BALLOON TO THE MOON

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ABSTRACT

Balloon Rocket Model Experiment was demonstrated to understand the fundamental Physics principle of 2nd law and 3rd law of Motion. This experiment applied a Physics concept involving pressure and thrust force. Different types of load were attached to the filled air balloon before release. The balloon was hung on a horizontal string with a straw used as a stabilizer. It was observed that the greater the load, the more force is needed to accelerate that object. Besides, the increased weight from the cargo slows down the balloon rocket. The results obtained obey the second law and third law of motion and give a clear visualization to enhance students' understanding of both laws.

Keywords: Pressure, Thrust, Newton's Second Law, Newton's Third Law

1. INTRODUCTION

The first principle of rocketry was tested more than two thousand years ago and this first principle is often associated with Elon Musk, who uses this approach to come up with his business ideas and innovative product designs. The first principle approach has been used by many great thinkers including inventor Johannes Gutenberg, military strategist John Boyd, and the ancient philosopher Aristotle, but no one embodies the philosophy of first principle thinking more effectively than entrepreneur Elon Musk.

[2]The hot water vapor causes a rise in pressure, and in this project we use this pressure to push water out of the soda bottles and propel the rocket upward. This rocket is controlled by an onboard timer circuit that runs off a 9-volt battery and ignites the gasses electrically using model rocket igniters. In this experiment, a rocket's movement depends on a concept of Force, Newton's Second Law, Newton Third Law of Motion, Thrust and Pressure. To propel a rocket, some kind of force must be expelled from the rocket in order to push it forward. [1]Sir Isaac Newton was one of the first scientists to study force. He states that a push or pull on an object is called a force. For this experiment, the mechanical force that pushes a rocket aircraft through the air is known as a thrust.

Two of Newton's Laws of motion are related to force, and therefore, related to thrust. Newton's Second Law of Motion states that the rate of momentum of a body is proportional to the applied force and takes place in the direction in which the force acts. Therefore, the greater the mass of an object, more force is needed to accelerate that object. According to Newton's Second Law, the rate change of momentum is proportional to the applied force F=ma where F is a force, m is a mass and a is an acceleration. Newton's Third Law of Motion states that for every action there is an equal and opposite reaction means that in every interaction, there is a pair of forces acting on the two-interacting object. The size of the force on the first object is equal to the size of the force on the second object. The direction of the force on the first object equals the size of the force on the second object.

Newton's Second and Third Laws of Motion play a part in how a rocket lifts off. As a rocket burns fuel, hot gas is created and forced out of the back of the rocket. As the gas is expelled, the rocket is propelled with equal force in the opposite direction, and the force exceeds the weight of the rocket.

[4] Scientists have to adjust the rocket fuel and the exhaust nozzle for different missions based on the distance the spacecraft has to travel and its mass.

[3]Building paper rockets enables students to tie together many different concepts in physics such as in particular, the equations of motion linking velocity, acceleration, distance and time, as well as the principles of aerodynamics. In this experiment, the rocket is propelled by pressure. Pressure is the amount of force exerted on an area. The pressure inside the balloon serves as the fuel for the rocket. When you release the opening of the balloon, gas quickly escapes, equalizing the pressure inside with the air pressure outside of the balloon. As the air escapes from the balloon, it exerts a force on the ground and the air outside of the balloon. According to Newton's Third Law of Motion, as the gas is released from the balloon and pushes against the outside air, the outside air pushes back. As a result, the rocket is propelled forward by the opposing force. This opposing force is thrust.

2. MATERIAL AND METHOD

Chairs, Balloons, Straws, String, Masking Tape, Eraser, Cloth Peg, A4 Paper, Scissors, Permanent Marker, Stopwatch, Measure Tape and Electronic Scale.

Experimental Procedure

Firstly, one end of the string was tied to a chair. The other end of the string was put through a straw. Then, the string was pulled tight and tied to another chair. Next, the balloon was blown up and pinched to keep the air inside. The balloon was not tied and later taped together with the straw so that the opening of the balloon was horizontal with the ground.

Next, two students were needed for this part where one student would ensure the air remained inside the balloon by continuing pinching the opening of the balloon and the other one student taped the balloon together with the straw. The balloon was pulled all the way back to the end of the string (the starting point) by one student, so the balloon opening would be against the chair.

