UNIT TEST - 4

PHYSICS

CLASS XII **SET - A** **Time : 1½ hrs.**

Mark : 35

SECTION - A (OBJECTIVE TYPE QUESTIONS) **9 × 1 = 9**

1. A biconvex lens of glass having refractive index 1.47 is immersed in a liquid. It becomes invisible and behaves as a plane glass plate. The refractive index of the liquid is

   a) 1.33 b) 1.62 c) 1.51 d) 1.47

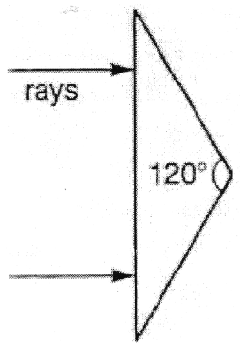
2. According to the Huygen's principle, light is a form of

   a) particle b) rays c) wave d) radiation

3. The image of an object, formed by a plano-convex lens at a distance of 8 m behind the lens, is real and is one-third the size of the object. The wavelength of light inside the lens is $\frac{2}{3}$ times the wavelength in free space. The radius of the curved surface of the lens is

   a) 1 m b) 6 m c) 2 m d) 3 m

4. An isosceles prism of angle 120^0 has a refractive index of 1.44. Two parallel monochromatic rays enter the prism parallel to each other in air as shown. The rays emerging from the opposite faces.



   a) makes an angle of 92^0 with each other
   b) are diverging
   c) make an angle of 32^0 with each other
   d) are parallel to each other

For question numbers 5-6 two statements are given - one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
c) Assertion (A) is true but Reason (R) is false.
d) Assertion (A) is false but Reason (R) is true.

5. Assertion (A) : The frequencies of the incident, reflected, and refracted beams of monochromatic light incident from one medium to another are the same.

   Reason (R) : The incident reflected and refracted rays are coplanar.

6. Assertion (A) : All bright interference bands have the same intensity.

   Reason (R) : Because all bands donot receive same light from two sources.

7. In Young's double-slit experiment, the source is white light. One of the holes is covered by a red filter and another by a blue filter. In this case:

   a) there shall be no interference fringes

   b) there shall be alternate interference patterns of red and blue

   c) there shall be an interference pattern for red distinct from that for blue

   d) there shall be an interference pattern for red mixing with one for green

8. Two coherent point sources S_1 and S_2 vibrating in phase emit light of wavelength λ. The separation between the sources is 2λ. The smallest distance from S_2 on a line passing through S_2 and perpendicular to $S_1 S_2$ where a minimum intensity occurs is:

   a) $\frac{\lambda}{2}$ b) $\frac{15\lambda}{4}$ c) $\frac{7\lambda}{12}$ d) $\frac{3\lambda}{4}$

9. If white light is used in the Newton's rings experiment, the colour observed in the reflected light is complementary to that observed in the transmitted light through the same point. This is due to:

   a) 180^0 change of phase in one of the reflected waves

   b) 90^0 change of phase in one of the reflected waves

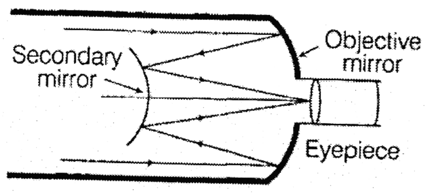
   c) 45^0 change of phase in one of the reflected waves

   d) 145^0 change of phase in one of the reflected waves

SECTION - B - SHORT ANSWER QUESTIONS

10. The image obtained with a convex lens is erect and its length is four times the length of the object. If the focal length of the lens is 20 cm, calculate the object and image distances. **2**

11. A Cassegrain telescope uses two mirrors as shown in the figure. Such a telescope is built with the mirrors 20 mm apart. If the radius of curvature of large mirror is 220 mm and the small mirror is 140 mm, where will the final image of an object at infinity be? **2**



12. For a single slit of width a, the first minimum of the interference pattern of a monochromatic light of wavelength λ occurs at an angle of λ / d. At the same angle of , we get a maximum for two narrow slits separated by a distance 'a'. Explain. **2**

13. In Young's double-slit experiment, red light of wavelength 620 nm is used and the two slits are 0.3 mm apart. Interference fringes observed on a screen are found to be 1.3 mm apart. Calculate

   i) the distance of slits from the screen and

   ii) the fringe width if this distance is doubled.

OR

What is the effect on the interference fringes if the monochromatic source is replaced by a source of white light?

SECTION - C - SHORT ANSWER QUESTIONS

14. How is Huygen's principle used to obtain the diffraction pattern due to single slit? Show the plot of variation of intensity with angle and state the reason for the reduction in intensity of secondary maxima compared to central maximum. **3**

OR

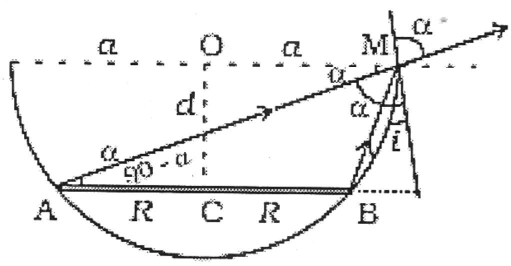
The mixture a pure liquid and a solution in a long vertical column (i.e, horizontal dimensions << vertical dimensions) produces diffusion of solute particles and hence a refractive index gradient along the vertical dimension. A ray of light entering the column at right angles to the vertical has deviated from its original path. Find the deviation in travelling a horizontal distance d << h, the height of the column.

