4-H Maker Challenge

Mousetrap Cars

Introduction

Overview

A mousetrap car is a model car made from simple materials that is powered by a mousetrap. A mousetrap car can be made from cardboard or balsa wood with CD's for wheels and axles of wood or brass tubing. Power to drive the wheels is provided by a mousetrap to which a wand and string is attached to the snap arm. Winding the string around the axle pulls back the snap arm and releasing the snap arm pulls the string, turning the wheels. Because of their simplicity, low cost and the nearly endless variation of ways to build a mousetrap car, they are a great project to help youth learn about engineering design and conducting investigations. They are also an excellent Maker project with the potential for participating in a design-build-race contest.

This curriculum guide is for 4-H leaders, teachers, afterschool professionals other educators and volunteers to offer a fun Maker type project for youth that teaches engineering design and investigation skills while building a working mousetrap car suitable for racing. The curriculum is split into two separate tracks that allow the mentor to focus on specific learning goals for the youth. Track 1 explores the engineering design process and gives youth the freedom to build a car of their own design and work to test and improve its design. This track takes slightly less time and results in more diverse car designs. Track 2 focuses on building and using a standard mousetrap car to test different variables that affect a car's performance. In addition to exploring the engineering design process, this track helps youth learn how to plan and conduct investigations. Both tracks 1 and 2 end with the potential to design a high performance mousetrap racer and hold a distance challenge contest. Read the complete track descriptions below to see which track meets your goals. If time is not a limiting factor, then tracks 1 and 2 complement each other and may be taught in sequence.

<u>Track 1 - Exploring Engineering Design with Mousetrap Cars</u>

Track 1 introduces youth to the engineering design process while exploring materials and physics principles to build a working model car powered by a mousetrap. It is suitable for out-of-school time learning as well as the classroom (grades 5-8) and is aligned with the Next Generation Science Standards (NGSS) Science and Engineering Practices. In this track, youth are challenged to build a working car with a limited set of materials and directions. Through exploring materials, trial and error and coaching from a teacher/mentor youth identify a problem, design solutions and test and improve their design. It requires a minimum of four hours of class time and can easily be extended to six hours. The materials cost for this program is about $2.50 per car (1 car per 2 students) plus $20 for building supplies like glue, tape etc. This track is best for educators and learners who are new to the engineering design process.

Track 2 – Conducting Investigations with Mousetrap Cars

Track 2 emphasizes planning and conducting investigations of car design, performance and materials. Activities focus on asking questions about car performance (distance traveled), isolating variables that affect performance and then planning and conducting investigations to improve the car's design. It is suitable for out-of-school time learning as well as the classroom and is aligned with the NGSS Science and Engineering Practices. In this track, youth design and build a car based on a standard design Appendix 6. P. 50. As they test their cars, youth generate questions about the car's performance and are guided in planning and conducting an investigation to find answers to their questions. This activity requires a minimum of 5 hours of class time and can easily be extended to 8 hours of class time. Materials cost about $5 per car (1 car per 2 students) plus $20-40 in additional materials. This track is best for educators and learners who are already familiar with the engineering design process. It can be completed on its own or as a follow-up to track 1.

Curriculum Goals

- Learners will build an understanding of energy being converted from one form to another. Mechanical energy stored in a spring is converted to energy of motion.
- Learners will design, build and test a mousetrap car using the engineering design process. They will identify a problem, develop and test car designs to come up with a working solution.
- Learners will plan and conduct investigations focusing on different variables that affect mousetrap car performance.
- Learners will evaluate their efforts and communicate their results to an audience of peers.

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Track 1
Exploring Engineering Design with Mousetrap Cars

Introduction
This track introduces youth to the engineering design process while exploring materials and physics principles to build a working model car powered by a mousetrap. It is suitable for out-of-school time learning as well as the classroom (grades 5-8) and is tied to the NGSS Science and Engineering Practices. In this track, youth are challenged to build a working car with a limited set of materials and directions. Through exploring materials, trial and error and with coaching from a teacher/mentor, youth experience the engineering design process of identifying a problem, designing solutions and testing and improving their design. It requires a minimum of four hours of class time and can easily be extended to six hours. The materials cost for this program is about $2.50 per car (1 car per 2 students) plus $20 for building supplies like glue, tape etc. This track is best for educators and learners who are new to the engineering design process.

<u>Activity 1 - Building a Basic Car</u>
In this lesson participants use common materials to design and build a basic model car that can be powered by a mousetrap. (1 or 2 class sessions)
<u>Activity 2 - Attaching a Mousetrap</u>
In this lesson participants attach a mousetrap to their car to drive the wheels and make it go. Teachers can use different progressions to help learners imagine and design a system that will power their car.
<u>Activity 3 - Building a new Racecar (Optional)</u>
Learners will take what they have learned in Activities 1 and 2 and build a car for a class wide or local Mousetrap Car Distance Challenge.
<u>Activity 4- Guidelines Holding a Mousetrap Car Distance Challenge</u>
Provides guidelines for holding a distance challenge contest.

Mousetrap Cars

Track 1 – Exploring Engineering Design with Mousetrap Cars

Activity 1 - Building a Basic Car

Time: 90 – 120 minutes (1-2 classes) Grades 6-8 Activity 1 of 4

Brief Activity Description:
Learners will design, build and test a simple car using available materials. They will refine their models to determine what characteristics are best for a car to roll far.

Specific Learning Outcomes: Youth will practice the following engineering practices:

- Planning and building a car from available materials
- Testing and analyzing the car's performance
- Making modifications and changes to the design to improve performance

Activity Lesson Plan:

Preparation**:** Review the background information in appendix 4 p.44 on building a basic mousetrap powered car. Take the opportunity to build one so that you have a sense of the build process and any steps that may be more challenging for your learners. Review the materials needed for this lesson and be sure you have enough for all of your learners. Materials should be set out on a table so that everyone can access them when needed. You will also need space to test cars, a long classroom or hallway.

Testing cars: You will also need to build a small ramp to roll cars down for testing. A ramp can be built out of a board or stiff piece of cardboard. Raise one end a foot or two by resting on some books or other sturdy object. Folding one set of legs on a folding table also makes a decent ramp for testing. You should have about 20 – 40 feet or so of runout space.

