of three mirrors which show their characteristics property.

(i) Convex mirror is the upper portion of the mirror

(ii) Concave mirror is the middle portion of the mirror

(iii) Plane mirror is the lower portion of the mirror.

153) (a)

Sno	**Interference**	**Diffraction**
1.	Width of central maxima is same as that of the other fringes.	Width of central maxima is more than of the other fringes
2.	all Bright fringes are of equal intensity	Intensity of secondary maxima keeps on decreasing.
3.	Large number of fringes	Only a small number of fringes.

(b) ${ y }_{ n }=\frac { n\lambda D }{ d }$

$d=\frac { n\lambda D }{ { y }_{ n } }$

$=\frac { 1\times 500\times { 10 }^{ -9 }\times 1 }{ 2.5\times { 10 }^{ -3 } } m$

$=2\times { 10 }^{ -4 }m(=0.2mm)$

154) (a) Any one of the values displayed by puja-curiosity/observation etc.

Any one of the values displayed by father-concern/knowledge/sense of duty etc.

(b) Interference of sunlight due to the soap bubbles.

155)

(a) (i) The least distance of distinct vision increase with age because the increase in the minimum possible focal length of the eye lens or contraction of the eye ball.

(ii) This defeat can be corrected by placing a convex lens in front of the eye.

(b) (i) Empathy : Helping and Caring nature.

(ii) Concern for his uncle.

156) (a) Reflecting telescope.

(b) No chromatic aberration, mirrors are relatively lighter and cheper compared to the lens.

(c) First hand experience, including a scientific temper, tem work, enthusiasm,kindling curiosity.

157)

(a) The values displayed by Rani are :

(i) High degree of general awareness

(ii) Helping and caring nature.

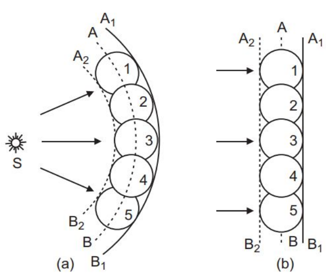
(b) In normal adjustment of telescope, the final image is formed at infinity

(c) Out of these three lenses, lens of power 0.5 D wilbe used for objective while lens of power 10 D as eye piece for construction of such telescope.

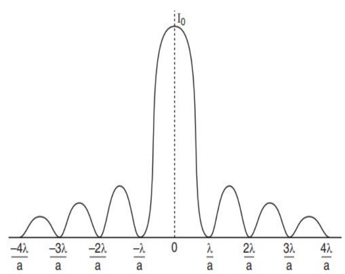
158)

Huygen's principle: Each point of wavefront is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions with the speed of the wave. The . common tangent/forward envelope, to all these secondary wavelets gives the new wavefront at later time.

Application to diffraction pattern: All the points of incoming wavefront (parallel to the plane of slit) are in phase with plane of slit. However the contribution of the secondary wavelets from different points, at any point, on the observation screen have phase differences dependent on the corresponding path differences. Total contribution, at any point, may add up to give a maxima or minima dependent on the phase differences.



Plot of intensity distribution and explanation:



The central point is a maxima as the contribution of all secondary wavelet pairs are in phase here. Consider next a point on the screen where an angIe,\theta =3\lambda /2a divide the slit into three equal parts. Here the first two-thirds of the slit can be divided into two halves which have a, \lambda /2 path difference. The contributions of these two halves cancel. Only the remaining one-third of the slit contributes to the intensity at a point between the two minima. Hence, this will be much weaker than the central maxima (where the entire slit contributes in phase). We can similarly show that there are maxima at \theta = (n + 1/2) \lambda/'a with n = 2, 3, etc. These become weaker with increasing n, since only one-fifth, one-seventh, etc., of the slit contributes in these cases.

159)

(a) The values noticed in both the students are:

(i) Curiosity,

(ii) Creativity.

(b) The size of the aperture/obstacle should be comparable to the wavelength of the light.

(c) As the wavelength of X-rays is much smaller than that of yellow light, so the diffraction pattern is not seen when the yellow light is replaced by X-rays in such condition.

160)

(a) The values shown by Neelam are:

(i) High degree of general awareness

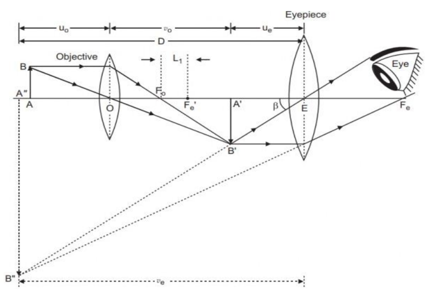
(ii) Ability to convince someone.

(iii) Thinking skill

(iv) Concern for her friend.

(b) The size the obstacle should be comparable to the wavelength of the light wavelength of the light wave in order to obtain an observable diffraction pattern. Size of the wall is 7 m, Which is comparable enough with sound wave but not with the light wave. So, the two students cannot see each other but can talk to each other.

161)



Expression for total magnification:

Magnification due to the objective, $m_o = \frac{h}{h} = \frac{L}{f}$

Magnification m" due to eyepiece, (when the final image is formed at the near point)

$m_e = \left(1+\frac{D}{f} \right)$

Total magnification,

$m = m_o m_e = \frac{l}{f_{\circ}} \left(1+\frac{D}{f} \right)$

Estimtion of magnifying power :

Given: u_o=-1.5 cm;f_o=1.25 cm;

we have

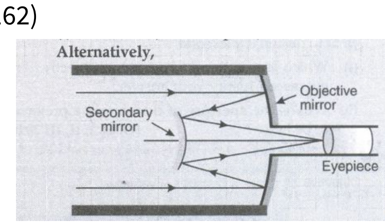
$\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$\frac{1}{1.25} = \frac{1}{v_o} - \frac{1}{-1.5} \Rightarrow v_o = 7.5\quad cm$

$m = \frac{v_o}{v_o} \left(1+\frac{d}{f_e} \right)$

$\frac{7.5}{-1.5} \left(1+\frac{25}{5} \right) \Rightarrow m = -30$

162)



For large magnifying power fo should be large and f_e should be small.

For higher resolution diameter of the objective

should be large.

(b) $\frac{1}{v_0} - \frac{1}{v_0} = \frac{1}{f_0}$

$\frac{1}{v_0} = \frac{1}{f_0} = \frac{1}{u_0} = \frac{1}{1.25} - \frac{1}{2.5} = \frac{1}{2.5}$

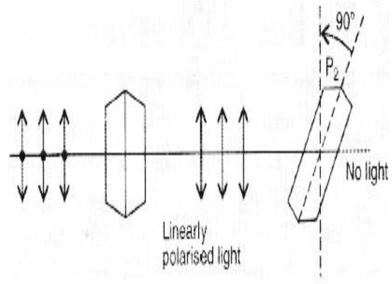
v_o=2.5 cm

= (2.5 + 5.0) cm = 7.5 cm

163)

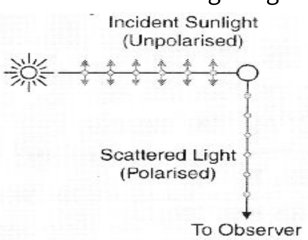
A light wave, in which the electric vector oscillates in all possible directions in a plane perpendicular to the direction of propagation, is known as unpolarized light.

If the oscillations of the electric vectors are restricted to put one direction, in a plane perpendicular to the direction of propagation, the corresponding light is known as linearly polarized light.



Unpolarized light passing through Polaroid P_I gets linearly polarized. [As the electric field vector components parallel to the pass axis of P_I are transmitted whereas the others are blocked]. When this polarized light is incident on a Polaroid P_2, kept crossed with respect ot P_I then these components also get blocked and no light is transmitted beyond P_2.

(c) It is due to scattering of light by molecules of earth's atmosphere



Under the influence of the electric field of the incident (unpolarized) wave, the electrons in the molecules acquire components of motion in both these directions. Charges, accelerating parallel to the double arrows, do not radiate energy towards the observer since their acceleration has no transverse component. The radiation scattered by the olecule is therefore represented by dots, i.e., it is polarized perpendicular to plane of figure.

164)

(a) When an unpolarized light falls on a Polaroid, it lets only those of its electric vectors that are oscillating along a direction perpendicular to its aligned molecules to pass through it. The incident light thus gets linearly polarised.

Alternatively, Whenever unpolarised light is incident on a transparent surface, the reflected light gets partially or completely polarized / the reflected light gets completely polarized when the reflected and refracted light are perpendicular to each other.

(b) Let \theta be the angle between the pass axis of A and C

Intensity of light passing through A = $1_0/2$

Intensity of light passing through C = $(1_0/2)\cos^2$ \theta

Intensity of light passing through B = $(1_0/2)\cos^2$ \theta

[$\cos^2$ (90 - \theta)]

\Rightarrow \frac { { I }_{ o } }{ 2 } \times \frac { { sin }^{ 2 }\theta }{ 4 } =\frac { { I }_{ o } }{ 8 } (given)

\therefore sin \ 2\theta = 1

2\theta ={ 90 }^{ ° }

The third Polaroid is placed at \theta = 45°

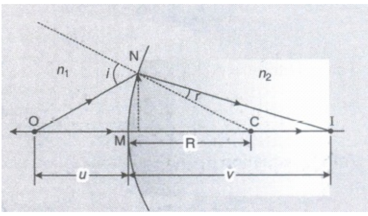
165)

(a) Curiosity to learn, approaching the teacher to learn new things, inquisitiveness.

(b) Definition of polarization.

(c) Sun glasses, LCD, CD players.

166)



The incident rays coming from the object 'O' kept in the rarer medium of refractive index n_1, incident on the refracting surface NM produce the real image at I.