15. In a Young's double experiment, the slits are 1.5 mm apart. When the slits are illuminated by a monochromaticlight source and the screen is kept 1 m apart from the slits, width of 10 fringes is measured as 3.93 mm.Calculate the wavelength of light used. What will be the width of 10 fringes when the distance between the slits and the screen is increased by 0.5 m. The source of light used remains the same. **3**

16. 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, when the monochromatic source is replaced by a source of white light? **3**

SECTION - D - LONG ANSWER QUESTIONS

17. A circular disc of radius R is placed co-axially and horizontally inside an opaque hemispherical bowl of radius 'a' (Figure). The far edge of the disc is just visible when viewed from the edge of the bowl. The bowl is filled with a transparent liquid of refractive index and the near edge of the disc becomes just visible. How far below. The top of the bowl is the disc placed. **5**



OR

i) Derive the mathematical relation between refractive indices μ_1 and μ_2 of two radii and radius of curvature R for refraction at a convex spherical surface. Consider the object to be a point source lying on the principal axis in rarer medium of refractive index μ_1 and a real image formed in the denser medium of refractive index μ_2. Hence, derive lens maker's formula.

ii) Light from a point source in air falls on a convex spherical glass surface of refractive index 1.5 and radius of curvature 20 cm. The distance of light source from the glass surface is 100 cm. At what position is the image formed?

SECTION - E - CASE BASED QUESTIONS

18. Interference is based on the super position principle. According to this principle, at a particular point in the medium, the resultant displacement produced by a number of waves is the vector sum of the displacements produced by each of the waves. If two sodium lamps illuminate two pinholes S_1 and S_2. the intensities will add up and no interference fringes will be observed on the screen. Here the source undergoes abrupt phase change in times of the order of 10^{-10} seconds.

a) Why cannot the phenomenon of interference be observed by illuminating two pinholes with two sodium lamps? **2**

b) Two independent monochromatic sources of light cannot produce a sustained interference pattern. Give reason. **1**

c) How does the fringe width of interference fringes change, when the whole apparatus of Young's experiment is kept in a liquid of refractive index 1.3? **1**

UNIT TEST - 4

PHYSICS

CLASS XII **SET - B** **Time : 1½ hrs.**

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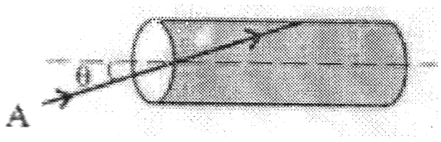
SECTION - A (OBJECTIVE TYPE QUESTIONS) **9 × 1 = 9**

1. A transparent solid cylinder rod has a refractive index of $\frac{2}{\sqrt{3}}$. It is surrounded by air. Light ray is incident at the mid-point of one end of the rod as shown in the figure. The incident angle θ for which the light ray grazes along the wall of the rod is:

   a) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$ b) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$

   c) $\sin^{-1}\left(\frac{1}{2}\right)$ d) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$



2. Calculate the limit of resolution of a telescope objective having a diameter of 200 cm, if it has to detect light of wavelength 500 nm coming from a star.

   a) 457.5×10^{-9} rad b) 305×10^{-9} rad

   c) 152.5×10^{-9} rad d) 610×10^{-9} rad

3. An equiconvex lens is cut into two halves along

   i) XOX' and ii) YOY' as shown in the figure.

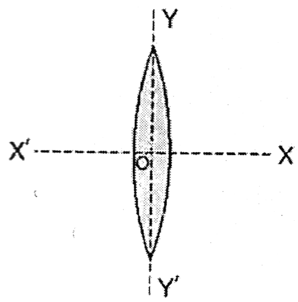
   Let f, f', f'' be the focal lengths of the complete lens, of each half in case (i) and of each half in case (ii), respectively. Choose the correct statement from the following:

   a) f' = f and f'' = 2f

   b) f' = f and f'' = f

   c) f' = 2f and f'' = f

   d) f' = 2f and f'' = 2f



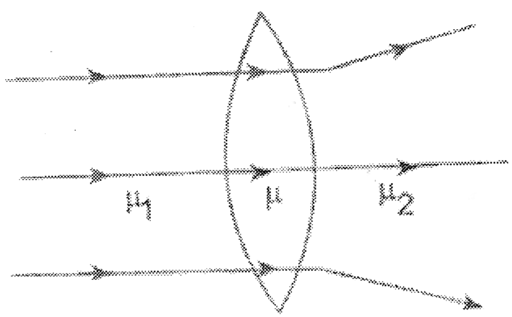
4. A parallel beam of light falls on a convex lens. The path of the rays is shown in the following figure. It follows that

   a) $\mu_1 > \mu > \mu_2$

   b) $\mu_1 = \mu < \mu_2$

   c) $\mu_1 = \mu > \mu_2$

   d) $\mu_1 < \mu < \mu_2$



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5. Assertion (A) : The frequencies of the incident, reflected, and refracted beam of monochromatic light incident from one medium to another is the same.

