

Mousetrap Lightweight Car Vs. The Rattrap Powerhouse Car

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Practical Applications of Advanced Math

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### Abstract

Mousetrap cars are simple cars that use a mousetrap to pull a string that moves an axle which makes the car move. These cars can range from the simplest designs to some very complex designs. Factors that can improve distance or speed of the cars include, the mass, the length of the lever arm, and the axle to wheel ratio. The testing allowed for the fewest amount of test while still having enough to be accurate, because since a rat or mousetrap is supposed to be thrown away after one use they break after about eight or nine uses therefore the testing had to be short. The results proved the research question by showing that the rattrap was far more effective for the car that was used, which was heavier than originally planned. The rattrap car had much better results, it had higher averages in each category, for distance it averaged 15.44 feet, for speed it averaged 3.2911 feet per second. Comparatively the mousetrap averaged 12.35 feet, and 2.0467 feet per second. After the car was not as good as planned, a decision was made to make another car with better materials, which was done and then tested the new car. Unfortunately the lever broke after four trials with the rattrap. The results from the second test actually differed from the first test. The rattrap continued its dominance with speed however the mousetrap outperformed the rattrap in the distance category. The rattrap averaged 18.6875 feet per trial and 4.1963 feet per second, while the mousetrap averaged 25.5 feet per trial and 2.0771 feet per second.

### Background

Mouse and rat trap cars use the kinetic power of a mouse or rat trap to move a car across a distance. The main parts of the car are a mouse trap or rat trap, wheels, axles, string, and the lever. To make the mouse or rat trap car move, it must have a string tied to the mouse or rat trap and also have string tied to the rear axle and lever (attached to the mouse or rat trap). The trap must then be set and the string must be completely wound around the back axle until it becomes taut. Finally, the trap is set off with some type of material that allows for a person not to actually touch the trap so there is no risk of injury. By setting off the trap the trap pulls forward, which pulls the string that is attached to the back axle engaging the wheels, which then in turn causes the car to move forward (Regio, Rio, 2009).

The basics of the propulsion of the car are similar in every car as is the need for a base of some kind. The base is used to attach the wheel axles and the wheels. One of the best bases to use for a mouse or rat trap car would be a piece of wood. The wood should be sturdy enough to support its attachments and light enough not to stress the car, a great base is a piece of balsa wood, which is light weight but yet still holds under the pressures of the car. Overall, any light type of material should work well. Also, the rat trap itself could be used for the base of a rat trap car. The rat trap is strong enough to support its axles. However this does limit the best possible size of an additional lever arm.

The wheels of a mouse or rat trap car are important when making the car. One of the most common form of wheels used in making the mouse or rat trap car are CD's. CD's are perfectly round and already have holes in the center of it for the wheel axles to enter. There are many materials that could be used for the wheels and a great example is plastic paint can lids. The design of a mouse or rat trap cars differs greatly. There is no set design for a car. The basic design for a mouse or rat trap car is having four wheels and two axles that are directly attached to the base of a car. The design for a car does not

matter as much as far as painting or adding aesthetic benefits to your mouse or rat trap car (Benac, Erin, n.d.).

In addition, the lever arm of a mouse or rat trap car mainly decides the distance the car goes. Distance is one of the important variables that are being tested when you compete with mouse or rat trap cars. Greater distance can be achieved by having a longer length lever arm (Koches, Robert, n.d.). An important piece of information about the lever is that it should not extend past the rear axle because you may not have enough torque through the entire distance to keep the car moving. The ideal length of the lever is long enough for it to be even with the axle. Another important variable that is usually being tested is the speed of a mouse or rat trap car.

Greater speed can be achieved by using a shorter length lever arm (Koches, Robert, n.d.). This is because in a long lever arm, the power of the trap is spread out over time because the lever decreases the power output and the pulling force, but it causes the arm to pull for a longer time causing the car to move further. The design of a mouse or rat trap car is vital when it comes down to performance. Unfortunately a car that is good at distance usually cannot compete with the fast vehicles seeing that to improve one's speed, the improvements actually might hurt the car's distance capability. Building mouse or rat trap cars is a somewhat popular activity that is done in physic classes because it teaches the concept of force (Kuhl, Bill, n.d.). The formula for force is mass times acceleration ( $F = ma$ ) and in this case it helps determine the speed and distance of a mouse or rat trap vehicle (Jones, Andrew, n.d.). The question that is hard to answer deals with the power of the rat trap car and the lightweight mousetrap car. This is why there are many competitions between these two types of cars.

### Research Question

Does the increased power of a rattrap outperform the smaller mousetrap even though the rattrap weighs more?

### Method

Our experiment was taking one car and attaching a mousetrap and then a rattrap to the car and comparing the distance and speeds that each provided. To make this a legitimate experiment we designed our car to be lightweight in order for the mass difference of the rattrap to come into play. Otherwise the rattrap car would be far more effective since it is much bigger and has much bigger springs therefore the rattrap could move a heavier object. The goal of our design was that the difference in the mass of the rattrap and mousetrap basically doubles the weight of the car. If we designed a heavier car then the added mass of the rattrap would not be quite as important since the difference in the rattrap and mousetrap would become insignificant at that point causing the rattraps increased power to win out. Our design is also based on the winning design from our class project competition that was held that Sruti Pisharody and Sarah White won. Our wheels were the plastic tops of paint cans and the container for electrical tape. Unfortunately these materials did not work out and we had to improvise and use the wheels from the car that we first made during the first week of Summer Ventures. Unfortunately these wheels were heavier than the plan, therefore they placed an extra burden on the car. The axles which were quarter inch dowels are connected to the wheels by epoxy and electrical tape. Our axles were connected to the car by eyehooks that are connected directly to the base of the car because we wanted to reduce the friction between the string and the base of the car. We also attached a dowel to the hammer of the trap. This increases the amount of string that is pulled by the trap as it snaps forward. This also spreads out the power of the trap rather than expending all of the energy in under a second which would cause the car to shoot forward, but the car would stop accelerating quickly and would be coasting rather than using the power spread over time making the car more efficient. Once we had built our car we did five trials with a mousetrap attached and five trials with a rattrap, we chose this number because a trap is supposed to only be used once or twice and then thrown out and therefore are not made for durability. We used the five trials for both the speed and

