جامعة بيرزيت

BIRZEIT UNIVERSITY

Physics Lab 211

Experiment No. 3

Newton's Laws of Motion

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Data Sheet:

Part I:

$Attempt$	Δt_1 (s)	Δt_2 (s)	V_1 (m/s)	V_2 (m/s)	$V_2 - V_1$ (m/s)	V_{avg} (m/s)	$\frac{V_2 - V_1}{V_{avg}}$
1	0.019	0.019	0.947	0.947	0.000	0.947	0.000
2	0.016	0.016	1.125	1.125	0.000	1.125	0.000
3	0.011	0.012	1.636	1.500	0.136	1.568	0.087
4	0.021	0.020	0.857	0.900	0.043	0.879	0.049
5	0.014	0.014	1.286	1.286	0.000	1.286	0.000

$\Delta x = (0.018 \pm 0.001)m$

Part II-A:

Δt (s)	t (s)	v (m/s)	d (m)
0.021	0.869	0.857	1.4
0.019	0.938	0.947	1.3
0.017	1.231	1.059	1.2
0.016	1.302	1.125	1.1
0.015	1.455	1.200	1.0

Part II-B:

$d = \frac{1}{2}at^2 \rightarrow a = \frac{2d}{t^2}, where\ d = 0.445\ m$

Δt (s)	t (s)	M (g)	$M`$ (g)	a (m/s^2)
0.021	0.946	216	20	0.995
0.019	0.868	212	24	1.181
0.018	0.813	208	28	1.347
0.017	0.786	204	32	1.441
0.016	0.673	200	36	1.965

Calculations:

1- Graph I $(\log v\ vs.\log t)$:

$slope = (0.60 \pm 0.06)$

2- Graph II-A $(\log d\ vs.\log t)$:

$slope = (1.1 \pm 0.14)$

3- Graph II-B $(M`g\ vs.a)$:

$slope = (0.161 \pm 0.030)kg$

Result & Conclusion:

$slope_1 = (0.60 \pm 0.06)$

$slope_2 = (1.1 \pm 0.14)$

$slope_3 = (0.161 \pm 0.030)\ kg$

In the first part, the first law of motion was demonstrated by proving that the velocity of an object stays constant unless an external force acts on it. From the data obtained, we can see that in almost all situations, the cart has the same velocity at two different times. Some deviations occurred of course, this is due to the friction that slows the cart down.

From the first graph ($\log v\ vs.\log t$):

$v = \frac{M`g}{M`+M}t \rightarrow \log v = \log\frac{C}{M`+M} + \log t$, the slope from the first graph should equal 1 according to the equation.

$slope = (0.60 \pm 0.06)$, By using the Discrepancy test:

$D = |slope_{real} - slope_{exp}| = |1 - 0.60| = 0.40$

$2 \times error >? D \rightarrow 0.12 < 0.40$, this means the result is not accepted.

From the second graph ($\log d\ vs.\log t$):

$d = \frac{1}{2}\frac{(M`g)}{M`+M}t^2 \rightarrow \log d = \log\frac{1}{2}\frac{(M`g)}{M`+M} + 2logt$, the slope must equal to 2 according to the equation.

$slope = (1.12 \pm 0.14)$, By using the Discrepancy test:

$D = |slope_{real} - slope_{exp}| = |2 - 1.12| = 0.88$

$2 \times error >? D \rightarrow 0.28 < 0.879$, this means the result is not accepted.

From the third graph ($M`g\ vs.\ a$):

$M`g = (M` + M)a$, from the third graph, the slope must equal to $(M` + M)$ according to the above equation.

