One Two Academy | Ray Optics

Maximum Marks : 25 **PHYSICS** **Time: 50 Minutes**

Choose the correct answer :- **3x1=3**

1. Stars twinkle due to,
(a) reflection (b) total internal reflection
(c) refraction (d) polarisation

2. The radius of curvature of curved surface at a thin planoconvex lens is 10 cm and the refractive index is 1.5. If the plane surface is silvered, then the focal length will be,
(a) 5 cm (b) 10 cm (c) 15 cm (d) 20 cm

3. In Non – Rayleigh scattering , the size of the dust particles are _____ to λ.
(a) greater (b) lesser (c) equal to (d) not equal to

Answer the following :- **3x2=6**

4. What is power of a lens?

5. State Snell's law.

6. Light travelling through transparent oil enters in to glass of refractive index 1.5. If the refractive index of glass with respect to the oil is 1.25, what is the refractive index of the oil?

Answer any two of the following:- **2x3=6**

7. Derive the relation between f and R for a spherical mirror.
8. What are the Cartesian sign conventions for lenses ?.
9. Find the position of the image of a point object O in the two cases given. Take the radius of curvature of the surface R as 15 cm, $n_1 = 1$ and $n_2 = 2$.
Case i) O is located 10 cm to the left of the surface.

Case ii) O is located 30 cm to the left of the surface.

Answer the following :- **2x5=10**

10. (a) Describe the Fizeau's method to determine the speed of light.

(OR)

(b) Derive the mirror equation and the equation for lateral magnification.

11. i) What is Snell's window?
ii) A optical fibre is made up of a core material with refractive index 1.68 and a cladding material of refractive index 1.44. What is the acceptance angle of the fibre if it is kept in air medium without any cladding?

ALL THE BEST

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Answer key attached in next page!!!

This page is to prevent seeing answer key

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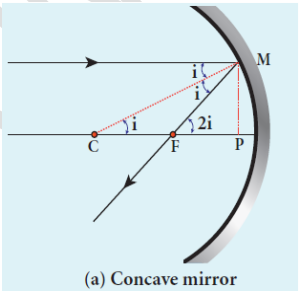
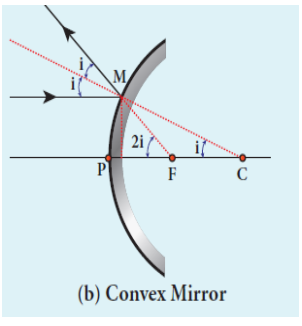
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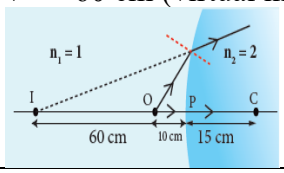
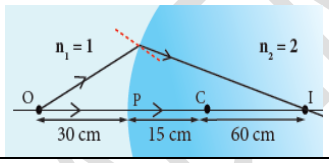
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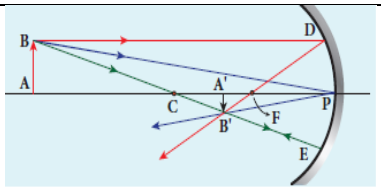
ANSWER KEY

Q NO	ANSWERS	MARKS
1.	(B) total internal reflection	**1**
2.	(B) 10 cm	**1**
3.	(A) greater	**1**
4.	The power of a lens is a measure of the degree of convergence (or) divergence the lens produces on the light falling on it. The power of a lens . P is the reciprocal of its focal length in meter. $P = 1/f$.	**2**
5.	The ratio of sine of angle of incident i in the first medium to the sine of angle of refraction r in the second medium is equal to the ratio of refractive index n_2 of the second medium to the refractive index n_1 of the first medium. $\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$	**2**
6.	Given, n_{go} =1.25 and n_g =1.5 $n_o = \frac{n_g}{n_{go}}$ $n_o = 1.2$	**2**
7.	Let C be the centre of curvature of the mirror. Consider a ray of light parallel to the principal axis is incident on the mirror at M. It passes through the principal focus F after reflection. Let i be the angle of incidence and the same will be the angle of reflection.  (a) Concave mirror  (b) Convex Mirror If MP is the perpendicular from M to the principal axis, then the angles $\angle MCP = i$ and $\angle MFP = 2i$ From right angle triangles ΔMCP and ΔMFP $\tan i = \frac{PM}{PC}$ *and* $\tan 2i = \frac{PM}{PF}$	**3**

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	2PF = PC , PC = R 2f = R f = R/2.	
8.	(i) The sign of focal length is *not decided* on the direction of measurement of the focal length from the pole of the lens as they have two focal lengths, one to the left and another to the right. (ii) The focal length of the thin lens is taken as positive for a converging lens and negative for a diverging lens. The other sign conventions for object distance, image distance, radius of curvature, object height and image height (except for the focal lengths as mentioned above) remain the same for thin lenses as that of spherical mirrors.	**3**
9.	Case i) $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ v = - 60 cm (virtual image in left)  Case ii) $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ v = 60 cm(real image in right)  	**3**
10. a	**Apparatus**: The light from the source S was first allowed to fall on a partially silvered glass plate G kept at an angle of 45° to the incident light. The light then was allowed to pass through a rotating toothed-wheel with N teeth and N cuts of equal widths whose speed of rotation could be varied through an external mechanism . The light passing through one cut in the wheel will get reflected by a mirror *M* kept at a long distance *d*, about 8 *km* from the toothed-wheel. If the toothed-wheel was not rotating, the light reflected back from the mirror would again pass through the same cut and reach the eyes of the observer who looks through the partially silvered glass plate. **Working** : The angular speed of rotation of the toothed-wheel was increased from zero to a value ω until the light passing through one cut would completely be blocked by the adjacent tooth. This is ensured by the disappearance of the light while looking through the partially silvered glass plate. **Expression for speed of light** : $v = \frac{2d}{t}$ $\omega = \frac{\theta}{t}$ $\theta = \frac{2\pi}{2N} = \frac{\pi}{N}$ $\omega = \frac{\pi}{Nt} \implies t = \frac{\pi}{N\omega}$ $v = \frac{2d}{\pi/N\omega} = \frac{2dN\omega}{\pi}$ the speed of light in air was determined as, $v = 2.99792 \times 10^8$ m s^{-1}.	**5**

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10. b	 The triangles ΔBPA and $\Delta B'PA'$ are similar. Thus, from the rule of similar triangles, $$\frac{A'B'}{AB} = \frac{PA'}{PA}$$ The other set of similar triangles are, ΔDPF and $\Delta B'A'F$. (PD is almost a straight vertical line) $$\frac{A'B'}{PD} = \frac{A'F}{PF}$$ From eqns, $$\frac{PA'}{PA} = \frac{PA' - PF}{PF}$$ PA = -u, PA' = -v, PF = f, $$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$ This eqn is known as mirror equation. Expression for lateral magnification : $$m = \frac{h'}{h}$$ Applying proper sign conventions, $$m = \frac{h'}{h} = -\frac{v}{u}$$ Using mirror eqn , $$m = \frac{h'}{h} = \frac{f - v}{f} = \frac{f}{f - u}$$	**5**
11	i) Snell's window is the restricted area of circular illumination which appears when seen from water due to critical angle incidence. The radius of the circular illumination is, $$R = \frac{d}{\sqrt{n^2 - 1}}$$ ii) Acceptance angle, $i_a = \sin^{-1}(\sqrt{n_1^2 - n_2^2}) = 60°$ if no cladding , n=2 $i_a = \sin^{-1}(1.35)$	**5**

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