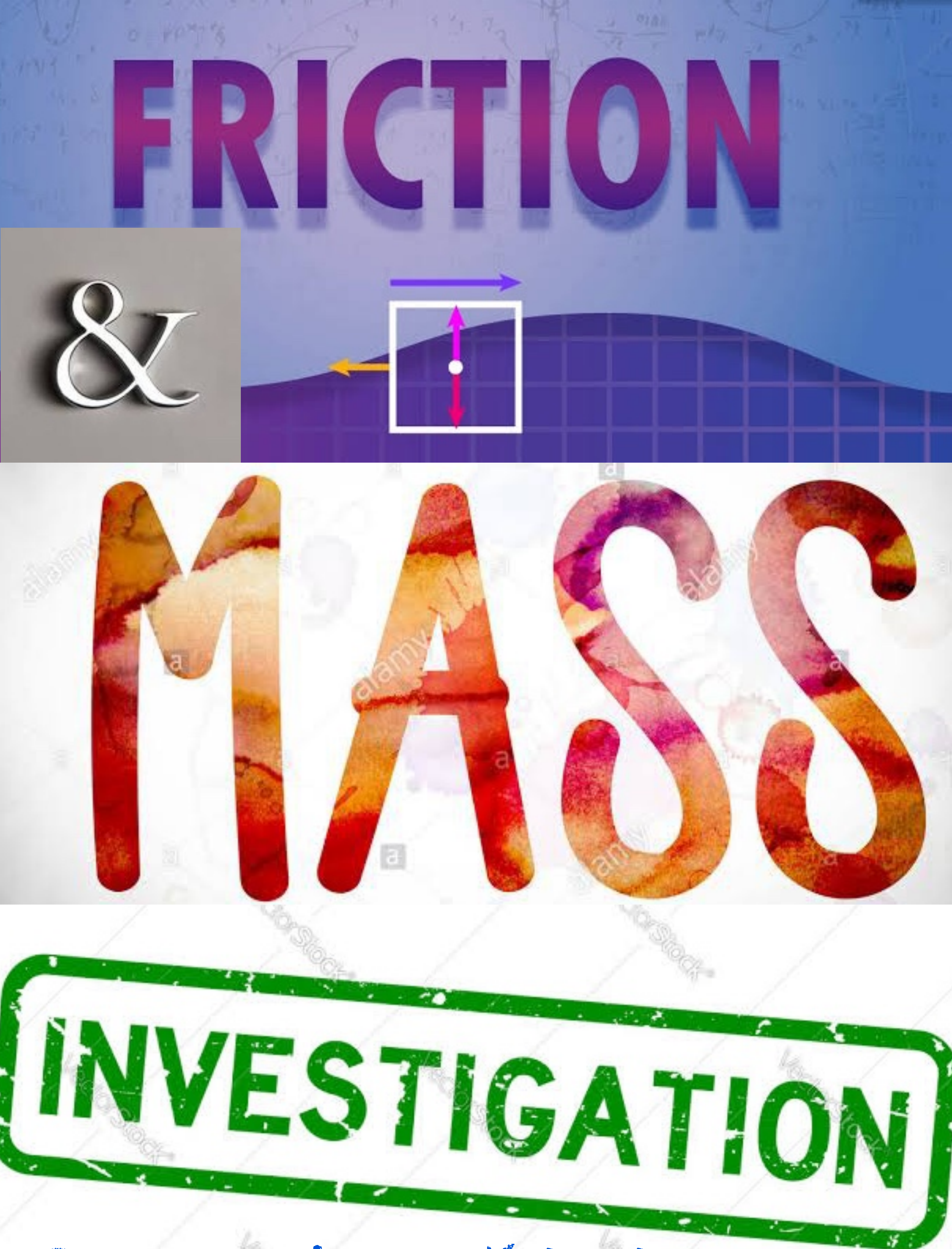


By; Lucas Krinninger

Contents

Abstract:
We are aiming to evaluate the relations between three forces: mass, acceleration, and friction. And find a correlation between these forces. After we gathered the equipment, we set up our apparatus. We stacked the three cardboard stands atop of each other to gain extra height for a steeper decline with our cardboard ramp. Next we weighed our clay with the scale, to get various masses (including the cars mass) to test. After the clay has been weighed and placed in the plastic car, we attached a piece of tape to the paper trail and taped it to the backside of the car. We placed the generator on the top carboard stand and connected the two wires into their correct colour placements (red to red, black to black) and then connected the wires to the ticker box. The end of the paper trail is then fed through the ticker box via slits on each end and runs below the black circle and needle. The car is then placed on top of the ramp and held in place. The ticker box is turned on and the car is let go to run along the ramp. After the car hits the bottom, turn off the ticker box and count the amount of dots that are one the paper trail (10 dots = to 1 second). Record the data and test two more times with different masses of clay. The results show that the car had a greater average acceleration when driving down the cardboard ramp as the cardboard produces less friction upon the vehicle than the bubble wrap ramp. This links back to the hypothesis that the car will have a greater acceleration as it runs down the carboard ramp than the same car with the same overall mass, running down the bubble wrap decline ramp.