Introducing the Lesson:
Introduce the 4-H Mousetrap Car Challenge. Explain to the group that they will have the opportunity to build a car and power it with a mousetrap. The first challenge will be to build a car that can roll evenly and straight. Arrange your learners in work groups of 2 or 3. Learners will stay in these groups for the first three lessons while they work to complete this model car.

Engage and Explore:

Challenge: Make a car out of available materials that can roll as far as possible when rolled down a ramp. (Note: you do not need to use all the materials.)
Think about: What characteristics make a car roll far? What design features should your car have to make it roll as far as possible when rolled down the ramp?

<u>Materials Needed for this Lesson</u>**:** (teams should get, but do not need to use all)

- 2 Pieces of Cardboard (see Teacher Notes)
- 4 CD's
- 4 Faucet Washers (see Teacher Notes)
- 2, 3/16 Dowels - 6" long
- 2 straws
- 4" zip ties
- Tape – Masking & Duct
- Hot Glue

<u>Discussion (10 minutes)</u>: *How do toy cars work*? & *What makes a good car?* – Take a few minutes to show the group some models of toy cars. Ask. *What qualities make a car roll far?*

Consider:

- What parts does a model car need? body, wheels, hubs, axles, bushings
- What would make it roll far?
- What would make it roll straight?
- How might you use some of these materials?

Record their ideas down on chalkboard or flipchart as a list of *things that <u>help</u> a car roll far* and *things that <u>prevent</u> a car from rolling far*.

Tell the learners that *some toy cars have a mechanism/part to make it go*. Remind them that they will be adding a mousetrap in the next activity. Demonstrate an example of the mousetrap mechanism that they will be using to power the car in the next lesson. Show them the basics of how the string will wind around the rear axle tensioning the spring and then, as the spring is released, will turn the axle powering the car. **Remember, they will not get a mousetrap until the second lesson, but still need to keep the mousetrap mechanism and access to the axle in mind when they design their cars.**

<u>Present the materials that the learners will have available.</u> Go over the materials that they have available. Do not tell them what the materials are for. Remind them that for this activity they are limited to these materials and may not use additional materials. Let the students determine how to use the available materials. They do not need to use all of the materials available.

<u>Safety Reminder</u>: Remind your learners that they will be using scissors, or possibly hobby knives for cutting and hot glue guns for gluing. Go over any safety precautions with the class and even designate and area for cutting and gluing.

<u>Initial Build (20-25 minutes):</u>

After the discussion, let the groups start building their cars. Let them try different ideas to make a working car. As they complete their cars they should test them by rolling them down the ramp observing the car's performance. Learners should note how far and straight it rolls, what may be preventing it from rolling straight and far, etc.

Teaching Tips
Mentoring

While the learners are working, circulate around to different groups and observe what they are doing. Ask them questions to guide their exploration. If groups are struggling suggest that they go look and see what other groups are doing. (see Teacher Notes for mentoring suggestions).

Discussion (5 minutes): *What's working & what's not working?* - After the groups have been working for a while (about 15 – 20 minutes). Ask the groups to stop what they are doing. Have them leave their cars at their workstations and sit at a central location. Hold a brief discussion about "What's Working" and "What's Not Working". Set up a T-Chart with the headings What's Working and What's Not Working (see teacher notes) and record their observations. Have them identify characteristics and patterns in a car's design that work well and lead to better performance. Also, be sure to record things that do not work as this can help them avoid trying things that will lead to a poor solution. Keep the discussion short, no longer than 5 minutes, and use it to focus their efforts.

Continue Building, Testing and Observing (20-30 minutes): After the *What's Working/Not Working* discussion have the learners continue to work on their cars. Continue to mentor and support their design and build questions, always guiding them towards improving their cars. As the build draws to a close, allow the learners one last time to test their cars before wrapping up the lesson.

Explain and Elaborate:
Individual Reflection (10 minutes): After they have completed the final tests on their cars, bring the build to a close. Review the T-chart from your previous discussion and then give everyone time to reflect on what has been working or not working on their car. Have the learners write down their reflection in their engineering notebooks or give them a t-chart to complete. You can give them prompts such as…

- What design features help your car roll straight and far?
- What problems are you having?
- What changes would you like to try that might improve your car's performance?

Final Discussion (5 minutes): After everyone has had time to write down their individual reflections, bring the group together for a final discussion. *What evidence do you have that shows a design is working? Or not working?* Using their reflection notes, have each pair share a finding and any evidence that backs it up. If they struggle with offering evidence, prompt them with questions such as

1. What kinds of observations or evidence did you see that supports your finding?
2. Did anyone else share that finding?
3. What other kinds of observations can you make about your cars?

You may get responses such as
- I saw my car traveling straighter or faster
- I measured my car and it went farther when I did…
- I noticed that…

Summarize (5 minutes):

After everyone has shared their findings, review them in the context of characteristics that make a good car. Start with class findings citing examples from their observations. If there are gaps in their findings or characteristics that they did not mention, you should fill them in. For example,

- The car should runs straight – crooked axles or wobbly wheels could interfere with this.
- The wheels should spin freely – excess glue or wheels rubbing against the frame would affect this.
- The body should be sturdy – a single piece of cardboard may not be strong enough to support a mousetrap

Once the groups have made cars that run straight and free with a solid body it is time to attach a mousetrap. Tell them the next step is to attach a mousetrap (see Activity 2).

Mousetrap Cars
Track 1 – Exploring Engineering Design with Mousetrap Cars

Activity 2 – Attaching a Mousetrap

Time: 45-60 minutes (1 class period) Grades 6-8 Activity 2 of 4

Brief Activity Description:
Learners will add power to their cars by attaching a mousetrap to the car built in Activity 1. After reviewing the previous lesson and having a brief discussion about what makes "a good car", the groups will test different ways to attach a mousetrap to drive the wheels of the car.

Specific Learning Outcomes: Youth will practice the following engineering practices:
- Design, build and test a mousetrap powered drive system
- Evaluate the car performance to identify aspects of the model that can be improved
- Make modifications and changes to the car design to improve its performance

<u>Activity Lesson Plan</u>:

<u>Preparation</u>: Gather the needed materials and the cars from the previous activity and set up the work area. Have the list of What's Working/Not Working from the last activity posted to review in a separate area for discussions.

