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Date of Experiment:

20 October 2023

Member Group:

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General Physics Experiment Report

Newton's Second Law

Purpose:

This experiment was designed not merely to verify Newton's second law of motion but to embark on a thorough exploration of the intricate relationship between force, mass, and acceleration. By utilizing an air track and external forces, our goal was to delve into the nuances of how force influences acceleration and how the interplay between these factors manifests in the real world. Concrete examples were sought to illustrate the practical applications of Newton's second law in our daily experiences.

Introduction .

The Newton's second law states that the acceleration of an object is dependent upon two variables – the net force acting upon the object and the mass of the object. The acceleration of an object depends directly upon the net force acting upon the object, and inversely upon the mass of the object. As the force acting upon an object is increased, the acceleration of the object is increased. As the mass of an object is increased, the acceleration of the object is decreased. In Newton's law, the acceleration of an object is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object. This can be expressed by:

$$\sum F = Ma$$

Where, ∑F is the net force acing on the object, it is the vector sum of all forces acting on an object. "M" is mass of an object; "a" is acceleration of an object.

This experiment aimed not only to validate this law but to dissect its implications. We endeavored to understand how variations in force and mass

dynamically affect acceleration. The air track provided a controlled environment to scrutinize these relationships systematically.

Materials/Methods:

The experiment employed an array of materials, including a smart block, track, pulley, and data capture software (SPARKvue). The meticulous execution involved several steps:

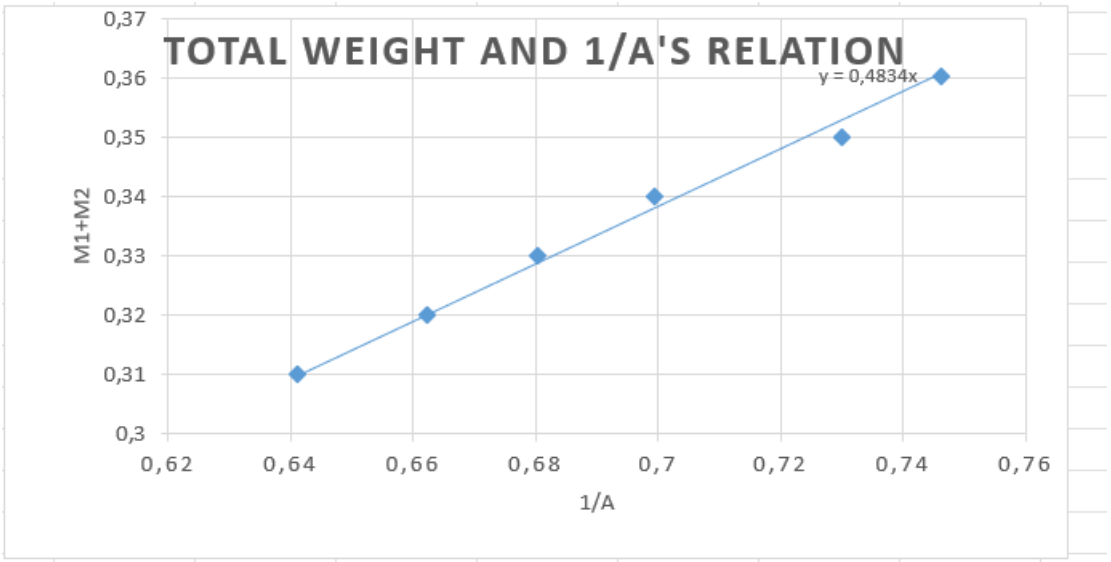
- Calibration of track stability.
- Placement and careful handling of the smart trolley.
- Verification of the protection frame's impact on the pulley.
- Activation of the smart trolley power supply and Bluetooth setup.
- Setting the smart pulley position and sample rate.
- Hanging the glider using a thread and observing changes using SPARKvue.

Results:

Two distinct sets of results were gathered—one with *M*2 held constant and the other with *M*1+*M*2 constant. The data portrayed a consistent pattern, with theoretical and experimental values demonstrating close alignment. The observed percentage errors were well within an acceptable range, affirming the reliability of the results.

