PENCILTUTOR SCHOOL (PTE) LTD.
Co. Reg. No. 200601708E
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Yishun Avenue 5
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Answers to 2015 O level Science Physics 5076/5077 Paper 5

Procedure:

1. With the aid of a blu-tack attach the metre rule firmly to the table.

2. Place the cross-wire at the 0 cm mark of the ruler.

3. Next place the screen at the 90 cm mark of the metre rule.

4. Position the torchlight as shown in the diagram below and move the torchlight close to the cross-wire.

5. Place the lens on the lens holder.

6. Place the lens near the cross-wire and adjust the position of the lens until a sharp image of the cross-wire is formed on the screen. Record the distance from the cross-wire to the lens as A_1.

7. Move the lens nearer to the screen and adjust the position of the lens until a sharp image of the cross-wire is formed on the screen. Record the distance from the cross-wire to the lens as B_1.

8. Repeat steps 6 and 7 to obtain a second measurement of the two distances and record them as A_2 and B_2.

9. Find the average between A_1 and A_2. Record this average as $A_{avg.}$

10. Find the average between B_1 and B_2. Record this average as $B_{avg.}$

11. Repeat steps 3 to 10 with the screen placed at the 85 cm, 80 cm, 75 cm, and 70 cm to get additional values of A_1, B_1, A_2 and B_2.

12. Plot a graph of $\frac{1}{A_{avg}}$ (y-axis) against $\frac{1}{B_{avg}}$ (x-axis). For the plotted points draw a best-fit straight line and determine the y-intercept and gradient of this straight line.

13. Calculate the focal length of the lens using the following relationship:

$$f = \frac{100}{-1.2m + c}$$

where m = gradient of straight line & c = y-intercept.

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Sample values from student 1

Position of screen/cm	A_1/m	A_2/m	A_{avg}/m	B_1/m	B_2/m	B_{avg}/m	$\frac{1}{A_{avg}}$	$\frac{1}{B_{avg}}$
90			0.190			0.710	5.26	1.40
85			0.195			0.650	5.13	1.54
80			0.200			0.600	5.00	1.67
75			0.205			0.545	4.83	1.84
70			0.220			0.480	4.59	2.08

From the straight line plot of $\frac{1}{A_{avg}}$ (y-axis) against $\frac{1}{B_{avg}}$ (x-axis),

Gradient, m = -0.79

y-intercept = 5.7

focal length = **15cm**

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Sample values from student 2

Position of screen/cm	A_1/m	A_2/m	A_{avg}/m	B_1/m	B_2/m	B_{avg}/m	$\frac{1}{A_{avg}}$	$\frac{1}{B_{avg}}$
90			0.210			0.690	4.81	1.44
85			0.215			0.635	4.67	1.58
80			0.220			0.580	4.52	1.73
75			0.230			0.520	4.33	1.92
70			0.250			0.450	4.03	2.22

From the straight line plot of $\frac{1}{A_{avg}}$ (y-axis) against $\frac{1}{B_{avg}}$ (x-axis),