<u>Background review</u>
You may have presented the class with the basic mousetrap, lever and string model in the last activity, so learners should have a basic idea of how this should work. A basic mousetrap car is powered by attaching a string to the "snap" lever on the trap, looping the other end to a small hook on the axle, winding the string around the axle of the car pulling back on the lever and arming it. When the snap lever is let go, the energy in the spring will pull the string, driving the wheels (This happens quite slowly). There are many of variations of how to attach a mousetrap to drive the wheels. Learners should be free to explore. But, you should remind them of the model you presented to start with. Figure 1 shows how a string on a dowel, attached to the lever on a mousetrap can drive the rear axle.

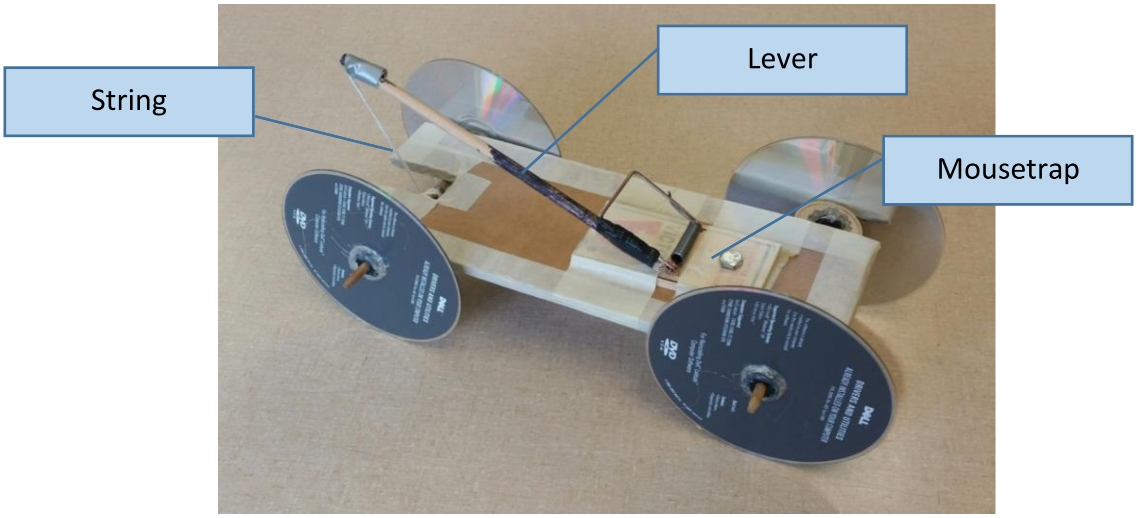


Figure 1

Safety Reminders: Mousetrap springs are strong and getting snapped by the trap will hurt and may break a finger. Explain how to safely handle a mousetrap. Involve the learners in establishing rules or guidelines. Ask their thoughts on safely handling a mousetrap. Write these guidelines on a poster and display for the duration of the activity.

Introducing the Lesson (5 minutes): Review the previous activity by having the learners share "what makes a good car". Learners should share the qualities of a car that ultimately will be able to travel as far as possible. For example, the car should roll straight, the wheels should be smooth and stable, the body should be sturdy and not flimsy, etc. Bring out the T-Chart from the Activity 1 and have the learners point out each of the findings.

Engage and Explore:

Challenge: Attach a mousetrap to your car so that it will drive the wheels and make the car move forward.

Materials Needed for this Lesson: (each group will need the following)

- Cars from Activity 1
- 1 Mouse trap
- Masking or duct tape
- 4" zip ties
- Different kinds of string
- 1 ¼" dowel about 12" long
- Hot glue (optional)

You may also need a measuring tape (25 – 50') for measuring distance traveled.

Discussion (5 minutes): *How to attach a mousetrap*?:
Bring the large group together and have them sit in their small groups with their cars built in Activity 1 . After you have had a mousetrap safety discussion, hand each pair a mousetrap mechanism with wooden dowel and string. Then give them 2-3 minutes to discuss ways to attach a mousetrap to power their car. They should consider:

- How to attach the mousetrap to the car
- Where to attach it
- How long the lever and string should be
- How they will connect the string to the axle

After a few minutes, call the learners back and have them share ideas. Record these ideas on a flipchart or poster. Have the group look at the list.

Show them a complete mousetrap and lever mechanism (see figure 2). Ask the group how they might use this to propel the car.

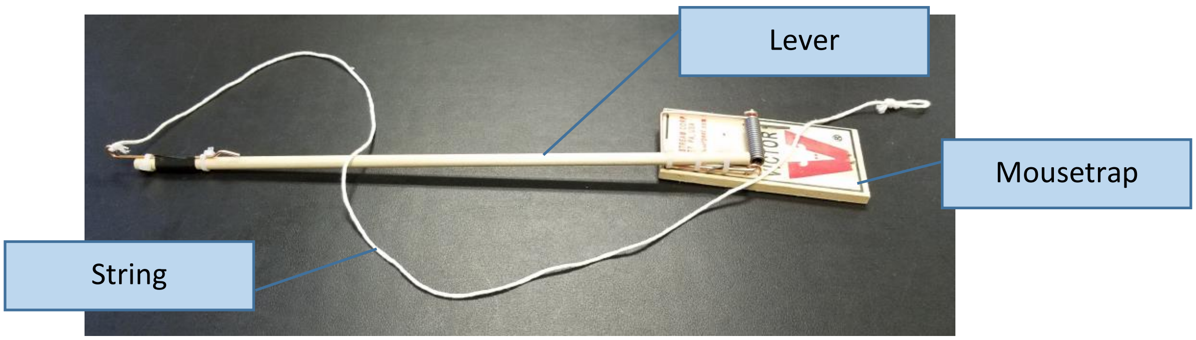


Figure 2

Build (30-40 minutes): Allow groups time to attach mousetraps to their cars. They may use tape or other methods of attachment. After adequate time to attach their mousetraps give them time to test them.

Ideas - Method of Attachment: The group may struggle with effective ways to attach a mousetrap. If so, show them a mousetrap with a dowel attached and extending the snap arm. Then give them time to explore how to attach this to their car body. They will need to develop some way to wind the string around the rear axle. You might want to present a working model for them to see.