Then, one student held the tip of the balloon. The finished line at a distance of 0.4meter was drawn by another student using the permanent marker near the end of another side of the string. The balloon flew freely through the string and the movement was observed as a result. Then, the process was repeated 2 times with different methods with 'cargo' such as no-load, added load as an eraser and a cloth peg across the string to the finish line. Lastly, data was recorded

3. RESULTS AND DISCUSSION

As shown in Table 1, the speed of the balloon flew twice during the trial without load for empty cargo with a mass of 0.003kg, it flew for 1.01s from starting point to the finishing line with a distance of 3.35m. The speed for a balloon without cargo (Table 2) was 3.29 m/s. Next, with load (cloth peg) refer to Table 3 with a mass of 0.008kg; it flew for 1.08s from the starting point to the finishing line with a distance of 2.23m. The speed for a balloon with cloth peg was 2.19 m/s. The last one with load (an eraser) refer to Table 4 with a mass of 0.015kg, flew for 0.77s from starting point to the finishing line with a distance of 1.40m. The speed for a balloon with an eraser was 1.81 m/s.

The way the balloon flew to the front or horizontally can be referred to Figure 3.6 and Figure 3.7. The prediction in this experiment is, when the balloon pulls all the air out and pressure exists to help the balloon fly to the front. Then the straw brings the balloon flying through the string from the starting point to the finishing line. Lastly, the number of time and distance were different each time the project was run due to the presence of cargo.

Pressure has subunits in it; Newton's First Law, Newton's Second Law and Newton's Third Law of Motion. Pressure is the amount of force exerted on an area (blow into balloon). In this experiment, Newton's Second Law and Newton's Third Law were applied to the rocketry balloon project. Newton's Third Law of motion was shown when the gas was released from the balloon and pushed against the outside air, the outside air pushed back. This opposing force is thrust. The thrust is a mechanical force that pushes a balloon through the air, refer Figure 8 and force is a push or pull acting on a balloon, which causes a change in position or motion.

Some precaution steps were taken during the experiment. Firstly, the experiment was run in an open space. Secondly, the equipment was placed and set on a flat surface. Thirdly, all the electrical instruments such as stopwatch and electronic scale must be functioning. The possible errors may occur during the experiment such as the balloon moves to the side and not horizontally and mistakes in calculating and taking data for the mass of loads, time taken and distance balloon flown from starting point to the finishing line.

3.1TABLE, IMAGE AND FIGURE

DATA:
Fix Distance: 0.4 meter
Mass Empty Cargo: 0.003kg

Table 1: Collected Data

TYPES OF LOAD	MASS (kg) (Load+Cargo)	TIME TAKEN, t(s)		DISTANCE FROM STARTING POINT TO FINISH LINE,s (m)	
		First Trial	Second Trial	First Trial	Second Trial
Without Load	0.003	1.05	0.97	3.94	2.75
Cloth Peg	0.008	0.91	1.25	2.15	2.30
Eraser	0.015	0.69	0.84	1.51	1.28

Table 2: Collected Data Without Load (Empty Cargo)

Trial 1	Mass,m (kg)	Time,t (s)	Distance,s (m)	Average speed, v (m/s)
1	0.003	1.05	3.94	$= \frac{3.94}{1.05}$ = 3.75
2	0.003	0.97	2.75	$= \frac{2.75}{0.97}$ = 2.83
Average	$= \frac{0.003 + 0.003}{2}$ =0.003	$= \frac{1.05 + 0.97}{2}$ = 1.01	$= \frac{3.94 + 2.75}{2}$ = 3.35	$= \frac{3.75 + 2.83}{2}$ = 3.29

Table 3: Collected Data Cargo with Load (Cloth Peg)

Trial 1	Mass (kg)	Time (s)	Distance (m)	Average speed (m/s)
1	0.008	0.91	2.15	= 2.15 0.91 = 2.36
2	0.008	1.25	2.30	= 2.30 1.25 = 1.84
Average	= 0.008 + 0.008 2 =0.008	= 0.91 + 1.25 2 = 1.08	= 2.15 + 2.30 2 = 2.23	= 2.36 + 1.84 2 = 2.19