Introduction:

The purpose of this investigation is to evaluate the relationship between friction, mass and acceleration using a plastic car loaded with different masses of clay that will be run along cardboard and bubble wrap declines to assess these relations. We are aiming to evaluate these relations between these three forces and find a correlation between them. I hypothesise that the car will have a greater acceleration as it runs down the carboard ramp than the same car with the same overall mass running down the bubble wrap decline. There are three laws that these three factors of force follow, these are referred to as Newton's laws of motion. Newtons 1st law states that all object will remain in rest or uniform motion unless acted upon by an external force. Newtons 2nd law states that acceleration is equal to mass times force. Newton's 3rd law states that for every action there is an equal and opposite reaction.

Variables:

IV- Mass of the clay
DV- Number of dots along the paper trail
Control- Same car, same angle (approximately 30 degrees)

Method:

Equipment:

- Plastic car
- Clay
- Three carboard stands
- Carboard ramp w/ bubble wrap underside
- Ticker box
- Tape
- Paper trail
- Pen or pencil
- Scale
- Red and black wires
- Generator

After we gathered the equipment, we set up our apparatus. We stacked the three cardboard stands atop of each other to gain extra height for a steeper decline with our cardboard ramp. Next we weighed our clay with the scale, to get various masses (including the cars mass) to test. After the clay has been weighed and placed in the plastic car, we attached a piece of tape to the paper trail and taped it to the backside of the car. We placed the generator on the top carboard stand and connected the two wires into their correct colour placements (red to red, black to black) and then connected the wires to the ticker box. The end of the paper trail is then fed through the ticker box via slits on each end and runs below the black circle and needle. The car is then placed on top of the ramp and held in place. The ticker box is turned on and the car is let go to run along the ramp. After the car hits the bottom, turn off the ticker box and count the amount of dots that are one the paper trail (10 dots = to 1 second). Record the data and test two more times with different masses of clay.

Results:

