BRAD & TIFFANIE'S

Guide to Mousetrap Cars

Mousetrap Car Module

ENGINEERING & TECHNOLOGY EDUCATION

Mouse Trap Car Introduction

For this module the students will design and build mouse trap cars, test them and do calculations of speed, acceleration, and distance. Only the mousetrap provided can be used to power the cars, absolutely no other propulsion method should be used including rubber bands. Mousetraps are used to power the vehicles by attaching a string to the arm of the trap and then wound around the axel. Experimenting with size and length of all parts on the vehicle should be encouraged. There will be two measured competitions, speed and distance, and at the end there will also be a competition on the class's favorite car judged by an anonymous vote. The vehicle must function correctly to win the unique competition. After the competitions, calculations will be made for speed, acceleration, and distance.

This module is broken up into four sections. Section 1, explain principals of speed and acceleration and their effect on the distance the car will travel. After students have a basic understanding of these principals, project proposal for the mousetrap cars will be given. There will be a contest for speed and distance. Everyone will use a standard supplied mousetrap, nothing else including rubber bands, to power their car. A unique car will be designed and built from almost anything imaginable. Wood dowel for the axles will be supplied. Students will be encouraged to bring supplies from home. Section 2, there will be time for construction and experimentation of the mousetrap cars. Documentation will be required of all ideas in their engineering journal. Section 3, there will be time and distance trials and instruction on how to do calculations for the mousetrap cars. There will also be discussion on how they could make their cars go further and go faster. Section 4, time should be allowed to make improvements and do non-competitive time trials, and finish up their documentation and written report.

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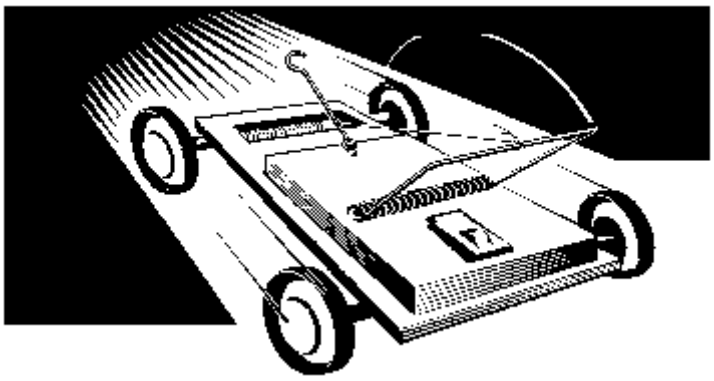
Mouse Trap Challenge

Specific Aims/ Problem Statement

Your classroom is sponsoring a competition for the fastest, farthest, and most unique vehicle ran by a simple mouse trap. They are even providing the mouse trap for you! Your mission is to figure out the best, most efficient way to design such a con**trap**tion. Only the mouse trap provided can be used to power your cars… and yes, using rubber bands is cheating! To use a mouse trap to power your vehicle, attach a string to the arm of the trap and wind the other end around the axel of your wheels. Experiment with size and length of all parts of your vehicle.



Competitions will be held ____(date)_____ . There will be two separate measured competitions, speed and distance. At the end of class your vehicle will be set on display for class to vote on the most unique. Note: your vehicle must function correctly to win the unique competition.

You will be required to keep track of everything you do in class. You can record this is your engineering journal. This is to prove that you did your own work. You will also be required to do a little bit of research about mouse trap cars.

After competitions calculations will be made for speed, acceleration, and distance. Good luck! Everything you need to know you can find in the scenario.

Scenario

This scenario is a guide to tell you everything you will need to know to do this project on mouse trap cars. You will choose a partner to form a building team or work on your own.

