**12/08/10** **Rubber Band Car** Sample A1

## Intro:

The definition of energy efficiency that I found was it "is the ratio between the useful output of an energy conversion machine and the input, in energy terms" (Wikipedia). In my groups project the output is the distance traveled by the car and the input is the rubber bands placed in the car. My groups used multiple rubber bands to increase the distance traveled so we found the ratio between just one band and how far it traveled. This definition is a good and accurate definition but could have some improvement in my opinion. They could add to the definition about how and energy efficient car should but out larger and more beneficial numbers then are put into in. There should not be a larger input number than an output number or the car would not be considered efficient.

My groups hypothesis was that the more rubber bands added to the car would increase the distance traveled and therefore increases the efficiency of the car. The variable that my group changed was the rear tires on the car. We made the tires larger and have more treed then that original ones. The bigger tires will have more grip on them allowing the tire to grab a hold of the floor and push it forward. The smaller tires were much smaller and smooth giving it less traction. We thought this would but a good adjustment to see how it affected the cars efficiency.

## Reflection Essay: *On separate paper*

## Drawing/Picture: *On separate paper*

## Description of Car:

My group's car was a four wheeled rubber band powered car. Our car was made out of Legos and was rear wheeled drive. The car was built so that the rubber bands would attach near the front of the car and stretch back to the rear axle. On the rear axle there were two tiny gears. The bands were split up amongst the gears and placed in their groves. Once the bands were in the groves we would rotate the wheels so that the band would twist around the axel. When you let go of the car the car the rubber bands would rotate the gears attached to the axel that would spin the wheels pushing the car forward. The smaller gears allowed the car to get a great lunge and start off the line and allow it to accelerate so that it would glide once the rubber bands were completely unwound. There were a lot of extra Lego pieces used to support the car's axel and hold the rubber bands in place.

Our car's design can be compared to Newton's laws of motion in several ways. Its movement can be compared to his 1st and 3rd law. The wheels pushing on the floor making it move applies to his 3rd law because there is an equal and opposite reaction from the floor pushing it in the opposite direction pushing it across the floor. As the car begins to slow down this demonstrates his 1st law because it shows the car doesn't remain in motion because on opposite force begins to act against it. This force is the friction of the floor bringing it to a stop. We got our teachers approval for this lab and began to build the car. After building the car we tested it a few times and began to modify it. We adjusted the width, length, tire size, and the amount of bands we used.

## Independent Variable: *Number of rubber bands used/ Weight*

## Dependent Variable: *Distance Traveled/ Time/ Speed*

We planned to determine the efficiency of our car by taking the car adding rubber bands and recording the distance traveled. We would than divide the distance traveled by the number of bands to get the ratio of distance traveled per band. Our teacher approved my groups safety steps and we than tested our experiment.

## Experiment Data:

My group altered the amount of bands used for our independent variable tested many different things. We did three test runs for each amount of bands and recorded the data for each run. We found the averages for the three runs and recorded it in a data table on the next page. After each run we exchanged the bands for new ones to keep the elasticity similar.

## Original Car Data Table:

| Bands | Avg. Distance (Ft) | Ratio (Band: Distance) | Avg. Time (Sec) | Avg. Speed (Ft/Sec) | Weight (g) |
|---|---|---|---|---|---|
| 1 | 4 | 1:4 | 2.1 | 1.9 | 336 |
| 2 | 9 | 1:4.5 | 4.25 | 1.88 | 336 |
| 3 | 12 | 1:4 | 4.9 | 2.44 | 336 |
| 4 | 16 | 1:4 | 5.6 | 2.86 | 337 |
| 5 | 22 | 1:4.4 | 6.2 | 3.54 | 337 |
| 6 | 28 | 1:4.6 | 6.9 | 4.05 | 337 |
| 7 | 27 | 1: 3.8 | 6.8 | 3.97 | 338 |
| 8 | 24 | 1:3 | 6.3 | 3.8 | 338 |

## Equation examples:

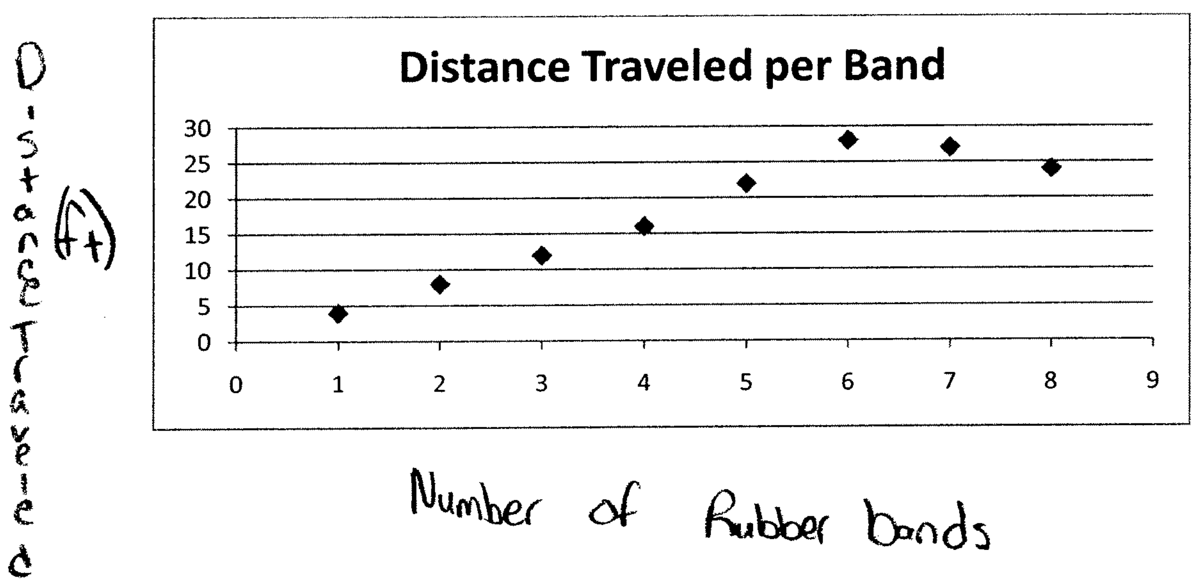
Avg. Distance- 3.5 ft + 5 ft + 3.5 ft = 12 ft /3(trials) = **4 ft**

