PHYSICS

BOOKS - DHANPAT RAI & CO PHYSICS (HINGLISH)

OPTICAL INSTRUMENTS

Example

1. Calculate the maximum magnifying power of a simple microscope consisting of a convex

lens of focal length $5cm$. Distance of distinct vision is $25cm$.

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2. A simple microscope is a combination of two lenses in contact of powers +15 D and +5D. Calculate the magnifying power of the microscope, if the final image is formed at 25 cm from the eye.

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3. An object is to be seen through a simple microscope of power 10D. Where should the object be placed so as to produced maximum angular magnification ? The least distance for distinct vision is 25 cm.

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4. A simple microscope is rated 5 X for a normal relaxed eye. What Nvill be its magnifying power for a relaxed farsighted eye whose near point is 40 cm?

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5. A man with normal near- point (25c m) reads a book with small print using a magnifying glass L a thin convex lens of focal length 5 cm.

(i) What is the closest and the farthest distance at which he can read the book when viewing thorugh the magnifying glass ?

(ii) What is the maximum and the minimum angular magnification (magnifying power) possible using the above simple microscope ?

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6. A cardsheet divided into squares each of size $1mm^2$ is being viewed at a distance of $9cm$ through a magnifying glass (a conerging lens of focal length $10cm$) held close to the eye.

(a) What is the magnification produced by the lenas ? How much is the area of each square to the virtual image ?

(b) What is the angular magnification (magnifying power) of the lens ?

(c) Is the magnification in (a) equal to the magnifying power in (b) ? Explain

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7. (i) At what distance should the lens be held from the card sheet in order to view the squares distinctly with the maximum possible magnifying power ?

(ii) What is the magnification in this case ?

(iii) Is the magnification equal to magnifying power in this case ? Explain.

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8. What should be the distance between the object and magnifying glass if the virtual image of each square in the figure is to have an area of $6.25mm^2$.Would you be able to see the squares distinctly with your eyes very close to the magnifier ?

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9. A compound microscope has a magnification f 30. the focal length of its eyepiece is 5 cm. assuming the final image to be formed at least distance of distinct vision (25 cm), calculate the magnification produced by the objective.

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10. The focal lengths of the objective and the eyepiece of a compound microscope are 1.0 cm

and 5.0 cm respectively. An object, placed at a distance of 1.1 cm from the objective, has its final image formed at a distance of 25 cm from the eye. Find the magnifying power of the microscope.

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11. A person with a normal near point $(25cm)$ using a compound microscope with an objective of focal length $8.0mm$ and eye piece of focal length $2.5cm$ can bring an object

placed $9.0cm$ from the objective in sharp focus. What is the separation between the two lenses ? Calculate the magnifying power of the microscope ?

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12. The total magnification produced by a compound microscope is 20. The magnification produced by the eye piece is 5. The microscope is focussed on a certain object. The distance between the objective and eye piece is

observed to be $14cm$. If least distance of distinct vision is $20cm$, calculate the focal length of objective and eye piece.

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13. An astronomical telescope consists of two thin lenses set 36 cm apart and has a magnifying power 8. calculate the focal length of the lenses.

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14. A small telescope has an objective lens of focal length 140 cm and an eyepiece of focal length 5.0 cm. what is the magnifying power of the telescope for viewing distant objects when

(a) the telescope is in normal adjustment (i.e, when the final image is at infinity),

(b) The final image is formed at the least distance of distinct vision (25 cm)

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15. (a) For the telescope described what is the separation between the objective lens and eye piece ?

(b) If this telescope is used to view a $100m$ tall tower $3km$ away, what is the height of the image of the tower formed by the objective lens ?

(c) What is the height of the final image of the tower if it is formed at 25 cm` ?

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16. (i) A giant refracting telescope at an observatory has an objective lens of focal length 15 m . If an eyepiece of focal length 1.0 cm is used, what is angular magnification of the telescope ?

(ii) If this telescope is used to view the moon, what is the diameter of the image of the moon formed by the objective lens ? the diameter of the moon is $3.48 \times 10^6 m$, and the radius of lunar orbit is $3.8 \times 10^8 m$.

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17. A telescope has an objective of focal length $50cm$ and eye piece of focal length $5cm$. The least distance of distinct vision is $25cm$. The telescope is focussed for distinct vision on a scale $200cm$ away from the objective. Calculate

(i) the separation between objective and eye piece

(ii) the magnification produced.

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18. An astronomical telescope consisting of an objective of focal length $60cm$ and eye-piece of focal length $3cm$ is focused on the moon so that the final image is formed at least distance vision, i.e. $25cm$ from the eye-piece piece. Assuming the angular diameter of moon as $1/2^{\circ}$ at the objective, calculate (a) angular size and (b) linear size of image seen through the telescope.

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19. A reflecting telescope has a large mirror for its objective with radius of curvature equal to 80 cm . What is the magnifying power of the telescope, if the eyepiece used has a focal length of 1.6 cm ?