Testing cars: Provide a long straight room or hallway to allow for testing. Let the learners test their cars to see how they work. Learners will want to go back and forth to modify and retest their cars. Remind learners to record any observations on the car's behavior and distance traveled in their engineering notebooks. After about 10-15 minutes stop the group and have a What's Working/What's not Working Discussion. Record their responses on a T-Chart.

Continue to modify and re-test: After the discussion allow the learners to go back to their cars to continue to improve their design.

Discussion, Measuring Distance (5 minutes). As they continue to record their observations and begin to use them as evidence, this presents an opportunity to discuss how to ensure accuracy and precision when observing distance traveled. Learners will easily get a general sense of how far their car goes, but as the need for using observations as evidence to support the "best" design arises, they will likely need a more accurate means of measuring distance. Ask the group to determine and agree upon a method of measurement. This will most likely include the use of a tape measure, but can also use 1 foot floor tiles or other made up units like "Johnny's feet". They should also consider other conventions, like where to measure from and what part of the car to measure to etc.

Review and Closure: With about 10-15 minutes of group time left. Bring everyone together and review the What's Working/What's not Working Chart one final time. Do they still agree with their original statements? Do they have any additions or changes they would like to make? What evidence do they have from their observations that support their statements?

Let them know at the upcoming sessions they will be planning and conducting investigations on materials and design features that improve a car's performance. You may want to encourage them to go online at home to view other mousetrap car designs.

Mousetrap Cars
Track 1 – Exploring Engineering Design with Mousetrap Cars

Activity 3 - Building a Race Car
(Optional)

Time: 60-90 minutes (1-2 class periods) Grades 6-8 Activity 3 of 4

Brief Activity Description:
Sometimes it is fun to take knowledge that's been learned and use it to build something completely new. In this optional activity, youth use new knowledge and understanding about mousetrap cars to build a mousetrap racecar to compete in a distance contest.

Specific Learning Outcomes: Learners will
- Explain what design elements helped their prototype cars perform well
- Elaborate on how design elements will be used to design and build a new car for competition
- Design and build a new car for competition

Activity Lesson Plan:

Preparation: The learners should now have built, tested, modified and retested one or more mousetrap powered cars. They should be able to describe some of the variables/features that make the car travel farther. Using knowledge about mousetrap cars that they have gained from their prior experience, observing peers, and perhaps researching online, they will design and build a mousetrap powered car for a maximum distance contest. You should have chart paper to record ideas for best design features and have lots of materials on hand for building new cars. Review the contest rules (page 14) and determine where and how you will run your contest. Consider if the contest will be for the group or classroom or if they will attend a local community event.

Introducing the Lesson (5 minutes):
Tell your learners that they will now begin work on a new car to race in a mousetrap powered car distance challenge. Share the contest rules (page 14) and then review what they have learned about building a mousetrap car optimized for distance.

Engage & Explore:

Challenge: Build a racecar using any available materials and powered only by a mousetrap that will travel as far as possible. Race the car in a contest. (all cars must follow the contest rules provided)

Contest Rules:

1. Vehicle must be powered by one Victor brand mousetrap measuring: 1 ¾ " x 3 7/8 ".
2. The mousetrap cannot be physically altered except for the following:
    a. holes can be drilled only to mount the mousetrap to a frame
    b. the mouse trap's snapper arm may be cut and lengthened
3. Vehicles must be self-starting. They may not start with additional potential and/or kinetic energy other than what can be stored in the mousetrap's spring.
4. The spring from the mousetrap cannot be altered or heat-treated.
5. The mousetrap's spring cannot be wound more than its normal travel distance or 180 degrees.
6. The vehicle must steer itself and may not receive a push in any direction in order avoid a collision.
7. The greatest linear distance will be the total distance a vehicle travels measured perpendicular from the front of the starting line to the point of the vehicle that was closest to the start line and will not "angle" to where the vehicle comes to rest.
8. The Judge has the final decision as to the appropriateness of any additional items that might be used in the construction of the vehicle.

Discussion: (10 minutes) Hold a discussion with the class and give a brief review of all the discussions, findings & flip charts from activities one and two. Ask questions like, *What makes a good car? What's better? Big or small wheels? Large or small diameter axles? Long or short levers? Heavy or light cars?* Etc.

Planning: (10 minutes) Form groups of 2 and have each group talk about & design a new car to enter into a contest. What qualities do they want to carry over from their last car? What design elements do they want? They may want to consider wheel and axle size, frame/body construction, etc. As they design, learners should sketch their model in their engineering notebooks. Once their designs are complete and they sketched their designs in the engineering notebooks allow them to proceed with building.

Build: (60+ minutes) Allow learners time to build a new car. You may want to make new materials available and encourage youth to research design ideas online at home and bring in other materials. Ultimately, this may take more than one class/meeting session. But you should give a general time limit and keep them appraised of how much time they have.

Closure: Possible contest ideas:
1. Hold a contest within your group, club or class
2. Contact your county 4-H Staff to see about any local contests coming up
3. New Hampshire 4-H State Activities Day, held in late spring. (Contact your local 4-H Staff for details.)

Mousetrap Cars

Track 1 – Exploring Engineering Design with Mousetrap Cars

Activity 4 - Holding a Distance Challenge

Time: 45-60 minutes (1 class) Grades 6-8 Activity 4 of 4

A Mousetrap Powered Car Distance Challenge can be a fun way to conclude your mousetrap car project. Holding a distance challenge contest can be a simple affair for your class, club or afterschool group or it can be a big contest for multiple groups or individuals, like 4-H County or State Activities Day. These rules and contest guidelines offer a template for any group to hold a distance challenge contest. Remember, this is a celebration of creativity, ideas, science, engineering and Making. It is meant to allow youth to test their cars and ability as Makers.

Distance Challenge Rules

The objective of the 4-H Maker Mousetrap Powered Car Challenge is for individuals and teams of 2 or 3 to build a vehicle, powered solely by a standard-sized mousetrap to race in a greatest distance contest.

These basic rules allow for a fair and consistent contest.