distance runs. We did this by timing the car from its stopped position until it stopped moving. Then we measured the distance from the starting point to the end point, which was from the starting line to the furthest point forward part of the car. For the speed we would take the distance traveled by the car and then divide it by the time that the car moved to find the feet per second for the car. Then we averaged them and compared the two. Our limitations were that the supplies were not ideal in that the all four of the original wheels had to be scrapped because they were too unstable. This caused for lots of improvising which hurt our results. We also were limited by time which made us have to use different materials, especially for our wheels which are by far the weakest part of the car. After we had finished the original set of trials we decided that we should redo the car and get a second set of results because of the issues with the wheels. We then built a second car that was very similar, but had better wheels, which were plastic lids for paint cans and electrical tape containers to make the car lighter like originally planned.

### Results

The original test for the method lead to one clear conclusion, which was the rattrap was much superior to the mousetrap. The rattrap was faster and had more distance power it averaged a speed of 3.2911 feet per second compared to the 2.0467 feet per second of the mousetrap. The rattrap also averaged 15.44 feet while the mousetrap averaged 12.35 feet per trial. However, after the ordeal with the wheels not working out and then being replaced, it was decided that a second car should be built from better materials. This second car lead to more interesting and probably better results, the rattrap won in the speed contest with an average of 4.1963 feet per second compared to the 2.0771 feet per second of the mousetrap. However the mousetrap was better at the distance portion averaging 25.5 feet per trial while the rat trap just averaged 18.6875 feet.

Mousetrap Car #1 Test	Distance (ft)	Time (s)	Speed (ft/s)
1	12.3333	6.05	2.0386
2	11.4167	4.19	2.7247
3	14.00	5.49	2.5501
4	11.4167	8.03	1.4218
5	12.5833	6.41	1.9631
Sum	61.75	30.17	
Average	12.35	6.034	2.0467

Rattrap Car #1 Test	Distance (ft)	Time (s)	Speed (ft/s)
1	18.4167	6.52	2.8246
2	13.8333	4.09	3.3822
3	18.1667	4.24	4.2846
4	19.7917	4.57	4.3308
5	9	4.04	2.2277
Sum	77.2083	23.46	
Average	15.44 ft	4.692	3.2911

Mousetrap Car #2 Test	Distance (ft)	Time (s)	Speed (ft/s)
1	24.8333	13.2	1.8813
2	25.1666	10.04	2.5066
3	25.9167	11.14	2.3265
4	26.0833	10.09	1.594
Sum	102	44.47	
Average	25.5	11.1175	2.0771

Rattrap Car #2 Test	Distance (ft)	Time (s)	Speed (ft/s)
1	13.25	3.53	3.7535
2	18.3333	6.61	2.7736
3	22.0833	3.97	5.5625
4	21.0833	4.49	4.6956
Sum	74.7499	18.6	
Average	18.6875	4.65	4.1963

### Conclusion

The rat trap car outperformed the mousetrap car because it went faster in both tests and farther in the first. The rat trap had more power than the mousetrap. The average distance with the first

car for the mousetrap car is 12.35ft while the rattrap car's average distance is 15.44ft. Also, the average speed for the mousetrap car is 2.0467ft/s and the rattrap car's average speed is 3.2911ft/s. The rat trap car and mousetrap car were made the exact same way, but to test both traps we just took one of them off and then put the other one back on. In addition, we were testing one vehicle, but different traps were being tested on it. If time were not an issue, we would try to make our rat/mousetrap car better by making it more lightweight so the mousetrap would have a better chance. One of the important parts of our car that we would definitely fix if we had more time would be the car's wheels (front and rear) which we were able to for the second car. The rat/mousetrap car's wheels were not sturdy enough. At some points, the car would hit something or slow down because the rear wheels would turn slightly. If our limitations were not an issue, we would have made a lighter car out of better materials. At one point, our front and rear wheels broke, and we had to replace them with the wheels we had used during the project we had done in class, which were heavier. In addition, we built one more rat/mousetrap car to test the wheels we had preferred from the beginning. Instead of having five trials for both traps, we could only do four trials each because our lever broke while we were testing our rattrap car, but we were still able to use the other half of the lever. For the second car we made, the rattrap car was much faster than the mousetrap car, but the mousetrap car went a farther distance. The average speed the rattrap car went was 4.1963ft/s and the mousetrap car's average speed was 2.0771ft/s. The average distance the rattap car went was 18.6875ft and the average distance the mousetrap car went was 25.5ft.

If we had had more time we would have hopefully looked further into the the actual force of each the mousetrap and the rattrap. The force of the rat/mousetrap car tells us the mass times the acceleration. This would add more information and help to back up our results.



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