Engineering Journal

Your engineering journal should be a record of everything you do on the project. **Refer to your assessment paper to get a more visual list of the required components.** The very first page should be a table of contents. Everyday you are in class you should date and number the top of a blank page and include everything you do in it. This includes, but not limited to, your brainstorming, sketches, modifications, and records of trials and materials. At the end of the day you and your partner should initial your entry (if you are working without a partner have the instructor initial) indicating that everything is your own work and that it was done on that day. Before you start your project and your daily entries you will be required to do research on mouse trap cars. The research can be internet based and is put in place in order to get some good ideas on how to build your car. Cite at least three sources and include a summary of the key points. Once you have completed your car you will be required to write a conclusion section in your journal. The conclusion needs to include a list of materials, design changes, observations and conclusions, and a final sketch. Questions to address in your observations and conclusions include: What problems did your car experience? What can be done to improve your mousetrap car's performance? What problems did your car experience? What can be done to improve your mousetrap car's performance? Make sure to also include other important observations and conclusions you may come up with. The final sketch should be done on graph paper or a cad program.

Building the Car

The basic idea is to build a car that is propelled by attaching a string to a mouse trap and wrapping the other end around an axel so that when the mouse trap is triggered it will pull the string spinning the axel.

Your instructor will provide the following:

- balsa wood or equivalent
- cardboard
- razor blade
- CDs (for wheels)
- rubber stoppers that fit snugly in the center of the CDs
- metal rods that fit snugly through the rubber stoppers for axels
- safety glasses
- string

- mouse traps
- hot glue gun
- wire cutters (to cut lever on the mouse trap)
- stiff wire (like a clothes hanger)
- graph paper
- and a portable electric drill (the teacher may choose not to let students use this directly).
- Anything else you wish to use you will have to provide unless indicated by your instructor.

A basic design for your car would be to drill holes into balsa wood slightly bigger than the size of your axel, and glue the mouse trap to the balsa wood. Attach string to the mouse trap lever arm and wrap the other end around one axel. Attach your wheels to the axels and voila you have a simple mouse trap car. Feel free to modify this design.

There are key ingredients to make the mouse traps the best. All good engineers solve their problems with the end in mind. In this situation the end of the experiment is the kind of race you want the car to excel in. There will be two measured competitions, one is a speed competition, and the other is a distance competition. Modifying the length of the lever arm on the mouse trap will greatly change the performance of the vehicle. If you want distance lengthen the lever arm, but if you want to win the speed race a short lever arm is the way to go. If you are modifying the lever arm to make it longer, keep in mind that it must stay rigid. Cutting coat hangers and then soldering them to the mousetrap is and efficient way of doing this. If the arm bends while it is in action, then energy will be taken from your outcome. Also, wheel size will affect the race. The larger your wheels are, the more distance will be traveled, but at the cost of speed.

Wheels for mouse trap cars are often hard to find. A common wheel to use for the cars is CDs. CDs are convenient because they are easy to find. CDs however have a large hole in the middle. The best way to solve that problem is by putting rubber stoppers in the CD. If you are using metal axels you can attach the axel to copper or brass tubing, as long as you use lubrication (like machine oil).

Getting the right string can be important. Fishing line works, but only for a couple of runs. Thread for sewing buttons onto coats is good. It is tough to break, and cheap to buy. Most likely whatever your instructor provides will be fine, but you may also provide your own.

Testing the car is extremely important; make sure the mousetrap is disarmed at all times until its ready to test. Testing can get a lot of the bugs out of a car. For example, one of the hardest things with mousetrap cars is steering, going straight doesn't happen without any effort. For speed cars you will want to find the best length for your lever arm; the peak speed should reach about 3/4ths of the track, and then the car can coast the rest of the way.

Measured Competitions

On competition day your car will do three trial runs for each measured competition. This way you will get a good average of your car's capabilities. After your competitions take time to figure out and experiment with what you can do to improve your car.

The distance competition is a little easier to do. Release your car at the starting line and record the distance it travels perpendicular to the starting point. You will run three distance trials to find an average distance your car runs. A good distance mouse trap car will run 20 to 30 feet. The record at Longwood JHS is seventy-nine feet. There are also rumors of cars running up into hundreds of feet.

The speed competition is based on the time it takes your car to travel five feet. When timing your car one person will start two stopwatches simultaneously as soon as the car is released. The first stopwatch should stop and record the time to travel five feet and the second stopwatch should stop and record the time to travel ten feet. The ten feet measurement is not part of the speed competition, but simply used to calculate acceleration on the worksheet.

The last day of competitions all cars will be set on display. All students will pick a favorite car, write it on a piece of paper, and submit it to the teacher. Your instructor will tally up the votes and announce the winner (who will receive 10 bonus points).