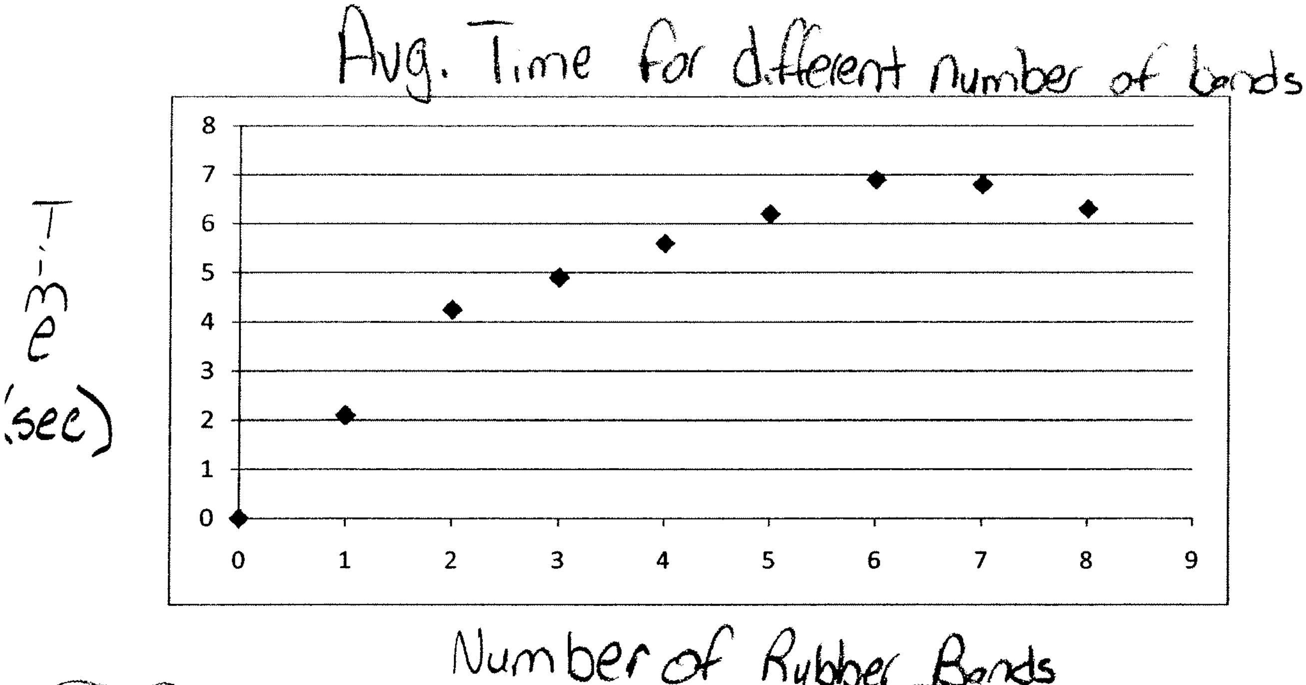
Ratio- 5 bands, 22 ft (traveled), 22ft/5 bands = **1:4.4** (For ever one band it goes 4.4 feet)

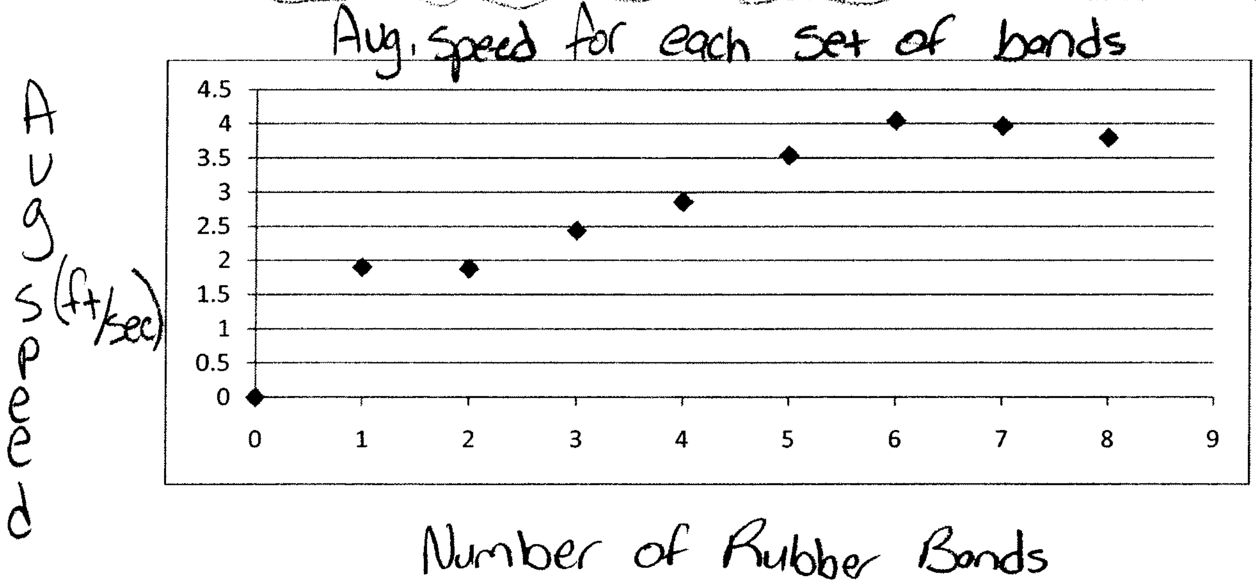
Avg. Time- 5.5 sec+ 5.6 Sec + 5.7 Sec = 16.8 sec/ 3 (trials) = **5.6 sec**

Avg. Speed- 27 ft (distance traveled), 6.8 sec (total time of travel) 27ft/6.8 sec = **3.97 ft/sec**

## Graphs:






Our graphs show that the number of bands used in the original car do affect how far the car will travel. The car went the farthest distance with 6 bands and had the fastest speed. It showed that it also has the best ratio out of all the other amount of bands. For every one rubber band the car traveled 4.6 feet. After 6 bands the car began to have worse numbers and a worse ratio.

## Car with Larger wheels chart:

| Bands | Avg. Distance | Ratio (Band: Distance) | Time (Sec) | Avg. Speed (Ft/Sec) | Weight (g) |
|---|---|---|---|---|---|
| 1 | 4 | 1:4 | 2.4 | 1.66 | 464 |
| 2 | 9 | 1:4.5 | 4.4 | 2.04 | 464 |
| 3 | 15 | 1:5 | 5.2 | 2.88 | 464 |
| 4 | 20 | 1:5 | 5.8 | 3.44 | 465 |
| 5 | 25 | 1:5 | 6.4 | 3.9 | 465 |
| 6 | 31 | 1:5.1 | 7.1 | 4.37 | 465 |
| 7 | 30 | 1:4.4 | 6.9 | 4.34 | 466 |
| 8 | 27 | 1:3.3 | 6.6 | 4.09 | 466 |

Equation Examples:

Avg. Distance- 3.5 ft + 5 ft + 3.5 ft = 12 ft /3(trials) = **4 ft**

Ratio- 5 bands, 22 ft (traveled), 22ft/5 bands = **1:4.4** (For ever one band it goes 4.4 feet)