Table 4: Collected Data Cargo with Load (Eraser)

Trial 1	Mass,m (kg)	Time,t (s)	Distance,s (m)	Average speed,v (m/s)
1	0.015	0.69	1.51	= 1.51 0.69 = 2.1
2	0.015	0.84	1.28	= 1.28 0.84 = 1.52
Average	= 0.015 + 0.015 2 =0.015	= 0.69 + 0.84 2 = 0.77	= 1.51 + 1.28 2 = 1.40	= 2.1 + 1.52 2 = 1.81

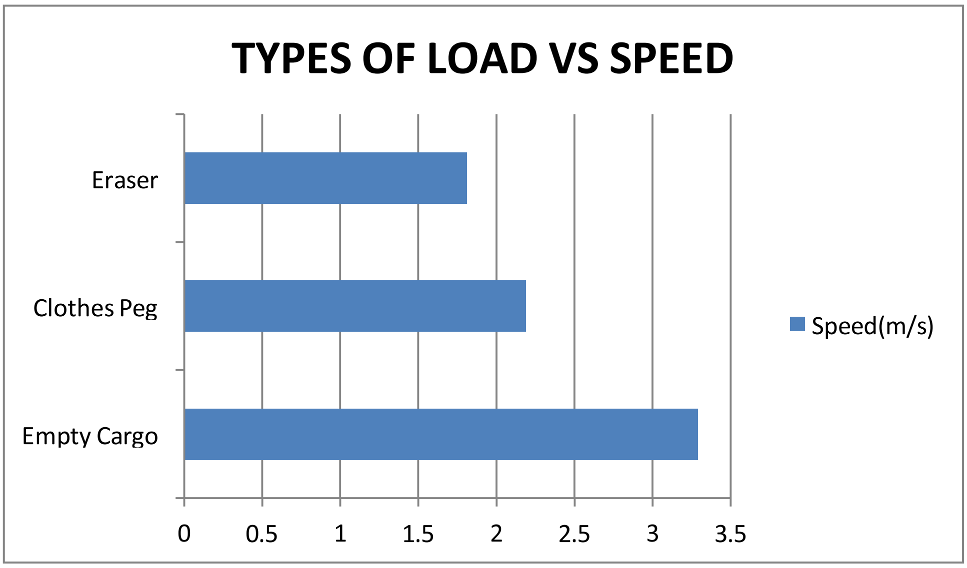

Figure 1: Types of load vs Speed

Based on **Figure 1 ,** it can be concluded that the speed of empty cargo is slower down which is 3.29 m/s compared with the speed of a cloth peg which is 2.19m/s and the speed of an eraser which is 1.81 m/s. It can be said that when more load is added, it will take a short time and distance to stop at the finishing line and there is also an increase in the value of speed. Additionally, different loads contribute to different values of speed.

IMAGE AND FIGURE:

Figure 2: Without Load (Empty Cargo)

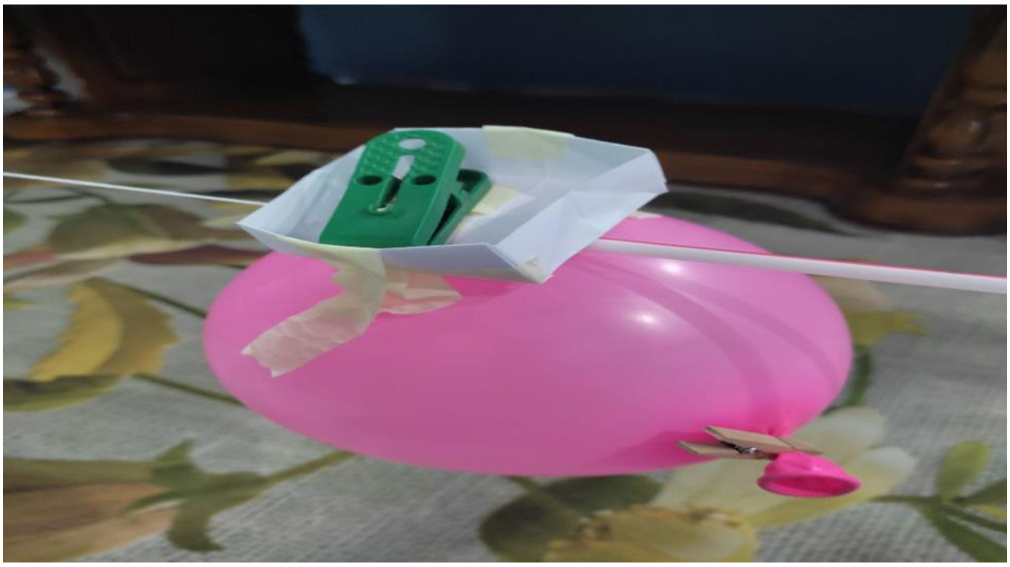
Figure 3: Cargo with Load (Cloth Peg)

