AIM

To verify Newton's second law and to determine the friction force acting on the wooden block.

BACKGROUND THEORY

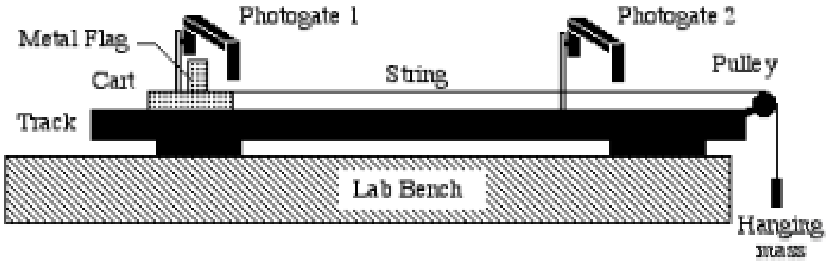
When a wooden block (cart) slides over a surface, the net force acting on the block is given by,

$$F_{applied} - F_{friction}$$

In the following set up, the applied is given by,

$$F_{applied} = mg$$

('m' is the mass suspended)



The net force provides acceleration 'a' to the wooden block. Hence,

$$F_{applied} - F_{friction} = Ma$$

('M' is the mass of the wooden block)

APPARATUS :

Vernier lab pro , photo gates , wooden block , string meter scale , standard weights , pulley, laser source.

RAW DATA :

Least count of Vernier Lab Pro : 0.000001 s
Uncertainty of Vernier Lab Pro : ± 0.000001 s

Least count of meter scale : 0.1 cm
Uncertainty of meter scale : ± 0.05 cm

Sr. No.	Weight suspended **(Kgs)**	Length of the Wooden block **(± 0.05 cm)**	Distance between the photo gates **(± 0.05 cm)**	Initial time at gate1 **(± 0.000001 s) (T1)**	Final time at gate 1 **(± 0.000001 s) (t1)**	Initial time at gate 2 **(± 0.000001 s) (T2)**	Final time at gate 2 **(± 0.000001 s) (t2)**
1	0.10	1.90	49.5	0.791711	0.807784	1.139284	1.151821
2	0.15	1.90	49.5	10.733984	10.745485	10.982284	10.991184
3	0.20	1.90	49.5	1.749819	1.759811	1.982129	1.990108
4	0.25	1.90	49.5	1.429185	1.437991	1.625008	1.632085
5	0.30	1.90	49.5	1.356000	1.364286	1.539210	1.545795

DATA PROCESSING

Sr. No.	Time taken for wooden block to pass **GATE 1** (± 0.000002 s) (T1 – t1)	Time take for wooden block to pass **GATE 2** (± 0.000002 s) (T2 – t2)
1	0.016073	0.012537
2	0.011501	0.008900
3	0.009992	0.007979
4	0.008806	0.007077
5	0.008286	0.006585

Sr. No.	Speed of the wooden block at **GATE 1 (Cm/s)**	Speed of the wooden block at **GATE 2 (Cm/s)**
1	118.210664 ± 3.110807	151.551407 ± 3.988195
2	165.203026 ± 4.347448	213.483146 ± 5.617978
3	190.152122 ± 5.004003	238.125078 ± 6.266449
4	215.761980 ± 5.677947	268.475342 ± 7.065140
5	229 ± 6	288.534548 ± 7.593014

Sr. No.	Acceleration (Cm/s^2)
1	92.584885 ± 7.099002
2	187.714307 ± 9.965426
3	199.646908 ± 11.270452
4	259.799714 ± 12.743087
5	312.183361 ± 13.639382

CONCLUSION & EVALUATION

Now let us compare the acceleration caused due to the force applied.

