



2020 Sec 4 Physics Practical 1

Waves: Convex Lens

Marking Scheme

Part 1

Approximate focal length of the lens

- 15.0 ± 1.0 cm

[1]

Predictions/observations

u	v	magnified/ diminished/ same size	upright/ inverted	real/ virtual
$u > 2f$	$v < 2f$	diminished	inverted	real
$u = 2f$	$v = 2f$	same size	inverted	real
$2f < u < f$	$v > 2f$	magnified	Inverted	real

Conclusion

As the illuminated object is moved closer to the lens,

- the image distance increased.
- the image became larger, but remained inverted and real.

Extension

u	v	magnified/ diminished/ same size	upright/ inverted	real/ virtual
$u = f$	?	magnified*	?	?
$u < f$	?	magnified*	upright*	virtual*

*experimentally inconclusive, but possible to reason from theory

Note: students might feel like they are able to find an image at $u = f$, however, the image will not be sharp

Part 2

Record of y , x , h_o , h_i and m (total 4 marks)

- Neat table drawn with the headings and units (y /cm, x /cm, h_o /cm, h_i /cm and m). No units for m . [1]
- At least 6 sets of evenly spread readings of y from >15 cm to 50 cm (min range 20 cm) [1]
- (remark: min. range of 20 cm may not be satisfied if height of image must be greater than 1.0 cm)
- x , y , h_o , h_i tabulated to 1 d.p in cm [1]
- m calculated to 2 or 3 s.f. [1]

Graph (total 5 marks)

- **Scale:** suitable scales used. [1]
- **Points:** All points correctly plotted (give allowance of 1 error). [1]
- **Line** of best fit line **NOT** passing through the origin (it should cut the y-axis at $m = -1$) [1]
- **Axes** correct (m on y-axis and x on x-axis); correctly labelled (m without units and x in cm) from origin with values labelled at regular intervals on both axes. [1]
- **Triangle:** Large, drawn using two suitable points along the line of best fit. }
- **Co-ordinates** of these two points clearly indicated at vertices of triangle. [1]

Calculation of gradient (total 2 marks)

- Calculation of gradient using the coordinates on the graph
 - Working. [1]
 - Answer = (3s.f.) 0.070 ± 0.010 [1]

Conclusion 15 ± 2 cm

Focal length of lens = value close to the approximate focal length obtained earlier. [1]

Questions

- 1 State **one** precaution that you have taken in this experiment.
The apparatus are to be aligned horizontally to ensure that the beam of light is directed towards the centre of the lens/ to minimize distortion of the image for accurate measurement of h_i . [1]
/ Close the curtains and switch off the lights to obtain a sharper image.
- 2 State **one** source of error in this experiment.
There is human judgement error in locating the sharpest image on the screen which will affect the measurement of x . [1]

Bonus [1]

- Graph of m against x : ① $m = Gx + c$ (Linear graph of the form $Y = m X + C$)
- Magnification $m = x / y$: ② $y = x / m$
- Lens formula: $1/f = 1/u + 1/v \rightarrow$ ③ $1/f = 1/y + 1/x$

Substitute ② into ③ $\rightarrow 1/f = m/x + 1/x \rightarrow x/f = m + 1$

$\rightarrow m = x/f - 1$ compare with ① $m = Gx + c$, hence $G = 1/f \rightarrow f = 1/G$