198-257A, Lab Two: Some Kind of Lens Thing

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1 Data

1.1 Part 1

See Table 1.

1.2 Part 2

See Table 2 and Figure 1.

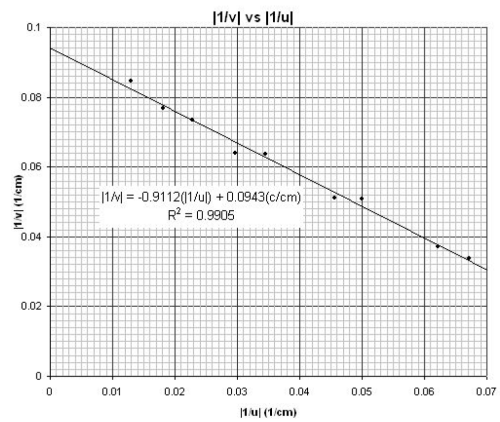

Figure 1: $\left|\frac{1}{v}\right|$ *vs* $\left|\frac{1}{u}\right|$

1.3 Part 3

See Table 3.

2 Conclusion

2.1 Chris Payette

(Ed: I do'n't have Chris'.)

2.2 Neil Edelman

The thin-lens formula, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$, was used to measure the focal lengths of three lenses using three different methods, checked against the manufacturer's values ($f_O = 50cm$; $f_B = 10cm$; $f_C = -10cm$.) Part 1 used a focusing method with a single trial, estimating measurement errors, to find $f_O = (50.4[3])cm$ and $f_B = 10.6[3]cm$. Part two used a parallax method with a series of nine different trials to find $f_B = 10.17[16]cm$. Part three used the average of three measurements with the parallax of a distant object to find f_C to be $-10.0[1]cm$.

f **marked on lens (**cm**)**	x_{screen} **(**$\pm 0.1cm$**)**	x_{lens} **(**$\pm 0.3cm$**)**	f **(**$\pm .3cm$**)**
50	90	39.6	50.4
10	90	79.4	10.6

Table 1: Results from Part 1

f marked $10cm$						
trial	x_{object} **(**$\pm 0.1cm$**)**	x_{lens} **(**$\pm 0.1cm$**)**	x_{image} **(**$\pm 0.6cm$**)**	u **(**$\pm 0.1cm$**)**	v **(**$\pm 0.6cm$**)**	f **(**$\pm 1cm$**)**
1	96.2	67.3	51.6	-28.9	15.7	10.17331839
2	96.2	62.6	47	-33.6	15.6	10.65365854
3	96.2	74.3	54.7	-21.9	19.6	10.34313253
4	96.2	52.5	38.9	-43.7	13.6	10.37207679
5	96.2	41	28	-55.2	13	10.52199413
6	96.2	80.1	53.2	-16.1	26.9	10.07186047
7	99.4	22	10.2	-77.4	11.8	10.23901345
8	50.1	30.1	10.4	-20	19.7	9.924433249
9	54.9	40	10.4	-14.9	29.6	9.911011236

Table 2: Results from Part 2

f marked $-10cm$			
trial	x_{lens} **(**cm**)**	x_{image} **(**cm**)**	v **(**cm**)**
1	3	13.1	-10.1
2	33.9	43.8	-9.9
3	49	58.9	-9.9
average			-9.966666667

Table 3: Results from Part 3

A Sample Calculations and Error Analysis

A.1 Part 1

Finding f from x_{screen} and x_{lens}:

$$\begin{aligned} f &= x_{screen} - x_{lens} \\ f_{50} &= 90.0[1]cm - 39.6[3]cm \\ &= 50.4[3]cm \end{aligned}$$

where the error on this value was:

$$\begin{aligned} \sigma_{f50} &= \sqrt{\sigma xs50^2 + \sigma xl50^2} \\ &= \sqrt{(0.1cm)^2 + (0.3cm)^2} \\ &= 0.316cm \end{aligned}$$

A.2 Part 2

Finding u from x_{object} and x_{lens}:

$$\begin{aligned} u &= x_{lens} - x_{screen} \\ u_1 &= 67.3[1]cm - 96.2[1]cm \\ &= -28.9[1]cm \end{aligned}$$

where the error on this value was:

$$\begin{aligned} \sigma_{u1} &= \sqrt{\sigma xl1^2 + \sigma xo1^2} \\ &= \sqrt{(0.1cm)^2 + (0.1cm)^2} \\ &= 0.141cm \end{aligned}$$

finding v from x_{image} and x_{lens}:

$$\begin{aligned} v &= x_{lens} - x_{screen} \\ v_1 &= 67.3[1]cm - 51.6[6]cm \\ &= 15.7[6]cm \end{aligned}$$

where the error on this value was:

$$\begin{aligned} \sigma_{v1} &= \sqrt{\sigma xl1^2 + \sigma xi1^2} \\ &= \sqrt{(0.1cm)^2 + (0.6cm)^2} \\ &= 0.608cm \end{aligned}$$

finding f from u and v:

$$
\begin{aligned}
f_1 &= \frac{1}{\frac{1}{v_1} - \frac{1}{u_1}} \\
&= \frac{1}{\frac{1}{15.7[6]cm} - \frac{1}{-28.9[1]cm}} \\
&= 10.2[3]cm
\end{aligned}
$$

where the error on this value was:

$$
\begin{aligned}
\sigma_{f1} &= \frac{10.173cm}{0.0983cm^{-1}} \sqrt{\left(\frac{1}{15.7cm}\frac{0.6cm}{15.7cm}\right)^2 + \left(\frac{1}{28.9cm}\frac{0.1cm}{28.9cm}\right)^2} \\
&= 0.2522cm
\end{aligned}
$$

(Ed: The page said there's an error.)

A.3 Part 3

(Ed: I do'n't know where this went.)

A.4 Finding f from part 2

$$
\sigma_T^2 = \frac{1}{\sum_{i=1}^{M} \frac{1}{\sigma_i^2}}
$$

$$
f_T = \sigma_T^2 \sum_{i=1}^{M} \frac{1}{\sigma_i^2}
$$