Gradient, m = -0.77

y-intercept = 5.3

focal length = **16cm**

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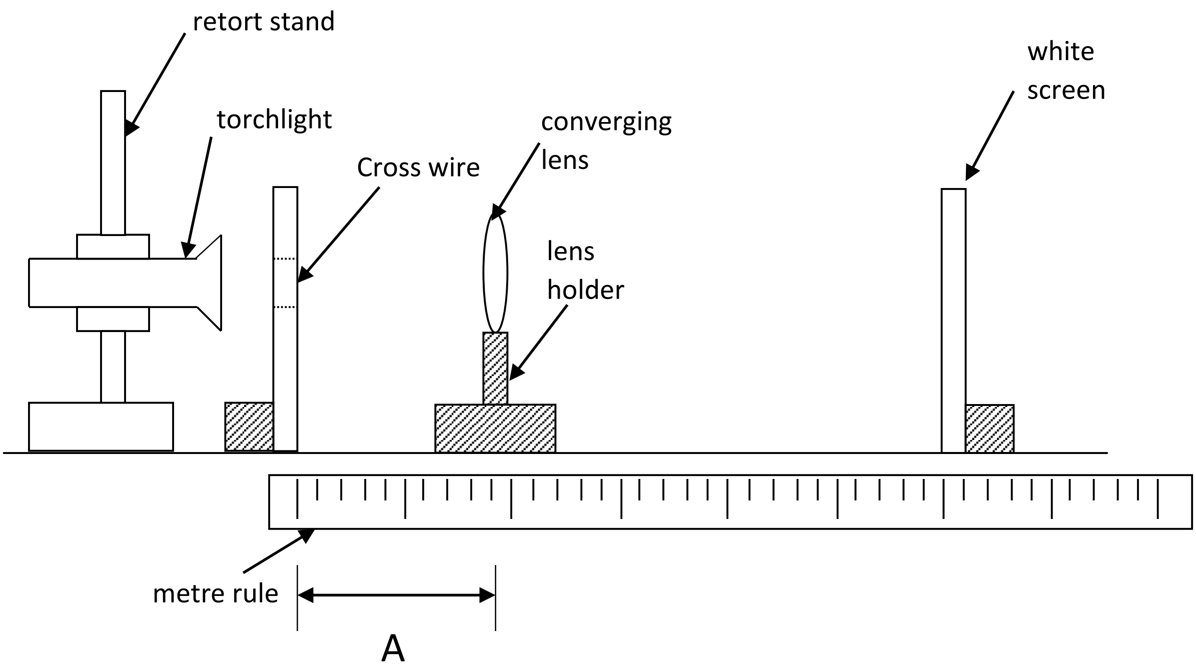
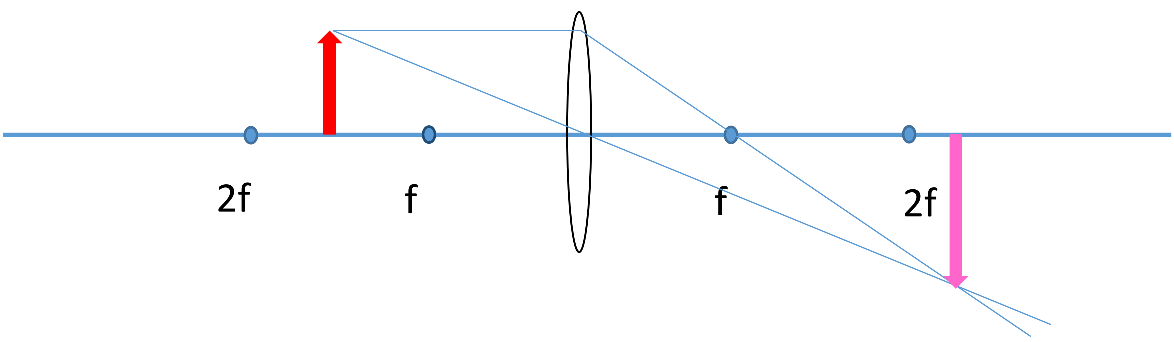


<u>Teacher's comment</u>

When the lens was placed near the cross-wire most of our candidates reported obtaining a magnified image on the screen. As such, the distance A must be greater than f (where f = focal length) and lesser than 2f.



Most of our candidates obtained values of A that were between 19cm and 25cm.

As such, we can be sure that the focal length of the converging lens should be lesser than 19cm.