Calculations

You will be provided a worksheet to record your measurements and do calculations. The first section on the worksheet is the distance table; simply record the distance your car runs over three trials. The second section on the worksheet is your first speed table. Simply record the time your car travels over 5 feet for three trials. Then Calculate your speed on each trial by using the formula Speed = Distance(5ft)/Time. The average speed is calculated by adding your three speeds and dividing by three.

e.g.

	Total Distance
Trial 1	26.5 ft
Trial 2	30 ft
Trial 3	29.8 ft

	Distance	Time	Calculated Speed
Trial 1	5 ft	1.1 s	4.5 ft/s
Trial 2	5 ft	1.1 s	4.5 ft/s
Trial 3	5 ft	1.2 s	4.2 ft/s
		Average Speed:	4.4 ft/s

The third section of your worksheet is probably the hardest. In the time column record the time it took your car to go 10 feet. In the column that reads “Time: 10ft-5ft” subtract the time it took your car to travel 10 feet by the time it took your car to travel 5 feet. In the column that reads “Calculated Speed: 10ft-5ft” calculate your speed using the formula Distance(10ft)/Time:10ft-5ft. The average time is figured by adding the times from the Time:10ft-5ft column and then diving by three. The average speed is calculated by adding the speeds and dividing by three.

e.g.

	Distance	Time	Time: 10 ft – 5 ft	Calculated Speed: 10 ft – 5 ft
Trial 1	10 ft	4.6 s	3.5 s	2.9 ft/s
Trial 2	10 ft	4.2 s	3.1 s	3.2 ft/s
Trial 3	10 ft	4.1 s	2.9 s	3.4 ft/s
Average Time 10ft-5ft: 3.2 s			Average Speed 10ft-5ft: 3.2 ft/s	

There is one final calculation question on the worksheet: Calculate the Acceleration from 5 ft to 10 ft. Acceleration = Average Speed/Time. Simply just use the provided formula.

e.g.

3.2 ft/s / 3.2s = 1 ft/s/s

Make sure to not forget to answer the final two questions on the worksheet.

Concepts and Standards

The key concept students should learn to do in this module is how to do calculations on velocity, acceleration, and distance. The idea is to teach students how to calculate these concepts and then see how it works in real life. They will be able to measure distance by trial, speed by a stopwatch, and then calculate acceleration.

The basic concept behind mousetrap cars is simple machines, though not emphasized in this module because of time restraints. We hope that the students think of experimenting with mechanical advantage in simple machines without any prompt. It may be a good idea to briefly talk about simple machines if you wish.

This module covers the following standards set in *Standards for Technological Literacy*.

- Standard 1: Students will develop an understanding of the characteristics and scope of technology.
- Standard 2: Students will develop an understanding of the core concepts of technology.
- Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
- Standard 8: Students will develop an understanding of the attributes of design.
- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
- Standard 11: Students will develop abilities to apply the design process.

This module covers the following *National Science Education Standards* for levels 9-12.

- Science as inquiry (Abilities necessary to do scientific inquiry, Understanding about scientific inquiry.)
- Physical Science (Motions and forces, interactions with energy and matter.)
- Science and Technology (Abilities of Technological Design, Understand about science and technology.)

This module covers the following Nation Mathematics Standards for levels 9-12.

