Unit 13 · Light

HARDER PRACTICE QUESTIONS

Full marks 49

Write your answers on separate paper. Show your working. Use the unit's signs: real distances positive, virtual negative, f positive for a convex lens and negative for a concave one. D = 25 cm.

1 Spot the error [3]

Roshan found the image of an object 15 cm from a convex lens of focal length 10 cm. He wrote: "$\frac{1}{v} = \frac{1}{10} + \frac{1}{15} = \frac{5}{30}$, so v = 6 cm, real, and m = 6 ÷ 15 = 0.4."

What is wrong? Find the true image.

2 Find the bad reading [4]

Students at an optical bench measured these distances with one convex lens.

u (cm)	15	20	24	30	40	60
v (cm)	60	30	24	20	23	15

i. Find the focal length and power of the lens.

ii. Which reading doesn't fit? What should v have been?

iii. Where was the object at 2F, and how do you know?

3 The school hall [4]

A projector's lens has a focal length of 10 cm. A slide 3 cm tall throws a sharp picture on a screen 3 m from the lens.

i. How far from the lens is the slide, and how tall is the picture?

ii. The screen is moved back to 5 m. Must the slide move towards the lens or away from it? How tall is the picture now?

4 Show that [4]

i. Starting from the lens formula, show that a convex lens forming a real image has $m = \frac{f}{u - f}$.

ii. Use it to find m for f = 15 cm, u = 20 cm.

iii. Where must the object be for m = 1?

iv. What happens to m as the object moves in towards F?

5 One screen, two places [5]

Sapana keeps a bulb and a screen 90 cm apart, with a convex lens of focal length 20 cm between them.

i. Show that a sharp image forms with the lens 30 cm from the bulb, and again with it 60 cm from the bulb.

ii. Find the magnification each time. What do you notice about the two?

iii. With the screen 70 cm from the bulb, v = 70 − u gives $u^2 - 70u + 1{,}400 = 0$. Show this, and say what it means for a sharp image.

6 Work backwards [4]

A microscope's objective has a focal length of 0.5 cm and its eyepiece 2.5 cm, and they are held 16 cm apart. The final image is at 25 cm from the eyepiece.

i. How far in front of the eyepiece must the first image lie?

ii. How far from the objective must the object be placed?

iii. Find the magnifying power.

7 The right way round [3]

Tashi has a telescope with an objective of focal length 90 cm and an eyepiece of focal length 3 cm.

i. How large would the Moon, half a degree across, look through it?
ii. She wants the Moon to fill 20°. Which eyepiece must she use, and how long is the telescope now?
iii. What would she see if she looked in through the objective end?

8 Find the unknown lens [4]

A convex lens of focal length 25 cm is in contact with an unknown lens. Together they have a focal length of +100 cm.

i. Find the power and focal length of the unknown lens. What kind is it?
ii. An object is 50 cm from the pair. Where is the image, and what is it like?

9 Fair test [3]

Srijana thinks that a more strongly curved convex lens has a greater power. Plan a fair test with three lenses.

i. What will she change, and what will she measure?
ii. Name two things she must keep the same.
iii. What result would support her idea?

10 Your phone's camera [4]

Take a phone's camera as one convex lens of focal length 6 mm.

i. Find its power.
ii. How tall is the image of a friend 1.7 m tall standing 5 m away?
iii. By how much must the lens move to focus instead on a page 50 cm away?

11 Predict, then explain [3]

i. Bipana fits a 100× objective and a 40× eyepiece to see a virus. Will she see it clearly?
ii. A convex lens throws a bulb's image on a screen. Black paper now covers its lower half. Will half of the image vanish?

12 Correct the misconceptions [3]

The paragraph has three mistakes. Write each one and correct it.

Anil wrote: "A lens of −8 D is weaker than a lens of +2 D, because −8 is smaller. If a lens has f = 20 cm, its power is 1 ÷ 20 = 0.05 D. Two lenses touching have a focal length equal to the sum of their focal lengths."

13 Think [3]

Using the lens formula, show that a concave lens can never form a real image of a real object, and that its image is always smaller than the object.

14 Make your own [2]

Invent a problem on a convex lens where f, u and v are all whole numbers and u isn't equal to v. Give the numbers, and show that they work.