PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

OPTICAL INSTRUMENTS

Example

1. The focal length of object glass of a microscope is 0.02 m, that of the eye-piece is

0.04 and distance between them is 0.20m. What is the distance of the object from the object glass when the image seen by the eye is 0.25m from the eye-piece? Calculate also the magnifying power of the microscope.

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2. In an astronomical telescope, focal length of objective lens is $75cm$ and that of eye piece is $5cm$. Calculate the magnifying power and the distance between the two lenses, when final

image of distant object is seen at a distance of $25cm$ from the eye.

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3. A microscope has an objective of focal length $1.5cm$ and eye piece of focal length $2.5cm$. If the distance between objective and eyepiece is $25cm$. What is the approximate value of magnification produced for relaxed eye ?

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4. Light from the sun is falling directly upon a Ramsden eye-piece consisting of lenses of focal length 0.05m. Find the position of the image formed and trace the path of rays through the eye-piece.

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5. A short-sighted person cannot see objects situated beyond 2m from him distinctly. What

should be the power of the lens which he should use for seeing distant objects clearly?

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6. A long-sighted person can see objects beyond 1 m distinctly. Calcualte the power of the lens that should be prescribed for him normal vision.

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7. A man stands on vertical tower of height 20 cm. Calculate the distance up to which he will be able to see on the surface of the earth. Neglect the height of the man. Take the radius of the earth $= 6400$ km

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Exercises

1. Two convex lenses of focal length 0.01 , and 0.06 m, respectively are arranged to from a microscope. A small object is placed 0.012 m from object glass. If the image seen appears to be 0.25m from the eye-piece, what is the distance between the object glass and eye-piece?

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2. The objective and the eye-piece of a microscope have focal lengths of 0.02m and 0.04m, respectively and are placed 0.15m apart. If the final image is situated 0.25m from the eye-piece, how far must the object be from the objective?

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3. A compound microscope consists of two convex lenses of focal lengths 0.02m and 0.15

m. An object is placed at a distance of 0.025m from the object glass and the final image is formed at the least distance of distinct vision. Find the magnification produced and the distance between the lenses.

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4. The focal lengths of the objective and eye piece of an astronomical telescope are $25cm$ and $2.5cm$ respectively. The telescope is fucussed on an object $1.5m$ from objective,

the final image being formed $25cm$ from eye of the observer. Calculate the length of the telescope.

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5. An astronomical telescope in normal adjustment has a tube length of 93 cm and magnification (angular) of 30. If eye-piece is to be drawn out by 3 cm to focus a near object, with the final image at infinity, find how far

away is the object and the magnification (angular) is this case.

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6. A telescope has two convex lenses of focal lengths 10 cm and 1 cm. If the telescope is focussed on a scale 1 m away from the objective and the final image is formed 25 cm away from the eye, calculate the magnification produced.

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7. A simple astronomical telescope is designed using two convex lenses of focal lengths 1 m and 0.05m. Find the magnifying power when the instrument is used to view a distant object if the final image is formed (a) at a great distance, (b) at a distance of 0.25m from the eye-piece.

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8. A telescope consisting of two convex lenses of focal lengths 0.20m and 0.01m is focussed on a distant object for normal vision. What is the distance between the glasses? If the same telescope is now focussed on an object which is 2 m away from the object glass without altering the accommodation of the eye, by how much does the eye-piece have to be shifted?

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9. The focal lengths of the objective and the eye-piese of an astronomical telescope are 0.25m and 0.025m, respectively. The telescope is focussed on an object 5 m from the objective, the final image being formed 0.25m from the eye of the observer. Calculate the length of the telescope and its magnifying power.

[Hint : Mag. power = v_0 / u_e]

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10. A Galilean telescope of 10-fold magnification has the length of $45cm$ when adjusted to infinity. Determine :

(a) the focal lengths of the telescope's objective and ocular,

(b) by what distance the ocualr should be displaced to adjust the telescope to the distance of $50m$.

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11. The objective of a telescope focussed for infinity is taken out and replaced by a diaphragm of diameter D.A screen placed on the other side of the eye-piece shows a sharp image of diameter d. What was the magnifying power of the telescope?

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12. A telescope with magnification M = 15 was submerged in water so that the inside of the

telescope is filled up with water. To make the system work as a telescope within the former dimensions, the objective was removed. What was the magnification of the telescope after the change? μ of the material of the eye-piece=1.5 and μ of water $= \frac{4}{3}$

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13. A Huygens eye-piece is made by arranging two planoconvex lenses of focal lengths 0.03m and 0.09m in the usual manner. Light falls

directly on the field lens of the eye-piece. Calculate the position of the final image formed by the eye-piece and trace the path of rays showing the formation of images.

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14. An eye-piece is constructed by using two thin lenses of focal lengths 0.03 m and 0.04m respectively and are spaced so as to reduce spherical aberration to minimum. Find (a) separation between lenses required, (b)

equivalent focal length and (c) magnifying power when the vision is distinct.