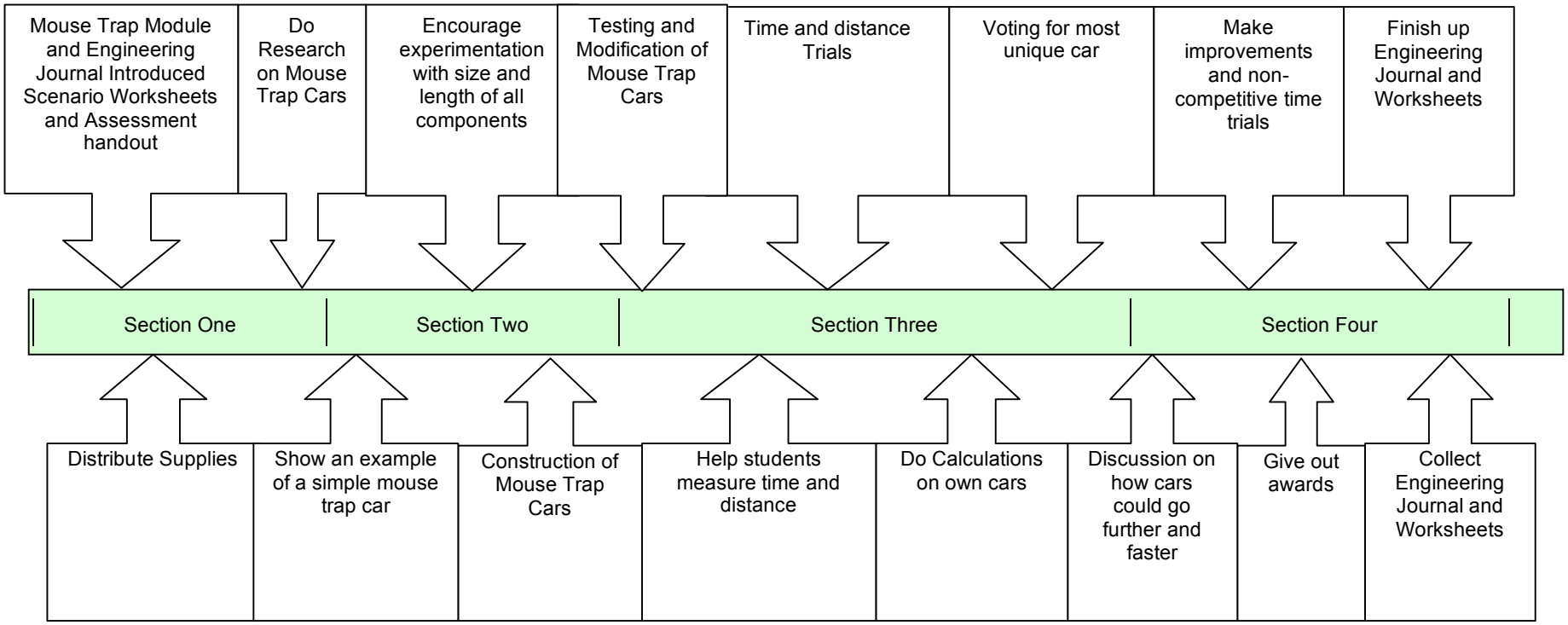
- NM-NUM.9-12.3: Compute fluently and make reasonable estimates

- NM-ALG.9-12.3: Use mathematical models to represent and understand quantitative relationships
- NM-ALG.9-12.4: Analyze change in various contexts
- NM-MEA.9-12.2: Apply appropriate techniques, tools, and formulas to determine measurements
- NM-DATA.9-12.3: Develop and evaluate inferences and predictions that are based on data

Assessment

Section	Requirement	Points Possible	Points Earned	Instructor Signoff
Engineering Journal	Table of Contents	5 pts		
	Daily entries	5 pts per day		
	Preliminary Sketches	5 pts		
	Research Done	20 pts		
	List of Materials used	10 pts		
	Design Changes	5 pts		
	Final Sketch	10 pts		
	Observations and Conclusions	15 pts		
Mousetrap Car	Correct use of mousetrap	20 pts		
	Ability for mouse trap to go at least five feet	20 pts		
	Distance Winner	10pts extra		
	Speed Winner	10 pts extra		
	Class Favorite	10 pts extra		
Worksheets	Calculations for speed, acceleration, and Distance Worksheet (Show your work)	20 pts		
Total Points	*There will be a Team evaluation; grade may be adjusted as teacher sees fair.	_____pts		

Mousetrap Timeline



Facilities, Equipment and Other Resources

A basic classroom is all that is required to build and teach this module. To run the races and test the mouse trap cars a large amount of floor space is needed. The hallway of your school may be a good place to do this.