1. Vehicle must be powered by one Victor brand mousetrap measuring: 1 ¾ “ x 3 7/8 “.
2. The mouse trap cannot be physically altered except for the following:
    a. holes can be drilled only to mount the mousetrap to a frame
    b. the mousetrap's snapper arm may be cut and lengthened
3. Vehicles must be self-starting. They may not start with any additional potential and/or kinetic energy other than what can be stored in the mousetrap's spring.
4. The spring from the mousetrap cannot be altered or heat-treated.
5. The mousetrap's spring cannot be wound more than its normal travel distance or 180 degrees.
6. The vehicle must steer itself and may not receive a push in any direction in order to avoid a collision.
7. All vehicles will go through a compliance check to be sure that it meets all the rules.
8. Each participant may have up to three trials to race their car. The best of measured distance will be scored.
9. The greatest linear distance will be the total distance a vehicle travels measured perpendicular from the front of the starting line to the point of the vehicle that was closest to the start line and will not "angle" to where the vehicle comes to rest.
10. The Judge has the final decision as to the appropriateness of any additional items that might be used in the construction of the vehicle.
11. Vehicles may <u>not</u> be altered during the contest between trials. Repairs may be made as long as they do not include any design changes.

Space

Well-constructed mousetrap powered cars can easily travel 100' – 200' (distance records approach 300') so you will need a space to accommodate at least that distance. A school gymnasium or cafeteria can work great or even a hallway is suitable for a smaller contest.

You will want the following materials to help you hold the contest

1. Blue Painters Tape – to mark a starting line on the floor
2. 100' Tape measure

Holding a large contest

If you are holding a larger contest for several afterschool groups or 4-H clubs you should also consider space for the registration, compliance checks, spectators and testing and fixing vehicles

Set-up and Materials

Registration

1. Have a table and chairs set up for someone to check in participants as they arrive
2. You may want to have a chart to collect youth name, vehicle name, club name and three blank spaces to record distance traveled for each vehicle (see appendix)

Compliance check in

1. Have a table set up for volunteers to check to see that all participating vehicles meet the rules and requirements as written
2. Have a copy of the rules as a checklist for each vehicle. You may want to have stickers to mark any vehicle that has been checked

Volunteers

You will need volunteers for the following roles. (Some roles can be combined)

1. Registration – check--in and record all participants and set up a score sheet with participant names
2. Compliance check - make sure all cars meet specifications and construction rules
3. Judge - oversee trial runs and measure distances
4. Score Keeper - keep score
5. Demonstrations Judges (optional, if you are having a demonstration/presentation exhibition)

Recognition: It is important to plan for recognition of achievement in this contest. Since it is a contest, recognition should go to the overall top three finishers, based on distance traveled. You may wish to add categories based on age such as Elementary, Middle and High School. In 4-H, Juniors are 8-13 and Seniors are 14 – 18. Awards can consist of ribbons, trophies or prizes, science books or kits make great prizes. Demonstrations should be recognized with participation ribbons or Danish ribbons (Blue, Red or White ribbons based on scores).

Mousetrap Cars

Track 2 – Conducting Investigations with Mousetrap Cars

Introduction

Track 2 emphasizes planning and conducting investigations of car design, performance and materials. Track 2 activities focus on asking questions about a car's performance (distance traveled), isolating variables that affect performance and then planning and conducting investigations to improve that car's design. It is suitable for out-of-school time learning as well as the classroom and is aligned with the NGSS Science and Engineering Practices. In this track, youth design and build a car based on a standard design. As they test their cars, youth generate questions about the car's performance and are guided in planning and conducting an investigation to develop answers to their questions. This activity requires a minimum of 5 hours of class time and can easily be extended to 8 hours of class time. Materials cost about $5 per car (1 car per 2 students) plus $20-40 in additional materials. This track is best for educators and learners who are already somewhat familiar with the engineering design process and can be completed on its own or as a follow up to Track 1.

<u>Activity 1 - Build a Better Mousetrap Car</u>

Learners will observe a model mousetrap car and then build and test their own mousetrap car using a standard design with a choice of different building materials.

<u>Activity 2 - Raising Questions</u>

Learners observe the performance of the cars the class has built and generate lists of questions about factors that influence performance (distance traveled).

<u>Activity 3 - Planning Investigations</u>

Learners plan an investigation based on a question generated in Activity 2.

<u>Activity 4 - Conducting Investigations</u>

Learners conduct investigations, collect and analyze data about their cars.

<u>Activity 5 - Presenting my Car</u>

Participants prepare a short presentation on the design and construction of their cars and the process and results of their investigations.

<u>Activity 6 - Building a new Racecar (Optional)</u>

Learners will take what they have learned in Activities 1 - 5 and build a "Distance Racer" for a class wide or local Mousetrap Car Distance Challenge contest.

<u>Activity 7 -Holding a Mousetrap Car Distance Challenge</u>

Provides guidelines for holding a distance challenge contest.

Mousetrap Cars

Track 2 Conducting Investigations with Mousetrap Cars

Activity 1 - Build a Better Mousetrap Car

Time: 45-90 minutes (1-2 class periods) Grades 6-8 Activity 1 of 7

Brief Activity Description:
Learners will build and test a mousetrap car following a standard design. They will have a choice of several different building materials.

Specific Learning Outcomes: Youth will practice the following engineering and science practices:

- Choose from available materials to build a car based on a standard design
- Test and analyze the car's performance

Activity Lesson Plan:
Preparation**:** Review the background information in the teacher notes on building the standard model mousetrap car. The instructions for building a standard mousetrap car are included at the end of this activity. They do not need to be followed exactly since learners will be trying different materials, but should instead serve as a template for a starting point for a car design. Take the opportunity to build a car so that you have a sense of the build process and any steps that may be more challenging for your learners. Review the materials needed for this lesson and be sure you have enough for all of your learners. Materials should be set out on a table so that everyone can access them when needed. Your learners should already be familiar with the basics of building mousetrap cars. This activity will focus on using different materials and design ideas to improve the performance of a standard mousetrap car design. Be sure to have a clear lane in the classroom or nearby hallway for testing cars. You will likely need about 50-60 feet.

Introducing the Lesson (5 minutes):
Introduce the 4-H Mousetrap Car Challenge – The Mousetrap Car Challenge is a distance contest to challenge learners to work in pairs or small groups to build a car powered by a mousetrap that can travel as far as possible. The teacher/mentor must decide when and how to run the contest and if they will participate in a local contest such as 4-H Maker Challenge. (see Activity 7)

Demonstrate (5 minutes):
Show your learners a mousetrap car (use the standard model) and tell them that they will be building similar mousetrap cars. Demonstrate the mousetrap car and how it works. Show the mousetrap/lever/string assembly by winding it around an axle to drive the wheels. Show them how the wheels spin and that it rolls straight.