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15. An eye-piece consists of a concave lens of focal length 2f and a convex lens of focal length 3f separted by a distance $\frac{f}{2}$. They are of the same material. Examine whether the eye-piece formed is free from spherical and chromatic aberration. Is it suitable for use of cross-wire?

[Hint : An eye-piece is suitable for cross-wire when it is a positive one. See example 6]

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16. You given two planoconvex lenses of focal lengths 0.03m and 0.05m and asked to design an eye-piece free from chromatic aberration. Explain how you will achieve it . Calculate the equivalent focal length of the eye-piece formed and its magnifying power if it is used by a person for whom least distance of

distinct vision is 0.25m. Will your eye-piece be free from spherical aberration?

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17. Two thin converging lenses of focal length 0.05m are separted by a distance of 0.03m. Find the focal length of the eye-piece and determine wheather this will be a positive or negative eye-piece. Will it be free from spherical and chromatic aberration?

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18. Two convex lenses of focal lengths 2f and f are arranged to from an eye-piece and are spaced by f. The first lens is to be used as field lens and the second one as eye-lens. Find (a) equivalent focal length. (b) See whether it is positive or negative eye-piece. (c) Whether it is free from spherical aberration and chromatic aberration? (d) What will be the disadvantage it f is used as field lens?

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19. A student with defective eye-sight cannot see clearly anything that is father from his eyes than 50 cm. What kind of lens would enable him to see distant objects clearly and what would be the power required?

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20. A person's range of distinct vision is from 6 cm to 60 cm from the eye. What spectacles would be required to see distant objects

clearly and what could be his least distance of distinct vision using the spectacles?

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21. A person can see objects as near as 40 cm and as far as 3 m. What kind of spectacles will be required (a) for reading purposes, (b) for seeing distant objects? Least distance of distinct vision = 25 cm. What is the range of clear vision with each pair of spectacles?

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22. A short-sighted man, the accommodation of whose eye is between 12 cm and 60 cm wears spectacles through which he can see remote objects distinctly. Determine the minimum distance at which the man can read a book through his spectacles.

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23. Two men, one far-sighted and one short-sighted one, see objects through their

spectacles of his short-sighted friend, he found that he could see distinctly puts on the spectacles of his short-sighted friend, he found that he found that he could see distinctly only infinitely far objects. At what minimum distance would the shortsighted man be able to read small type if he wore the spectacles of far-sighted man?

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24. The velocity of light in vacuum is $3 \times 10^8 ms^{-1}$. What is the velcoity of light in glass if the index of refraction of glass if 1.5?

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25. A star is at a distance of 50×10^{12} km from earth. If the star disappears due to collision with some other star so that its light is extinguished, how long would we continue the

star (even after it stops) existing. Velocity of light in vacuum $= 3 \times 10^8 ms^{-1}$.

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26. In Fizeau's experiment the distancec between the source and the reflector is 8 km and there are 720 teeth in the toothed wheel. At what speed would the first, second and third eclipses occur? (Velocity of light $= 3 \times 10^9 ms^{-1}$)

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27. In an experiment on measuring the velocity of light by Focault's method the fixed and the fixed and the revolving mirror were 3 km apart, the latter revolving at 500 revvolutions per second. The angular diviation of the return ray was $7^{\circ} 12'$. Calcualte velocity of light.

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28. The distance beween the toothed wheel with 720 teeth and the mirror in an

experiment based on Fizeau's method is 7 km. The two consecutive speeds of rotation of the wheel for which light disappeared were 283 rps and 313 rps. Find the velocity of light.

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29. Two places A and B on the same longitude are h km apart along the surface of the earth, A is at the equator. The shadow of a vertical pole is zero at A at some hour of observation and the shadow of an identical pole at B is just

half its length at the same hour of observation. Show that these observations enable us to find the radius of the earth.

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30. On a new-moon day, a man on earth sees the annular eclipse of the sun? Diametre of the sun. How high would he have rise above the earth's surface so as just see the total eclipse of the sun? Diametre of the sun $= 1.4 \times 10^9$m, diametre of the moon

$= 1.7 \times 10^6$m. Distances of the sun and the moon from the position of the man on earth are respectively,1.5×10^{11}m. and 3.8×10^8m.

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31. When Sun's rays pass through small holes in the ventilator of a room, they produce elliptical spots on the floor. The major and minor axes of the ellipses are $a = 4.9$cm and $b = 4.6$cm respectively. What is the height of

the room? The angular dimensions of the Sun's disc are $\beta = \frac{1}{100}$rad.

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32. A rod of height h stands erect on a flat horizontal mirror. Sunrays fall on the mirror at some angle and reflected on to the nearby wall. Find the length of the shadow.

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33. Two candles of equal height h are placed in between vertical walls on a line perpendicular to the walls at a distance a from each other and also from the nearer wall. With what speed will the shadows of the candles move along the walls if one burns out completely in time t_1 and the other in time t_2.

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