To build the cars it is suggested to provide the following items for your students;

- balsa wood or equivalent
- cardboard
- razor blade
- CDs (for wheels)
- rubber stoppers that fit snugly in the center of the CDs
- wooden dowels or metal rods that fit snugly through the rubber stoppers
- safety glasses
- string
- mouse traps
- hot glue gun
- wire cutters (to cut lever on the mouse trap)
- stiff wire (like a clothes hanger)
- graph paper
- and a portable electric drill (the teacher may choose not to let students use this directly).

These items will be all a student needs to build a basic mouse trap car. **Students may want to use other materials**, it is up to you whether to provide those materials or have the students bring them.

For the measured competitions you will need a couple of things.

- 2 Stopwatches
- Masking tape (to designate the 5 foot track)
- Measuring tape

Other equipment may be used if you want to allow access to it, such as a soldering iron, band saw, a miter saw, cad program, or other supplies the teacher would feel appropriate.

Literature Cited

Balmer, Alden and Harnish, Mike. *Mouse Trap Cars: The Secrets To Success*. Texas: Doc Fizziz Publishing, 1998.

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Poggio, Patricia, "Moustrap Action!," http://www.ic.sunysb.edu/stu/ppoggio/ewebquest/frames.html, 2002, accessed April 26, 2006.

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Rutherford Brian, *Mousetrap Vehicles*, Pittsburg, KS: Pitsco, Inc., 2001.

Teacher's Guide Description

Project Description

In this module students will design and build their own mousetrap car. The students will also test them to collect data for calculations of speed, acceleration, and distance. They will work as two person teams or on their own. Students will do research, worksheets, and graphs to make a conclusion on how they could redesign their cars to make them go further and faster.

The student's grade should be based on three sections their engineering journal, mouse trap car, and worksheets. There is an assessment page provided in this module breaking it up into smaller sections and by points.

Present the project as a contest for the fastest, farthest, and most unique vehicle ran by a simple mouse trap. This will let them know that they can be as creative as they want, and it should be fun and exciting. It's important to clearly define everything that will be required of the students before they start the project.

Providing a mousetrap for the students is a good idea so that they are less likely to cheat, and more likely to be prepared. Explain how it is possible to use a mouse trap to power the car, e.g. attach a string to the arm of the trap and wind the other end around the axel of your wheels.

A basic classroom is all that is required to build and teach this module. To run the races and test the mouse trap cars a large amount of floor space is needed. The hallway of your school may be a good place to do this.

To build the cars it is suggested to provide the following items for your students;

- balsa wood
- cardboard
- razor blade
- CDs (for wheels)
- rubber stoppers that fit snugly in the center of the CDs
- wooden dowels or metal rods that fit snugly through the rubber stoppers
- safety glasses
- string
- mouse traps
- hot glue gun
- wire cutters (to cut lever on the mouse trap)
- stiff wire (like a clothes hanger)
- graph paper

- and a portable electric drill (the teacher may choose not to let students use this directly).

These items will be all a student needs to build a basic mouse trap car. **Students may want to use other materials**, it is up to you whether to provide those materials or have the students bring them.

For the measured competitions you will need a couple of things.

- 2 Stopwatches
- Masking tape (to designate the 5 foot track)
- Measuring tape

Other equipment may be used if you want to allow access to it, such as a soldering iron, band saw, a miter saw, cad program, or other supplies the teacher would feel appropriate.

An engineering journal is very important habit to get into for projects. This module is geared toward teaching the students how to start keeping a simple engineering journal. The first page of their journal needs to be a table of contents, that way it can be easily referenced whenever they need it. The engineering journal should include all the work and information the student did for the project. This is includes daily entries, preliminary sketches, research, list of materials used, design changes, final sketch, and observations and conclusions.

This module is divided up into four sections; each section should take two to three days. In the first section the mouse trap module and engineering journal should be introduced, the scenario, worksheets, assessment, and supplies should be handed out, and the students should start doing research on mouse trap cars. Introduce the mouse trap module by handing out the specific aims/problem statement, and summarizing the scenario for them. Let them know that the winner of each competition (distance, speed, and class favorite) will receive ten extra points as an incentive to work hard on their cars. Make sure to give the students time to ask questions about the challenge. It's important to handout all the information (scenario, worksheets, assessment) at this point so that the project is clear to the students. Time in class should be allowed to do research on mouse trap cars. This is beneficial to the students by letting them see what other students have done. Students should be required to cite three sources with a brief summary of the key points in each reference. Handout supplies individually to students after they are done doing their research.