$slope = (0.161 \pm 0.030)kg$, the theoretical value of $(M` + M) = 0.236$, By using the Discrepancy test:

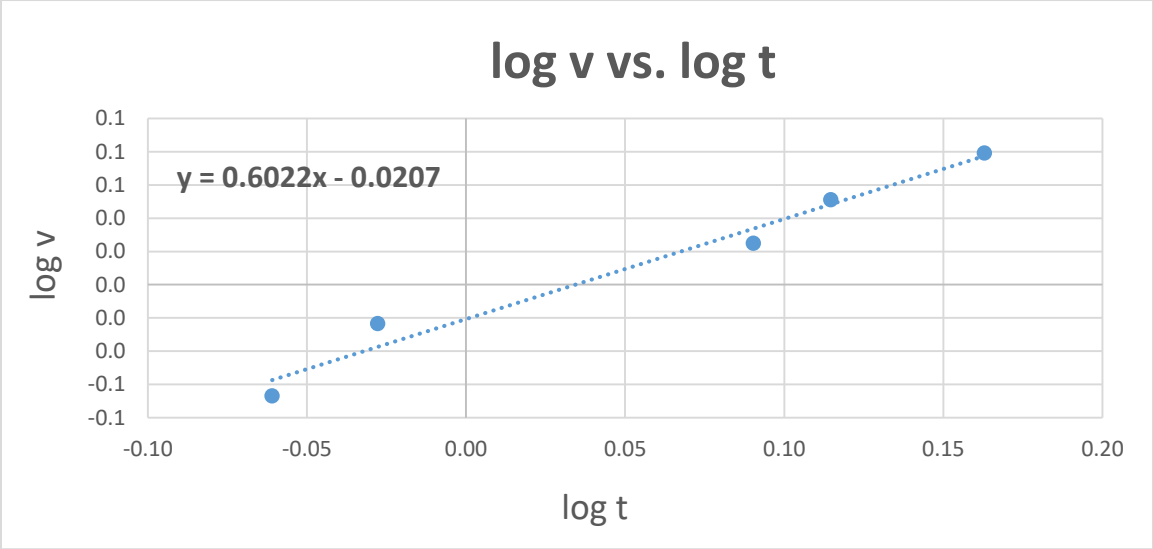
$D = |slope_{real} - slope_{exp}| = |0.236 - 0.161| = 0.075$

$2 \times error >? D \rightarrow 0.060 < 0.075$, this means the result is not accepted.

Our results were not accepted due to reasonable reasons. The error in the apparatus is very high in many aspects such as the poor wire connections and the old half-working timers. Most of the time, the timer starts working before the cart started moving due to the poor sensors. Moreover, the distance is not very precise due to the normal random errors.

GRAPH I

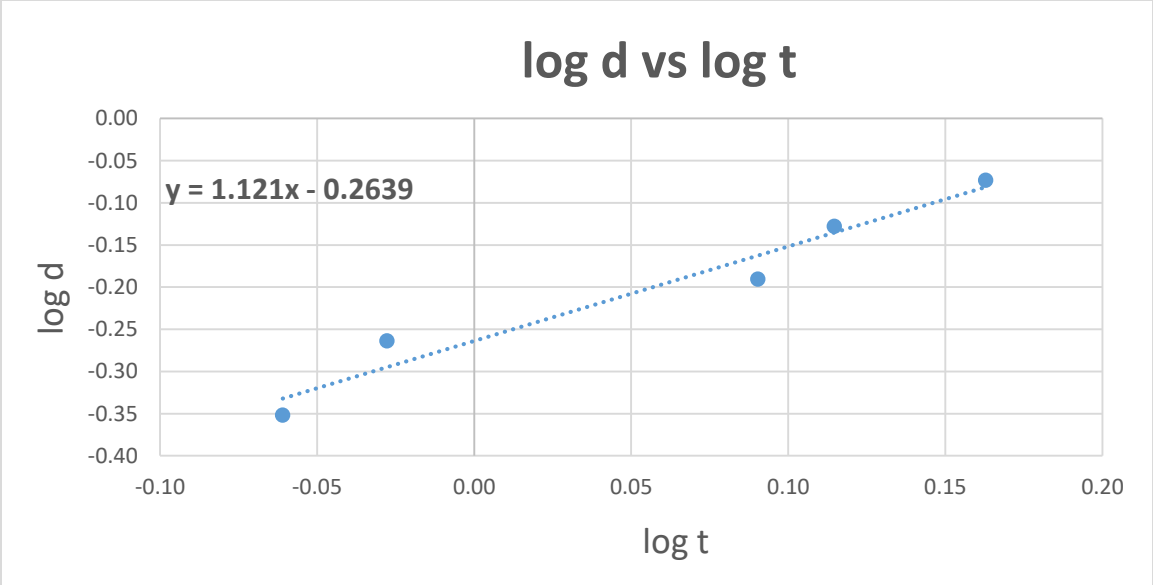
$t\ (s)$	$v\ (m/s^2)$
0.869	0.857
0.938	0.947
1.231	1.059
1.302	1.125
1.455	1.200



