



PHYSICS

BOOKS - BETTER CHOICE PUBLICATION

REFRACTION OF LIGHT

Very Short Answer Type Questions

1. Define critical angle.



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2. Write the conditions for total internal reflection to take place?



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3. Can absolute refractive index of any material be less than one? Why?



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4. How does the frequency of a beam of ultraviolet light change when it goes from air to glass?



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5. How the speed of light in vacuum is affected by the change of wavelength of light?



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6. Give illustrative examples for total internal reflection.



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7. What is astigmatism?



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8. An air bubble inside the water behaves as:



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9. Define the principal axis of a lens.



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10. When does snell's law in refraction fails?



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11. State Snell's law of refraction of light.



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12. A convex lens made of material of refractive index n_1 is kept in a medium of refractive index n_1 . Parallel rays of light are incident on the lens. Complete the path of light emerging from the convex lens, if $n_1 = n_2$



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13. A convex lens made of material of refractive index n_1 is kept in a medium of refractive

index n_2 . Parallel rays of light are incident on the lens. Complete the path of light emerging from the convex lens, if $n_1 < n_2$



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14. A convex lens made of material of refractive index n_1 is kept in a medium of refractive index n_1 . Parallel rays of light are incident on the lens. Complete the path of light emerging from the convex lens, if $n_1 > n_2$



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Short Answer Type Questions

1. What is meant by power of a lens? What does its sign indicate? State its SI unit, how is it related to the focal length of a lens?



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2. Why diamond is hard while graphite is soft ?



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3. Write the conditions for total internal reflection to take place?



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4. How will you explain twinkling of stars?



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5. When does snell's law in refraction fails?



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6. The sun appears red at sun rise or sunset, why?



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7. A concave mirror and a convex lens are held separately in water. What changes, if any, do you expect in the focal length of either?



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8. Answer the following questions: 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?



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9. Write the conditions for total internal reflection to take place?



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10. Derive the expression for the power of two thin lenses placed in contact with each other.



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11. Explain total internal reflection. What are its conditions?



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12. Prove the relation ${}^a\mu_b = \frac{1}{{}^b\mu_a}$



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13. State generalized Snell's law of refraction through multiple parallel media. Prove the relation.

$${}^a\mu_c = {}^a\mu_b \times {}^b\mu_c$$



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14. Explain total internal reflection. What are its conditions?



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15. Write the conditions for total internal reflection to take place?



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16. State the condition of total internal reflection. Calculate the speed of light in the medium whose critical angle of 45° .



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17. What are opiates? Give their functions.



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18. What is the relation between critical angle and refractive index? What is critical angle for diamond?



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19. What are the uses of optical fibre?



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Most Expected Questions

1. What do you mean by laws of refraction?



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2. What will happen if the refractive index of glass is the same as that of air?



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Long Answer Type Questions

1. Prove the following formula when refraction takes place at a convex spherical refracting surface and source of light lies in the rarer medium and image formed is real

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

Where the terms have their usual meanings.



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2. With the help of suitable diagram, sign conventions and assumptions, derive lens

Maker's formula for a convex lens.



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3. Obtain a relation between a critical angle and refractive index of medium.



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4. What is refraction of light?



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5. Prove the following formula when refraction takes place at a convex spherical refracting surface and source of light lies in the rarer medium and image formed is real

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

Where the terms have their usual meanings.



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6. For a spherical surface, when refraction takes place from a rarer medium (μ_1) to a denser

medium (μ_2), we write

$$-\frac{\mu_1}{u} + \frac{\mu_2}{v} = \frac{\mu_2 - \mu_1}{R}$$

where the symbols have their usual meanings.

Now suppose that the object is placed in the denser to the rarer medium . Then, rewrite the above equation.



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7. A ray of light enters from a rarer to a denser medium. What will happen?



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8. By giving sign-conventions, derive the lens formula relating object distance, image distance and focal length for a thin convex lens. Draw a ray diagram to show the formation of image of an object placed between optical centre and focus of a convex lens.



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9. By giving assumptions made, derive the lens maker formula for a double convex lens.



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Numerical Problems

1. A convex lens of refractive index 1.5 has a focal length of 18 cm in air. Calculate the change in focal length, when it is immersed in water of refractive index $\frac{4}{3}$.



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2. The radii of curvature of a convex lens are 20 cm and 30 cm and the refractive index of its material is 1.5. How its nature and focal length will change, when it is immersed in a liquid of refractive index = 1.6?



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3. A glass ($\mu = 1.5$) convex lens of focal length 40 cm is placed in water ($\mu = 1.3$). What will

be its new focal length?