From the diagram,

$\angle i=\angle NOM+\angle NCM$

$=\frac { NM }{ OM } +\frac { NM }{ MC }$

$\angle r=\angle NCM-\angle NIM$

$=\frac { NM }{ MC } -\frac { NM }{ MI }$

From Snell's law

$\therefore \frac { { n }_{ 2 } }{ { n }_{ 1 } } =\frac { sini }{ sinr } \sim \frac { i }{ r }$

(for small angles, $\sin \theta \sim \theta$)

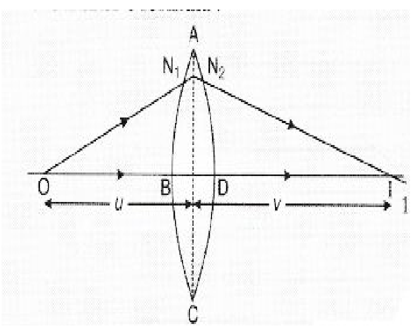
$\therefore \quad { n }_{ 2 }r={ n }_{ 2 }i$

or ${ n }_{ 2 }\left(\frac { NM }{ MC } -\frac { NM }{ MI } \right) ={ n }_{ 1 }\left(\frac { NM }{ OM } +\frac { NM }{ MC } \right)$

or ${ n }_{ 2 }\left(\frac { 1 }{ +rR } -\frac { 1 }{ +v } \right) ={ n }_{ 1 }\left(\frac { 1 }{ -u } +\frac { 1 }{ R } \right)$

or $\frac { { n }_{ 2 }-{ n }_{ 1 } }{ R } =\frac { { n }_{ 2 } }{ v } -\frac { { n }_{ 1 } }{ u }$

Lens maker's formula:



The first refracting surface ABC forms the image I_1 of the object O. The image I_1 acts as a virtual object for the second refracting surface ADC which forms the real image I as shown in the diagram

$\therefore$ for refraction at ABC

$\frac { { n }_{ 2 } }{ { v }_{ 1 } } -\frac { { n }_{ 1 } }{ u } =\frac { { n }_{ 1 }-{ n }_{ 2 } }{ { R }_{ 2 } }$

For refraction ADC

$\frac { { n }_{ 1 } }{ { v } } -\frac { { n }_{ 2 } }{ { v }_{ 1 } } =\frac { { n }_{ 1 }-{ n }_{ 2 } }{ { R }_{ 2 } }$

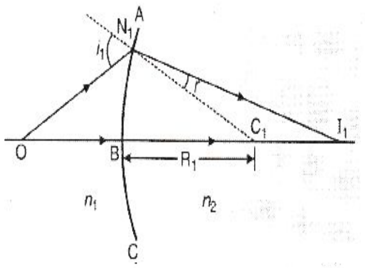
Adding equation (i) and equation (ii), we get

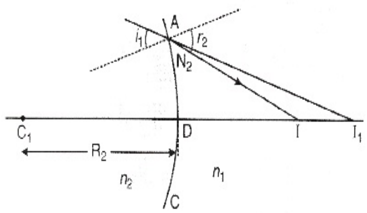
$\frac { { n }_{ 1 } }{ v } -\frac { { n }_{ 1 } }{ u } =\left({ n }_{ 2 }-{ n }_{ 1 } \right) \left(\frac { 1 }{ { R }_{ 1 } } -\frac { 1 }{ { R }_{ 2 } } \right)$

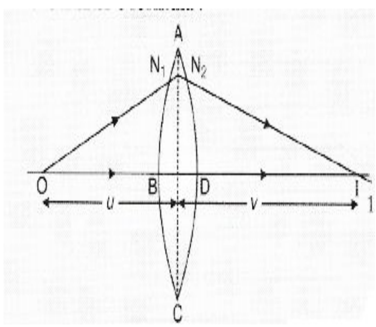
$\frac { 1 }{ v } -\frac { 1 }{ u } =\left(\frac { { n }_{ 2 } }{ { n }_{ 1 } } -1 \right) \left(\frac { 1 }{ { R }_{ 1 } } -\frac { 1 }{ { R }_{ 2 } } \right) \frac { 1 }{ f } =\left({ \mu }_{ 21 }-1 \right) \left(\frac { 1 }{ { R }_{ 1 } } -\frac { 1 }{ { R }_{ 2 } } \right)$

167)

)







The first refracting ABC forms the image I_1 of the object O. The image I_1 acts as virtual object for the second refracting surface ADC, which forms the real image I as shown in the diagram

For refraction at ABC

$$\frac{n_2}{v_1}-\frac{n_1}{u}=\frac{n_2-n_1}{R_1}$$

For refraction at ADC

$$\frac{n_1}{v}-\frac{n_2}{v_1}=\frac{n_1-n_2}{R_2}$$

Adding equation (i) and equation (ii)

$$\frac{n_1}{v}-\frac{n_2}{u}=\left(n_2-n_1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\frac{1}{v}-\frac{1}{u}=\left(\frac{n_2}{n_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

We know, If $u=\infty, v=f$

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

$$\frac{1}{f}=\left(\frac{n_2}{n_1}-1\right)\frac{1}{R_1}-\frac{1}{R_2}$$

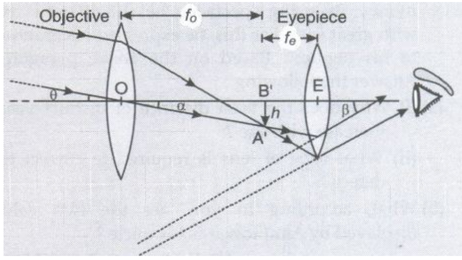
$$\frac{1}{f}=\left(\mu_{21}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\frac{1}{f}=\left(\mu_{21}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\frac{1}{f}=\left(1.55-1\right)\left(\frac{1}{R}-\frac{1}{-R}\right)$$

$$=0.55\times\frac{2}{R}$$

$$R=0.55\times 2\times 20=22\ cm$$

168) 

Derivation

Magnifying Power

$M = \frac { tan\beta }{ tan\infty } =\frac { \beta }{ \infty }$

Final image is formed at infinity when the image 'RB' is formed by the objective lens at the focus of the eye piece,

$m = \frac { h }{ { f }_{ e } } =\frac { { f }_{ 0 } }{ h }$

$=\frac { { f }_{ 0 } }{ { f }_{ o } }$

(b) Given

$f_o + f_e = 105$, $f_o = 20 f_e$

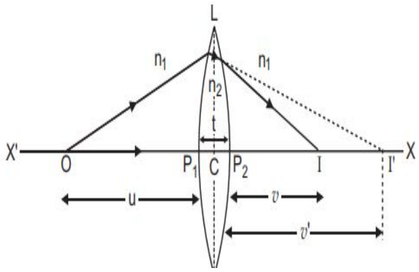
$20fe+f_e = 105$

$f_e = 105/21-5$ cm

$f_e = 20 \times 5-100$ cm

Magnification, $m =\frac { { f }_{ 0 } }{ { f }_{ o } }$ $=\frac { 100 }{ 5 } =20$

169)



For refraction at the first surface

$\frac{n_2}{v_1}-\frac{n_1}{u}=\frac{n_2-n_1}{R_1}$

For the second surface, I_1 acts as a virtual object (located in the denser medium) whose final real image is formed in the rarer medium at I.

so for refraction at this surface, we have

$\frac{n_2}{v}-\frac{n_1}{v_1}=\frac{n_2-n_1}{R_2}$

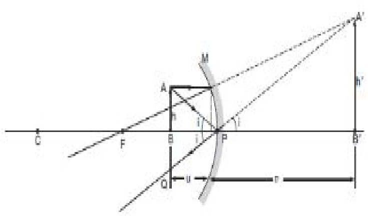
From the above two equation, $\frac{1}{v}-\frac{1}{u}=\left(\frac{n_2}{n_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

The point, where image of an object, located at infinity is formed, is called the focus F, of the lens and the distance f gives its focal length.

So for $u=\infty, v=+f$

$\Rightarrow \frac{1}{f}=\left(\frac{n_2}{n_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

(b)



$\triangle ABP$ is similar to $\triangle A'B'P$

So $\frac{A'B'}{AB}=\frac{B'P}{BP}$

Nor A'B'=I, AB = O, B'P = + v and BP = - u

So magnification $m=\frac{I}{O}=-\frac{v}{u}$

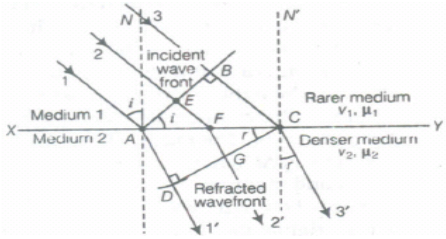
170)

Wavefront A wavefront is the locus of all particles oscillating in same phase (a surface of constant phase) of oscillations.

A line perpendicular to a wavefront is called a ray.

Laws of refraction (Snell's Law) at a plane surface by Huygens' principle

Let 1, 2, 3 be the incident rays and 1', 2', 3' be the corresponding refracted rays.



If V_1, V_2 are the speed of light in the two mediums and t is the time taken by light to go from B to C to D or E to G through F, then

$t = {{EF}\over{{v}_{1}}}+{{FG}\over{{v}_{2}}}$

In $\triangle$ AFE, $\sin i = {{EF}\over{AF}}$

In $\triangle$ FGC, $\sin r = {{FG}\over{FC}}$

or $t = {{AF\ \sin\ i}\over{{v}_{i}}}+{{FC\ \sin \ r}\over{{v}_{2}}}$

or $t = {{AC\ \sin\ r}\over{{v}_{2}}}+AF\left({ { \sin\ i }\over{ {v}_{i} } }-{ {\sin\ r }\over{ {v}_{2} } } \right)$

For rays of light from different parts on the incident wavefront, the values of AF. are different. But light from different points of the incident wavefront should take the same time to reach the corresponding points on the refracted wavefront.

So, t should not depend upon AF.

This is possible only, if

${ { \sin\ i }\over{ {v}_{i} } }-{ { \sin\ r }\over{ {v}_{2} } }=0;{ { \sin\ i }\over{ \sin\ r } }={ { {v}_{1} }\over{ {v}_{2} } }=\mu$

Now, if c represents the speed of light in

vacuum, then ${\mu}_{1}={{c}\over{{v}_{1}}}$ and ${\mu}_{2}={{c}\over{{v}_{2}}}$

as the refractive indices of medium 1 and medium 2, respectively.

Then, ${\mu}_{1} \sin i = {\mu}_{2} \sin r$

$\Rightarrow \mu={{\sin \ i}\over{\sin\ r}}$

This is known as **Snell's law of refraction**.