Review the basic properties that make a car perform well. Do **not** disclose in what way to vary these properties (e.g., wheel size, car body length) to affect performance.

Some of the basic properties of a good car include:

- Car Body – stiff, light, strong, allow access to the axle to wind the string
- Axles/bushings – straight, secure, able to spin freely, low friction
- Wheels – able to spin freely, round, smooth, axle centered, roll straight & not wobbly
- Mousetrap/lever arm – does not get caught on things, string can easily be wound around axle

Engage and Explore:

Challenge: Following a standard mousetrap car design, choose from a collection of materials to make a mousetrap car that will travel as far as possible.
Think about: What characteristics make a mousetrap car travel far? What materials or minor design changes will make a car travel farther?

Show the learners the materials they will have available to build their cars. Tell them they will work in groups of 2 or 3 to build a car. Some materials they will be able to choose and others are standard. Groups will need to make the following material decisions:

- what length of cardboard to use for the body (9", 12", 15", 18")
- what material to use for the axle (wood or brass)
- how long the lever arm will be (9", 12", 15", 18")
- type of string (**Optional** – cotton, dental floss, braided fishing line, etc.)
- What size wheel (**Optional** if you can find mini cd's)

Materials Needed for this Lesson:

Car Body	Axles/bushings	Mousetrap/Lever	Wheels	String(optional)
Have precut lengths of cardboard 4 ½" wide by 9" 12" 15" & 18" long.	• Wooden dowels (3/16") • Brass tubes (3/16") • steel rod (optional) • Straws	• ¼" wooden dowels of different lengths (8", 12", 16", 20")	• CD's • Mini CD's (8cm) optional	• Cotton string • Dental floss • Braided fishing line

You will also need: duct tape, masking tape, faucet washers, hot glue, Super glue, zip ties, Velcro and other materials to aid in the building of the cars.

Safety Reminder: Remind your learners that they will be using mousetraps, scissors, and possibly hobby knives for cutting and hot glue guns for gluing. Go over any safety precautions with the class and even designate and area for cutting and gluing.

Build (30-60 minutes):
Let the groups start building their cars. Help them focus on building a working car with their chosen materials. Caution them about trying to make fancy modifications. Remind them that their goal is to build a working car. They will need to test their cars as they build.

Teaching Tips

Mentoring

While the learners are working, circulate around to the different groups and observe what they are doing. Ask them questions to guide their exploration. If groups are struggling, suggest that they go look and see what other groups are doing. (See the Teacher Notes for mentoring suggestions).

Wrapping Up: Each group should have a working car by the end of the lesson. They will present and share their car designs with the rest of the class at the beginning of the next activity, 2.2 Raising Questions. They will also have an opportunity to improve their cars and test different materials and design solutions in future activities.

Standard Mousetrap Car – Build Directions

Note: for this activity, youth will be selecting different materials and making a variation of this car. Their cars should look somewhat different depending of their choice of materials. The goal for the class is to get several working cars that are each a little bit different so that when the learners demonstrate and observe the performance of the different cars, they will generate several questions about mousetrap cars design and materials.

The following steps are a guide to build a simple mousetrap car.

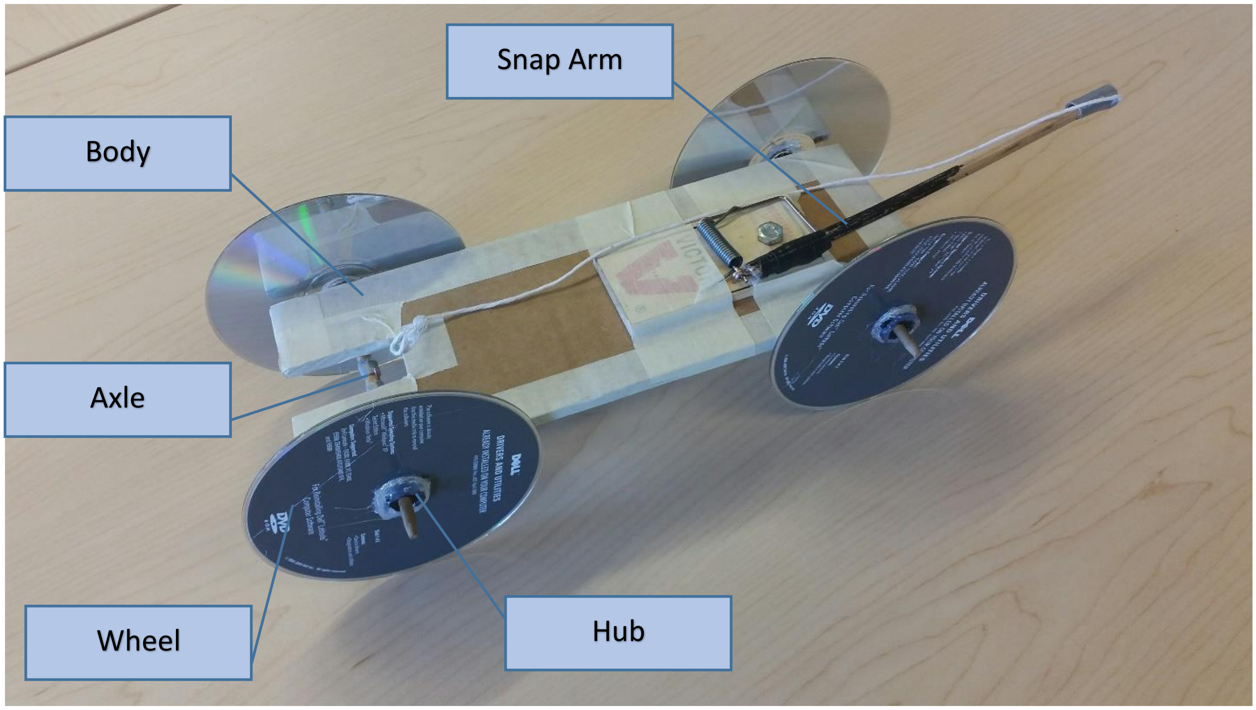


Figure 1 standard car design

Materials (for basic model car)

- **Body**
  - 2 pieces of Cardboard 4 ½ " wide x 9", 12", 15" or 18"- <u>Choose what length to use</u>
- **Wheels & axles**
  - 4, CD's
  - 4, 1/4L (19/32") Beveled Faucet Washers
  - 2 axles 6" long - 3/16" - <u>Choose wooden dowels or brass tubing</u>
  - 2, Straws
- **Mousetrap Mechanism**
  - 1 Mousetrap
  - 1, ¼ inch dowel, 9", 12", 15", or 18" long - <u>Choose what length to use</u>
  - String
- **Miscellaneous Supplies**
  - Tape (Masking & Duct), Hot Glue
  - zip ties (an assortment of 4" & 8" works well), Velcro
  - Scissors and/or utility knives(discuss safety with students)

Body

Step 1 – Choose what length cardboard to use (9”, 12”, 15”, 18”). Cut a rectangular notch (about 1 1/2” x 2 “) on the short side of each piece of cardboard so that the notches overlap (Figure 2).

