Newton’s Second Law Lab from Carolina Kits

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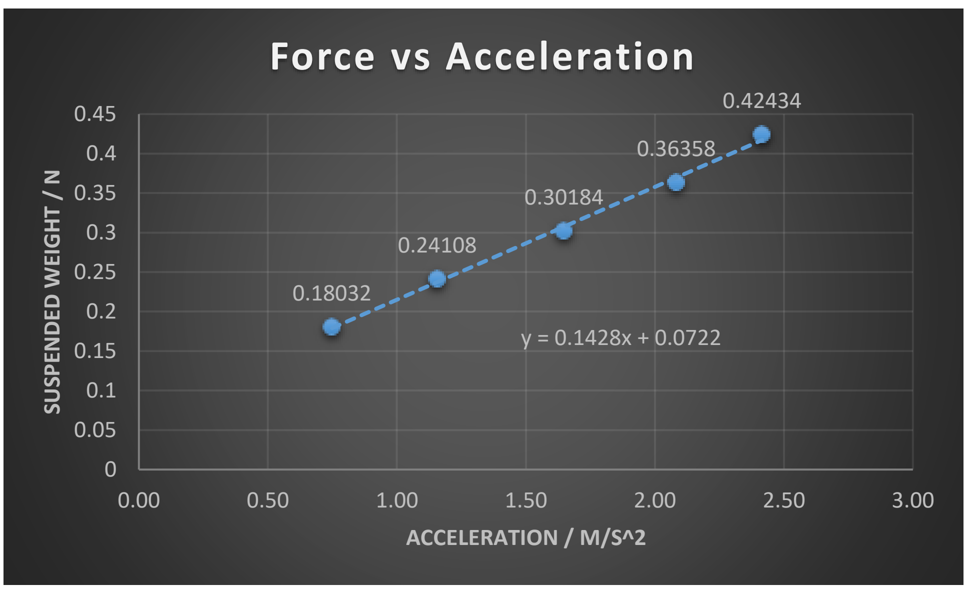
Activity 1: Newton's Second Law Data Table 1

Suspended Mass (kg)	Weight of Suspended Mass (mass x 9.8 m/s^2), Newtons	Time (sec)	Average Time	Average $Time^2$	d (m)	2d (m)	Acceleration = $2d/t^2$
3 Washers 0.0184	.18032	Trial 1: 1.78	1.79	3.20	0.6	1.2	0.75
		Trial 2: 1.81					
		Trial 3: 1.78					
4 Washers 0.0246	.24108	Trial 1: 1.44	1.44	2.07	0.6	1.2	1.16
		Trial 2: 1.44					
		Trial 3: 1.44					
5 Washers 0.0308	.30184	Trial 1: 1.17	1.21	1.46	0.6	1.2	1.65
		Trial 2: 1.24					
		Trial 3: 1.21					
6 Washers 0.0371	.36358	Trial 1: 1.08	1.07	1.15	0.6	1.2	2.08
		Trial 2: 1.1					
		Trial 3: 1.04					

7 Washers 0.0433	.42434	Trial 1: 1.01 Trial 2: 0.97 Trial 3: 1.01	1.00	0.99	0.6	1.2	2.42
Mass of the system	.2705 kg				Slope of the Line (kg)	$0.1428\ kg$	

$$Slope = \ Mass = 0.1428\ kg$$



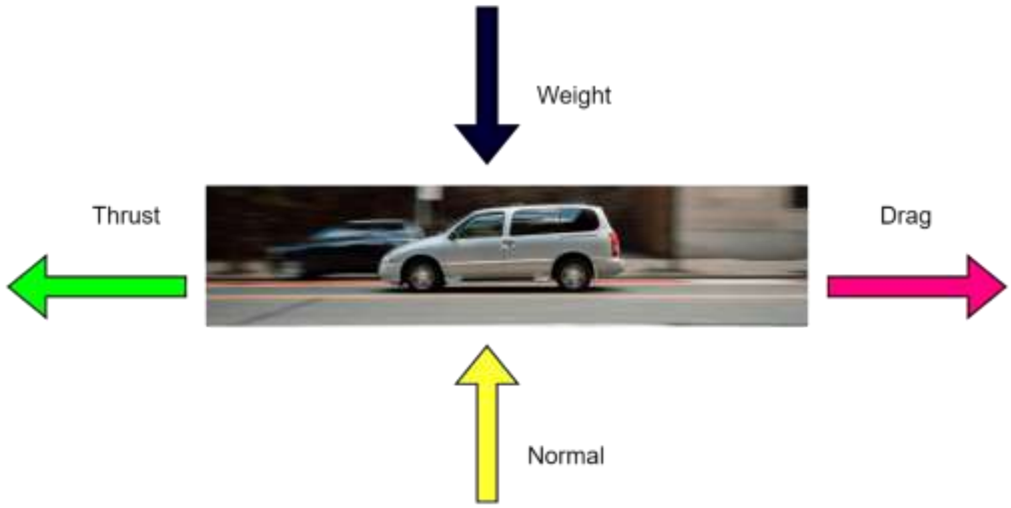
Activity 1: Questions for Newton's Second Law