Polarisation also occurs when light is scattered while traveling through a medium. When light strikes the atoms of a material, it will often set the electrons of those atoms into vibration. The vibrating electrons then produce its own electromagnetic wave that is radiated outward in all directions. This newly generated wave strikes neighbour atoms, forcing their electrons into vibrations at the same original frequency these vibrating electrons produce another electromagnetic wave that is once again radiated put ward in all directions. This absorption and re-emission of light wave cause the light to be scattered about the medium. The scattered light is partially polarised.

From Brewster's law

$\mu = \tan i_p$

where, i_p = Brewster's angle

Given, $\mu = 1.5$

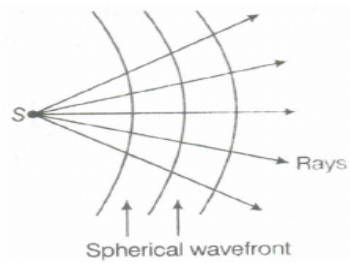
$1.5 = \tan ip$

$ip = \tan^{-1}\left({{3}\over{2}} \right)$

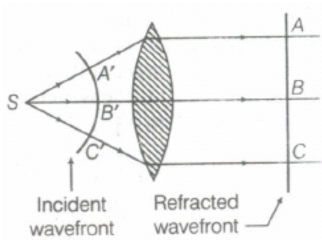
171)

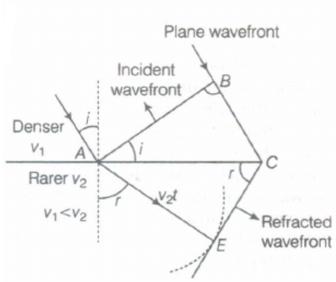
A wavefront is defined as the locus of all the particles vibrating in same phase at any instant. A lines perpendicular to the wavefront in the direction of propagation of light wave is called a ray.

The wavefront will be spherical of increasing radius as shown in figure



When sources is at the focus, the rays coming out of the convex lens are parallel. so wavefront is plane as shown in figure.





172)

Huygens' Principle Each point on the primary wavefront acts as a source of secondary wavelets, sending out disturbance in all directions in a similar manner as the original source of light does.

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

173)

To find the point of coincidence of bright fringes, we can equate the distance of bright fringes from the central maxima, made by both the wavelengths of light.

Given, D = 1 m, d = 4×10^{-3} m, $\lambda =$ 560 nm,

and ${\lambda}_{2}$ = 420 nm

Let nth order bright fringe of ${\lambda}_{1}$ coincides with (n + 1)th order bright fringe of ${\lambda}_{2}$.

$\Rightarrow {{D{\lambda}_{1}}\over{d}}={{D(n+1){\lambda}_{2}}\over{d}}$ $({\lambda}_{1} > {\lambda}_{2})$

$\Rightarrow n{\lambda}_{1}=(n+1){\lambda}_{2}$

$\Rightarrow {{n+1}\over{n}}={{{\lambda}_{1}}\over{{\lambda}_{2}}}$

$1+{{1}\over{n}}={{560\times{10}^{-9}}\over{420\times{10}^{-9}}}\Rightarrow 1 + {{1}\over{n}}={{4}\over{3}}$

$\Rightarrow {{1}\over{n}}={{1}\over{3}} \Rightarrow n = 3$

$\therefore$ Least distance from the central fringe where bright fringe of two wavelength coincides

= Distance of 3rd order bright fringe of ${\lambda}_{1}$

$\Rightarrow {y}_{n}={{3D{\lambda}_{1}}\over{d}}={{3\times1\times560\times{10}^{-9}}\over{4\times{10}^{-3}}}$

$y_n = 420 \times 10^{-6}$ m = 0.42×10^{-3} m

$\therefore y_n = 0.42$ mm

Thus, 3rd bright fringe of ${\lambda}_{1}$ and 4th bright fringe of ${\lambda}_{2}$ coincide at 0.42 mm from central fringe.

174)

The separation between two consecutive bright fringes gives fringe width (β) of dark fringe and vice-versa.

Fringe width, $\beta={{D\lambda}\over{d}}$

Forgiven Young's double slit experiment, D and d are constants

$\Rightarrow {{{\beta}_{1}}\over{{\beta}_{2}}}={{{\lambda}_{1}}\over{{\lambda}_{2}}}$ ...(i)

as ${{D}\over{d}}=constant$

Here, ${\beta}_{1}=8.1\times{10}^{-3}m$

${\lambda}_{1}$ = 630 nm = 630×10^{-9} m

${\beta}_{2}=7.2\times{10}^{-3}m$

$\therefore {{{\beta}_{1}}\over{{\beta}_{2}}}={{{\lambda}_{1}}\over{{\lambda}_{2}}}$

Wavelength of light from the second source

$\Rightarrow{\lambda}_{2}={{{\beta}_{2}}\over{{\beta}_{1}}}\times{\lambda}_{1}=$

${{7.2\times{10}^{-3}}\over{8.1\times{10}^{-3}}}\times630\times{10}^{-9}$

$= {{8}\over{9}}\times630\times{10}^{-9}=560\times{10}^{-9}m$

${\lambda}_{2}$ = 560 nm

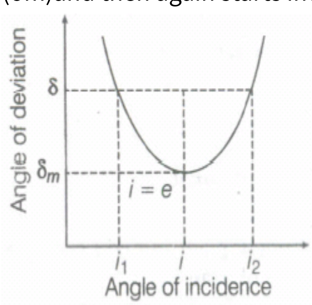
The coloured fringe pattern would be obtained if monochromatic light is replaced by white light.

175)

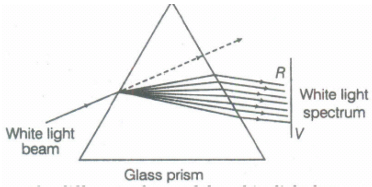
(a) Angular separation of the fringes remains constant (= \lambda / d). The actual separation of the fringes increases in proportion to the distance of the screen from the plane of the two slits.
(b) The separation of the fringes (and also angular separation) decreases. See, however, the condition mentioned in (d) below.
(c) The separation of the fringes (and also angular separation) decreases. See, however, the condition mentioned in (d) below.
(d) Let s be the size of the source and S its distance from the plane of the two slits. For interference fringes to be seen, the condition s / S < \lambda /d should be satisfied; otherwise, interference patterns produced by different parts of the source overlap and no fringes are seen. Thus, as S decreases (i.e., the source slit is brought closer), the interference pattern gets less and less sharp, and when the source is brought too close for this condition to be valid,
the fringes disappear. Till this happens, the fringe separation remains fixed.
(e) Same as in (d). As the source slit width increases, fringe pattern gets less and less sharp. When the source slit is so wide that the condition s / S < \lambda /d is not satisfied, the interference pattern disappears.
(f) The interference patterns due to different component colours of white light overlap (incoherently). The central bright fringes for different colours are at the same position. Therefore, the central fringe is white. For a point P for which \mathrm{S}_{2} \mathrm{P}-\mathrm{S}_{1} \mathrm{P}=\lambda_{b} / 2, \text { where } \lambda_{\mathrm{b}} (\approx4000 Å) represents the wavelength for the blue colour, the blue component will be absent and the fringe will appear red in colour. Slightly farther away where\mathrm{S}_{2} \mathrm{Q}-\mathrm{S}_{1} \mathrm{Q}=\lambda_{b}=\lambda_{r} / 2 \text { where } \lambda_{r}(\approx 8000 Å) is the wavelength for the red colour, the fringe will be predominantly blue.
Thus, the fringe closest on either side of the central white fringe is red and the farthest will appear blue. After a few fringes, no clear fringe pattern is seen.

176)

(i) If the angle of incidence is increased gradually, then the angle of deviation first decreases, attains a minimum value (om)and then again starts increasing.



When angle of deviation is minimum, the prism is said to be placed in the minimum deviation position.
There is only one angle of incidence for which the angle of deviation is minimum.
when \delta =\delta _{ m } [prism in minimum deviation position]
e = i and $r_2 = r_1$ ...(1)
$r_1+r_2=A$
From Eq. (i). r + r = A or r= \frac { A }{ 2 }
Also, we have
A+\delta =i+e
putting \delta =\delta _{ m } and e = i in Eq. (ii}, we get
A+\delta _{ m }=i+1\Rightarrow i=\left(\frac { A+\delta _{ m } }{ 2 } \right)
\mu =\frac { sini }{ sinr } \therefore \mu =\frac { sin\left(\frac { A+\delta _{ m } }{ 2 } \right) }{ sin\frac { A }{ 2 } }
(ii) The phenomenon of splitting of light into its component colours is known as dispersion. The pattern of colour components of light is called the spectrum of the sunlight.



The different colours of the white light have different wavelengths. The wavelength of violet light is smaller than that of red light. The refractive index of a material in terms of the wavelength of the light is given by

Cauchy's expression

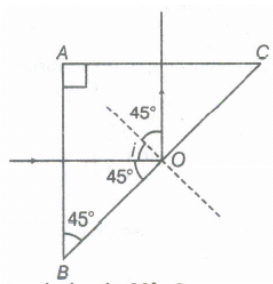
\mu =a+\frac { b }{ \lambda ^{ 3 } } +\frac { e }{ \lambda ^{ 4 } }

where, a, b, C are constants for the material. Refractive index of material of prism is maximum for violet colour (minimum wavelength) and minimum for red colour (maximum wavelength).

\mu _{ v } > \mu _{ v }

For a small angle prism, we have'the violet light will suffer greater deviation than red light,

(Hi) Applying Snell's law at surface BC



\mu xsini=sin90^{ 0 }x1

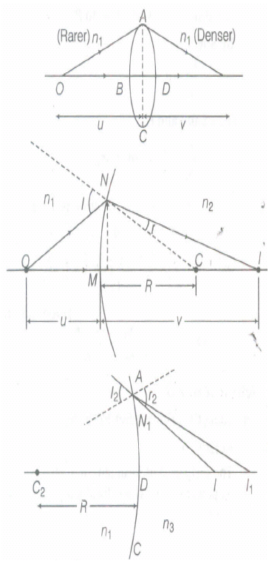
\Rightarrow sini=\frac { 1 }{ \mu } \Rightarrow \mu =\frac { 1 }{ sin45^{ 0 } }

\Rightarrow \mu =\sqrt { 2 }

Be the minimum refractive index of glass so that the incident light undergoes total internal reflection.

