2023 Sec 3 Physics Practical 04

Convex Lens

Marking Scheme

Part 1

Approximate focal length of the lens

- 15.0 ± 1.0 cm

Observations

u / cm (range)	v / cm (range in terms of f)		size	orientation	nature of image
		image h_i / cm	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

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 u, v, h_o, h_i *and* m $\qquad$ *[record readings in ink!]*

- Neat table drawn with the headings and units (**u /cm, v /cm, h$_o$ /cm, h$_i$ /cm and m).** No units for m.
- At least 6 sets of evenly spread readings *[test smallest & largest u to choose suitable range]*
- **u, v, h$_o$, h$_i$** tabulated to 1 d.p in cm
- m calculated to 2 or 3 s.f. $\qquad$ *[apply least s.f. rule!]*

Graph

- **Scale**: suitable scales used.   *[y-intercept not needed, so scales <u>need not</u> start from origin]*
- **Points**: All points correctly plotted (give allowance of 1 error).
- **Line** of best fit line **NOT** passing through the origin (it should cut the y-axis at m = – 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.

Calculation of gradient

- **Triangle**: Large, drawn using two suitable points along the line of best fit.
- **Coordinates** of these two points clearly indicated at vertices of triangle.
- Calculation of gradient using the coordinates on the graph
    - Working.
    - Answer = ……..   (3s.f.) 0.070 ± 0.010

Conclusion

The focal length of the lens f is <u>15 ± 2 cm</u>

Questions

1 State **one** precaution that you have taken in this experiment.
- The apparatus (object, lens & screen) 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$_i$.
- Close the curtains and switch off the lights to obtain a sharper image.

2 State **one** significant 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 v.

Optional

- Graph of m against v: $\qquad$ ① m = Gv + c $\qquad$ *(Linear graph of the form Y = mX + c)*
- Magnification m = v / u : $\qquad$ ② 1/u = m / v $\qquad\qquad$ *G: gradient of plotted graph*
- Lens formula: $\qquad$ ③ 1/f = 1/u + 1/v

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

$\qquad\qquad\qquad\qquad\qquad$ ➜ **m = v/f – 1** $\qquad$ compare with ① **m = Gv + c**

$\qquad\qquad$ hence G = 1/f $\qquad$ ➜ f = 1/G