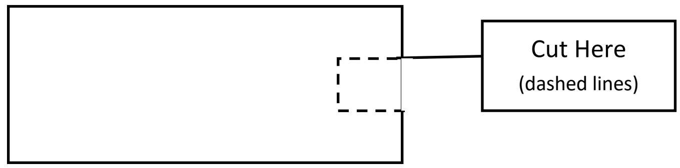


Figure 2 Cutting the cardboard pieces

Step 2 – Place the two pieces of cardboard on top of each other and tape them together to make a double thick piece of cardboard. Make sure the notches line up as in Figure 2.

Step 3 – Cut 3 sections of straw to fit on the body of the car like in the illustration below. Glue them in place using a glue gun (Figure 3). Make sure the straws are parallel and the axles spin freely.

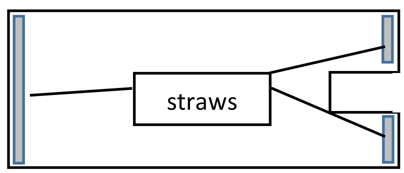


Figure 3 Attaching the straws

Mousetrap

Step 4 – Choose a ¼” dowel length (9”, 12”, 15”, or 18”) and use 2 or 3 zip ties to secure the dowel to the snap arm and reinforce it with tape or hot glue (Figure 1).

Step 5 – Glue the mousetrap in place near the front on top of the cardboard with the glue gun. Be sure the closed snap and dowel is pointing forward (away from the notch in the cardboard). Alternatively, use Velcro to attach it allowing you to try different placement options.

Wheels & Axle

Step 6 – Glue the faucet washers into the center of the CD’s. Be sure to use a generous bit of glue to make sure they hold.

Step 7 – Choose an axle material (Wood or Brass). Place the 3/16” axles into the straws and press the wheels onto each end.

Step 8 – Attach a 4” zip tie to the center of the rear axle exposed by the notch in the cardboard, and cut it short, about ¼ inch. This is the hook for the string. A dab of glue will help keep it in place.

Step 9 – Tape a piece of string to the end of the ¼ inch dowel. On the other end tie a small loop. It should be long enough to reach the hook on the rear axle.

Your car should look something like Figure 1. Hook the loop over the zip tie on the rear axle and wind the wheel up. Place the car on the floor and let it go. You will likely have to tinker a bit with it to make it run smoothly.

Mousetrap Cars

Track 2 Conducting Investigations with Mousetrap Cars

Activity 2 – Raising Questions

Time: 45-60 minutes (1 class period) Grades 6-8 Activity 2 of 7

Brief Activity Description:
The purpose of the Raising Questions activity is to engage learners and get them to generate questions about their cars that they can investigate further. The groups will start by sharing and demonstrating their cars from the previous lesson. During the demonstrations, each learner will write down a list of questions and observations they have about mousetrap cars, their performance and the materials used. Finally, learners will choose a question to investigate further.

> Facilitator Note:
> Conducting investigations and testing variables is an important part of the Engineering Design Process. The lessons in Part 2 – Investigating Mousetrap Cars offer a basic format for investigating variables that affect a mousetrap car's performance with suggestions and background information on variables to test. Before starting these activities with your learners, they should have completed lesson 2.1 Build a Better Mousetrap Car and have a basic working knowledge of how mousetrap cars work.

Specific Learning Outcomes: Youth will practice the following science and engineering practices:

- Ask questions based on observations and choose a testable question to investigate
- Identify variables to investigate

Activity Lesson Plan:

Overview**:** in this lesson, the class will hold a "Car Show" where teams will each give a brief presentation of their car design (what they did) and then demonstrate how their car works for the group. During the car show, all learners will make observations and record questions about how the cars perform.

Preparation**:** Learners should have the mousetrap cars they built in Activity 1 to share and demonstrate. You should also have a completed model car of the standard Mousetrap Car design from the previous activity (2.1 Build a Better Mousetrap Car). You will also need note cards, sentence strips and a large whiteboard or flip chart paper.

Introducing the Lesson (5 minutes):

When the learners designed and built cars in the previous lesson, they made observations about some of the fundamentals of mousetrap car design. Now as a larger group they will have the opportunity to observe several mousetrap cars and evaluate some of the factors that influence how a mousetrap car performs.

Tell the students that they will be making short presentation to the class of the cars they built in the previous lesson. Each presentation should be brief, only 3 - 5 minutes. During the demonstrations, the rest of the class will record questions (at least 1 per car) and observations that come up. Learner questions should reflect factors they think might improve the car's performance.

Planning Group Presentations (10 minutes):

These presentations are not meant to be formal and your learners should not spend a significant amount of time preparing them. Give each group the following criteria (on either the blackboard or a handout) and about 10 minutes to plan.

For each presentation, learners should:

- Tell what they did to build their car, what materials they used and any special design features
- Tell about what worked and what didn't work on their car
- Demonstrate how their car works

Holding a Car Show (Class Presentations) (30 minutes): Presentations should be made in a place where learners can stand and present and then test their car on an open space on the floor. Time needed will depend on class size and number of cars. Keep track of time and limit presentation length if needed.

Making Observations and Raising Questions:
During the presentations, learners record their observations and the questions they come up with about each car, including their own. Have each group number their cars for easy identification and to track which questions and observations are associated with a particular car.