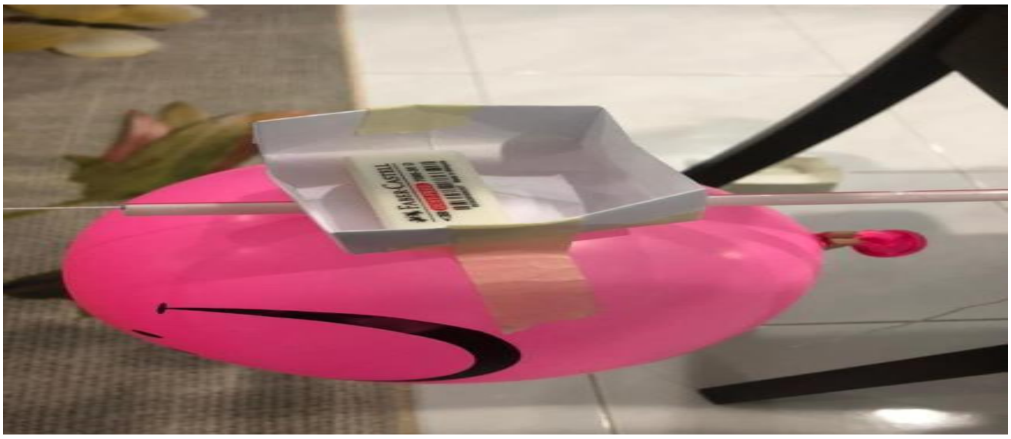
Figure 4: Cargo with Load (Eraser)

Figure 5: Blow the air into the Balloon

Figure 6: Balloon at an Upper Side

Figure 7: Balloon at Downside

Figure 8: Movement of the Balloon

4. CONCLUSION

A simple rocket made with a balloon was propelled down a string according to Newton's Laws of Motion, because of thrust generated by pressure. This is because the acceleration (a) of an object as produced by a net force is directly proportional to the magnitude of the net force (F), in the same direction as the net force, and inversely proportional to the mass (m) of the object. This relationship is described by the equation: F = ma. The acceleration of an object depends on the mass of the object and the amount of force applied. When one object exerts a force on a second object, the second object exerts an equal and opposite force on the first.

Furthermore, once the balloon has been set up, the balloon travels along the string track. Pressure from the gasses inside the balloon pushes those gasses out of the balloon when it is released. As the gasses escape from the balloon, they exert a force on the outside air, which in turn exerts an opposing force and pushes the balloon forward.

The experiment was successful and the objectives were achieved, thus following the fundamental Physics principle of 2nd law and 3rd law of Motion. Newton's Second Law of Motion states that the relationship between a balloon mass (kg), its acceleration (a), and the applied force (F) is described by the formula F = ma. The results showed different speeds with different loads where the speed of empty cargo is 3.29 m/s, cargo with cloth peg is 2.19 m/s and cargo with eraser is 1.81 m/s. Newton's Third Law of Motion states that for every action, there exists an equal and opposite reaction.

For future research, in order to move the balloon faster along the track, pressure of the gas inside the balloon needs to be increased. Besides, when more loads are added into empty cargo to the balloon rocket, the increased weight from the cargo slows down the balloon rocket and thus, speed will increase. In addition, this set of balloon rocket model is cheap but at the same time enhances students' understanding and creates more fun and interesting learning for students.

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