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20. A small telescope has an objective lens of focal length 140 cm and an eyepiece of focal length 5.0 cm. what is the magnifying power of the telescope for viewing distant objects when

(a) the telescope is in normal adjustment (i.e, when the final image is at infinity),

(b) The final image is formed at the least distance of distinct vision (25 cm)

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21. An eyepiece of a telescope consists of two plano-convex lenses L_1 and L_2 each of focal length f separated by a distance of 2f/3. where should L_1 be plaecd relative to the focus of

the objective lens of the telescope so that the final image through L_2 is seen at infinity ?

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22. The objective of telescope A has a diameter 3 times that of the objective of telescope B. How much greater amount of light is gathered by A compared to B ? Show that range of A is three times the range of B.

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23. The angular magnification of a telescope is 300 What should be the diameter of the objective, if our eyes at the eye ring, are just able to collect all the light refracted from the objective. Take diameter of pupil of eye $= 3mm.$

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24. Calculate the separation of two points on moon that can be resolve using $600cm$ telescope. Given distance of moon from earth

$= 3.8 \times 10^{10} cm$. The wavelength most sensitive to eye is $5.5 \times 10^{-5} cm$.

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25. A telescope has an objective of diameter $60 cm$. The focal lengths of the objective and eye piece are $2.0 m$ and $1.0 cm$. Respectively. The telescope is directed to view two distant almost point sources of light (e.g. two stars of a binary). The sources are roughly at the same distance (10^4 light years) along the line of

sight, but separated transverse to the line of sight by a distance of $10^{10}m$. Will the telescope resolve the two objects ?

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26. Calculated the numerical aperture of a microscope required to just resolve two points separated by a distance of 10^{-4} cm, using light of wavelength $5.8 \times 10^{-5}cm$.

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27. Calculate the resoving power of a microscope if its numerical aperture is 0.12 and the wavelength of light used is 6000 Å

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28. The objective of a telescope has a diameter of $125cm$. Calculate the smallest angular separation of two stars that may be resolved by it. Wavelengthof light used is 6000Å.

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Problems From Competitive Examination

1. In a compound microscope, the objective and eye piece have focal lengths $0.95cm$ and $5cm$ respectively, and are kept at a distance of $20cm$. The final image is formed at a distance of $25cm$ from the eye piece. Calculate the position of the object and the total magnification.

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2. A compound microscope is used to enlarge an object kept at a distance $0.03m$ from cuts objective which consists of serval convex lenses in contact and has focal length $0.03m$. If a lens focal length $0.1m$is removed from the objective, find out the distance by which the eye-piece of the microscope must be moved to refocus the image.

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3. The eyepiece and the objective of a microscope, of focal lengths 0.3 m and 0.4 m respectively, are separated by a distance of 0.2 m. the eyepiece and the objective are teo be interchanged such that the angular magnification of the instrument remains same. what is the new separtion between the lenses ?

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Problems For Self Practice

1. A converting lens of power 100 dioptre is used as a simple microscope. What is its magnifying power, if the distance of distinct vision is 25 cm.

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2. (a) An object is seen through a simple microscope of focal length $12cm$. Find the angular magnification produced if the image is formed at the near point of the eye which is

$25cm$ away from it.

(b) A $10D$ lens is used as a magnifier. Where should the object be placed to obtain maximum angular magnification for a normal eye (near point $= 25cm$)?

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3. A converging lens of focal length 6.25 cm is used as a magnifying glass. If the near point of the observer is 25 cm from the eye and the lens is held close to the eye, calculate (i) the

distance of the object from the lens and (ii) the angular magnification. Find the angular magnification when the final image is formed at infinity.

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4. The magnifying glass is made of combination of lenses of power $+20D$ and $-4D$. If the distance of distinct vision is 25 cm, calculate the size of an object 2 cm high seen through the magnifying glass.

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5. A magnifying glass is a combination of a convex lens of focal length 5 cm and a concave lens of power - 5D. If the distance of distinct vision 20 cm, calculate the magnifying power of the magnifying glass.

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6. Magnifying power of a simple microscope A is 1.25 less than that of a simple microscope B.

If the power of the lens used in B is 25 D, find the power of lens used in A. Given that distance of distinct vision is 25 cm.

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7. A child has near point at 10 cm. What is the maximum angular magnification the child can have with a convex lens of focal length 10 cm?

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8. The magnification produced by the objective of a compound microscope is 8. If the magnifying power of the microscope be 32, then calculate the magnification produced by the eye piece.

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9. A convex lens of focal length 5cm is used as a simple microscope. What is the magnifying power, if final image is formed at the distance

of distinct vision i.e. 25 cm ? If it is used as an eyepiece in a compound microscope with objective of magnifying power 40, what is the magnifying power of the compound microscope ?

