PREVIOUS 8 YEARS QUESTIONS (1 mark & 2 marks)

1 mark questions

1. An object is held at the principal focus of a concave lens of focal length *f*. Where is the image formed? (AISSCE – 2008)

   Ans: That is image will be formed between optical centre and focus of lens; towards the side of the object.

2. What is the geometrical shape of the wavefront when a plane wave passes through a convex lens? (AISSCE – 2008)

   Ans: The wavefront is spherical of decreasing radius.

3. A diverging lens of focal length 'F' is cut into two identical parts each forming a plano-concave lens. What is the focal length of each part? (ISSCE – 2008)

   Ans: Focal length of each half part will be **twice the** focal length of initial diverging lens.

4. How the angular separation of interference fringes in Young's double slit experiment change when the distance between the slits and screen is doubled? (AISSCE – 2009)

   Ans: Angular separation between fringes, $\beta_\theta = \lambda/d$ where λ = wavelength, *d* = separation between coherent sources. So, β_θ is independent of distance between the slits and screen. So angular separation (β_θ) will remain unchanged.

5. Two thin lenses of power +6 D and – 2 D are in contact. What is the focal length of the combination? (AISSCE – 2009)

   Ans: Net power of lens combination $P = P_1 + P_2 = +6\text{ D} - 2\text{ D} = +4\text{ D}$

   $\therefore$ Focal length, $f = 1/P = ¼\text{ m} = 25\text{ cm}$

6. Two thin lenses of power +5 D and –2.5 D are in contact. What is the focal length of the combination? (AISSCE – 2009)

   Ans: Net power of lens combination, $P = P_1 + P_2 = +5 - 2.5 = +2.5\text{ D}$

   $\therefore$ Focal length, $f = 1/P = 1/2.5 = 0.4\text{m} = 40\text{cm}$

7. A converging lens is kept co-axially in contact with a diverging lens – both the lenses being of equal focal lengths. What is the focal length of the combination? (AISSCE – 2010)

   Ans: Let focal length of converging and diverging lenses be + f and - f respectively.

   Power of converging lens $P_1 = 1/f$ and Power of diverging lens $P_2 = -1/f$

   $\therefore$ Power of combination $P = P_1 + P_2 = 1/f - 1/f = 0$

   $\therefore$ Focal length of combination $f = 1/P = 1/0 = \infty$

8. When light travels from a rarer to a denser medium, the speed decreases. Does this decrease in speed imply a decrease in the energy carried by the light wave? Justify your answer. (AISSCE – 2010)

   Ans: No; when light travels from a rarer to denser medium, its frequency remains unchanged. According to quantum theory, the energy of a light beam depends on frequency and not on speed.

9. How does the angular separation between fringes in single-slit diffraction experiment change when the distance of separation between the slit and screen is doubled? (AISSCE – 2012)
Ans: Angular separation is $\theta = \beta / D = \lambda / d$
Since θ is independent of *D*, angular separation would remain same.

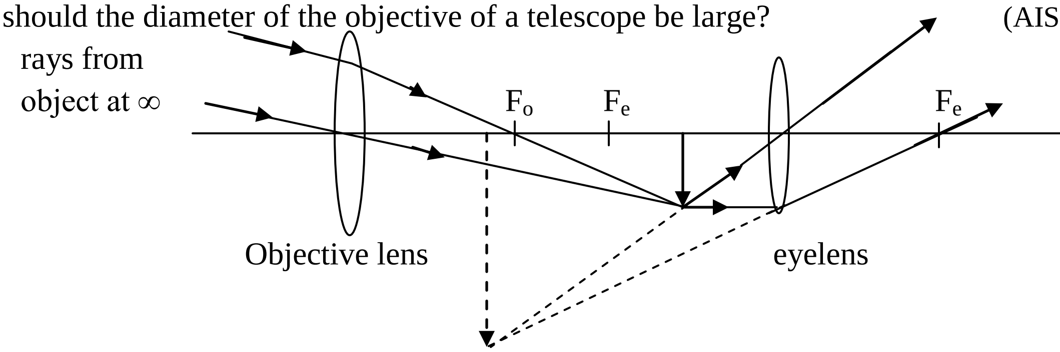
10. For the same value of angle incidence, the angles of refraction in three media *A*, *B* and C are 15°, 25° and 35° respectively. In which medium would the velocity of light be minimum? (AISSCE – 2012)
Ans: From Snell's law, $n = \sin i / \sin r = c/v$
For given i, $v \propto \sin r$; r is minimum in medium A, so velocity of light is minimum in medium A.

