Challenging Newton How dare I!

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1 Aim

The aim of this lab is to test if Newton's second law – $a \propto \frac{1}{m_{\text{system}}}$, which in words: Is acceleration inversely proportional to the mass of the system, is true or not.

2 Apparatus

See lab sheet.

3 Procedure

See lab sheet.

4 Variables

Independent Variable

- m_{total}: total mass of the system (g)

Dependent Variable

- a: acceleration ($\mathrm{m\,s^{-2}}$)

Constants

- $m_{\text{suspended}}$: suspended mass (20g)

5 Data Collection

See Table 1 for raw data collected.

Table 1: Raw Data

m **mass** (g)	**trial #**	a **acceleration** ($\mathrm{m\,s^{-2}}$)
246.67	1	0.64580 ± 0.0030940
	2	0.64540 ± 0.0044560
	3	0.64960 ± 0.0037840
	4	0.64340 ± 0.0063140
370.94	1	0.44040 ± 0.0060040
	2	0.43800 ± 0.0052920
	3	0.45060 ± 0.0070900
	4	0.45880 ± 0.0049000
	5	0.44820 ± 0.0050420
495.26	1	0.34300 ± 0.0043580
	2	0.34720 ± 0.0216400
	3	0.34340 ± 0.0049760
	4	0.34480 ± 0.0049200
	5	0.34480 ± 0.0044780
619.53	1	0.26480 ± 0.0042480
	2	0.27280 ± 0.0042760
	3	0.25620 ± 0.0034120
	4	0.24840 ± 0.0028800
743.85	1	0.21380 ± 0.0028640
	2	0.22320 ± 0.0031280
	3	0.22080 ± 0.0034900
	4	0.22000 ± 0.0033820
	5	0.21980 ± 0.0031660
868.16	1	0.18928 ± 0.0031320
	2	0.19398 ± 0.0029600
	3	0.19228 ± 0.0030780
992.47	1	0.15040 ± 0.0012968
	2	0.14726 ± 0.0011436
	3	0.15414 ± 0.0013516

6 Data Analysis

Using the raw data collected as stated in Table 1, we can calculate out the mean acceleration for each 'mass' data group we collected, whereas Table 2 shows.

Table 2: Analytical Data

m **mass** (g)	$\bar{a}$ **mean acceleration** ($\mathrm{m\,s^{-2}}$)
266.67	0.64693 ± 0.00631
390.94	0.44720 ± 0.01160
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Table 2 – continued from previous page

m **mass** (g)	a **acceleration** ($\mathrm{m\,s^{-2}}$)
515.26	0.34464 ± 0.02164
639.53	0.26055 ± 0.01225
763.85	0.21952 ± 0.00572
888.16	0.19185 ± 0.00313
1012.47	0.15060 ± 0.00354

In order to have a better insight into the trending between the two variables, m and a, we can plot them as a line chart as shown as Figure 1, and evaluate a fit-line against it in order to see the correlation of it with the exponential decay equation, $y = \frac{c}{x}$.

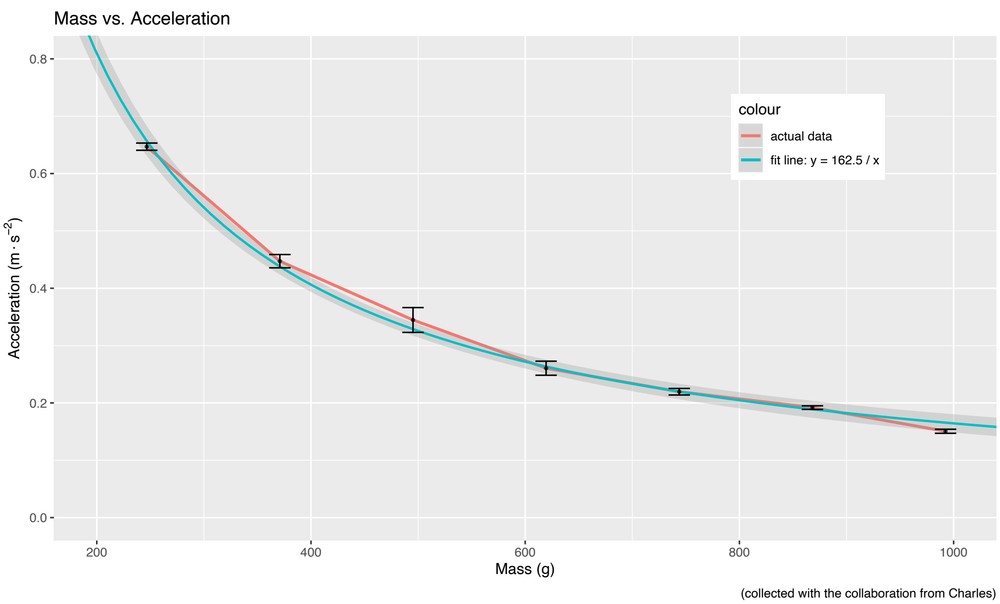

Figure 1: Mass vs. Acceleration

We can clearly see there's a strong exponential decay trend whereas we can do a fit using $y = \frac{c}{x}$ where c is the coefficient of the function, and as result we got $a = \frac{162.5}{m}$ where it shows a very strong exponential decay trend. Also, by interpreting the graph we can also see that the confidence interval of the fit line successively aligned within the error bar range of the data points.

7 Conclusion

The coefficient of the fit line equation $a = \frac{162.5}{m}$ is very huge, and also the correlation of the fit line is 0.9981 indicating a very strong correlation with the fit equation $y = \frac{c}{x}$, thus we can conclude that the acceleration of a system is inversely proportional to the mass of the system, indicating Newton is correct with his statement!