Avg. Time- 5.5 sec+ 5.6 Sec + 5.7 Sec = 16.8 sec/ 3 (trials) = **5.6 sec**

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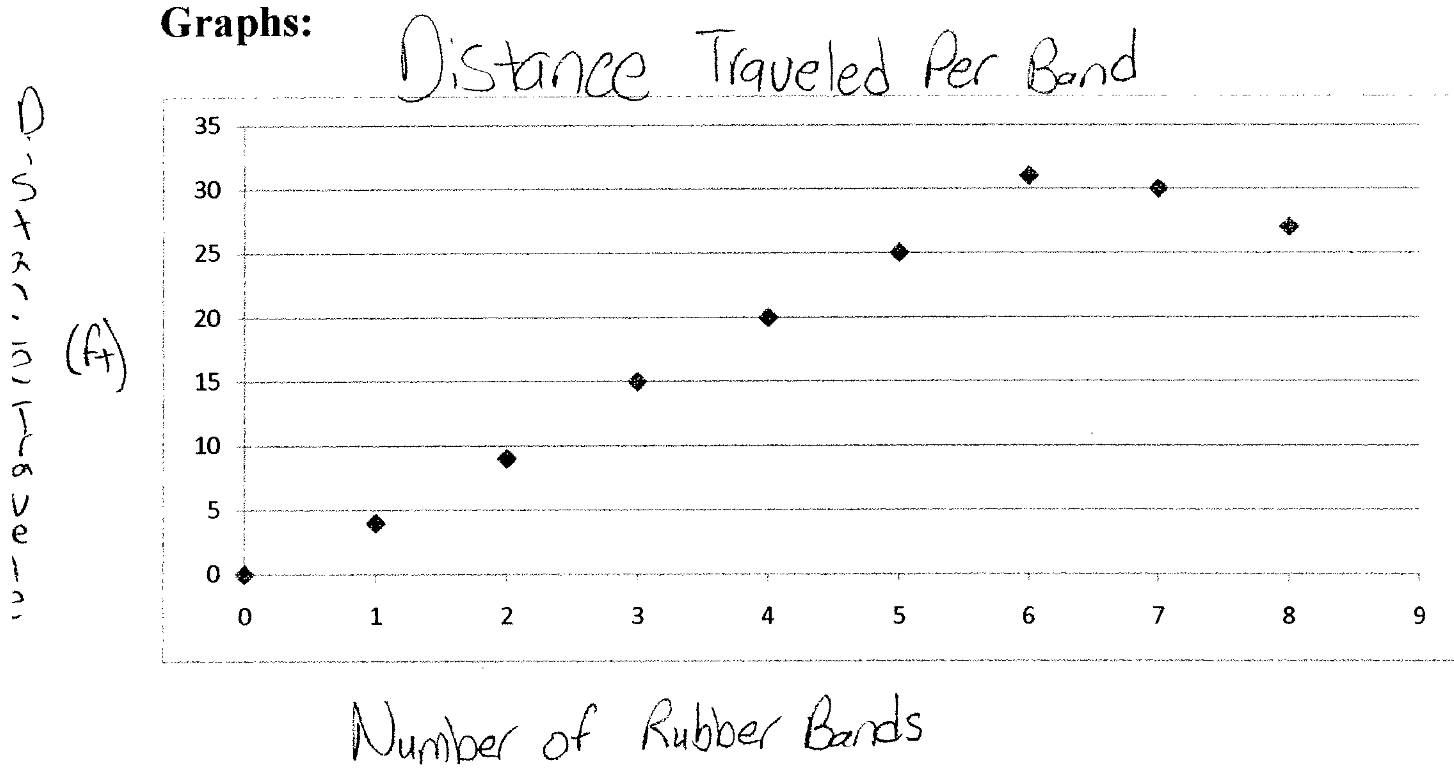
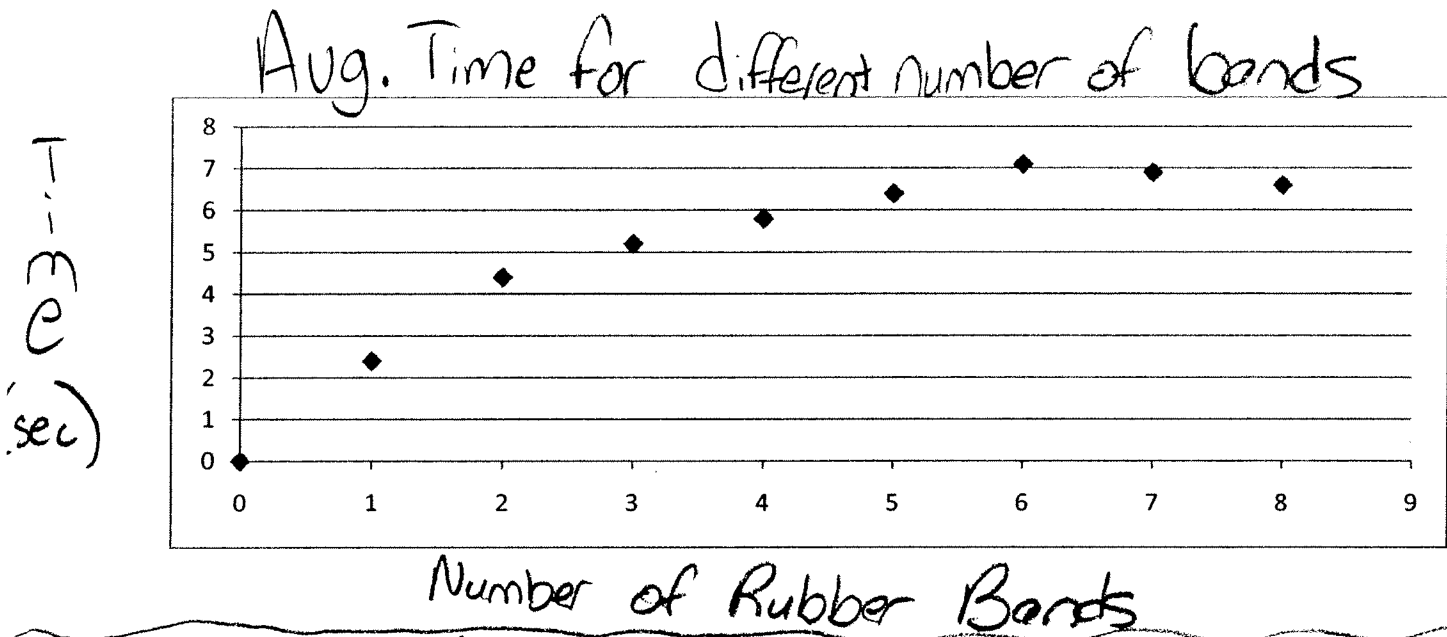
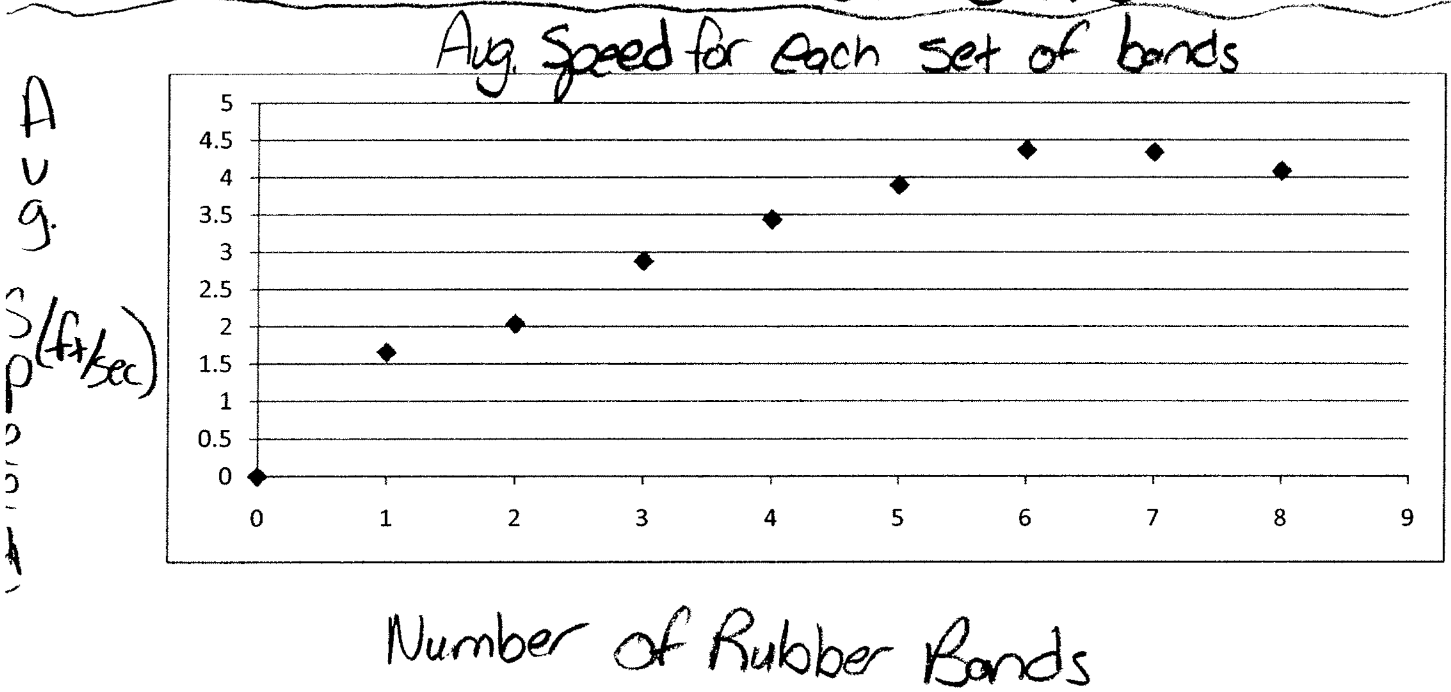
## Graphs:





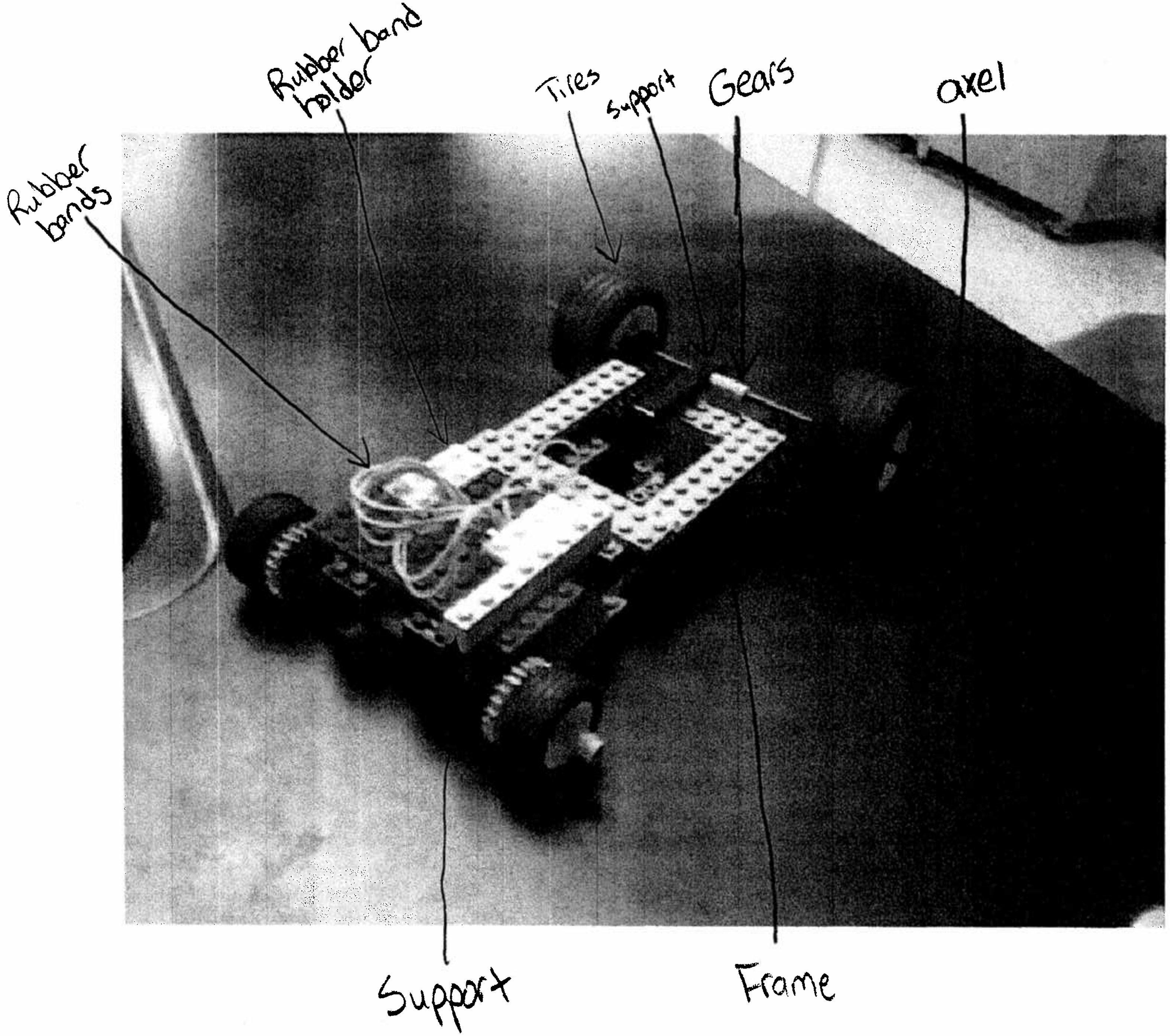

After making my adjustment I found that the number of bands still does affect the distance traveled by the car. With the bigger wheels it still travels farther with 6 rubber bands. The ratio is still greater with 6 bands also and it was 1:5.1.

## Conclusion:

For both of our cars the final result was that both of them ran more efficiently on 6 rubber bands. The car with larger wheels had a better ratio than the original car though. It had a ration of 1:5.1, while the original has 1:4.6. The car with bigger wheels had more traction and resulted in it being the more efficient car. Our hypothesis was correct in the fact that more rubber bands would make it most efficient, but we did not predict with more rubber bands than 6 that it would begin to lose efficiency. Some sources of error could be in some of the rounding of numbers along with the math. Also we tested on different days and had to test in several different spots. The rubber bands also were different on each test and could have affected it some. We could test all at once and the same spot to limit these sources of error. I would also like to test in the future if we add even more gears if we could increase the speed and distance traveled.

## Bibliography:

"Energy conversion efficiency". Wikipedia.
Wikipedia, Nov 29,2010. http://en.wikipedia.org/wiki/Energy_conversion_efficiency


Rubber bands
Rubber band holder
Tires
support
Gears
axel
Support
Frame

**12/08/10 Reflection Essay**

Factors affecting the energy efficiency of our car were the friction, amount of traction, weight, elasticity of the rubber bands, and many other small uncontrollable factors. Friction most likely played the biggest key role in this project because it was in direct contact with the car the entire time. It is what cause the car to stop moving once the rubber bands ran out and stopped turning the axel of the car. The elasticity changes also as we had to rotate the stretched out bands for new ones to keep it consistent. During this project we discovered that the acceleration of the car was the greatest right at the start of the track. We tested many different gears to see which one would benefit the car the most. We found out that the smaller gears were best for a great initial burst off the line with great acceleration. The bigger gears would give the car more distance but it would not accelerate very fast and once the bands ran out it wouldn't glide anymore. The small gears allowed for the velocity of the car to constantly increase until it ran out of rubber band and it than had so much momentum pushing it that it continued to glide for many more feet until friction stopped the car.