Question 1:
According to Newton's Second Law ***F*** = *m**a***.
If the force applied to an object is doubled, what happens to the acceleration?

Acceleration is proportional to the force applied. If we were to double the force applied to an object, mathematically, then we would multiply both sides of the equation by 2. This would yield the equation $2\,\boldsymbol{F} = 2\,(m * \boldsymbol{a})$.

Using the multiplicative rule, we can conclude that the acceleration is doubled when the force applied to an object is doubled.

Question 2:
You observe a vehicle traveling on a highway. The vehicle is maintaining a constant velocity. What can you determine about the forces on the vehicle?



That are multiple forces acting on a vehicle will it is traveling on the highway. Referring to the diagram above, we will deal with thrust, weight, normal force, and drag. Thrust is needed to move the car forward. Drag is the opposing force to thrust and increases proportionally to the square of the speed. Weight of the vehicle is a downward force or restated, the mass of the vehicle times the acceleration of gravity. Finally, the normal is the reactionary force that opposes the weight.

The car does not produce any aerodynamic lift. Thus, the normal force will be equal and opposite in magnitude to the weight. The internal combustion engine produces the thrust required to move the car. We discussed earlier that drag increases proportionally to the square of the speed.

The car is moving at a constant velocity. Subsequently, the car is not accelerating or deaccelerating. Restated, the force of thrust/drag does not cause a change in velocity. Thus, we can conclude that the forces are in equilibrium.

Question 3:
What are some error sources in the Second Law experiment?

We were instructed to calculate the percent difference between the calculated and actual mass of the system. Please refer.

$$percent\ difference = \left|\frac{.2705 - .1428}{\left(\frac{.2705 + .1428}{2}\right)}\right| * 100 = \left|\frac{-.1277}{.2067}\right| * 100 = 61.78\ \%$$

Referring to the guidelines for the second law experiment. Most of the uncertainty is due to human error. Slow reaction times make humans incapable of measuring timed events that have very short intervals. Additionally, I did not account for friction caused by the table, pulley, and wheels.

The experiment is prone to parallax errors that are caused by improper viewing angles. Additionally, each scale will some level of inaccuracy. Multiple trials may help minimize the error, but the error will remain. The actor is required to perform calculations to derive a conclusion. This conclusion could be flawed when is based on faulty decision logic.

Question 4:
In the Second Law experiment, the acceleration is calculated by measuring the time for the cart to move from the start point to the end point and applying the kinematics equation:

$$\boldsymbol{s} = \frac{1}{2}\,\boldsymbol{a}t^2$$

Explain how this equation is used to find the acceleration.

The Newton's second law experiment is a one-dimensional Kinematics activity that explores the Kinematics displacement equation $x = x_0 + v_0 t + \frac{1}{2}at^2$. The beginning position and initial velocity is zero. Thus, the displacement equation simplifies to $\boldsymbol{s} = \frac{1}{2}\,\boldsymbol{a}t^2$.

Where s is the movement distance, a is the acceleration due to the mass suspended system and t is the displacement time. Multiplying both sides by 2 and dividing both sides by t^2 will yield $\boldsymbol{a} = \frac{2\boldsymbol{s}}{t^2}$.

I measured a distance of 60 cm and recorded the cart moving from start to finish. After observing the footage, averaged the time. After plugging in the known values into the aforementioned equation, I was able to determine the acceleration of each system.