177)

(i) The incident rays coming from the object 0 kept in the rarer medium of refractive index n_1 ' incident on the refracting. Surface NM produces the real image at I



From the diagram

$\angle i=\angle NOM+\angle NCM=\frac { NM }{ OM } +\frac { NM }{ MC }$

$\angle r=\angle NCM-\angle NIM=\frac { NM }{ OM } -\frac { NM }{ NI }$

From Snell's law

$\therefore \frac { n_{ 2 } }{ n_{ 1 } } =\frac { sini }{ sinr } =\frac { i }{ r }$ (For small angle)

$\therefore n_{ 2 }r=n_{ 1 }i$

$\Rightarrow n_{ 2 }\left(\frac { NM }{ MC } -\frac { NM }{ NI } \right) =n_{ 1 }\left(\frac { NM }{ OM } +\frac { NM }{ MC } \right)$

$\Rightarrow n_{ 2 }\left(\frac { 1 }{ R } -\frac { 1 }{ V } \right) =n_{ 2 }\left(\frac { 1 }{ -v } +\frac { 1 }{ R } \right)$

The first refracting surface ABC forms the image I_1.of the object O. The image acts as a virtual object for the second refracting surface ADC which: forms the real image I as shown in the diagram. For refraction at ABC,

$\frac { n_{ 2 } }{ v_{ 1 } } =\frac { n_{ 1 } }{ u } =\frac { n_{ 2 }-n_{ 1 } }{ R_{ 1 } }$

For refraction of ADC,

$\frac { n_{ 2 } }{ v } =\frac { n_{ 1 } }{ u } =\frac { n_{ 1 }-n_{ 2 } }{ R_{ 12 } }$

Adding Eq. (i) and Eq. (ii). we ge

$\frac { n_{ 2 } }{ v } =\frac { n_{ 1 } }{ u } =\frac { n_{ 1 }-n_{ 2 } }{ R_{ 12 } } \left(\frac { 1 }{ R_{ 1 } } -\frac { 1 }{ R_{ 2 } } \right)$

(ii) Given $\mu =1.55$

f = 20cm

We know that

$\frac { 1 }{ f } =\left(\mu -1 \right) \left(\frac { 1 }{ R_{ 1 } } -\frac { 1 }{ R_{ 2 } } \right)$

$\frac { 1 }{ 20 } =(1.55-1)\left[\frac { 1 }{ R } -\left(\frac { 1 }{ -R } \right) \right]$

$\frac { 1 }{ 20 } =0.55\times\frac { 2 }{ R }$

R=0.55 x 2 x 20

R=22cm

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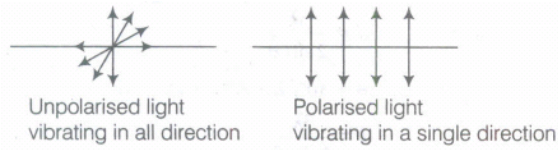
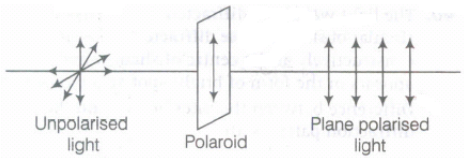
178)

A polarised light has plane of vibration only in one plane whereas, in unpolarised light. plane of vibration is spreaded in all directions as shown below. Here, vibration relates to electric and magnetic fields.



Polaroid is a special crystalline solid which contains a special axis called optic axis. When we make a unpolarised light to fall on a polaroid. only vibration parallel to optic axis is allowed to pass through and all other vibration are cut. Thus, the output is a plane polarised light.



Intensity coming out of a single polaroid is half of the incident intensity so, intensity of transmitted light from Polaroid

P1. $I = {{{I}_{0}}\over{2}}$

By using law of Malus, intensity of emergent light

P_2 is = $I' = I\cos^2\theta$

where, θ = angle between P_1 and P_2.

Intensity of light after transmission from polaroid

$I'=I\ {\cos}^{2}\theta={{{I}_{0}}\over{2}}\times(\cos\ 60°)^{2}$

$= { { {I}_{0} }\over{ 2 } }\times{\left({ { 1 }\over{ 2 } } \right)}^{2}={ { {I}_{0} }\over{ 8 } }$

---

179)

The features to distinguish is given as

In Young's experiment width of all the fringes are equal but in diffraction fringes, width of central fringe is twice the other fringes.

The intensity of all the fringes are equal in interference fringe but intensity of fringes go on decreasing in diffraction as we go away from the central fringe.

Given, wavelength (A)= 500 nm = 500 x 10^{-9} m

Width of single slit (a) = 0.2 mm = 0.2 x 10^{-3} m

Angular width of central fringe = $2\times{{\lambda}\over{a}}$

$= {{2 \times 500 \times {10}^{-9}}\over{0.2 \times {10}^{-3}}}={{10^{-6}}\over{2 \times {10}^{-4}}}={{1}\over{100}}$

= 5 x 10^{-3} radian

Let distance between the slit and screen be 1m.

(which is not given in the problem but this data is necessary to solve the problem).

Linear width of central fringe of single slit

= 5 x 10^{-3} x 10^{3} mm = 5mm

Number of double slit fringe accommodated in central fringe = ${{50}\over{5}}=10$ fringes.

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180)

The reciprocal of focal length of lens is known as power of lens when focal length is taken in metre.

$p=\frac { 1 }{ f(in\ metre) }$

SI unit of power of lens is dioptre (D).

$f_1=+50cm, f_2=-20$ cm

$\because \frac { 1 }{ f } =\frac { 1 }{ f_{ 1 } } +\frac { 1 }{ f_{ 2 } } =\frac { 1 }{ 50 } -\frac { 1 }{ 20 } =\frac { 2-5 }{ 100 } =\frac { -3 }{ 100 }$

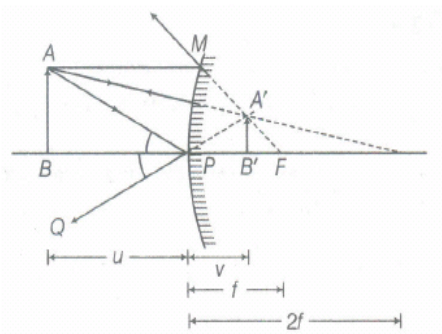
$f=\frac { 100 }{ 3 } cm\Rightarrow f=\frac { 1 }{ 3 } m$

$\therefore F=\frac { 1 }{ f(in \ m) } =\frac { 1 }{ \left(-1/3 \right) } =-3D$

181)

Let the convex mirror form virtual, erect diminished image A' B' on the other side of mirror of an object AB as shown in the figure.

Let PC =+ 2f =R, PB' =+ v, PB =- u



$\triangle A^{ ' }B^{ ' }C$ similar to ABC

$\Rightarrow \frac { A^{ ' }B^{ ' } }{ AB } =\frac { CB^{ ' } }{ CB } =\frac { PC-PB }{ PC+PB } =\frac { R-v }{ R-u }$

Also $\triangle A^{ ' }B^{ ' }P-\triangle ABP$

$\Rightarrow \frac { A^{ ' }B^{ ' } }{ AB } =\frac { AB }{ PB } =\frac { -v }{ u }$

From Eqs. (i) and (ii), we get

$\frac { R-v }{ R-u } =-\frac { v }{ u }$

uR - uv = - vR + uv

2uv= uR + vR

On dividing by uvR, we get

$\frac { 2 }{ R } =\frac { 1 }{ v } +\frac { 1 }{ u }$

$\because R=2f\quad \frac { 1 }{ f } =\frac { 1 }{ v } +\frac { 1 }{ u }$

This is the required expression for mirror formula.

For concave mirror, f < O.

Object distance, u < 0 (1)

But, (f) > lul > 0

By mirror formula, we have

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

$f=-|f|$

$u=-|u|$

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

(v > 0)

But |u|< (f)

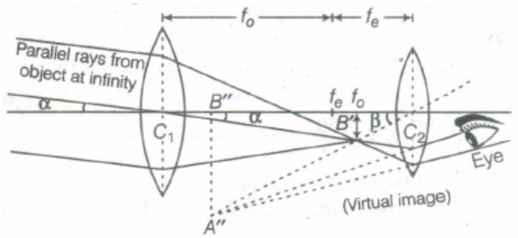
$\Rightarrow \frac { 1 }{ |u| } < \frac { 1 }{ |f| } \Rightarrow \frac { 1 }{ |u| } -\frac { 1 }{ |f| } > 0\Rightarrow \frac { 1 }{ v } > 0$

The image form on the other side of mirror as v is positive.

182)

(i) In astronomical telescope for normal adjustment final image is formed at infinity and it is virtual.

The labelled ray diagram to obtain one of the real image formed by the astronomical telescope is as follows.



Magnifying power is defined as the ratio of the angle subtended at the eye by the focal image as seen through the telescope to the angle subtended at the eye by the object seen directly, when both the image and the object lies at infinity.

(ii) (a) We know objective lens of a telescope should have larger focal length and eyepiece lens should have smaller focal length. And focal length is inverse of power, so lens of power

$\left(P=\frac { 1 }{ f } \right)$ 10 D can be used as eyepiece and lens of power 0.5 D can be used as objective lens.

(b) The objective lens of a telescope should have larger aperture, in order to form bright image of an distant objects. so that it can gather sufficient light rays from the distant objects.

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183)

The magnifying power of the astronomical telescope in normal adjustment.

Magnifying power = $\frac { \beta }{ \alpha }$

$=\frac { Visual \ angle \ formed \ by \ final \ image \ at \ eye \ lens }{ Visual \ angle \ formed \ by \ objects \ at \ naked \ eye }$

$m=\frac { \beta }{ \alpha } =\frac { tan\beta }{ tan\alpha } =\frac { \frac { A^{ ' }B^{ ' } }{ B^{ ' }E } }{ \frac { A^{ ' }B^{ ' } }{ OB^{ ' } } } =\frac { OB^{ ' } }{ BE } =\frac { +f_{ e } }{ -u_{ e } }$

When final image is formed at D

$m=-\frac { f_{ 0 } }{ f_{ e } } \left(1+\frac { f_{ e } }{ D } \right)$

For final image at infinity, B' point must lie on focus of eye lens, i.e. $u_e = f_e$

Magnifying power in normal adjustment,

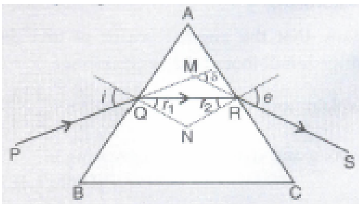
$m=-\frac { f_{ 0 } }{ f_{ e } }$

(i) Telescope has objective of a large aperture and large focal length whereas microscope have objective of small aperture and focal length.