During the project my ideas didn't change much about energy efficiency because from the start I believed that the car that used the least amount of energy but at the same time increased the amount of energy going out. The types of strategies that helped my group out the most were testing all of the different designs that we could think of. We test tested three different gears separate and some at the same time working together. We tested different dimensions of the car and different amounts of rubber bands used. We tried front wheel and back wheel drive cars and different designs for the tires. Next time to improve the lab we could use strategies like looking up some different designs for the car and doing more research for it.

I learned many things when designing this vehicle like how traction can affect the distance the car travels. Also how the different size of the gears play a factor in speed and distance the car goes. I helped contribute to the team by helping come up with the design of the gears. I also helped be recording all the data from the test runs. The strengths of the team were that we all worked together but at the same time we all worked on separate tasks to make the process go faster. If anyone were to get stuck we would all come together to figure it out.

Interactions that could be improved are making sure we all listen to each other's ideas and let one another share them.

## Energy Efficiency of Cars

### Introduction

Sample B1

Theoretical Background:

Energy efficiency is percentage of total energy input to a machine or equipment that is consumed in useful work and not wasted as useless heat. It is a very popular topic in today's world. State and national government agencies, such as The U.S. Department of Energy, work hard every day to find ways to be more fuel efficient in every aspect of the world we live in. Creating a more energy efficient world to live in would lead to a cleaner environment, reduce foreign oil dependency, strengthen the economy, cut fuel costs, and improve the welfare of consumers.

The goal of becoming a more energy efficient world requires us, the people, to successfully establish our energy conservation. In today's society, people use oil, natural gas, and coal at high rates. Scientists predict that within the next 10-12 years, these resources could become very scarce. It is crucial that we find a way to reduce the use of fossil fuels and find a cleaner, longer-lasting process of powering the world we live in.

One major area that needs a lot of attention is the transportation industry. The transportation industry consumes 20% of the world's total energy. It is the automobile itself that is responsible for 90% of this energy use. In order to reduce the energy we use daily, we must first analyze and reduce the energy being used to power automobiles. If we could cut down the energy used for transportation, the world would have more energy and more recourses for generations to come.

Purpose:

The purpose of the lab is to find a way to make a home-made car, become maximum in its energy efficiency. We as students must show how certain variables either increase or decrease the energy efficiency of the car. My group plans to investigate how the weight of a given car factors into the energy efficiency of the car as a whole.

### Hypothesis

I hypothesize that if the weight of the car increases, the distance that the car travels with the same amount of energy will decrease. If you apply the same amount of energy to an object that has increasing weight, the object will eventually start to slow down and not travel as far.

### Experimental Design

To begin the experiment, our group plans to test how the weight of the car affects the distance the car travels, which will represent how efficiently the car uses energy under different amounts of weight. The independent variable will be the weight that is placed on the car, and the dependent variable will be the distance at which the car travels. The controls during the experiment will be the amount of energy used to push the car, the surface at which the car is tested on, and the structure of the car.

## Materials

For this experiment, the items needed are:

2 – 6in rectangular lengths of wood

2 – 3in rectangular lengths of wood

2 – 10in small-diameter cylinder lengths of wood

1 – Power drill

4 – Medium-size screws

2 – Small nails

4 – Plastic lids

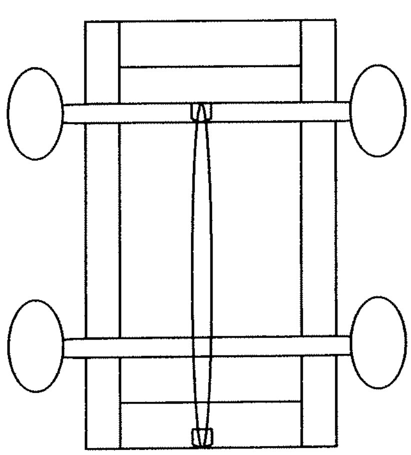
1 – Cardboard 2" x 4" cutout

1 – Hot glue gun and glue

1 - Hammer

Step One: Constructing the Car

To begin constructing your car, start by placing the two 6in rectangular lengths parallel to each other 3in away from one another. At each end of the lengths, place the 3in wood in between the two 6in wood. Next, using the power drill, screw each 6in lengths to the 3in lengths at their ends. Using the drill once again, drill two holes in each of the 6in lengths large enough to slide in your cylinder pieces as axels. Make sure that each set of holes are across from each other for the axels to be straight. Now that the frame is built, slide in the two cylinder pieces, one in each set of drilled holes. Cut holes into the plastic lids and slide them onto the cylinder pieces as wheels. Decide which part of the car you wish to be the "front" of your car. On the back 3in length, lightly nail in one of your small nails with a little less than half of the nail still sticking out of the wood. Then, do the same with the second small nail, except now nail the nail into the front cylindrical axel of your car. To finalize the construction of the car, use the hot glue gun to glue down the cardboard cutout onto the top of the front 3in length to use as the holder of the weights during the experiment.



*(Rough Image of the final product after constructing the experimental car)*

Step Two: Conducting the Experiment

To begin the experiment, place the car on a tile floor, aligned the front wheels with the "0 cm" marker of the meter sticks lied down in a row for easy measuring. The rubber band mechanism will then be wound up 3 times in a backwards motion around the cylinder rotator and released with the car firmly on the ground. The distance the car travels is measured in cm and recorded. This will be repeated for the weights of: 0g, 50g, 100g, 150g, 200g, 250g, 500g, and 1000g. We will conduct the experiment twice per set of weight to make sure our data is accurate and we will use the average to be used as our final distance.

**Safety Precautions**

- Be sure to have someone nearby while constructing the car.
- Use power drill and hammer wisely making sure to wear gloves and protective eyewear to protect hands and eyes from injury and flying objects
- Use gloves around the hot glue gun making sure to not touch the body of the hot glue gun, or glue as it comes out of the gun
- Be sure to have large enough floor space for your car to travel so that nothing is in the way of the car