The following results were collected when M2 (kg) was kept constant

m	0	10	20	30	40	50
m1(kg)	0.25707	0.26706	0.2771	0.287	0.29703	0.30733
m2(kg)	0.053	0.053	0.053	0.053	0.053	0.053
m1+m2(kg)	0.31007	0.32006	0.3301	0.34	0.35003	0.36033
a (theory)(m/s^2)	1.68	1.62	1.57	1.53	1.48	1.44
a (exp)(m/-s^2	1.56	1.51	1.47	1.43	1.37	1.34
error(%)	6.87%	6.95%	6.58%	6.39%	7.67%	7.04%
1/a(exp)	0.641025641	0.6622516556	0.6802721088	0.6993006993	0.7299270073	0.7462686567
F theory	0.5194	0.5194	0.5194	0.5194	0.5194	0.5194
F exp	0.4837092	0.4832906	0.485247	0.4862	0.4795411	0.4828422



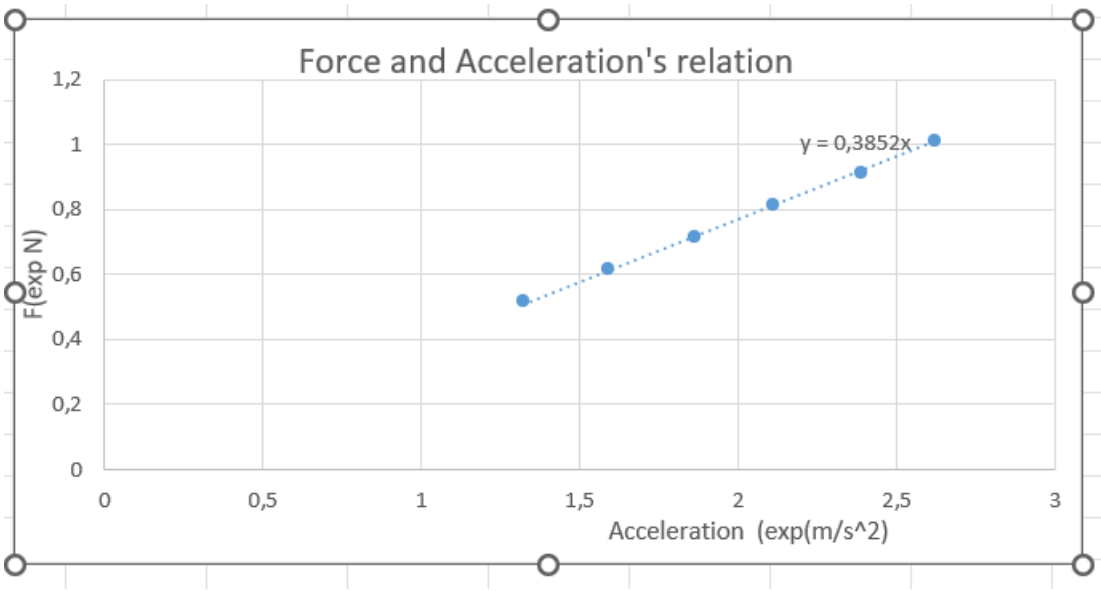
The following were collected when M1+M2 was constant

m	0	10	20	30	40	50
m1(kg)	0.25707	0.26707	0.27707	0.28707	0.29707	0.30707
m2(kg)	0.103	0.093	0.083	0.073	0.063	0.053
m1+m2(kg)	0.36007	0.36007	0.36007	0.36007	0.36007	0.36007
a (theory)(m/s^2)	2.803343794	2.531174494	2.259005193	1.986835893	1.714666593	1.442497292
a (exp)(m/-s^2	2.62	2.39	2.11	1.86	1.59	1.32
error(%)	6.54%	5.58%	6.60%	6.38%	7.27%	8.49%
F(exp N)	1.0094	0.9114	0.8134	0.7154	0.6174	0.5194

m(total theory) 0.36007

m(total exp) 0.3852

error 7%



Discussion

Diving deeper into the discussion, the success of the experiment in corroborating Newton's second law is noteworthy. The observed correlation between force and acceleration was unmistakable, shedding light on the direct impact force variations exert on an object's acceleration. The inverse relationship with mass was equally apparent, and any discrepancies in the experimental values were scrutinized in the context of potential system imperfections or limitations in measurement precision.

Furthermore, the discussion extended beyond mere verification, venturing into the subtleties of the force and acceleration relationship. The experiment served not only as a validation of principles but as a pedagogical journey, elucidating the intricacies that govern motion in the Newtonian framework.

Conclusion

In conclusion, this experiment robustly validates Newton’s second law, emphasizing the direct proportionality of force and acceleration. The results, derived from a meticulous manipulation of force and mass variables, not only align with theoretical expectations but contribute to a profound understanding of classical mechanics.

References

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