   Reason (R) : The incident, reflected and refracted rays are coplanar.

6. Assertion (A) : In Young's double slit experiment the fringes become indistinct if one of the slits is covered with cellophane paper.

   Reason (R) : The cellophane paper decreases the wavelength of light.

7. The phase difference between the incident wave and reflected wave is 180^0 when light ray:

   a) enters into glass from air b) enters into glass from diamond

   c) enters into the water from a glass d) enters into air from glass

8. The main difference in the phenomenon of interference and diffraction is that:

   a) diffraction is due to the interaction of light from the same wavefront, whereas the interference is the interaction of two waves derived from the same source

   b) diffraction is caused by the reflected waves from a source whereas interference is caused due to refraction of waves from a source

   c) diffraction is due to the interaction of light from the same wavefront whereas interference is the interaction of waves from two isolated sources

   d) diffraction is due to the interaction of waves derived from the same source, whereas the interference is the bending of light from the same wavefront

9. Two identical coherent sources are placed on a diameter of a circle of radius R at separation x (<< R) symmetrically about the centre of the circle. The sources emit identical wavelength λ each. The number of points on the circle with maximum intensity is: $(x = 5\lambda)$

   a) 26 b) 22 c) 20 d) 24

SECTION - B - SHORT ANSWER QUESTIONS

10. Why should the objective of a telescope have a large focal length and large aperture?

Justify your answer. **2**

11. 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 the normal adjustment. Determine the angular magnification and length of microscope tube. **2**

12. An observer sees a green fringe passing through a given point in an oil film. Would other observer looking at the same point necessarily see green fringe there? Explain by writing down the necessary relation. **2**

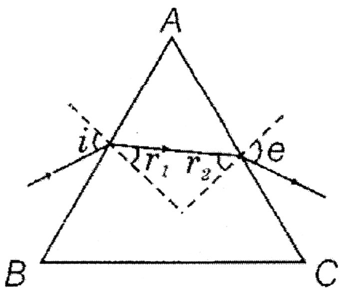
13. In a Young's double-slit experiment, fringes are obtained on a screen placed a certain distance away from the slits. If the screen is moved by 5 cm towards the slits, the fringe width changes by 30 μm. Given that the slits are 1 mm apart, calculate the wavelength of the light used. **2**

OR

In double slit experiment using light of wavelength 600 nm, the angular width of the fringe formed on a distant screen 0.1^0. Find the spacing between the two slits.

SECTION - C - SHORT ANSWER QUESTIONS

14. In the given figure, for what value of $\angle i$ should a ray of light be incident on the face of a prism of refracting angle 60^0, so that it just suffers total internal reflection at other face? (For pı **3**



OR

Draw a labelled ray diagram to show the image formation in a refracting type astronomical telescope in the normal adjustment position. Write two drawbacks of refracting type telescopes.

15. 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 of1.0 m from the slits. **3**

16. Two sources S_1 and S_2 emitting light of wavelength 600 nm placed 0.1 mm apart. A detector is moved on the line S_1 P which is perpendicular to S_1 S_2.

    i) What would be the minimum and maximum path difference at the detector as it is moved along the line S_1P.

ii) Locate the position of farthest minimum detected. **3**

SECTION - D - LONG ANSWER QUESTIONS

17. 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 $n(r) = 1 + \frac{2GM}{rc^2}$ 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. **5**

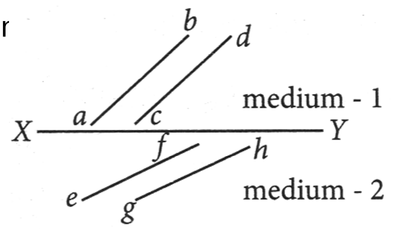
OR

a) Derive the expression for the angle of deviation for a ray of light passing through an equilateral prism of refracting angle A.

b) A prism is found to give a minimum deviation of 51^0. The same prism gives a deviation of 62^0 48' for two values of the angles of incidence, namely, 46^0 6' and 82^0 42'. Determine the refractive angle of the prism and the refractive index of its material.

SECTION - E - CASE BASED QUESTIONS

18. Wavefront is a locus of points which vibratic in same phase. A ray of light is perpendicular to the wavefront. According to Huygens principle, each point of the wavefront is the source of a secondary disturbance and the wavelets connecting from these points spread out in all directions with the speed of wave. The figure shows a surface XY separating two transparent media, medium- I and medium-2. The lines ab and cd represent wavefronts of a light wave travelling in medium- 1 and incident on XY. The lines ef and gh represent wavefror m -2 after refraction.



i) How is a wave front different from a ray? **2**

OR

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

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

a) Light diverging from point source. **1**

b) Light emerging out of a convex lens when a point source is placed at its focus. **1**