## Data Collection, Calculation, and Graphs

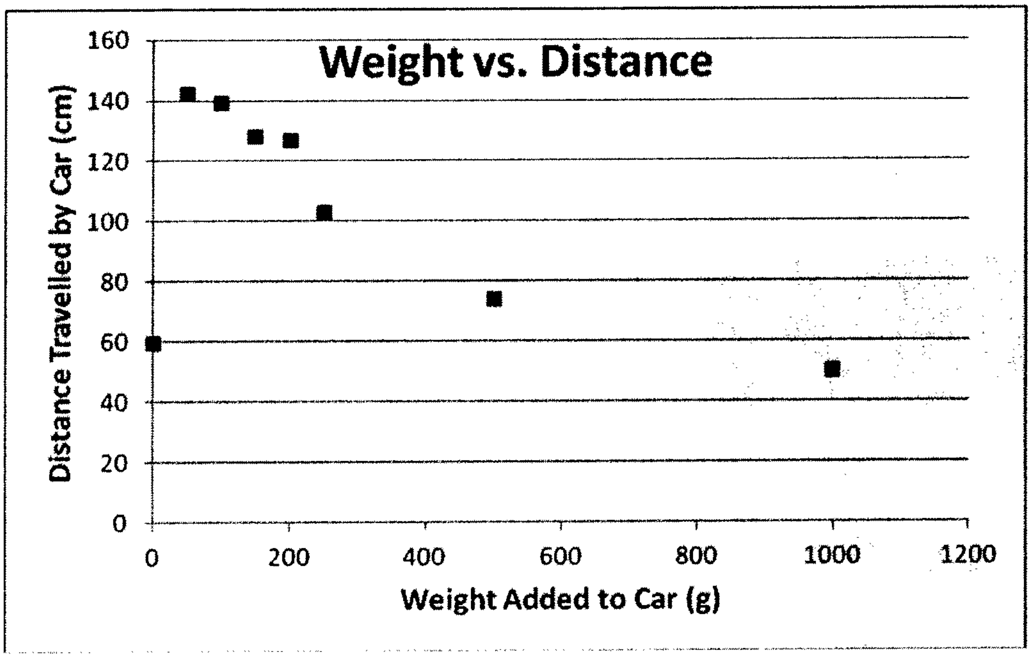
Chart:

| Weight vs. Distance Experiment Data | | | |
|---|---|---|---|
| Weight Added (g) | Distance (cm) | | |
| | Trial 1 | Trial 2 | Average |
| 0 | 56 | 63 | 60 |
| 50 | 137 | 147 | 142 |
| 100 | 141 | 137 | 139 |
| 150 | 129 | 127 | 128 |
| 200 | 129 | 125 | 127 |
| 250 | 100 | 106 | 103 |
| 500 | 70 | 78 | 74 |
| 1000 | 49 | 51 | 50 |

Calculations:

1. (56+63)/2 = 60
2. (137+147)/2 = 142
3. (141+137)/2 = 139
4. (129+127)/2 = 128
5. (129+125)/2 = 127
6. (100+106)/2 = 103
7. (70+78)/2 = 74
8. (49+51) = 50

Graph:




## Analysis and Interpretation of Data

Our findings from our data show that the weight has a negative linear relationship with the distance travelled. From our findings you can see that as the weight of the car increases, the distance travelled by the car decreased. It is clearly shown in our graph that the points have a linear correlation rather than exponential. The point (0, 60) could have very well been a direct result of not enough friction between our car's wheels and the surface of the floor. The lab and the results show that it takes more energy to move objects of heavier weight. It can also be said as, as the amount of force remains the same and the weight of the car increases, distance travelled by the car decreases.

## Conclusions

After conducting this experiment, it has been discovered that as the weight of a given car increases, the distance traveled under the same amount of forces decreases. This indeed does prove my hypothesis of "I hypothesize that if the weight of the car increases, the distance that the car travels with the same amount of energy will decrease" to be true. An explanation of these results can easily be explained in the statement that: as a weight increases and the forces stay the same, the distance traveled will decrease.

In this experiment, the sources of error could be: the lack of accurate distance measuring, problems with the car, and the lack of friction between the tires of the car and the surface in our first test run; which was when there was no weight added to the car.

These results can be used for real world problems we are assigned to try and solve. With the data we have gathered, scientists can see that more energy is conserved when there is less mass to move. If scientists were looking to make a more energy efficient car, they would need to construct a lighter automobile. The only downfall to this implication would be that the new lighter cars would still need to maintain safety regulations and be safe for the customers to drive. The problems that could occur with a lighter automobile could be that it would not get enough traction while driving, and if it were to encounter another object, it would not be a hefty as a heavier automobile.

During our experiment, our group figured that another important point of interest that may need investigated is the wheels of the car. How would the size of the wheels on a car affect how energy efficient the car is? This could easily be investigated in further research. The only thing you would change on the car is the size of the wheels. You would have the variables being the size of the wheel (independent variable) and the distance the car travels (dependent variable). There are many aspects of the car and energy being used that can be investigated to make a more energy efficient world. All of these aspects need to be investigated if we ever hope to have a world of self reliance for oil dependency and not worrying about running out of fossil fuel. These different investigations can be conducted by anyone as long as they try to keep things the same throughout the entire experiment.

http://www.businessdictionary.com/definition/energy-efficiency.html

Sample C1

# Energy Efficient Car

**Introduction** Natural Resources are being used up around the world very quickly. Research has shown that the natural resources being used by humans will only last 10-12 years more if we keep at the same rate of consumption. For this reason is why scientists and engineers are looking for ways to create energy efficient vehicles. We were to research energy efficiency, and use that research to create an energy efficient vehicle that would run on rubber bands.

This experiment is being used to find out if rubber bands can be used as an energy efficient method for vehicles. The vehicle created will run on rubber bands, and data will be recorded for the distance it travels with different amounts of rubber bands used at one time. The amount of rubber bands, the distance it travels with that amount of rubber bands, the time it takes to travel, and the weight of the car in the trial will all be recorded in the experiment.

Energy efficiency is the goal of efforts to reduce the amount of energy required to provide products and services. Reducing energy use reduces energy costs and may result in consumers saving money from conservation of energy, if they use energy conservation technology.

**Purpose** Energy Efficiency is becoming a major concern around the world, so in this experiment we were to find the most efficient way of energy to power a vehicle. We used rubber bands as the source of energy to operate the vehicle, which was made of Lego pieces. We had many trials and a different amount of rubber bands were used each time and the results were recorded.

**Hypothesis** I think that in this experiment we will find that we can use rubber bands to power the car, but it will not be enough to keep the car in motion/moving. I believe that the larger wheels we will use to change the experiment will have the greatest effect or go the longer distance in the trials.

**Experimental Design** In our experiment, we will use different amounts of rubber bands and record the amount used and also the distance the vehicle went and the time it took to go that far. The dependent variables were distance traveled and speed. The independent variables were the number of rubber bands used, and the weight of the car.

| | | | |
|---|---|---|---|
| **Materials** | Lego car | Rubber Bands | Stop Watch |
| | 2 sizes of Lego wheels | Yard Stick | Weight Scale |

**Procedure** The first step in the experiment was to create a car that could be run by rubber bands. The car my group created was made from Lego pieces. Two different sizes of wheels were used to change the experiment and see which would work better. We first used a set of wheels that were very wide, much like drag racing wheels. We put a set amount of rubber bands on the car and then put the rubber band on a gear on the axel, and turned the axel backwards to wind up the rubber bands. Then we put the car in a starting spot that was set and let the rubber bands unwind and make the car move forward. We recorded the distance traveled by the car and how long it took to go that distance. The amounts of rubber bands were changed and then the distance traveled and time for that amount of rubber bands was recorded. Eight rubber bands was the maximum amount of rubber bands used in the experiment because the distance started to decrease after around 6 rubber bands. After recording distances and times from one to eight rubber bands, we changed the wheels on the rear axel to a set of wheels that had larger rims but a much narrower tire. The eight trials were run with the larger wheels and all the data was recorded.