(ii) The relative distance between objective and eye lens may change in telescope whereas the separation between objective and eye lens in compound microscope remain fixed.

184) (a) The device is a prism.

The Ray diagram, for this device is as shown,



For the quadrilateral AQNR, we have

$\angle a+\angle QNR=180^0$

For the triangle QNR, we have

$\angle r_1+\angle r_2\angle QNR=180^0$

$(r_1 + r_2)=A$

Also, form MQR, we have

$\angle \delta=\angle MQR+\angle MRQ$

$(\angle i-\angle r_1)+(\angle e-\angle r_2)$

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

$=(i+e-A)$

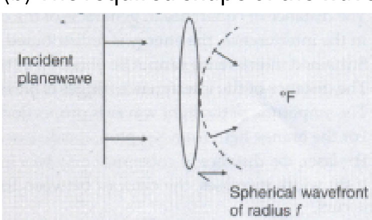
When $\delta=\delta_m$, we must have i=e and $r_1 = r_2$

$\delta_m=2i-A\ or\ i={\delta_m+A\over 2}$

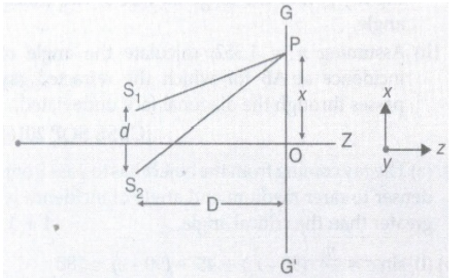
Also, $r_1+r_2=2r_1=A\ or\ \left(A\over 2\right)$

$\therefore\ \ \mu={Sin\ i\over Sin\ r}={Sin\ i(A+\delta_m)\over Sin\left(A\over 2\right)}$

(b) The required shape of the wavefront is as shown.



185)



From figure

Path difference = $(S_2P - S_1P)$

$({S}_{2}P)^{2}-({S}_{1}P)^{2}=[{D}^{2}+\left(x+\frac{d}{2}\right)^{2}-[{D}^{2}+(x-\frac{d}{2})^{2}$

$(S_2P + S_1P)(S_2P - S_1P) = 2xd$

$S2P-S1P=\frac{2xd}{{S}_{2}P+{S}_{1}P}$

For x,d < $S_2P + S_1P = 2D$

$S_2P-S_1P=\frac{2xd}{2D}=\frac{xd}{D}$

For constructive interference

$S_2P-S_1P=n\lambda$, n=0,1,2...

$x=\frac{n\lambda D}{d}$

$\frac{xd}{D}=(2n+1)\frac{\lambda}{2}$

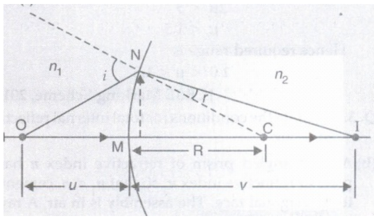
$\frac{{n}_{1}-{n}_{2}}{{R}_{2}}=\frac{{n}_{1}}{v}-\frac{{n}_{2}}{v}$ ......(ii)

$({n}_{2}-{n}_{1})\left(\frac{1}{{R}_{1}}-\frac{1}{{R}_{2}}\right)={n}_{1}\left(\frac{1}{v}-\frac{1}{v}\right)$

$u=\propto v=f$

$\Rightarrow \frac{1}{f}=\left(\frac{{n}_{2}}{{n}_{1}}-1\right)\left(\frac{1}{{R}_{1}}-\frac{1}{{R}_{2}}\right)$

186)



From the given diagram, for small angles:

$\tan\angle NOM=\frac{MN}{OM}=\angle NOM$

$\tan\angle NCM=\frac{MN}{MC}=\angle NCM$

$\tan\angle NIM=\frac{MN}{MI}=\angle NIM$

For Δ NOC, $\angle$ i is the exterior angle

$\angle i=\angle NOM+\angle NCM$

$=\frac{MN}{OM}+\frac{MN}{MC}$

Similarly,

$\Rightarrow \quad \angle r=\angle NCM+\angle NIM$

$\Rightarrow \quad n_1\left(\frac{MN}{OM}+\frac{MN}{MC}\right)=n_2\left(\frac{MN}{MC}-\frac{MN}{MI}\right)$

$\Rightarrow \quad n_1\left(\frac{1}{OM}+\frac{1}{MC}\right)=n_2\left(\frac{1}{MC}-\frac{1}{MI}\right)$

$\Rightarrow \quad \frac{n_2}{v}-\frac{n_1}{u}=\frac{n_2-n_1}{R}$

(ii) Lens Maker's formula

$\frac{1}{f}=(n_{21}-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

For equiconvex lens:

R1=+ve=R

R2=-ve=-R

$\frac{1}{f}=(\mu-1)\left(\frac{2}{R}\right)$

For f be greater than R

$2(\mu-1)<1$

$\Rightarrow 2\mu-2<1$

$2\mu<3$

$\mu<1.5$

Hence required range is

$1.0<\mu<1.5$

---

187)

(a) The ray coming from the object has to pass from denser to rarer medium and angle of incidence is greater than the critical angle.

(b) $\sin c=\frac { { n }_{ 1 } }{ n } (90-{ r }_{ 1 })+45+(90-v)=180$

${ r }_{ 1 }=45-c$

$\frac { \sin i }{ \sin r_{ 1 } } =n$

$\sin i=n \sin r_1=n \sin(45-c)$

$=n(\sin 45 \cos c-\cos 45 \sin c)$

$=\frac { n }{ \sqrt { 2 } } (\cos c-\sin c)$

$=\frac { n }{ \sqrt { 2 } } \left(\sqrt { [1-\sin^{ 2 }C]-\sin c } \right)$

$=\frac { 1 }{ \sqrt { 2 } } \left(\sqrt { { n }^{ 2 }-{ n }_{ 1 }^{ 2 } } \right) { n }_{ 1 }$

$i=\sin^{ -1 }\left(\frac { 1 }{ \sqrt { 2 } } \left(\sqrt { { n }^{ 2 }-{ n }_{ 1 }^{ 2 } } \right) -{ n }_{ 1 } \right)$

(ii) $r_2=0$ $r_1+r_2=45$, $r_1=45$

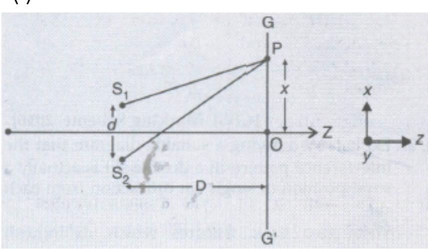
$\frac { \sin\quad i }{ \sin\quad { r }_{ 1 } }$

$\sin i=n \sin r_1=1.352 \sin 45=0.956$

$i=\sin^{-1}(0.956)=72.58$

188)

(i)



From figure

$(S_2P)^2-(S_1P^2)=$

$\left[D_2+\left(x+{d\over 2}\right)^2\right]-\left[D_2+\left(x-{d\over 2}^2\right)\right]$

$=2xd$

$\Rightarrow\ S_2P-S_1P={2xd\over (S_2P+S_1P)}$

Since $S_2P \approx S_1P\approx D$

For constructive interference,

$S_2P- S_1P = n\lambda_1$, $n = 0, 1,2,3$

$\Rightarrow{xd\over D}=n\lambda$

$x={n\lambda D\over d}$

Position of the nth bright fringe on screen:

$={n\lambda D\over d}$

And position of the $(n + 1)^{th}$ bright fringe on screen

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

Fringe Width

$={(n+1)\lambda D\over d}-{n\lambda D\over d}$

$={\lambda D\over d}$

(ii) On shifting principal source point '5' little upwards i.e., towards SI, the position of the central maximum on the screen will shift downwards on the screen, i.e., below its previous position, Hence whole interference pattern will get shifted little downwards but Fringe width will remain same as that of the initial arrangement.

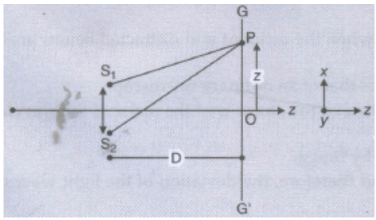
189) (a) The light rays from the two (coherent) slits, reaching a point 'P' on the screen, have a path difference (S_2P - S_1P). The point 'P' would, therefore be a

(i) Point of maxima (bright fringe), If

$S_2P - S1P = n\lambda$.

(ii) Point of minima (dark fringle), If

$S_2P - S_1P = (2n + 1) \lambda/2$



We have $(S_2P)^2 - (S_1P)^2$

$=\left\{D^2-\left(x+{d\over2}\right)^2\right\}-\left\{D^2+\left(x-{d\over2}\right)^2\right\}$

= 2 xd

$S_2P-S_1P={2xd\over S_3P+S_1P}={2xd\over 2D}={xd\over D}$

We have maxima at point, where

${xd\over D}=n\lambda$

and minima at points where

${xd\over D}=\left(2n+1\over 2\right)\lambda$

Now, fringe width β = separation between two successive maxima (or two successaive minima)

$= x_n - x_{n-1}$

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

(b) We have ${I_{max}\over {I_{min}}}={(a_1+a_2)^2\over (a_1-a_2)^2}={25\over 9}$

$\therefore\ \ {a_1+a_2\over a_1-a_2}={5\over 3}\Rightarrow{a_1\over a_2}={4\over 1}$

$\therefore\ {W_1\over W_2}={I_1\over I_2}={(a_1)^2\over (a_2)^2}={16\over 1}$

190) (i) Ravi was referring to the phenomenon of total internal Reflection

Alternatively:

Development of techniques for rapid transmission of e.m. waves / setting up of linking network (or development of mobile telephony).