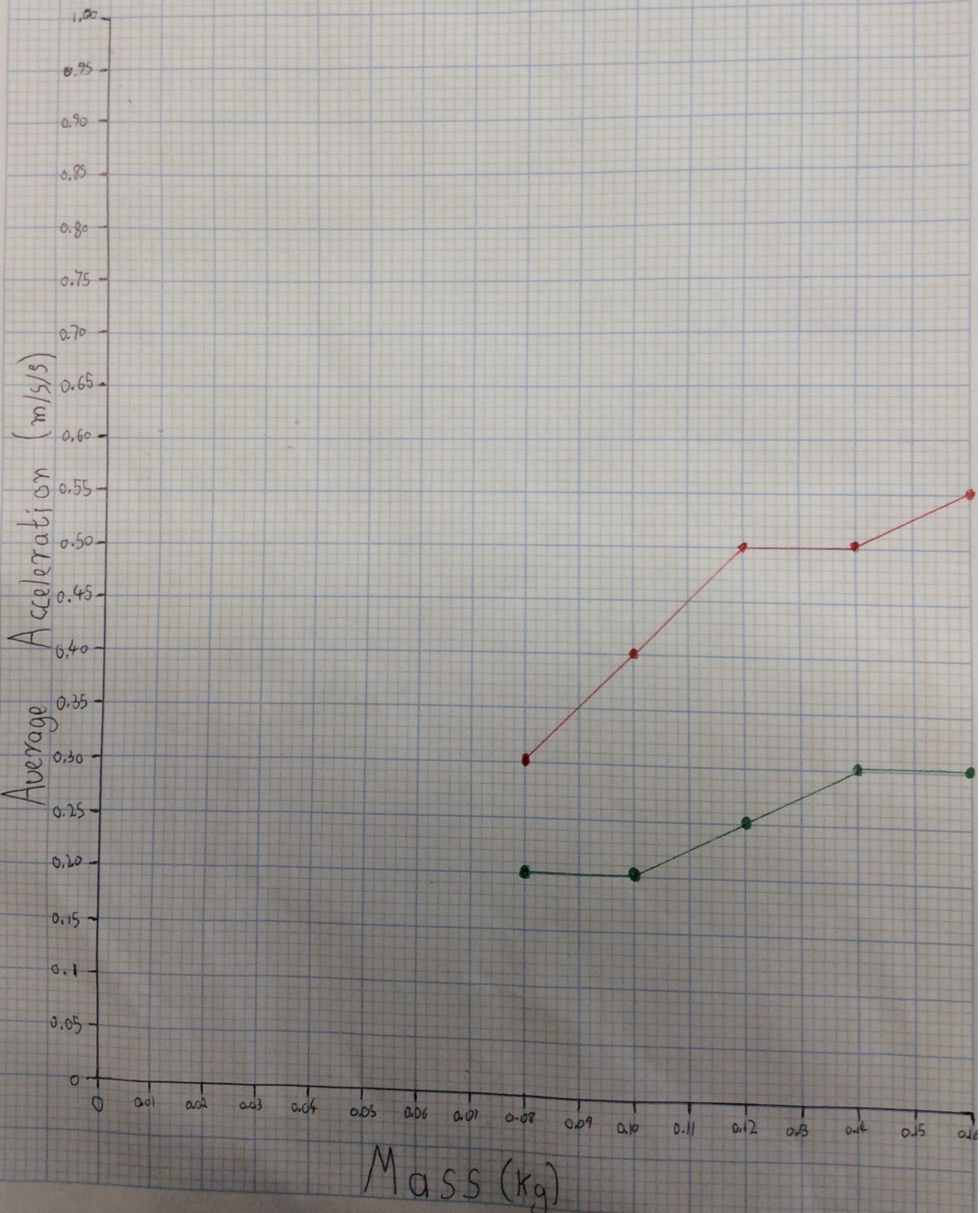
Force of Car Without BubbleWrap

Mass (g) (80/1000)	Trial number	Initial Velocity (m/s)	Final velocity (m/s)	Time (sec)	Acceleration (m/s/s) (v-u)/t	Average (Trial 1 + Trial 2 + Trial 3 / 3)	Force (M x A)
80 Kg = 0.08	1	0.05	0.246	5.6	(0.246-0.05)/ 5.6=0.035	0.030	0.0024
	2	0.07	0.23	6.1	0.026		
	3	0.032	0.225	6.2	0.031		
100	1	0.048	0.252	5	0.040	0.040	0.0040
	2	0.041	0.24	5.1	0.039		
	3	0.038	0.245	5	0.041		
120	1	0.034	0.290	5	0.051	0.049	0.0058
	2	0.045	0.295	5.2	0.048		
	3	0.045	0.290	5.1	0.048		
140	1	0.045	0.285	4.7	0.051	0.052	0.0072
	2	0.034	0.315	4.8	0.058		
	3	0.045	0.295	5.1	0.049		
160	1	0.040	0.307	4.8	0.055	0.054	0.0086
	2	0.037	0.295	4.9	0.052		
	3	0.045	0.295	4.5	0.055		

How Does Mass Affect The Average Acceleration Of A Car

= With BubbleWrap

= Without BubbleWrap



Force of Car With BubbleWrap

Mass (g) (80/1000)	Trial number	Initial Velocity (m/s)	Final velocity (m/s)	Time (sec)	Acceleration (m/s/s) (v-u)/t	Average (Trial 1 + Trial 2 + Trial 3 / 3)	Force (M x A)
80 **Kg = 0.08**	1	0.030	0.194	7.4	(0.194-0.030)/7.4=0.022	0.019	0.0015
	2	0.037	0.187	7.6	0.0197		
	3	0.024	0.164	8.7	0.016		
100	1	0.031	0.196	10.4	0.015	0.019	0.0019
	2	0.034	0.194	7.8	0.020		
	3	0.015	0.186	7.2	0.023		
120	1	0.042	0.207	6.8	0.024	0.024	0.0028
	2	0.037	0.214	6.9	0.025		
	3	0.032	0.201	7.2	0.023		
140	1	0.027	0.217	6.7	0.028	0.029	0.0040
	2	0.033	0.214	6.0	0.030		
	3	0.037	0.223	6.3	0.029		
160	1	0.033	0.227	6.1	0.031	0.030	0.0048
	2	0.034	0.220	6.2	0.030		
	3	0.036	0.227	6.3	0.030		

Discussion:

Cardboard: The results from the result table show the car having a higher average acceleration when compared to the bubble wrap testing. The results also show a increasing trend where the mass is increased, the acceleration increase also. The cardboard exerts a small amount of friction onto the wheels of the car, much like roads on motor vehicles. The added mass of the clay adds to the stress the cardboard has to exert to slow the car down; this is why it is dangerous to drive at high speeds with heavy loads as the force needed to slow you down increase every time more weight is added to the vehicle.

Bubble wrap: The result from the tests with the bubble wrap ramp show a clear indication why friction on roads is needed. The average acceleration is much lower than the average acceleration of the cardboard tests. Like the cardboard tests, there is an incline in acceleration when more mass is added to the vehicle. The bubble wrap ramp as more friction than the cardboard ramp resulting in smaller average acceleration speeds due to an increase in frictional forces on the wheels of the car.

Evaluation:

To improve validity and reliability, we could have done more tests to get a larger data set to find the median, mode, range and mean for each mass test for both the bubble wrap and cardboard ramps. Having only two materials to test the force of friction on a plastic car was the only limitation I could spot; testing the force of friction with different materials such as sand, gravel and damp cardboard with a vehicle with rubber wheels would also show the affects real roads would have on motor vehicles and help us understand the importance of friction, mass and acceleration using a real world example.

Conclusion:

The results show that the car had a greater average acceleration when driving down the cardboard ramp as the cardboard produces less friction upon the vehicle than the bubble wrap ramp. This links back to the hypothesis that the car will have a greater acceleration as it runs down the carboard ramp than the same car with the same overall mass, running down the bubble wrap decline ramp.