**Data**

Drag Racing Wheels

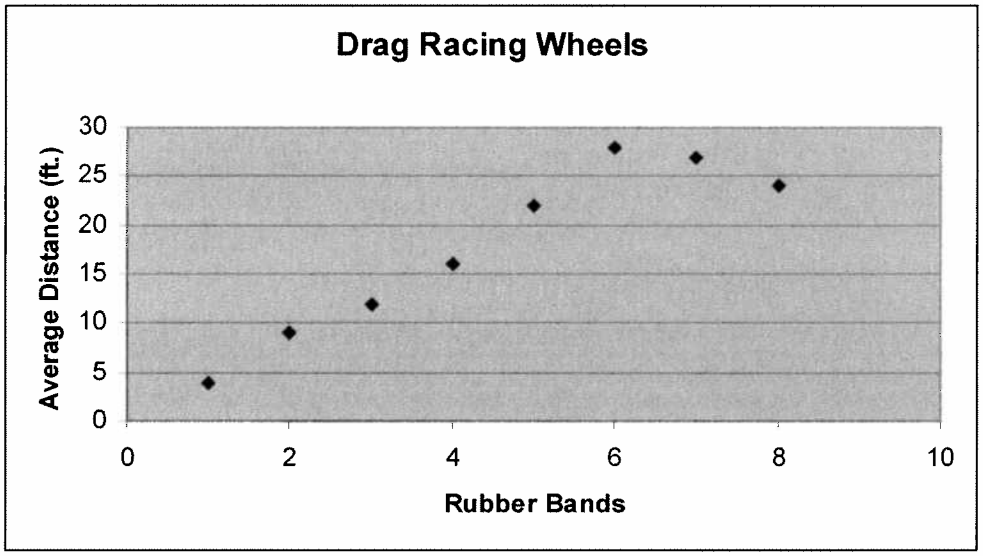
| **Rubber Bands** | **Average Distance (ft.)** | **Ratio (Band: Distance)** | **Time (sec)** | **Average Speed (ft/ sec)** | **Weight (g)** |
|---|---|---|---|---|---|
| **1** | **4** | **1:4** | **2.1** | **1.9** | **336** |
| **2** | **9** | **1:4.5** | **4.25** | **2.12** | **336** |
| **3** | **12** | **1:4** | **4.9** | **2.45** | **336** |
| **4** | **16** | **1:4** | **5.6** | **2.86** | **337** |
| **5** | **22** | **1:4.4** | **6.2** | **3.55** | **337** |
| **6** | **28** | **1:4.7** | **6.9** | **4.06** | **337** |
| **7** | **27** | **1:3.9** | **6.8** | **3.97** | **338** |
| **8** | **24** | **1:3** | **6.3** | **3.81** | **338** |

Bigger Wheels

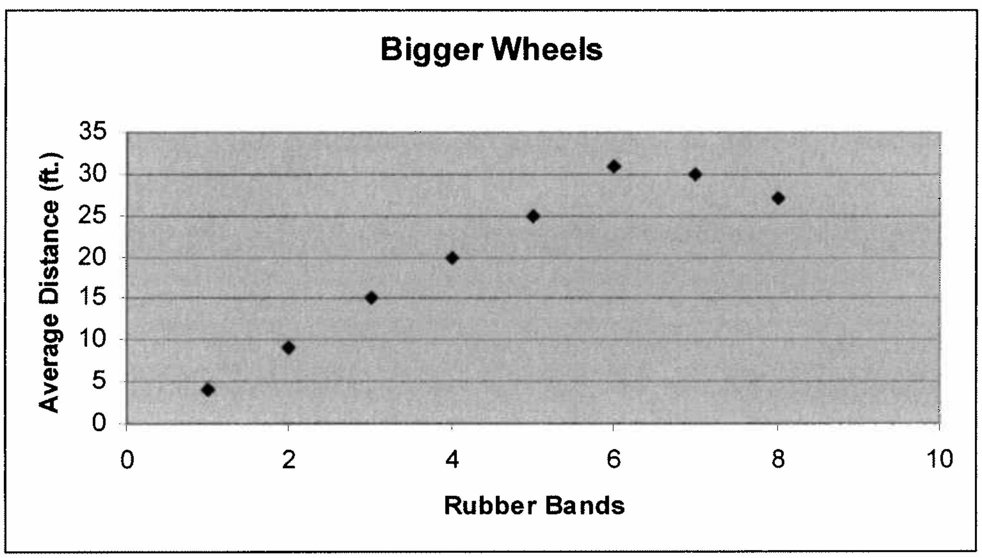
| **Rubber Bands** | **Average Distance (ft.)** | **Ratio (Band: Distance)** | **Time (sec)** | **Average Speed (ft/ sec)** | **Weight (g)** |
|---|---|---|---|---|---|
| **1** | **4** | **1:4** | **2.4** | **1.67** | **464** |
| **2** | **9** | **1:4.5** | **4.4** | **2.05** | **464** |
| **3** | **15** | **1:5** | **5.2** | **2.88** | **464** |
| **4** | **20** | **1:5** | **5.8** | **3.45** | **465** |
| **5** | **25** | **1:5** | **6.4** | **3.91** | **465** |
| **6** | **31** | **1:5.2** | **7.1** | **4.37** | **465** |
| **7** | **30** | **1:4.3** | **6.9** | **4.35** | **466** |
| **8** | **27** | **1:3.4** | **6.6** | **4.09** | **466** |