(ii) Conditions required for the occurrence of total internal reflection :

1.Angle of incidence > Critical Angle

2. Light should travel from denser to rarer medium

Alternatively:

(a) Setting up of appropriate transmission cable network/antennas

(b) Availability of appropriate transducers (or setup of mobile cell network)

(iii) Ravi

Helpful (concerned) nature

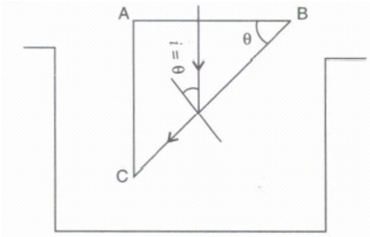
oldman

Thankful (Grateful)

191) (i) Convex mirror, to get a wide view of traffic behind.

(ii) Compassion, courtesy, concern for others, and knowledgeable.

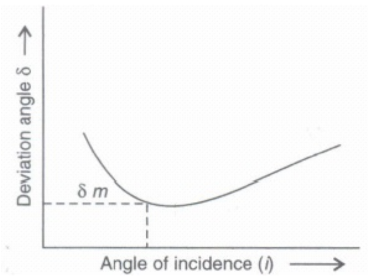
192) (i) Diagram:



$\mu_g/\mu_w=1/\sin i_C$ ($\therefore i_C=\theta$)

$\sin i_C=8/9 \Rightarrow \sin\theta=8/9 \Rightarrow \theta=\sin^{-1}(8/9)$

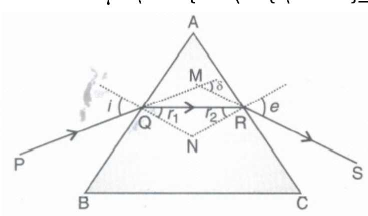
(ii) i-S graph is shown in figure



Interpretation: The path of the ray can be traced back resulting in same angle of deviation if i & e are interchanged

$\delta+A=i+e$

To derive $\mu=\frac{\sin(A+\delta_m)/2}{\sin A/2}$



Δ mQR, $(i-r_1)+(e-r_2)=\delta$

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

From Δ PQN, $r_1+r_2+\angle QNR=180^0$

Also $A+\angle QNR=180^0$

Thus $A=r_1+r_2$

So $i+e-A=\delta$

At minimum deviation, $i=e$, $r_1=r_2=r$ and $\delta=\delta_m$

$i=\frac{A+\delta_m}{2}$

and $r=A/2$

Also $\mu=\frac{\sin\quad i}{\sin\quad r}$

Hence $\mu=\frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

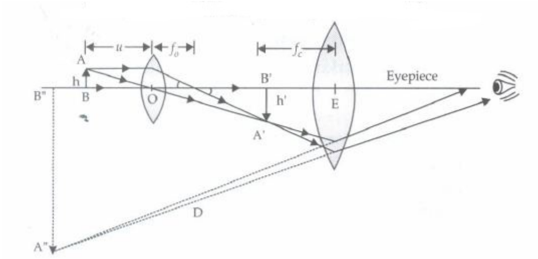
193) (i) Reflecting telescope

(ii) No chromatic aberration, mirrors are relatively lighter and cheaper compared to the lens.

(iii) First hand experience, inculcating a scientific temper, team work, enthusiasm, finding curiosity.

194)

(a) The ray diagram, showing image formation by a compound microscope, is given below:



Linear magnification due to the objective = $=\frac { h^{ ' } }{ h } =\frac { L }{ f_{ 0 } }$

$\left(\therefore \tan\beta =\frac { h }{ f_{ 0 } } =\frac { h^{ ' } }{ L } \right)$

Here, L = tube length = distance between the second focal point of the objective and the first focal point of the eyepiece.

When the final image is formed at infinity, the angular magnification due to the eyepiece equals

$\frac { D }{ f_{ e } }$ (D = least distance of distinct vision)

$\therefore$ Total magnification when the final image is formed

at infinity = $\left(\frac { L }{ f_{ 0 } } ,\frac { D }{ f_{ e } } \right)$

(b) Resolving power increases when the focal length of the objective is decreased.

(i) This is because the minimum separation $d_{ min }\left(=\frac { 1.22f\lambda }{ D } \right)$ decreases when f is decreased

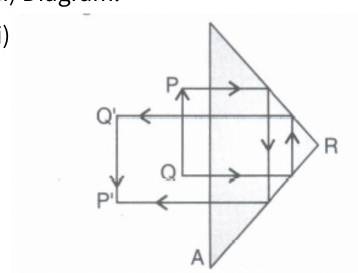
(ii) Resolving power decreases when the wavelength of light is increased.

This is because the minimum separation, $d_{ min }\left(=\frac { 1.22f\lambda }{ d } \right)$ increases when λ is increased.

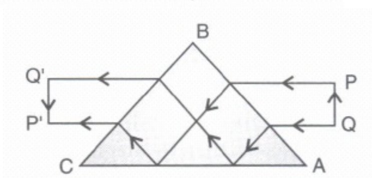
195) (i) To derive $\frac { { \mu }_{ 2 } }{ v } -\frac { { \mu }_{ 1 } }{ u } =\frac { { \mu }_{ 2 }-{ \mu }_{ 1 } }{ R }$

(ii) Diagram:

(i)

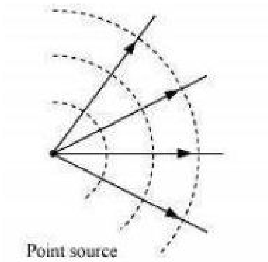


(ii)

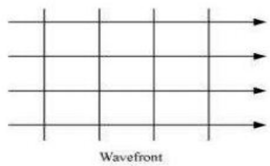


196)

(a) The shape of the wavefront in case of a light diverging from a point source is spherical. The wavefront emanating from a point source is shown in the given figure.



(b) The shape of the wavefront in case of a light emerging out of a convex lens when a point source is placed at its focus is a parallel grid. This is shown in the given figure.



(c) The portion of the wavefront of light from a distant star intercepted by the Earth is a plane.

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197)

Ray 1 has a longer path than that of ray 2 by a distance $d \sin 45°$, before reaching the slits. Afterwards ray 2 has a path longer than ray 1 by a distance $d \sin \theta$. The net path difference is therefore, $d \sin \theta - d \sin 45^{o}$

(i) Central maximum is obtained, where net path difference is zero,

$d \sin \theta - d \sin 45° = 0$

$\Rightarrow = 45^{o}$

(ii) Third order maxima is obtained, where net path difference is 3λ , i.e

$d \sin\theta - d\sin45° = 3 \lambda$

$\Rightarrow \quad \sin \theta=\sin 45^{\circ}+\frac{3 \lambda}{d}$

Putting $d = 20 \lambda$, we have

$\sin \theta=\sin 45^{\circ}+\frac{3 \lambda}{20 \lambda}$

$\therefore \quad \theta \approx 59^{\circ}$

---

198)

(a) For interference fringes to be seen $\frac{s}{S} \leq \frac{\lambda}{d}$ condition should be satisfied where, s = size of the source and d = distance of the source from the plane of two slits. As, the source slit width increases, fringe pattern gets less and less sharp. When the source slit is so wide, the above condition does not get satisfied and the interference pattern disappears.

(b) The interference pattern due to the different colour components of white light overlap. The central bright fringes for different colours are at the same position. Therefore, central fringes are white. And on the either side of the central fringe (i.e. central maxima), coloured bands will appear.The fringe closed on either side of central white fringe is red and the farthest will be blue. After a few fringes, would be clear fringe pattern is seen.

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199) Given, the displacements of two coherent sources

$y_{1}=a \cos \omega t \text { and } y_{2}=a \cos (\omega t+\phi)$

By principle of superposition

$y=y_{1}+y_{2}=a \cos \omega t+a \cos (\omega t+\phi)$

$y=a \cos \omega t+a \cos \omega t \cos \phi-a \sin \omega t \sin \phi$

$y=a(1+\cos \phi) \cos \omega t+(-a \sin \phi) \sin \omega t$

Let $a(1+\cos \phi)=A \cos \theta$ ....(i)

and $a \sin \phi=A \sin \theta$ ....(ii)

$\therefore \quad y=A \cos \theta \cos \omega t-A \sin \theta \sin \omega t$

$\Rightarrow y=A \cos (\omega t+\theta)$ ....(iii)

Squaring and adding Eqs. (i) and (ii), we get

$(A \cos \theta)^{2}+(A \sin \theta)^{2}$

$=a^{2}(1+\cos \phi)^{2}+(a \sin \phi)^{2} A^{2}\left(\cos ^{2} \theta+\sin ^{2} \theta\right)$

$=a^{2}\left(1+\cos ^{2} \phi+2 \cos \phi\right)+a^{2} \sin ^{2} \phi$

$\Rightarrow A^{2} \times 1=a^{2}+a^{2}+2 a^{2} \cos \phi=2 a^{2}(1+\cos \phi)$

$\Rightarrow \quad A^{2}=2 a^{2}\left(2 \cos ^{2} \frac{\phi}{2}\right)=4 a^{2} \cos ^{2}\left(\frac{\phi}{2}\right)$

If I is the resultant intensity, then $I=4 a^{2} \cos ^{2} \frac{\phi}{2}$

200)

(a) Consider two coherent sources S_1, and S_2 Suppose waves from these two sources meet at a point on the screen with a phase difference Φ between their displacements.

If the displacement produced by S_1, is Y_1 = a cos

ωt and displacement produced by S_2 is Y_2 = a cos

(ωt + Φ) then, then resultant displacement will be

$y =y_{1}+y_{2}$

$\therefore \quad y =a[\cos \omega t+\cos (\omega t+\phi)]$

$=2 a \cos \phi / 2 \cos (\omega t+\phi / 2)$

From the above equation, we find that the amplitude of resultant displacement is A = 2 a cos (Φ/2).

∴ Intensity at the point,

$I=k A^{2}$

$I=k 4 a^{2} \cos ^{2} \phi / 2=4 I_{0} \cos ^{2} \phi / 2 \ {\left[\because I_{0}=k a^{2}\right]}$

Therefore,

(i) For constructive interference leading to maximum intensity,

$\phi=0, \pm 2 \pi, \pm 4 \pi, \ldots$

(ii) For destructive interference leading to zero intensity,

$\phi=\pm \pi, \pm 3 \pi, \pm 5 \pi, \ldots$

(b) When waves from the slits meet at a point on the screen with same phase, the maxima are obtained and with a phase difference of n, the minima are obtained.