11. 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? (AISSCE – 2012)
Ans: In single slit diffraction experiment fringe width is, $\beta = 2D\lambda / d$
If *d* is doubled, the width of central maxima is halved. Thus size of central maxima is reduced to half. Intensity of diffraction pattern varies square of slit width. So, when the slit gets double, it makes the intensity four times.

12. How does the fringe width, in Young's double-slit experiment, change when the distance of separation between the slits and screen is doubled? (AISSCE – 2012)
Ans: The fringe width is, $\beta = D\lambda / d$
If D (distance between slits and screen) is doubled, then fringe width will be doubled.

<u>2 mark questions</u>

1. Draw a labeled ray diagram to show the image formation in a refracting type astronomical telescope. Why should the diameter of the objective of a telescope be large? (AISSCE – 2006)



Final image at D

For large light gathering power and higher resolution, the diameter of the objective should be large.

2. Define resolving power of a compound microscope. How does the resolving power of a compound microscope change when
   (i) Refractive index of the medium between the object and objective lens increases?
   (ii) Wavelength of the radiation used is increased? (AISSCE – 2007)

Ans: Resolving power of a microscope is defined as the reciprocal of the minimum separation of two points seen distinctly.

$$\text{Resolving power} = 2\, n \sin\theta / 1.22\, \lambda$$

(i) Increase in the refractive index (n) of the medium increases resolving power because RP$\propto n$

(ii) On increasing the wavelength of the radiation, resolving power decreases because RP $\propto 1/\lambda$

3. Define resolving power of a telescope. How does it get affected on
   (i) Increasing the aperture of the objective lens?
   (ii) Increasing the focal length of the objective lens? (AISSCE – 2007)

Ans: Resolving power of a telescope is defined as the reciprocal of the smallest angular separation between two distant objects.

Resolving power = D / 1.22 λ where D is aperture of the objective lens

(i) Resolving power increases on increasing the aperture of the objective lens, since RP $\propto$ D.

(ii) Resolving power does not get affected on increasing the focal length of objective lens, since RP is independent of focal length.

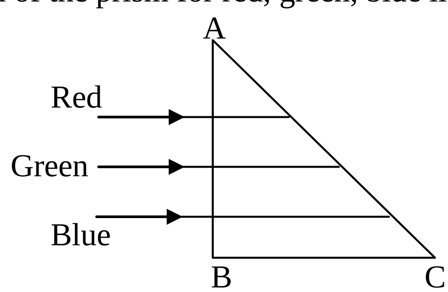
4. How will the angular separation and visibility of fringes in Young's double slit experiment change when (i) screen is moved away from the plane of the slits, and (ii) width of the source slit is increased? (AISSCE – 2008)

Ans. (i) Angular separation = β / D = λ/d

It is independent of *D*; therefore, angular separation remains unchanged if screen is moved away from the slits. But the actual separation between fringes β = D λ/d increases, so visibility of fringes increases.

(ii) When width of source slit is increased, then the angular fringe width remains unchanged but fringes becomes less and less sharp; so visibility of fringes decreases. If the condition s/S =λ/d is not satisfied, the interference pattern disappears.

5. In the figure given below, light rays of blue, green, red wavelengths are incident on an isosceles right angled prism. Explain with reason, which ray of light will be transmitted through the face AC. The refractive index of the prism for red, green, blue light is 1.39, 1.424, and 1.476 respectively. (AISSCE – 2008)



Ans. The critical angle for green light Cg is, $\sin C_g = 1/n_g = 1/1.424 = 0.7022$

$\therefore$ $C_g = \sin^{-1}(0.7022) = 44.6°$

The critical angle for red light, $\sin C_r = 1/n_r = 1/1.39$

$\therefore$ $C_r = \sin^{-1}(0.7194) = 46°$

The critical angle for blue light, $\sin C_b = 1/n_b = 1/1.476 = 0.6775$

$\therefore$ $C_b = \sin^{-1}(0.6775) = 42.6°$

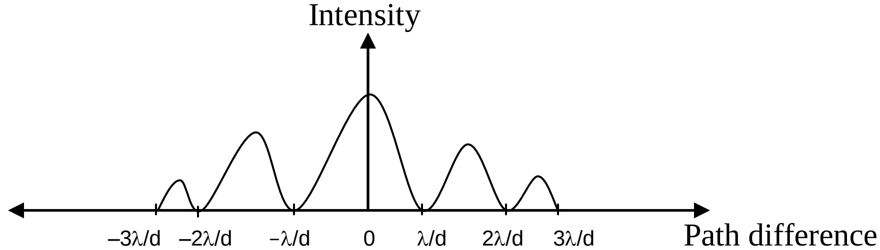
As angle of incidence at face AC is 45°, which is smaller than critical angle for red ray but greater than critical angles, for green and blue rays, therefore, red-ray will be transmitted through the face AC.