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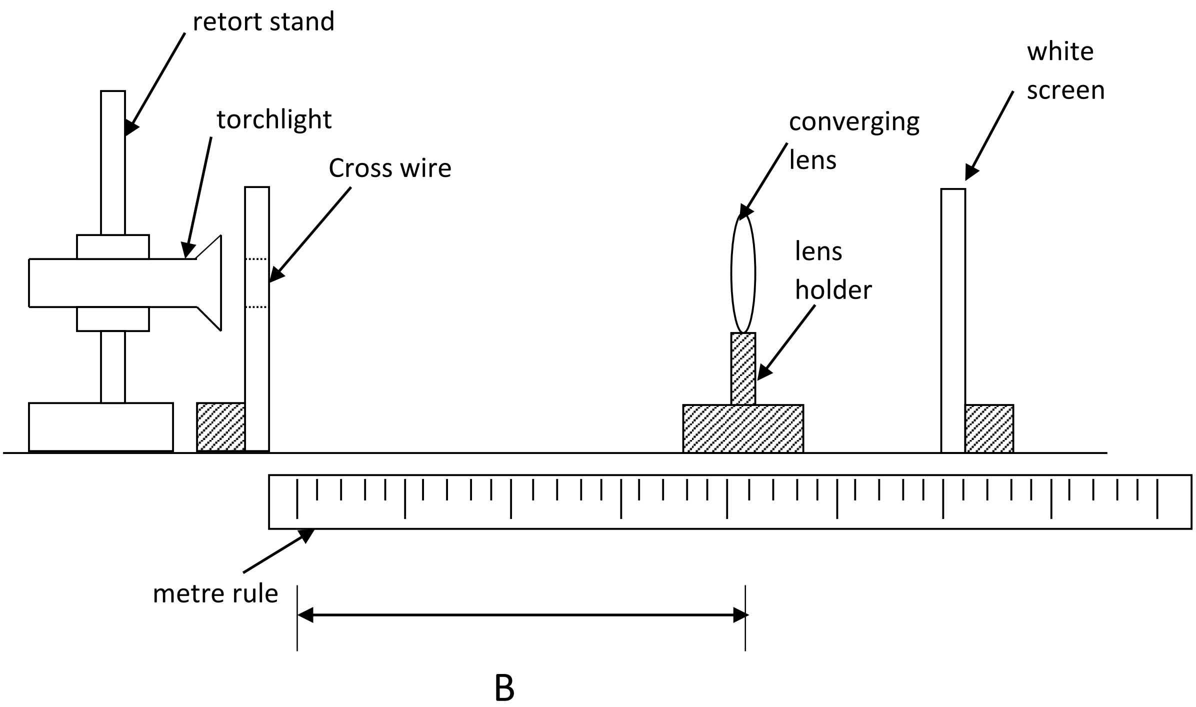
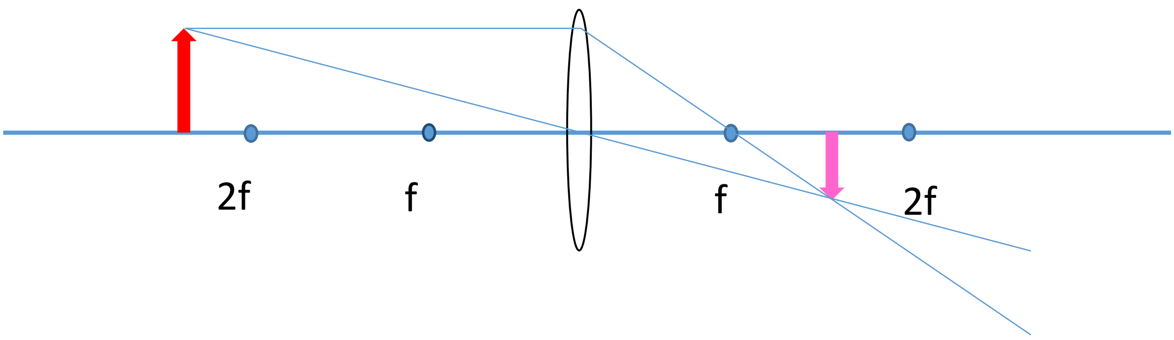


Teacher's comment

When the lens was placed near the screen, most of our candidates reported obtaining an image that was reduced in size. As such, the distance B must be greater than 2f (where f = focal length).



Most of our candidates obtained values of B that were between 45cm and 71cm.

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Teacher's Comment:

Although the value of the focal length of the lens used in this experiment is unclear, previous examinations have used lens with a focal length of 15.0cm. If the focal length of the lens was indeed 15.0cm, then mark schemes usually accept ± 2.0cm values (i.e. 13.0cm to 17.0cm).

Question:

What are possible source of error and how can this experiment be improved?

Possible source of error:

1. **Parallax error in reading ruler to measure A and B.**
2. **The lens and screen not perpendicular to ruler. (This can be overcome with the use of a set square)**
3. **Different judgements by students on the sharpness of the image formed.**

Improvement:

1. **Conduct experiment in a dimmer/darkened room.**
2. **Repeat more times (measuring distance) & average.**