



PHYSICS

BOOKS - HC VERMA PHYSICS (ENGLISH)

OPTICAL INSTRUMENTS

Example

1. Two boys one 52 inches tall and the other 55 inches tall, are standing at distances 4.0 m

and 5.0 m respectively from an eye. Which boy will taller?



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2. A compound microscope has an objective of focal length 1 cm and an eyepiece of focal length 2.5 cm. An object has to be placed at a distance of 1.2 cm away from the objective for normal adjustment. a. Find the angular magnification. b. Find the length of the microscope tube.



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3. A nearsighted man can clearly see objects up to a distance of 1.5m. Calculate the power of the lens of the spectacles necessary for the remedy of this defect.



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Worked Out Examples

1. An object is seen through a simple microscope of focal length 12 cm. Find the angular magnification produced if the image is formed at the near point of the eye which is 25 cm away from it.



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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 small object is placed at distance of 3.6 cm from a magnifier of focal length 4.0 cm . a. find the position of the image. B. find the linear

magnification c. Find the angular
magnification.



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4. A compound microscope consists of an objective lens of focal length 1.0 cm and an eyepiece lens of focal length 5.0 cm separated by 12.2 cm. At what distance from the objective lens should an object be placed to focus it properly so that the final image is formed at the least distance of clear vision (25cm)? b.

calculate the angular magnification in this case.



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5. The separation L between the objective ($f = 0.5\text{cm}$) and the eyepiece ($f=5\text{cm}$) of a compound microscope is 7 cm. Where should a small object be placed so that the eye is least strained to see the image? Find the angular magnification produced by the microscope.



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6. An astronomical telescope has an objective of focal length 20 cm and an eyepiece of focal length 4.0 cm. The telescope is focused to see an object 10 Km from the objective .The final image is formed at infinity. Find the length of the tube and the angular magnification produced by the telescope.



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7. A Galilean telescope is constructed by an objective of focal length 50 cm and an eyepiece of focal length 5.0 cm.

a. find the tube length and magnifying power when it is used to see an object at a large distance in normal adjustment.

b. if the telescope is to focus an object 2.0 m away from the objective, what should be the tube length and angular magnification, the image again forming at infinity?



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8. The image of the moon is focused by a converging lens of focal length 50 cm on a plane screen. The image is seen by an unaided eye from a distance of 25 cm. Find the angular magnification achieved due to the converging lens.



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9. The near and far points of a person are at 40cm and 250cm respectively. Find the power of the lens he/she should use while reading at

25cm. With this lens on the eye, what maximum distance is clearly visible?



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10. A young boy can adjust the power of his eye lens between 50 D and 60 D. His far point is infinity. A. What is the distance of his retina from the eye-lens? b. What is the near point?



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Objective 1

1. The size of an object as perceived by an eye depends primarily on

- A. A. actual of the object
- B. B. distances of the object from the eye
- C. C. aperture of the pupil
- D. D. size of the image formed on the retina

Answer: D



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2. The muscles of a normal eye are least strained when the eye is focussed on an object

- A. far away from the eyes
- B. very close to the eye
- C. at about 25 cm from the eye
- D. at about 1 m from the eye

Answer: A



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3. A normal eye is not able to see objects closer than 25 cm because

A. the focal length of the eye is 25 cm

B. the distance of the retina from the eye lens is 25 cm

C. the eye is not able to decrease the distance between the eye lens and the retina beyond a limit

D. the eye is not able to decrease the focal length beyond a limit.

Answer: D



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4. When objects at different distances are seen by the eye, which of the following remain constant?

A. the focal length of the eye lens

B. the object distance from the eye lens

C. the radii of curvature of the eye lens

D. the image distance from the eye lens

Answer: D



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5. A person can clearly see objects between 25 cm and 200 cm. Which of the following may represent the range of clear vision for a person B having muscles stronger than A but

all other parameters of eye identical to that of

A

A. 25 cm to 200 cm

B. 18 cm to 200 cm

C. 25 cm to 300 cm

D. 1 cm to 300 cm

Answer: B



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6. The focal length of a normal eye lens is about

A. 1 mm

B. 2 cm

C. 25 cm to 300 cm

D. 1 m

Answer: B



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7. The distance of the eye lens from the retina is x . For a normal eye, the maximum focal length of the eye lens

A. $= x$

B. $< x$

C. $> x$

D. $= 2x$

Answer: A



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8. A man wearing glasses of focal length $+1\text{ m}$ cannot clearly see beyond 1 m . What does it signify?