6. 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? Draw a plot of the intensity distribution.

(AISSCE – 2008)

Ans: The angular size of central diffraction band, $2\theta = (2\lambda/d) \propto 1/d$

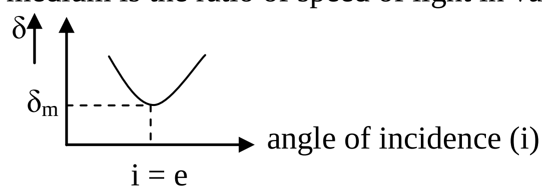
When width of slit 'd' is doubled, the size of central band becomes half and the intensity is doubled.



7. Define refractive index of a transparent medium.

   A ray of light passes through a triangular prism. Plot a graph showing the variation of the angle of deviation with the angle of incidence. (AISSCE – 2009)

   Ans: Refractive index of a medium is the ratio of speed of light in vacuum to the speed of light in medium.



8. Answer the following questions :

   (a) Optical and radio telescopes are built on the ground while *X*-ray astronomy is possible only from satellites orbiting the Earth. Why?

   (b) The small ozone layer on top of the stratosphere is crucial for human survival. Why?

   (AISSCE – 2009)

   Ans: (a) The visible radiations and radiowaves can penetrate the earth's atmosphere but X-rays are absorbed by the atmosphere.

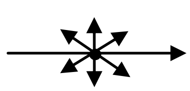
   (b) The ozone layer absorbs ultraviolet and other low wavelength radiations which are harmful to living cells of human bodies and plants; hence ozone layer is crucial for human survival.

9. Define the term 'linearly polarised light.'

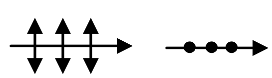
   When does the intensity of transmitted light become maximum, when a polaroid sheet is rotated between two crossed polaroids? (AISSCE – 2009)

   Ans: The light having vibrations of electric field vector in only one direction perpendicular to the direction of propagation of light is called plane (or linearly) polarised light.

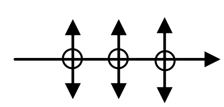
   The unpolarised and polarised light is represented as



(a) Unpolarised light



(b) Polarised light



(c) Partially polarised light

Intensity of transmitted light is maximum when the polaroid sheet makes an angle of 45° with the pass axis. This is maximum when $\sin 2\theta = 1$ or $\theta = 45°$.

10. (i) State the principle on which the working of an optical fiber is based.

(ii) What are the necessary conditions for this phenomenon to occur? (AISSCE – 2009)

Ans: (i) The working of optical fiber is based on total internal reflection.

<u>Statement</u>**:** When a light ray goes from denser to rarer medium at an angle greater than critical angle, the ray is totally reflected in first (denser) medium. This phenomenon is called total internal reflection.

(ii) Conditions:

(a) Ray of light must go from denser medium to rarer medium.

(b) Angle of incidence must be greater than critical angle (i. e., i > C).

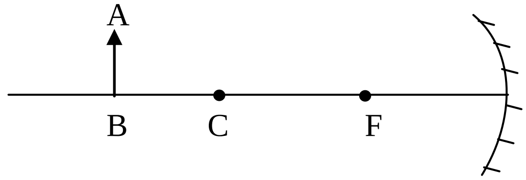
11. (i) What is the relation between critical angle and refractive index of a material?

(ii) Does critical angle depend on the colour of light? Explain. (AISSCE – 2009)

Ans: (i) Relation between refractive index (*n*) and critical angle (*C*) is $n = 1 / \sin C$

(ii) Yes, critical angle depends on wavelength or colour of light; it increases with increase of wavelength being maximum for red and minimum for violet.

12. An object *AB* is kept in front of a concave mirror as shown in the figure.

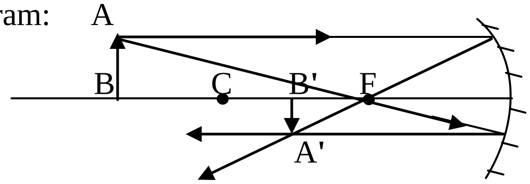


(i) Complete the ray diagram showing the image formation of the object.