**Distance vs. Rubber Bands Graphs**

Drag Racing Wheels

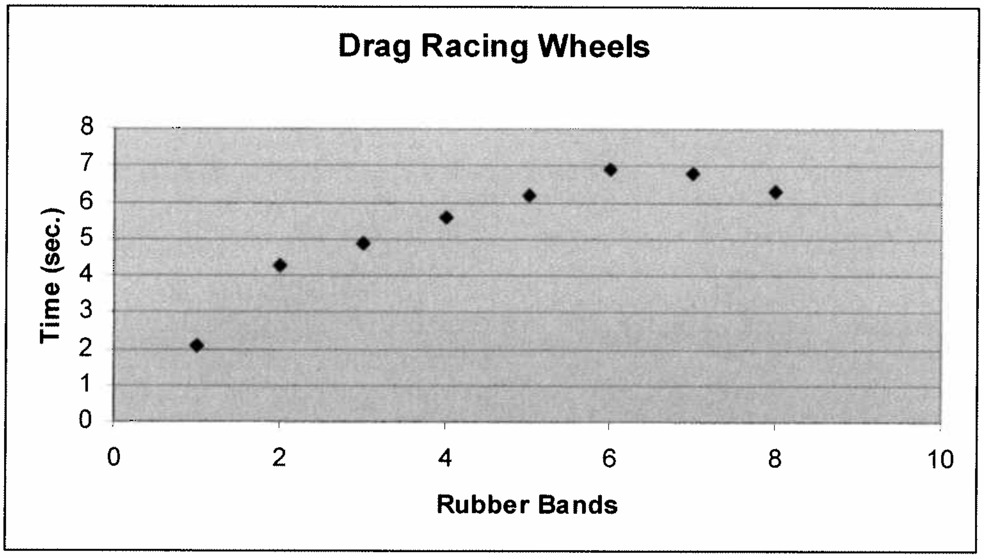



Bigger Wheels

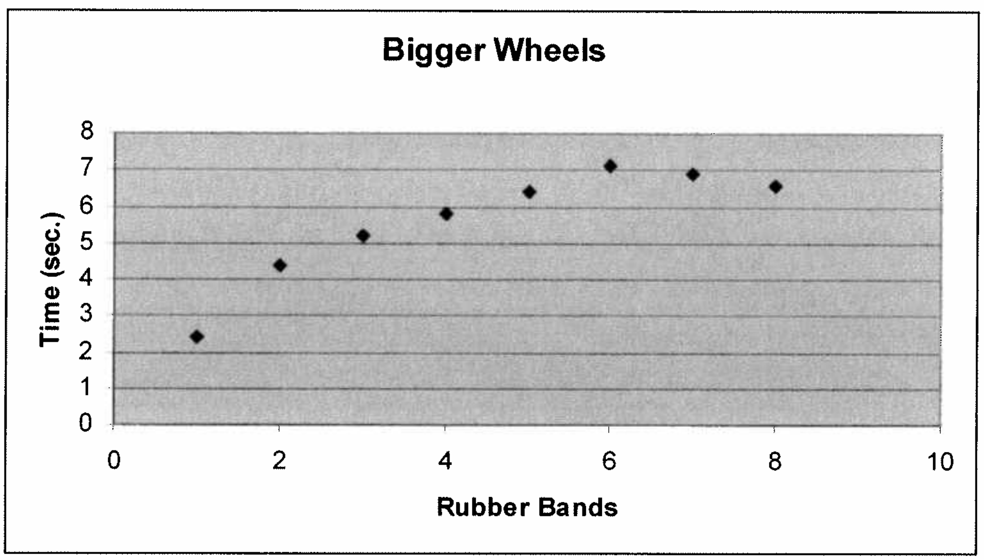


**Time vs. Rubber Bands Graphs**

Drag Racing Wheels

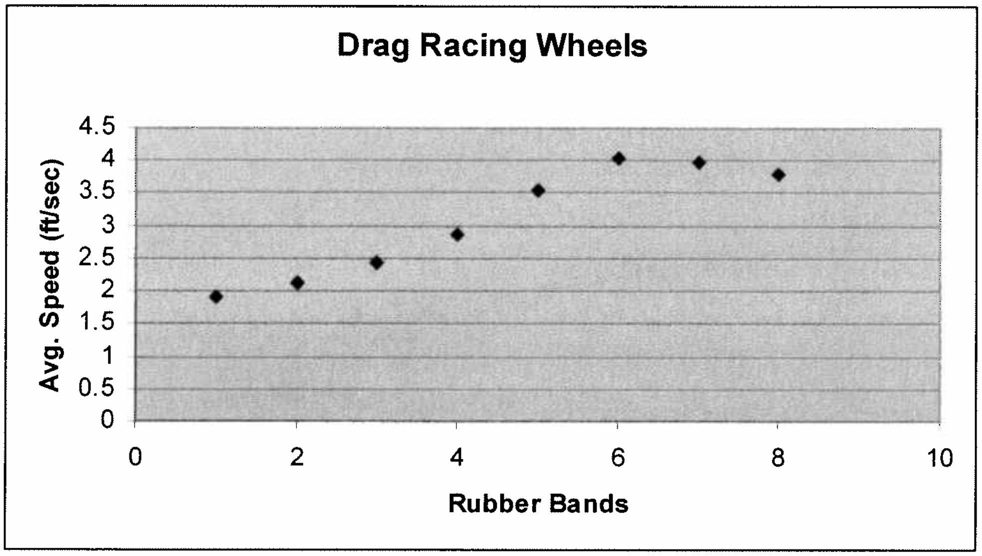



Bigger Wheels

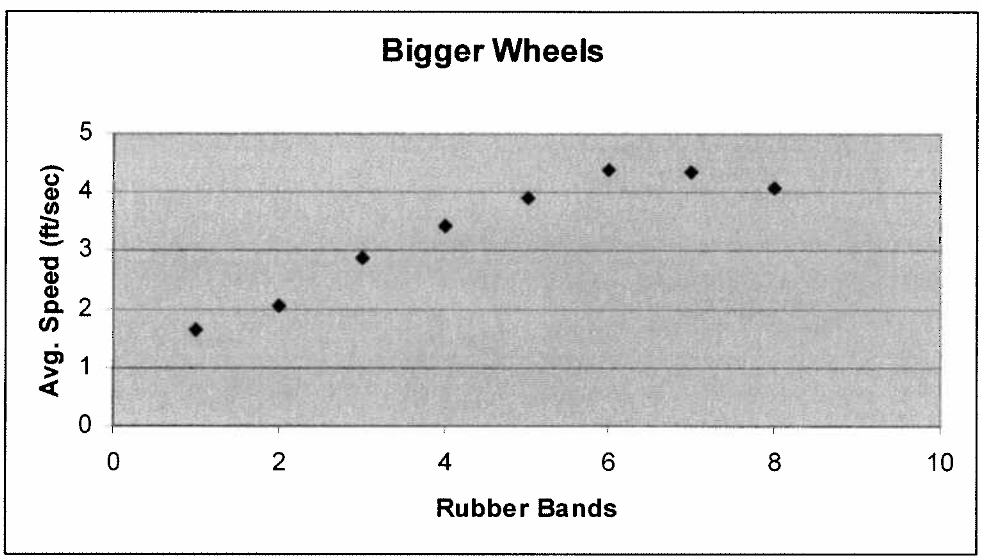


**Average Speed vs. Rubber Bands**

Drag Racing Wheels




Bigger Wheels




The average distance in this experiment was found by dividing the average distance the car traveled, by the time it took to travel that distance.

Ex. 4 ft / 2.4 sec = 1.67 ft/sec

Ex. 25 ft / 6.4 sec = 3.91 ft/sec

Average Distance (ft) / Time (sec) = Average Speed (ft/sec)

**Analysis and Interpretation** All of the graphs show that for average speed, time, and distance vs. the rubber bands, all of those factors increase with the more rubber bands put on the car. The factors increase until six rubber bands are put onto the car. With six rubber bands on the car is when the car peaks on average distance, time, and average speed, but when more rubber bands than six were put on the car then all of the factors began to decrease compared to six rubber bands.

My hypothesis was correct for both parts. I thought that the rubber bands would not be able to keep the car in motion, because there is no continuous force acting on the car to keep it moving after the rubber bands have been unwound. I also believed that the bigger wheels would go a greater distance and have a greater time than the drag racing wheels. My group did discover that rubber bands are an energy efficient way to power a car and will work to put a car in motion, but will not keep the car moving.

**Conclusion** In this experiment, my group and I found that rubber bands are a useful method of energy efficiency. The rubber bands put the car into motion without any forms of natural resources, but when the rubber bands unwound there was no force acting on the car to keep it moving forward. So rolling friction caused the car to eventually come to a stop.

The experiment was began by using one rubber band on the car to move it, then more were applied after every recording and those results ere recorded. Every added rubber band to the car increased the distance that the car traveled and the time it traveled. Although six rubber bands was the peak at which the distance and time was the highest, when more than six rubber bands were put on the car then the distance and time began to decrease with every added rubber band.

Possible sources of error in this experiment could be the timing of how long the car traveled. Most reaction times of humans are not exact in every measurement, so to solve this problem a computer or motion detector could be used to get an accurate reading.

# Bibliography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