According to the Young's experiment, the path difference between the waves is given by

$\Delta P =S_{2} Q-S_{1} Q=S_{2} M$

$\text { i.e. } \quad \sin \theta =\frac{\Delta P}{a}$

$\text { From } \Delta Q O O^{\prime}, \tan \theta=\frac{Y}{D}$

For a small angle, $\sin \theta \approx \tan \theta \text { i.e. } \Delta P=\frac{Y a}{D}$

(i) For bright fringes, $\Delta P = n\lambda$

Thus, $\frac{Y_{n} a}{D}=n \lambda \Rightarrow Y_{n}=\frac{n \lambda D}{a}$

(ii) For dark fringes, $\Delta P=(2 n-1) \frac{\lambda}{2}$

Thus, $\frac{Y_{n}^{\prime} a}{D}=(2 n-1) \frac{\lambda}{2} \Rightarrow Y_{n}=\frac{(2 n-1) D \lambda}{2 a}$

The separation between two consecutive dark or bright fringes is called fringe width.

$\beta =Y_{n}-Y_{n-1}$

$=\frac{n \lambda D}{a}-\frac{(n-1) \lambda D}{a}=\frac{\lambda D}{a}$

Here β is the fringe width.

(b) When we close one of the slits, we obtain a diffraction pattern. With both the slits open, we get an interference pattern. It proves that the interference pattern is the superposition of two diffraction patterns.

$\text{(c) } n=10, d=1 \mathrm{~mm}$

$\because \quad n \beta=\frac{2 \lambda D}{a} ; \frac{n \lambda D}{d}=\frac{2 \lambda D}{a}$

a = size of aperture of each slit, d = separation between the slits

$\therefore \quad 10 \frac{\lambda}{d}=2 \frac{\lambda}{a} \Rightarrow a=\frac{d}{5}=\frac{1}{5}=0.2 \mathrm{~mm}$

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201)

(a) Two sources of light having same frequency and a constant or zero phase difference are said to be coherent.
A light wave emitted from an ordinary source (like a sodium lamp) undergoes the abrupt phase changes in times of the order of 10^{-10} seconds. Thus, two independent sources of light will not have a fixed phase relationship and would be incoherent.
(b) When waves from the slits meet at a point on the screen with same phase, the maxima are obtained and with a phase difference of n, the minima are obtained.
According to the Young's experiment, the path difference between the waves is given by
$\Delta P =S_{2} Q-S_{1} Q=S_{2} M$
$\text { i.e. } \quad \sin \theta =\frac{\Delta P}{a}$
$\text { From } \Delta Q O O^{\prime}, \tan \theta=\frac{Y}{D}$
For a small angle, $\sin \theta \approx \tan \theta \text { i.e. } \Delta P=\frac{Y a}{D}$
(i) For bright fringes, $\Delta P = n\lambda$
Thus, $\frac{Y_{n} a}{D}=n \lambda \Rightarrow Y_{n}=\frac{n \lambda D}{a}$
(ii) For dark fringes, $\Delta P=(2 n-1) \frac{\lambda}{2}$
Thus, $\frac{Y_{n}^{\prime} a}{D}=(2 n-1) \frac{\lambda}{2} \Rightarrow Y_{n}=\frac{(2 n-1) D \lambda}{2 a}$
The separation between two consecutive dark or bright fringes is called fringe width.
$\beta =Y_{n}-Y_{n-1}$
$=\frac{n \lambda D}{a}-\frac{(n-1) \lambda D}{a}=\frac{\lambda D}{a}$
Here β is the fringe width.
(c) For interference fringes to be seen, the condition $\frac{s}{d}< \frac{\lambda}{a}$ should be satisfied.

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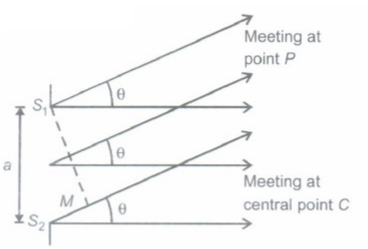
202)

To explain a diffraction pattern in case of a single slit (illuminated by monochromatic source), we divide the slit into much smaller parts and add their contributions at any point 'P' on the screen with proper phase differences. [Using Huygen's principle]



[We are taking parallel beam of light because angles are very small]
We treat each point on the wavefront at the slit, as secondary sources [Using Huygen 's principle].
As the incoming wavefront is parallel to the plane of the slit, these sources are in phase [using Huygen's principle].
The path difference between the waves coming out from the two edges of the slits is $S_2P - S_1P = S_2M$.
$\therefore \quad S_{2} M=a \sin \theta \approx a \theta$
For any two point sources, S_1 and S_2 in the plane of the slit having a separationy, the path difference would be
$S_{2} P-S_{1} P \approx y \theta \quad \text { i.e. } \Delta P \approx y \theta$
As the initial phase difference is zero, the phase difference between the waves is introduced only due to this path difference.
For the central point on the screen, $\theta=0 \Rightarrow \Delta P=0$
i.e. $\Delta\Phi = 0$
All the parts of the slit contribute in phase. So, the maximum intensity is obtained at C.
Secondary Maxima: These are found at $\theta=\left(n+\frac{1}{2}\right) \frac{\lambda}{a}$
For n^{th} secondary maxima, we can imagine as if the slit is divided into (2n + 1) parts.
The contributions from 2n parts of the slit get cancelled. Only $(2n + 1)^{th}$ part of the slit contributes to the intensity at a point between two minima. With an increase in n, the secondary maxima become weaker.

point between two minima. With an increase in n, the secondary maxima become weaker.

Secondary Minima: These are found at $\theta=\frac{n \lambda}{a}$

For n^{th} minima, we can imagine as if slit is divided into 2n parts. The separation between two point sources on consecutive parts will be $\frac{a}{2 n}$

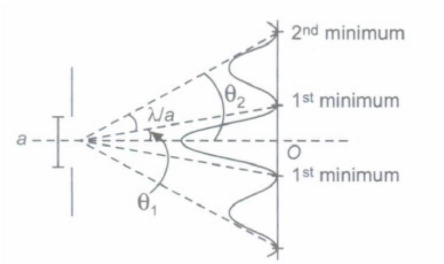
As $\ \Delta P =\theta y \left[\because y=\frac{a}{2 n}\right]$

$\Delta P =\frac{n \lambda}{a} \times \frac{a}{2 n}=\frac{\lambda}{2}$

The path difference of $\frac{\lambda}{2}$ corresponds to phase difference of π (i.e. waves meet out of phase).

There are even number of parts so net intensity is zero at the point on the screen.

Condition for 1 st minimum on the screen is $a \sin \theta_{1}=\lambda$



As angle is very small i.e. $\sin \theta \approx \theta$

$\therefore \quad \theta_{1}=\frac{\lambda}{a}$

$\text{ For } 2^{\text{nd}} \text{ minimum, } \theta_{2}=\frac{2 \lambda}{a}$

Angular width of 1^{st} secondary maximum,

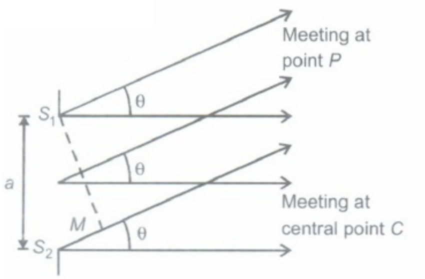
$\Delta \theta=\frac{2 \lambda}{a}-\frac{\lambda}{a}=\frac{\lambda}{a}$

The central fringe lies between 1^{st} minima on both sides of the central maximum. Hence, the angular width of central fringe is given by $2 \theta=\frac{2 \lambda}{a}$

Hence, the angular width of central fringe is twice the angular width of first fringe.

203)

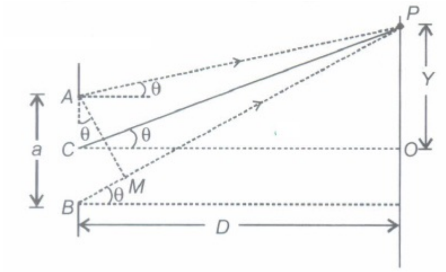
(a) To explain a diffraction pattern in case of a single slit (illuminated by monochromatic source), we divide the slit into much smaller parts and add their contributions at any point 'P' on the screen with proper phase differences. [Using Huygen's principle]



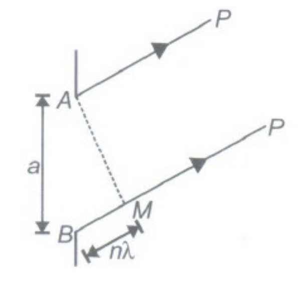
[We are taking parallel beam of light because angles are very small]
We treat each point on the wavefront at the slit, as secondary sources [Using Huygen 's principle].
As the incoming wavefront is parallel to the plane of the slit, these sources are in phase [using Huygen's principle].
The path difference between the waves coming out from the two edges of the slits is $S_2P - S_1P = S_2M$.
$\therefore \quad S_{2} M=a \sin \theta \approx a \theta$
For any two point sources, S_1 and S_2 in the plane of the slit having a separationy, the path difference would be
$S_{2} P-S_{1} P \approx y \theta \quad \text { i.e. } \Delta P \approx y \theta$
As the initial phase difference is zero, the phase difference between the waves is introduced only due to this path difference.
For the central point on the screen, $\theta=0 \Rightarrow \Delta P=0$
i.e. $\Delta\Phi = 0$
All the parts of the slit contribute in phase. So, the maximum intensity is obtained at C.
Secondary Maxima: These are found at $\theta=\left(n+\frac{1}{2}\right) \frac{\lambda}{a}$
For n^{th} secondary maxima, we can imagine as if the slit is divided into (2n + 1) parts.
The contributions from 2n parts of the slit get cancelled. Only $(2n + 1)^{th}$ part of the slit contributes to the intensity at a point between two minima. With an increase in n, the secondary maxima become weaker.
Secondary Minima: These are found at $\theta=\frac{n \lambda}{a}$
For n^{th} minima, we can imagine as if slit is divided into 2n parts. The separation between two point sources on consecutive parts will be $\frac{a}{2 n}$
As $\ \Delta P =\theta y \left[\because y=\frac{a}{2 n}\right]$
$\Delta P =\frac{n \lambda}{a} \times \frac{a}{2 n}=\frac{\lambda}{2}$
The path difference of $\frac{\lambda}{2}$ corresponds to phase difference of π (i.e. waves meet out of phase).
There are even number of parts so net intensity is zero at the point on the screen.
(b) (i) Linear width of central maxima, $W=\frac{2 D \lambda}{d}$
Angular width of central maxima,
$\theta_{n}=\frac{W}{D}=\frac{2 \lambda}{d}$
So, when the width of the slit (d) is decreased, the angular width θ_n increases, and the diffraction pattern is spread out.
(ii) When a monochromatic source of light is replaced by a source of white light, the following changes are observed in the diffraction pattern:
(i) Differaction pattern is coloured. As the fringe width is directly proportional to the wavelength, so, the fringe width of red colour is wider than that of violet colour.
(ii) The central maximum is white.