(ii) How will the position and intensity of the image be affected if the lower half of the mirror's reflecting surface is painted black? (AISSCE – 2012)

Ans: (i) Image formed will be inverted diminished between C and F.

Ray diagram:

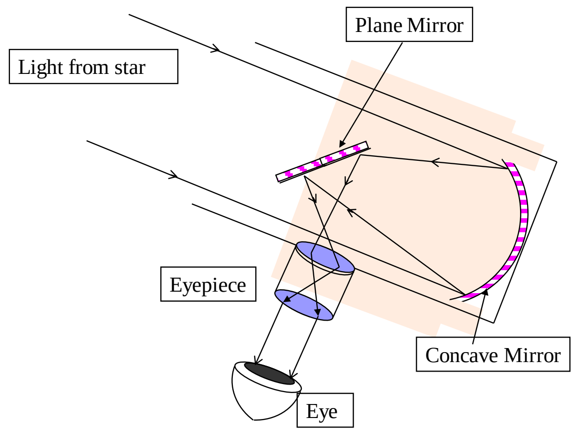


(ii) No change in position of image and its intensity will get reduced.

13. Draw a labelled ray diagram of a reflecting telescope. Mention its two advantages over the refracting telescope. (AISSCE-2012)

Ans: Ray diagram

Newtonian Telescope: (Reflecting Type)



Advantages:
(*i*) It is free from chromatic and spherical aberrations.
(*ii*) Its resolving power is greater than refracting telescope due to larger aperture of mirror.

14. A parallel beam of light of 500nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1m away. It is observed that the first minimum is at a distance of 2.5mm away from the centre of the screen. Calculate the width of the slit. (AISSCE-2013)

Ans: Given: λ=500nm = 5×10^{-7} m, D=1m, Position of first minima, x = 2.5mm = 2.5×10^{-3} m, d = ?

Calculations: Position of first diffraction minima, $x = \lambda D/d$

Or $2.5 \times 10^{-3} = (5 \times 10^{-7} \times 1) / d$

Or $d = (5 \times 10^{-7}) / 2.5 \times 10^{-3} = 2 \times 10^{-4}$m = 0.2 mm

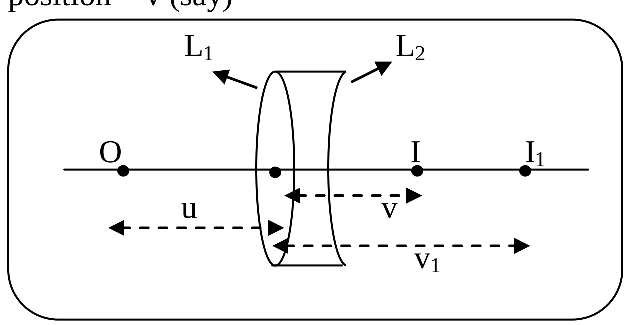
15. A convex lens of focal length f_1 is kept in contact with a concave lens of focal length f_2. Find the focal length of the combination. (AISSCE-2013)

Ans: For a thin convex lens of focal length f_1 in contact with another thin concave lens of focal length f_2: let 'u' denote distance of object from f_1.

Then, for L_1, $\frac{1}{f_1} = \frac{1}{v_1} - \frac{1}{u}$ …………. (i)

For L_2, u = + v_1, focal length = - f_2, final image position = v (say)

Then, $\frac{1}{v} - \frac{1}{v_1} = -\frac{1}{f_2}$ ……………….. (ii)



Adding (i) and (ii), we get

$\frac{1}{f_1} - \frac{1}{f_2} = \frac{1}{v} - \frac{1}{u}$ …………… (iii)

If 'f ' is focal length of the combination, we get

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ ………………. (iv)

From (iii) and (iv), we get

$\frac{1}{f} = \frac{1}{f_1} - \frac{1}{f_2}$ or $f = \frac{f_1 f_2}{f_2 - f_1}$

16. A parallel beam of light of 600nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1.2 m away. It is observed that the first minimum is at a distance of 3mm away from the centre of the screen. Calculate the width of the slit. (AISSCE-2013)

Ans: Given: λ=600nm = 6×10^{-7} m, D=1.2m, Position of first minima, x = 3mm = 3×10^{-3} m, d = ?

Calculations: Position of first diffraction minima, $x = \lambda D/d$

Or $3 \times 10^{-3} = (6 \times 10^{-7} \times 1.2) / d$

Or $d = (6 \times 10^{-7} \times 1.2) / 3 \times 10^{-3} = 240 \times 10^{-6}$m = 0.24 mm

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