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



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5. A small black dot is made on the surface of a glass sphere ($\mu = 1.5$) and is viewed from the other side. If radius is 15 cm, find the position of the image.



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6. Two lenses of powers +4 D and -14 D form a combination. If a 2 cm size object is placed 30 cm from this combination, find the position, nature and size of the image.





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7. A spherical refracting surface of denser medium ($\mu = 1.5$) is placed in a rarer medium ($\mu = 1.3$). For an object lying in rarer medium at 20 cm from the surface, the virtual image is formed at 60 cm in rarer medium. Find out the radius of curvature of the surface.



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8. A convex lens of power 4 D is combined with a other lens. For an object placed 25 m from the combination, the real image is formed 50 cm away from the combination. Find power of the other lens.



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9. A equiconvex lens of focal length 30 cm is divided into two equal halves in thickness.find the focal lnegth of eah half.





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10. A equiconvex lens of focal length 30 cm is divided into two equal halves in thickness. find the focal length of each half.



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11. A double convex lens of focal length 25 cm is divided into two equal halves in thickness. Find the focal length of each half.



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12. A 5.0 cm long needle is placed vertically at a distance 20 cm in front of a double convex lens made of a material of refractive index 1.5 having radii of curvature as 20 cm and 30 cm .Find the height of image formed.



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15. A ray of light of frequency of $5 \times 10^{14} \text{ Hz}$ is passed through a liquid. The wavelength of light measured inside the liquid is found to be $450 \times 10^{-9} \text{ m}$. Calculate refractive index of the liquid.



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16. A ray of monochromatic light travelling in vacuum with speed c , wavelength γ and frequency ν , enters into a medium of refractive

index 1.5 .What will be its new speed ,wavelength and frequency?



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17. For the same angle of incidence,the angles of refraction in three different mediaA,B and C are 15° , 25° and 35° respectively.In which medium will the velocity of light be minimum?



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18. Two lenses, one diverging of power 2D and the other converging of power 6D are combined together. Calculate the focal length and power of the combination.



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19. The radii of curvature of the faces of a double convex lens are 20 cm and 30 cm. Its focal length is 24 cm. What is the refractive index of the glass?





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20. A convex lens has 10 cm focal length in air. What is its focal length in water? (refractive index of air water is 1.33, refractive index for air glass =1.5).



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21. If the critical angle for total internal reflection from a medium to vacuum is 30° then velocity of light in the medium is:



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22. The radii of curvature of the faces of a double convex lens are 20 cm and 20 cm. Its focal length is also 20 cm. What is the refractive index of the glass?



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23. A convex lens has 12 cm focal length in air. What is its focal length in water ? (Refractive

index of air water is 1.33, refractive index for
air glass =1.5)



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24. The radii of curvature of the faces of a double convex lens are 10cm and 15 cm, its focal length is 12 cm. What is the refractive index of the glass?



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25. A convex lens has 20 cm focal length in air. What is its focal length in water ? (Refractive index of air water is 1.33, refractive index for air glass =1.5)



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26. 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 the object is at a

distance of 40 cm. What is the focal length of the concave lens?



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27. A convex lens of focal length 0.2 m and made of glass ($\mu = 1.50$) is immersed in water ($\mu = 1.33$). Find the change in the focal length of the lens.



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28. A concave lens is kept in contact with a convex lens of focal length 20 cm. The combination works as a convex lens of focal length 50 cm. Find the power of the concave lens.



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29. A convex lens is made of glass of refractive index 1.5. If radius of curvature of the each of its two surfaces is 20 cm, find the ratio of the

power of the lens,when placed in air to its power ,when immersed inside a liquid of refractive index 1.25.



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30. A needle placed 40 cm from a lens forms an image on a screen placed 80 cm on the other side of the lens. Identify the type of lens and determine its focal length. What is the size of the image, if the size of needle is 15 cm ?



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31. A lens of focal length 12 cm produces a virtual image, whose linear dimensions are $\frac{1}{3}$ that of the object. What kind of a lens is it? Determine the position of the object and the image.



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32. 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 distance.



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33. A lens placed at a distance of 20 cm from an object produces a virtual image $\frac{2}{3}$ the size of the object. Find the position of image, kind of lens and its focal length.



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34. A needle placed 40 cm from a lens forms an image on a screen placed 80 cm on the other side of the lens. Identify the type of lens and determine its focal length. What is the size of the image, if the size of needle is 15 cm ?



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35. What is the focal length of a convex lens of focal length 30cm in contact with a concave

lens of focal length 20cm? Is the system a converging or a diverging lens? Ignore thickness of the lenses.



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36. Two lenses of power +15D are in contact with each other. What is focal length of Combination?



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