Sr. No.	Acceleration (Cm/s^2)	Force applied (Newtons)
1	92.584885 ± 7.099002	0.98
2	187.714307 ± 9.965426	1.47
3	199.646908 ± 11.270452	1.84
4	259.799714 ± 12.743087	2.45
5	312.183361 ± 13.639382	2.94

ACCELERATION Vs FORCE APPLIED GRAPH

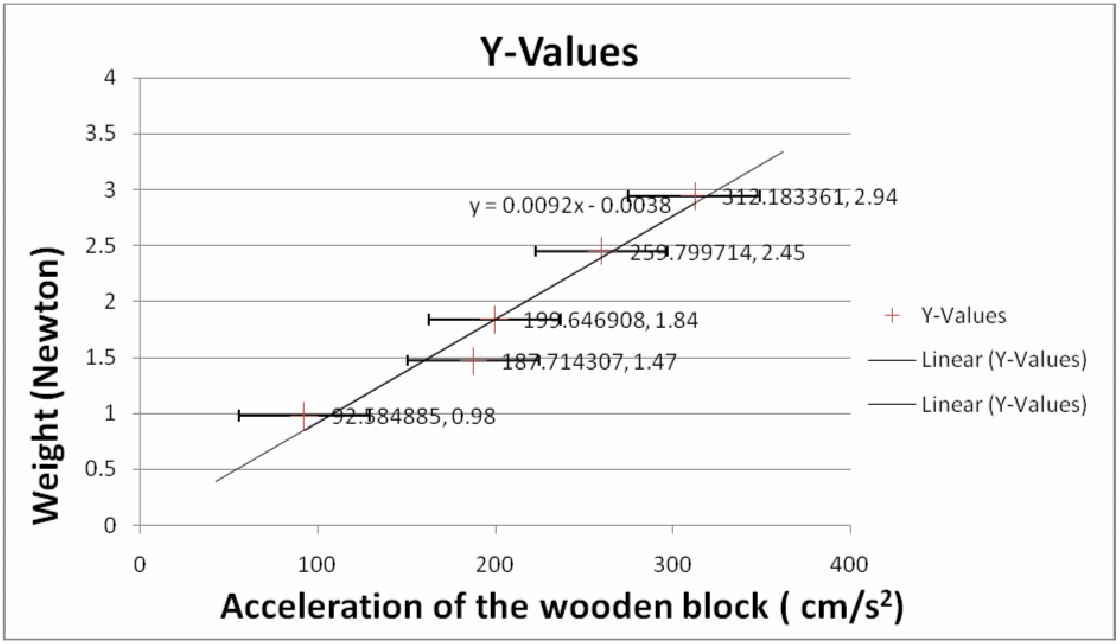


Figure 1 Acceleration Vs Force Applied

ANALYSIS FROM THE GRAPH

- From the graph the friction force acting on the wooden block is -0.003 N i.e. the Y-intercept of the graph
- As the force applied is increased , the acceleration of the wooden block also increases.
- Therefore in this case : $Force \propto Acceleration$
- Also as the weight is increased the acceleration increases therefore :

$Force \propto Mass$

CONCLUSION

As the Newton's second law states,
The force applied on a body is directly proportional to the mass and the acceleration therefore

$$f \propto m$$

and

$$f \propto a$$

Therefore

$$f \propto m.a$$

$$\rightarrow f = k.m.a$$

Since the S.I. Unit of k is 1
There fore

$$f = m.a$$

SOURCES OF ERROR

- There were some errors caused due to the quality of the **lab bench** used. There was some unevenness in the lab bench which could have caused the error while the wooden block travelled.
- The wooden block did not have a sharp cut because of which it would have cut the laser beam at a wrong place.
- The atmosphere also played a major role for the errors because it provided many obstacles for the experiment to happen smoothly.
- There is a possibility to have some friction in the pulley.

SUGGESTION TO IMPROVE

- The errors could have been prevented by using a good quality of lab bench.
- The quality and the cutting of the wood should be accurate so that the laser beam is cut at a proper place.
- If the experiment was done in vacuum, then it could have 0 % error.
- The pulley should be greased before the experiment so that there is least possible error by the pulley.