

Experimental General Physics for Engineers I

Laboratory Report PHYS 192 spring 2022

Section: _L06____

Experiment name:

Newton's second Law

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Table of results (1.25 pts)	
Graph (1.25 pts)	
Data analysis (2 pts)	
Discussion (0.5 pt)	
References	
Others	
Report Grade (5 pts)	

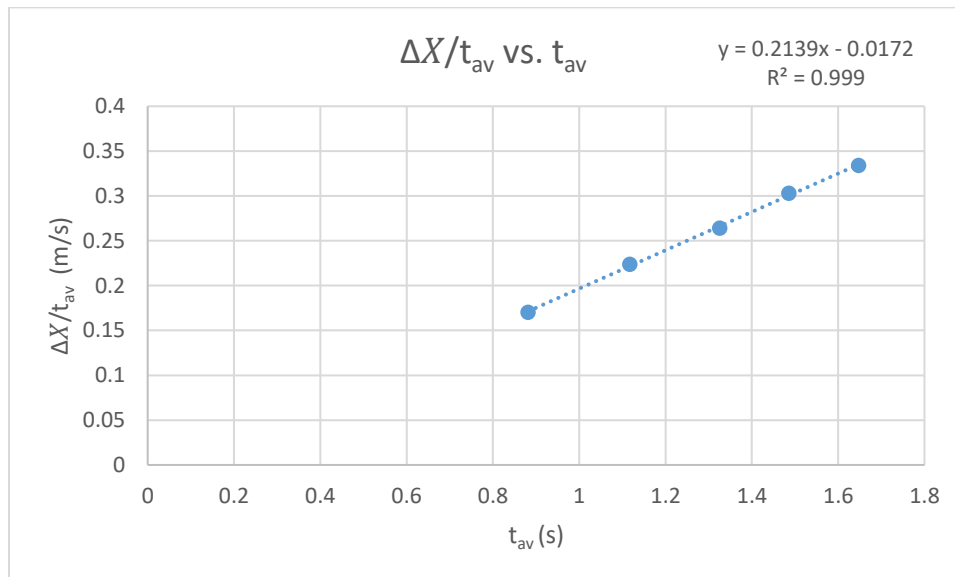
1. Table of results (Put correct units in the table)

ΔX (m)	$u(\Delta X)$ (m)	Time t (sec)			t_{av} (s)	$u(t_{av})$ (s)	$\frac{\Delta X}{t_{av}}$ (m/s)	$u\left(\frac{\Delta X}{t_{av}}\right)$ (m/s)
		t_1 (s)	t_2 (s)	t_3 (s)				
0.15	± 0.001	0.896	0.874	0.874	0.881	± 0.0073	0.170	± 0.0018
0.25	± 0.001	1.102	1.127	1.122	1.117	± 0.0076	0.223	± 0.0017
0.35	± 0.001	1.325	1.324	1.327	1.325	± 0.0008	0.264	± 0.0007
0.45	± 0.001	1.498	1.482	1.478	1.486	± 0.0061	0.303	± 0.0014
0.55	± 0.001	1.643	1.661	1.638	1.647	± 0.0070	0.334	± 0.0015

2. Graph of the $\frac{\Delta X}{t_{av}}$ vs. t_{av}

Draw graph on EXCEL and insert it here.

Don't forget axes titles, units, and error bars.



Errors are too small; hence no error bars are visible.

3. Data analysis

3.1. Propagated error of $\frac{\Delta x}{t}$

Show explicitly how you calculated $u\left(\frac{\Delta x}{t}\right)$ for the first row, by using error propagation

$$U(\Delta X/t) = \sqrt{(d(\Delta X/t) d(\Delta X) * U(\Delta X))^2 + (d(\Delta X/t) d(t) * U(t))^2}$$

$$U(\Delta X/t) = \sqrt{(1/t) U(\Delta X))^2 + (-\Delta X * (t^{-2}) * U(t))^2}$$

$$= \sqrt{((1/0.881 * 0.001)^2 + (-0.15 * (0.881^{-2}) * 0.0073)^2} = \pm 0.0018 \text{ m/sec}$$

3.2. Slope and intercept of the graph and their uncertainties.

Slope (m/s^2): 0.213854
Slope Error (m/s^2): 0.003924

Intercept(m/s): -0.01721
Intercept Error(m/s): 0.005177

3.3. Experimental value of the acceleration

From your result in point 3.2 above calculate your experimental value of the acceleration.

$$\Delta X = \frac{1}{2} a t^2$$

$$\Delta X/t = \frac{1}{2} a t$$

$$\text{Hence, slope} = \frac{1}{2} a$$

$$\text{And } a = 2 * \text{slope}$$

$$a = 2 * 0.213854 = 0.428 \text{ m/s}^2$$

3.4. Propagated error of the experimental value of the acceleration

$$a = 2 * \text{slope}$$

$$U(a) = \sqrt{(d(2 * \text{slope})/d(\text{slope}) * U(\text{slope}))^2} = 2 * U(\text{slope})$$

$$U(a) = 2 * 0.003924$$

$$= \pm 0.007848 \text{ m/s}^2$$

$$a = 0.428 \pm 0.007848 \text{ m/s}^2$$

3.5. Theoretical value of the acceleration according to Newton's second law

$$M_1 = 210\text{g} = 0.21 \text{ kg} \quad m_2 = 11\text{g} = 0.011 \text{ kg}$$

Friction assumed to be 0

$$a = m_2 g / m_1 + m_2 = 0.488 \text{ m/s}^2$$

3.6. Propagated error of the theoretical value of the acceleration.

$$U(a) = \sqrt{(d(m_2 g / m_1 + m_2) / d(m_2) * U(m_2))^2 + (d(m_2 g / m_1 + m_2) / d(g) * U(g))^2 + (d(m_2 g / m_1 + m_2) / d(m_1) * U(m_1))^2}$$

$$m_1 = 0.21 \pm 0.001 \text{ kg}$$

$$m_2 = 0.011 \pm 0.001 \text{ Kg}$$

$$g = 9.81 \pm 0.01$$

$$U(a) = \sqrt{(m_1 g (m_1 + m_2)^2 * U(m_2))^2 + (m_2 / (m_1 + m_2) * U(g))^2 + (m_2 g / (m_1 + m_2)^2 * U(m_1))^2}$$

$U(a) =$

$$\sqrt{(0.21 \times 9.81(0.21 + 0.011)^2 \times 0.001)^2 + (0.011 / (0.1 + 0.011) \times 0.01)^2 + (0.011 \times 9.81(0.21 + 0.011)^2 \times 0.001)^2}$$

$$= \pm 0.042 \text{ m/s}^2$$

3.7. Comparison between the theoretical and the experimental acceleration

Find the percentage of error between the experimental value and theoretical value of a

$$\text{Comparison} = |(\text{Theoretical value} - \text{obtained value}) / \text{theoretical value}| \times 100$$

$$= 12.29\%$$

4. Comment on the results

(give a brief comment on whether your results are in agreement with what was expected or not. If it is not try to give a possible explanation).

The result is almost in agreement with the theoretical value of acceleration with an error of 12.29% due to some sources of error.

These errors could be human error while calculating the distance, x. Another source of error could be inaccuracy of the device which was used in calculating the velocity that might have caused some slight errors in the calculation leading to a more % error in the result. Also, the theoretical value takes the friction to be 0 which is a hypothetical assumption. Hence, there could also be errors due to friction in the experiment.

References