2021 Sec 4 Physics Practical 01

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,
(i) the image distance increased.
(ii) 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. [1]
- **Co-ordinates** of these two points clearly indicated at vertices of triangle.

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 = Gv + c (Linear graph of the form Y = m X + C)
- Magnification m = v / u : ② u = v / m
- Lens formula: 1/f = 1/u + 1/v ③ $1/f = 1/u + 1/v$

Substitute ② into ③ $1/f = m/v + 1/v$ $v/f = m + 1$

 $m = v/f - 1$ compare with ① **$m = Gx + c$**, hence $G = 1/f$ $f = 1/G$