- A. if he is farsighted
- B. if he is nearsighted
- C. if his vision is normal
- D. in each of these cases

Answer: D



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9. An object is placed at a distance u from a simple microscope of focal length f . The angular magnification obtained depends

- A. on f but not on u
- B. on u but not on f
- C. on f as well as u
- D. neither on f nor on u

Answer: C



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10. To increase the angular magnification of a simple microscope, one should increase

A. the focal length of the lens

B. the power of the lens

C. the aperture of the lens

D. the object size

Answer: B



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11. A man is looking at a small object placed at his near point. Without altering the position of his eye or the object, he puts a simple microscope of magnifying power $5\times$ before his eyes. The angular magnification achieved is

A. 5

B. 2.5

C. 1

D. 0.2

Answer: C





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Objective 2

1. When we see an object the image formed on the retina is

A. real

B. virtual

C. erect

D. inverted.

Answer: A::D



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2. In which of the following the final image is erect? A) simple microscope B) compound microscope C) Astronomical telescope D) Galilean telescope

A. simple microscope

B. compound microscope

C. Astronomical telescope

D. Galilean telescope

Answer: A::D



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3. The maximum focal length of the eye lens of a person is greater than its distance from the retina. The eye is

A. always strained in looking at an object

B. strained for objects at large distances

only

C. strained for objects at short distances

only

D. unstrained for all distances

Answer: A



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4. Mark the correct options.

A. A) If the far point goes ahead, the power of the divergent lens should be reduced

B. B) If the near point goes ahead, the power of the convergent lens should be reduced.

C. C) If the far point 1 m away from the eye, divergent lens should be used.

D. D) If the near point is 1 m away from the eye, divergent lens should be used

Answer: A::C



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5. The focal length of the objective of a compound microscope is f_0 and its distance from the eyepiece is L . The object is placed at a distance u from the objective. For proper working of the instrument.,

A. $L < u$

B. $L > u$

C. $f_0 < L < 2f_0$

D. $L > 2f_0$

Answer: B::D



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Exercises

1. An object is to be seen through a simple microscope of focal length 12 cm. Where should the object be placed so as to produce

maximum angular magnification? The least distance for clear vision is 25 cm.



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2. A simple microscope has a magnifying power of 3.0 when the image is formed at the near point (25 cm) of a normal eye. (a) What is its focal length? (b) What will be its magnifying power if the image is formed at infinity?



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



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5. Find the maximum magnifying power of a compound microscope having a 25 diopter lens as the objective, a 5 diopter lens as the eyepiece and the separation 30 cm between the two lenses. The least distance for clear vision is 25 cm.



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6. The separation between the objective and the eyepiece of a compound microscope can be adjusted between 9.8 cm to 11.8 cm. If the focal lengths of the objective and the eyepiece are 1.0 cm and 6 cm respectively, find the range of the magnifying power if the image is always needed at 24 cm from the eye.



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7. An eye can distinguish between two points of an object if they are separated by more than 0.22 mm when the object is placed at 25 cm from the eye. The object is now seen by a compound microscope having a 20 D objective and 10 D eyepiece separated by a distance of 20 cm. The final image is formed at 25 cm from the eye. What is the minimum separation between two points of the object which can now be distinguished?



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8. A compound microscope has a magnifying power of 100 when the image is formed at infinity. The objective has a focal length of 0.5 cm and the tube length is 6.5 cm. Find the focal length of the eyepiece.



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9. A compound microscope consists of an objective of focal length 1 cm and an eyepiece of focal length 5 cm. An object is placed at a

distance of 0.5 cm from the objective. What should be the separation between the lenses so that the microscope projects an inverted real image of the object on a screen 30 cm behind the eyepiece?



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10. An optical instrument used for angular magnification has a 25 D objective and a 20 D eyepiece. The tube length is 25 cm when the eye is least strained. (a) Whether it is a

microscope or telescope? (b) What is the angular magnification produced?



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11. An astronomical telescope is to be designed to have a magnifying power of 50 in normal adjustment. If the length of the tube is 102 cm, find the powers of the objective and the eyepiece.