204)

The wavelength of incident light should be comparable to the aperture of the slit/opening or size of the obstacle.



We consider a single slit AB on which a plane wavefront is incident. The slit width is so small in comparison to the distance of the screen from the slit that the rays coming out of it, can be considered almost parallel.



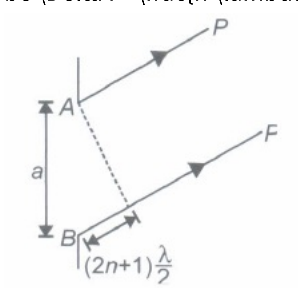
According to the Huygen's principle, each point on the slit will behave like a fresh source of secondary wavelets. The waves from the different parts ofthe same wavefront reach a point on the screen and superpose to form a diffraction pattern.

For n^{th} secondary minimum,

$a \sin \theta_{n}=n \lambda, \text { where } n=1,2,3 \ldots \ldots \ldots \ldots$

a sin θ_n is the path difference between the waves reaching a point on the screen.

We can imagine as if the slit is divided into 2n parts. The separation between two adjacent parts of the slit is a/2n. For a separation of a, the path difference is nA. So, for a separation of a/2n, the path difference between the waves will be $\Delta P=\frac{n \lambda}{a} \times \frac{a}{2 n}=\frac{\lambda}{2}$



i.e. the phase difference, $\Delta\Phi = \pi$ will be there and the waves will superpose destructively. We find the fringes of minimum intensity on the screen.

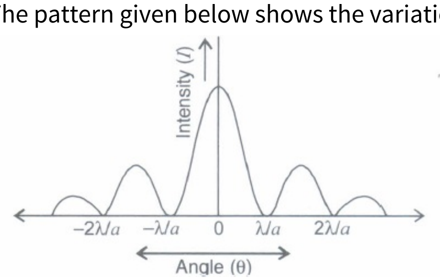
For n^{th} maximum,

$a \sin \theta_{n}^{\prime}=(2 n+1) \frac{\lambda}{2}, \text { where } n=1,2,3, \ldots$.

We can imagine as if the slit is divided into odd number of parts (e.g. 3,5,7, etc.).

In this case, only (2n+ 1yh part of the slit illuminates the screen. This is the reason why the intensity of secondary maxima falls rapidly.

The pattern given below shows the variation of intensity (I) with angle (θ).



205)

(a) According to the question,

$X_{n}=\frac{1}{4} \cdot \beta$

$X_{n}=\frac{1}{4} \frac{\lambda D}{d}$

∴ Path difference $=\frac{\lambda}{4}$

Phase difference,

$\phi =\frac{2 \pi}{\lambda} \times \frac{\lambda}{4}=\frac{2 \pi}{2}$

$\therefore \quad I =4 I_{0} \cos ^{2} \frac{\phi}{2}$

$=4 I_{0} \cos ^{2} \frac{\pi}{4}=2 I_{0}$

b) If I_1 and I_2 be the intensities of waves from the sources, then the net intensity will be $I_{\text {net }}=I_{1}+I_{2}$

$\text { (c) } \theta_{10}=10 \frac{\lambda}{d} \left[\because \theta_{n}=\frac{n \lambda}{d}\right]$

θ = angular fringe width of 10^{th} maxima

$\left.\theta=\frac{\lambda}{d} \text { (independent of } n\right)$

(d) $\quad x_{5}^{\max }-x_{3}^{\min } =\frac{5 \lambda D}{d}-(2 \times 3-1) \frac{\lambda}{2} \frac{D}{d} =[10-5]$

$\frac{\lambda d}{2 d}=2.5 \frac{\lambda D}{d}$

(e) $\quad(\text { i) } \theta=5 \pi \therefore \quad I=4 I_{0} \cos ^{2} \frac{5 \pi}{2}=0$

Therefore, dark fringe will be formed.

$\theta =2 \pi \therefore \quad I=4 I_{0} \cos ^{2} \frac{2 \pi}{2}=4 I_{0}$

Therefore, the colour of fringe will be bright red.

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206)

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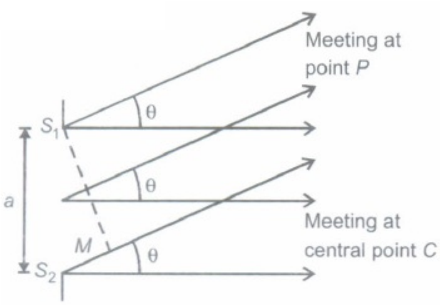

[We are taking parallel beam of light because angles are very small]

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The path difference between the waves coming out from the two edges of the slits is $S_2P - S_1P = S_2M$.

$\therefore \quad S_{2} M=a \sin \theta \approx a \theta$

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$S_{2} P-S_{1} P \approx y \theta \quad \text { i.e. } \Delta P \approx y \theta$

As the initial phase difference is zero, the phase difference between the waves is introduced only due to this path difference.

For the central point on the screen, $\theta=0 \Rightarrow \Delta P=0$

i.e. $\Delta\Phi = 0$

All the parts of the slit contribute in phase. So, the maximum intensity is obtained at C.

Secondary Maxima: These are found at $\theta=\left(n+\frac{1}{2}\right) \frac{\lambda}{a}$

For n^{th} secondary maxima, we can imagine as if the slit is divided into (2n + 1) parts.

The contributions from 2n parts of the slit get cancelled. Only $(2n + 1)^{th}$ part of the slit contributes to the intensity at a point between two minima. With an increase in n, the secondary maxima become weaker.

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As $\ \Delta P =\theta y \left[\because y=\frac{a}{2 n}\right]$

$\Delta P =\frac{n \lambda}{a} \times \frac{a}{2 n}=\frac{\lambda}{2}$

The path difference of $\frac{\lambda}{2}$ corresponds to phase difference of π (i.e. waves meet out of phase).

There are even number of parts so net intensity is zero at the point on the screen.

(b) Given: $a=2 \times 10^{-6} \mathrm{~m}, \lambda_{1}=5.9 \times 10^{-7} \mathrm{~m}$

$\lambda_{2}=5.96 \times 10^{-7} \mathrm{~m}, D=1.5 \mathrm{M}$

$The \ position \ of \ maxima \ is$

$Y_{n}^{\max }=\frac{(2 n+1) \lambda D}{2 a}$

$\therefore \Delta Y=Y_{2}^{\max }-Y_{1}^{\max } \text { for } n=1$

$\therefore \quad \Delta Y=\frac{3 D}{2 a}\left(\lambda_{2}-\lambda_{1}\right)$

$\therefore \quad \Delta Y=\frac{3 \times 1.5}{2 \times 2 \times 10^{-6}}(5.96-5.9) \times 10^{-7}$

$\Delta Y=6.75 \times 10^{-3} \mathrm{~m}$

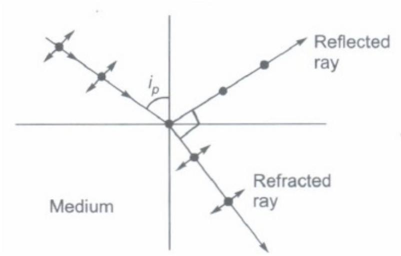
207)

A light wave in which an electric vector is confined to a single plane is said to be linearly polarised. Only transverse waves can be polarised.

Polarisation by reflection

When an unpolarised light is incident on a boundary between two transparent media, the reflected light is polarised with its electric field. The electric vector perpendicular to the plane of refracted and reflected rays makes an angle of 90° with each other. The intensity of polarised light after it comes out of the first polaroid is

$I_{1}=\frac{I_{0}}{2}$



As second' polaroid is at 45° with respect to the first, the component of intensity coming out of the second polaroid is

$I_{2}=I_{1} \cos ^{2} 45^{\circ} \Rightarrow I_{2}=\frac{I_{0}}{2} \times \frac{1}{2} \Rightarrow I_{2}=\frac{I_{0}}{4}$

Third polaroid at 45° with respect to the second one. Thus, the intensity of the light coming out of it is

$I_{3}=I_{2} \cos ^{2} 45^{\circ}=\frac{I_{0}}{4} \times \frac{1}{2}=\frac{I_{0}}{8}$

208)

A wavefront is the locus of all the points in space which receives the light waves from a source in phase.

Reflection on the Basis of Wave Theory

The angle between the reflected ray and the normal is called angle of reflection. The two laws of reflection are:

(i) Angle of incidence is equal to angle of reflection.

(ii) The incident ray, the reflected ray and the normal at the point of incidence all lie in the same plane.

Proof of'law reflection using Huygens Principle.

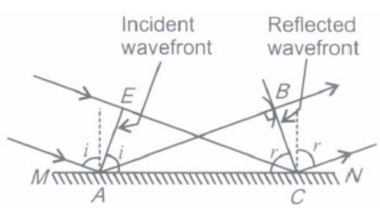
Consider a plane wave AB incident at an angle i on a reflecting surface MN. If v is the speed of the wave in the medium and I is the time taken by the wavefront to cover the distance Be, then

Be = vt

To construct the reflected wavefront we draw an are (representing reflected wavefront) of radius vt from the point A.

Draw a tangent on the arc (i.e., reflected wavefront). We obtain

AE = Be = vt



From the triangles ECA and BAC we will find that they are congruent. This is the law of reflection.

Thus, $\angle i=\angle r$