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10. The focal lengths of the objective and eye piece of a compound microscope are $4cm$ and $6cm$ respectively. If an object is placed at a distance of $6cm$ from the objective,

calculate the magnification produced by the microscope. Take distance of distinct vision $= 25cm.$

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11. The focal lengths of the objective and the eyepiece of a compound microscope are 11 cm and 2 cm, respectively and the separation between them is 15 cm. At what distance should an object be placed so that the final

image is formed at a distance of 25 cm from the eyepiece.

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12. The focal lengths of the objective and eye piece of a microscope are $2cm$ and $5cm$ respectively, and the distance between them is $20cm$. Find the distance of the object from the objective when the final image seen by the eye is $25cm$ from the eye piece. What is the magnifying power ?

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13. A compound microscope is made using a lens of focal $10mm$ as objective and another lens of focal length $15mm$ as eye piece. An object is held $1.1cm$ from the objective and final image is obtained at ∞. Calculate distance between objective and eye piece.

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14. An astronomical telescope having a magnifying power of 8 consists of two thin lenses 45 cm apart. Find the focal length of the lenses.

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15. A telescope has an objective of focal length 200 cm and eyepiece of focal length 5 cm. Calculate its magnifying power when the final

image is formed (a) at infinity and (b) at distance of distinct vision.

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16. A telescope consists of an objective of focal length 50 cm and an eyepiece of focal length 5 cm. In normal adjustment of the telescope, what will be (i) the magnifying power and (ii) the length of the telescope.

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17. An astronimical telescope is to be designed to hve a magnifying power of 50 in normal adjustment. If the length of the tube is 102 cm, fid the powers of the objective and the eyepiece.

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18. A telescope has an objective of focal length $30cm$ and an eye piece of focal length $3.0cm$. It is focussed on a scale distant $2.0m$. For seeing with relaxed aye, calculate the

separation between the objective and eye piece.

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19. The focal length of the objective of an astronomical telescope is 1.0 m. If the magnifying power of the telescope is 20, find the focal length of the eyepiece and the length of the telescope for the relaxed eye.

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20. The diameter of the moon is $3.5 \times 10^3 km$ and its distance from the earth is $3.8 \times 10^5 km$. It is viewed by a telescope which consists of two lenses of focal lengths 4m and 10 cm. Find the angle subtended at eye by the final image.

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21. On seeing with unaided eye, the visual angle of moon at the eye is 0.6°. The focal lengths of the objective and the eyepiece of a

telescope are respectively 200 cm and 5 cm. What will the visual angle on seeing through the telescope?

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22. A telescope objective lens has a focal length of $100cm$. When the final image is formed at the least distance of distinct vision, the distance between the lenses is $105cm$. Calculate the focal length of eye piece and magnifying power of telescope.

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23. A refracting telescope has an objective of focal length $1m$ and an eye piece of focal length $20cm$. The final image of the sun $10cm$ in diameter is formed at a distance of $24cm$ from eye piece. What angle does the sun subtend at the objective ?

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24. The eye-piece of an astronomical telescope has focal length of 10 cm. The telescope is focused for normal vision of distant objects when the tube length is 1.0 m. Find the focal length of the objective and the magnifying power of the telescope.

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25. How would you combine two lenses of focal lengths 25 cm and 2.5 cm to make a

telescope ? What is the magnifying power of this telescope ?

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26. A terrestrial telescope consists of three convex lenses in row whose focal lengths are 100 cm, 5 cm and 10 cm respectively (i) Calculate the total magnification in normal adjustment (ii) What would the nature of the final image ?

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27. A Galilean telescope is 27 cm long when focussed to form an image at infinity. If the objective has a focal length of 30 cm, what is the focal length of the eyepiece?

28. In a Galileo's telescope the focal lengths of the objective and the eyepiece are 0.3 m and 0.06 m respectively. Find the magnifying power and the length of the telescope.

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29. A reflecting type telescope has a concave reflector of radius of curvature 120 cm. Calculate focal length of eye piece to secure a magnification of 20.

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30. Calculate the resolving power of a telescope whose objective has a diameter of

5.08 m and $\lambda = 6000\text{Å}$.

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31. Find the limit of resolution of the human eye taking $\lambda = 6 \times 10^{-5} cm$ and diameter of the pupil as 2mm.

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32. The objective of a telescope has a diameter of $125 cm$. Calculate the smallest angular

separation of two stars that may be resolved by it. Wavelengthof light used is 6000Å.

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33. What is the aperture of the objective of a telescope that can be used to just resolve stars separated by 6×10^{-6} rad. Given $\lambda = 5.8 \times 10^{-5} cm.$

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34. Two point objects, separated by a distance of $6 \times 10^{-5} cm$, are to be resolevd using a microscope. Calculate the numerical aperture if light of wavelength 546 nm is used.

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35. Calculate the limit of resolution of a microscope if an object of numerical aperture 0.12 is viewed by using light of wavelength $6 \times 10^{-7} m$.

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