The second section should start off my showing an example of a simple mouse trap car. This car should be simple so that students can be creative in modifying their car on their own. Make sure to encourage experimentation with size and length of all components of their cars. Now go ahead and let the students construct their cars. Make sure to give them a due date so they know how fast they need to work.

The third section is basically the competition section. Testing of the cars should be a large portion of this section. It is important for the students to test their cars in order to know what might be wrong with them. Make sure to be around while students are testing so they understand how the trials are done. Then do the actual time and distance

trials; you don't actually have to do the timing and recording yourself, but supervision is necessary so the students do not cheat. Also, make sure to keep your own record of the trials to determine the winner of the speed and distance trials. Finally, before you finish the section have the students display their cars and each student will write down their favorite car and submit it to you as an anonymous vote.

The last section should start off with a discussion on the best parts of cars, and what are important features of mouse trap cars. Then have the students make improvements on their cars with non-competitive time trials. Lastly, have the students finish up their engineering journal and worksheets, and turn it in.

A basic design for a car would be to drill holes into balsa wood slightly bigger than the size of your axel, and glue the mouse trap to the balsa wood. Attach string to the mouse trap lever arm and wrap the other end around one axel. Attach your wheels to the axels and voila you have a simple mouse trap car.

The concept that should be focused on for this module is speed and acceleration of objects. Through measured values, students will learn how to calculate these basic principles of motion in a fun and interesting way. The key concept in designing a good mousetrap car is using principles of simple machines. Mechanical advantage of all components on their car is necessary to produce the best results; however, we feel that the students should come up with that basic concept on their own. Discussion on mechanical advantage can take place if you feel it's necessary. Modifying the length of the lever arm on the mouse trap will greatly change the performance of the vehicle. If you want distance lengthen the lever arm, but if you want to win the speed race a short lever arm is the way to go. If you are modifying the lever arm to make it longer, keep in mind that it must stay rigid. Cutting coat hangers and then soldering them to the mousetrap is and efficient way of doing this. If the arm bends while it is in action, then energy will be taken from your outcome. Also, wheel size will affect the race. The larger your wheels are, the more distance will be traveled, but at the cost of speed.

Wheels for mouse trap cars are often hard to find. A common wheel to use for the cars is CDs. CDs are convenient because they are easy to find. CDs however have a large hole in the middle. The best way to solve that problem is by putting rubber stoppers in the CD. If you are using metal axels you can attach the axel to copper or brass tubing, as long as you use lubrication (like machine oil), but tubing is not necessary.

Getting the right string can be important. Fishing line works, but only for a couple of runs. Thread for sewing buttons onto coats is good. It is tough to break, and cheap to buy. Most likely whatever you provide will be fine.

The biggest part of the student's assessment will be their written report or engineering journal. The engineering journal should include daily entries, research on mousetrap cars or related principles, initial sketches, final sketch, and their calculations on their individual cars. To get credit for the actual car it must use the mousetrap correctly (no modifications to the spring and no rubber bands used), and the car must have the ability to travel five feet. The students should also be graded on the worksheets. There is also extra credit offered to each of the winners of the three competitions. A grading rubric is provided in the assessment section.

Worksheets

Group members' names: _____

_____

Distance Table

	Total Distance
Trial 1	
Trial 2	
Trial 3	

Speed Tables (Speed = Distance/Time)

	Distance	Time	Calculated Speed
Trial 1	5 ft		
Trial 2	5 ft		
Trial 3	5 ft		
		Average Speed:	

	Distance	Time	Time: 10 ft – 5 ft	Calculated Speed: 10 ft – 5 ft
Trial 1	10 ft			
Trial 2	10 ft			
Trial 3	10 ft			
Average Time 10ft-5ft:			Average Speed 10ft-5ft:	

Calculate the Acceleration from 5 ft to 10 ft. Acceleration = Average Speed/Time:

Questions:

1. Your mousetrap car uses potential energy. Where is this energy stored? Be specific.

2. How did the cars designed for distance differ from those designed for speed?