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12. The eyepiece of an astronomical telescope has a focal length of 10 cm. The telescope is focussed 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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13. 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?



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14. A farsighted person cannot see objects placed closer to 50 cm. Find the power of the lens needed to see the objects at 20 cm.



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15. A nearsighted person cannot clearly see beyond 200 cm. Find the power of the lens needed to see objects at large distances.



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16. A person wears glasses of power $-2.5D$. Is the person short sighted or long sighted ? What is the far point of the person without glasses ?



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17. A professor reads a greeting card received on his 50th birthday with $+ 2.5$ D glasses keeping the card 25 cm away. Ten years later, he reads his farewell letter with the same glasses but he has to keep the letter 50 cm away. What power of lens should he now use?



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18. A normal eye has retina 2 cm behind the eye-lens. What is the power of the eye-lens

when the eye is (a) fully relaxed, (b) most strained?



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19. The near point and the far point of a child are at 10 cm and 100 cm. If the retina is 2.0 cm behind the eye-lens, what is the range of the power of the eye-lens?



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20. A nearsighted person cannot see beyond 25 cm. Assuming that the separation of the glass from the eye is 1 cm, find the power of lens needed to see distant objects.



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21. A person has near point at 100 cm. What power of lens is needed to read at 20 cm if he/she uses (a) contact lens, (b) spectacles

having glasses 2.0 cm separated from the eyes?



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22. A lady uses + 1.5 D glasses to have normal vision from 25 cm onwards. She uses a 20 D lens as a simple microscope to see an object. Find the maximum magnifying power if she uses the microscope (a) together with her glass (b) without the glass. Do the answers suggest that an object can be more clearly

seen through a microscope without using the correcting glasses?



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23. A lady cannot see objects closer than 40cm from the left eye and closer than 100cm from the right eye. While on a mountaining trip, she is lose from her team. She tries to make an astronomical trip, from her reading glasses to look from her teammates. (a) Which glass

should she use as the eyepiece? (b) What magnification can she get with relaxed eye?



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Question For Short Answer

1. Can virtual image be formed on the retina in a seeing process?



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2. Can the image formed by a simple microscope be projected on a screen without using any additional lens or mirror?



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3. The angular magnification of a system is less than one. Does it mean that the image formed is inverted?



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4. A simple microscope using a single lens often shows coloured image of a white source. Why?



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5. A magnifying glass is a converging lens placed close to the eye. A farsighted person uses spectacles having converging lenses. Compare the functions of a converging lens used as a magnifying glass and as spectacles.



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6. A person is viewing an extended object. If a converging lens is placed in front of his eyes, will he feel that the size has increased?



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7. The magnifying power of a converging lens used as a simple microscope is $\left(1 + \frac{D}{f}\right)$. A compound microscope is a combination of two such converging lenses. Why don't we

have magnifying power $\left(1 + \frac{D}{f_0}\right) \left(1 + \frac{D}{f_e}\right)$

. In other words, why can the objective not be treated as a simple microscope but the eyepiece can?



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8. By mistake, an eye surgeon puts a concave lens in place of the lens in the eye after a cataract operation. Will the patient be able to see clearly any object placed at any distance?



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9. The magnifying power of a simple microscope is given by $1 + \frac{D}{f}$, where D is the least distance for clear vision. For farsighted persons, D is greater than the usual. Does it mean that the magnifying power of a simple microscope is greater for a farsighted person as compared to a normal person? Does it mean that a farsighted person can see an insect more clearly under a microscope than a normal person?



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10. Why are the magnification properties of microscopes and telescopes defined in terms of the ratio of angles and not in terms of the ratio of sizes of objects and images?



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11. An object is placed at a distance of 30 cm from a converging lens of focal length 15 cm. A normal eye (near point 25 cm, far point

infinity) is placed close to the lens on the other side. (a) Can the eye see the object clearly? (b) What should be the minimum separation between the lens and the eye so that the eye can clearly see the object? c. Can a diverging lens, placed in contact with the converging lens, help in seeing the object clearly when the eye is close to the lens?



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12. A compound microscope forms an inverted image of an object. In which of the following cases it is likely to create difficulties? a. Looking at small germs. b. Looking at circular spots. c. Looking at a vertical tube containing some water.



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