	slope	y-intercept
	0.602229	-0.020653
error	0.058317	0.0059642

GRAPH II

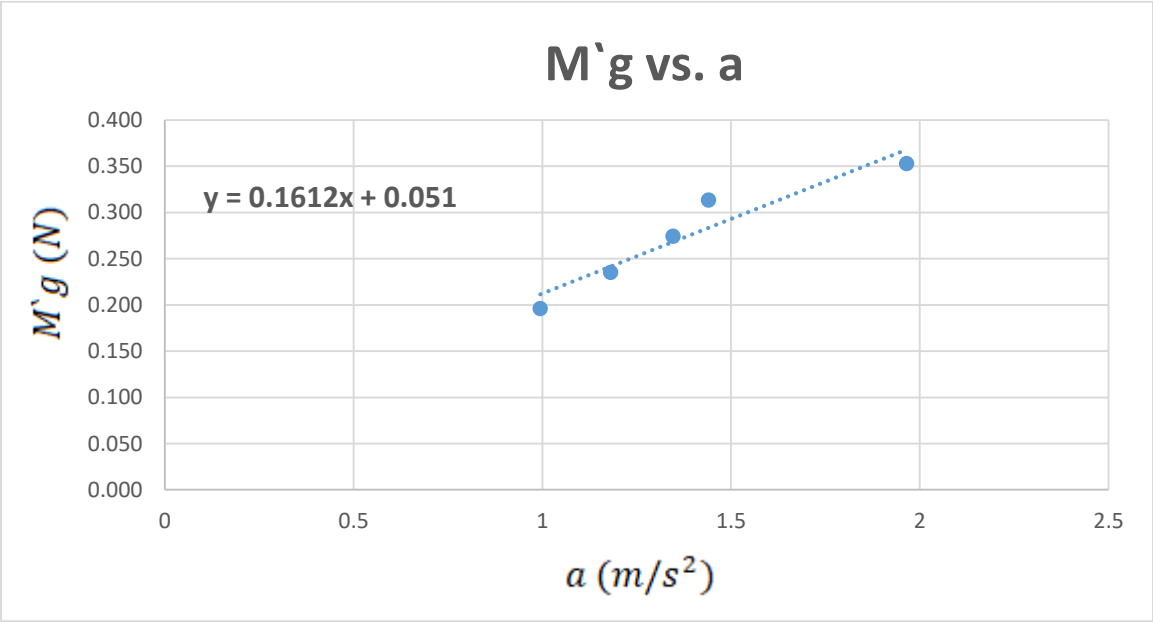
$\log d$	$\log t$
-0.352	-0.061
-0.264	-0.028
-0.190	0.090
-0.128	0.115
-0.073	0.163



	slope	y-intercept
	1.121017	-0.263877
error	0.143141	0.0146393

GRAPH III

$a\ (m/s^2)$	$M`g\ (N)$
0.995	0.196
1.181	0.235
1.347	0.274
1.441	0.314
1.965	0.353



	slope	y-intercept
	0.161234	0.0509984
error	0.030159	0.0429368