- Have a stack of 4x6 notecards or half sheets of paper for each learner.
- Learners record the car # and one observation or question per card
- Questions should reflect things they wonder about and can investigate. For example, things they might change to improve a car's performance
- Observations should note things they wonder about but might not be able to form into a question

If learners need help or guidance in making observations or forming questions you may want to offer the following format and prompts. On each notecard, complete the following prompts after each presentation

> Car # (group)
>
> What did you notice about the car
> *Ex) I noticed it had a very short lever arm, about 4 inches.*
>
> What do you wonder about changing its performance
> *Ex) I wonder if making the lever arm longer will make it go farther.*
>
> Question: *How does changing the length of the lever arm affect the distance a car travels?*

Sorting Questions (15 minutes):
After the Car Show, using chart paper, make one sign per car # and one for "general questions". Quickly post them around the classroom. Each team should post their questions by car number (thereby sorting all the questions/observations by car #). Questions that are not about any specific car can be posted by the "General Questions" sign. Then have the individuals do a gallery walk (moving about the room) to read the variety of questions.

Reconvene the class. Give each team the collection of questions about their car. Together with their teammates, learners will go through the questions and sort them based on whether they can investigate them or not.

1. Discuss investigable (scientific) vs. non-investigable questions
   Learners will work with their partners to determine which questions can be investigated and which questions cannot. Questions that can be investigated are ones that students can act on. For example, changing materials used (size of the cardboard body) or car design features (wheel size, axle material, or lever length). Non-investigable questions are typically limited by available materials, safety or questions that can't be answered through investigation.
2. Review any observations from the Car Show. Ask the groups to read through the observations. If there are any observations that they want to know more about, have them set them aside. Have each group read each observation to see if they have any questions about it that can be investigated. If so add those questions to their list of questions.
3. Sort questions
   Tell the students to sort their questions into two piles: 1) Investigable questions and 2) Non-investigable questions. Set aside any non-investigable questions.

Choosing and Refining Questions (10 Minutes):
From the collection of investigable questions, pairs will narrow down and choose a question they want to investigate.

1. Materials Scan
   Share any new materials that they will have available for building. This will help them see what is possible to test. (See materials list at the end of lesson).
2. Selecting a Question
   Give the class time (5 minutes) to review all of their questions. Then have each team select one question to investigate about their car.
3. Refining Questions
   Direct the groups to refine their question to a single variable and be sure that it is a scientific, or testable, question. One that they can take an action on to investigate.

   Remind students about the definition of a scientific question. Scientific (testable) questions are ones that lead to an action. They can often be answered by conducting an investigation. Questions like "What would happen if I changed ______…?" or "How does ______ affect the distance my car will travel?" These questions are often answered by testing a specific variable or condition.

Teaching Tip
If you are concerned about the learners investigating too many different questions, you can constrain the kind of questions learners can pursue by limiting the materials available. Keep in mind other constraints (e.g., time) and consider only making sub-sets of additional materials available to your students to help tailor the investigations to particular topics.

Learners may need help refining or focusing their questions. To help the learners refine their questions, you may want to focus them on a specific aspect of their car. Use prompts to help them focus. Example:

- What part of the car or material (variable) would you like to investigate? *Wheels or axles*
- What changes could you make to your car? *Axle material*.
- What question will you investigate? *Will wood or brass axles make my car go farther?*

<u>If necessary, give examples of scientific questions</u>: Remind them that scientific questions are ones that they can take an action to test.

<u>Question</u>: Does the weight of the car affect the distance it can travel?
<u>Action</u>: add or remove weight to a car and test how far it travels.
<u>Question</u>: What size drive wheel will make the car travel farthest?
<u>Action</u>: test different size drive wheels for distance.
<u>Question</u>: What axle or bushing material gives the least amount of friction?
<u>Action</u>: test brass, steel, plastic and wooden axles or bushings to see which rolls farther
<u>Question</u>: Will increasing the length of the lever arm make the car travel farther?
<u>Action</u>: Test different length lever arms to see which one travels farther.

<u>Wrap up</u>:
Once the groups have selected and refined their questions, have them write down their final question on top of a Planning Investigations guide (See lesson 2.3). If any groups finish early they can begin planning.

Materials Needed for this Lesson:

Car Body	Axles/bushings	Levers	Wheels	String
Precut lengths of different materials (9" 12" 15" 18") • Double cardboard • Balsa wood • Foam board • Corrugated plastic	• Wood dowels (3/16") • Brass tubes (3/16") • steel rod (3/16") (optional) • Straws • Metal Washers, Screw eyes & other bushing materials	• ¼" wood dowels of different lengths • Balsa wood beams (3/16"x ½ ") of different lengths (8", 12", 16", 20")	• CD's <u>optional</u> • Mini CD's,8cm • Foam Board & corrugated plastic for cutting custom wheels	• Cotton string • Dental floss • Braided fishing line

You may also want to add other materials or allow students to bring their own materials for testing. But, bear in mind, providing fewer materials will constrain or focus the kind of questions learners can pursue, while providing more materials offers youth more possibilities for investigation, but also make it difficult for youth to focus their investigations. Consider only making limited sets of additional materials available to your students to help tailor the investigations to particular topics.

Mousetrap Cars
Track 2 Conducting Investigations with Mousetrap Cars

Lesson 3 – Planning Investigations

Time: 45-60 minutes (1 class period) Grades 6-8 lesson 3 of 7

Brief Activity Description:
Learners will plan an investigation based on a question developed in Activity 2.2 Raising Questions and adapt their car for testing during their investigation. Learners will carry out investigations in Activity 2.4 Conducting Investigations.

Specific Learning Outcomes: Youth will practice the following science and engineering practices:
- Plan an investigation to answer a specific question about a variable that affects how far a mousetrap car can travel.

Activity Lesson Plan:
There are two parts to this lesson, the first is to make a plan for an investigation and the second is to adapt your mousetrap car for testing or build a test car to use for your investigation.

Part 1 - Planning your Investigation
Preparation: In this part of the lesson, learners will develop a plan for their investigation based on the question they chose in the previous lesson. Learners will need to develop a procedure, a materials list, determine what data they will collect and how they will collect it. They can use the handout “Planning Your Investigation”(page 30) to write their plan for your approval.

Introduce the lesson (5 minutes): Tell the students that they will be making plans for their investigation. Review the materials they will have available to use for testing and remind them that their question and investigation should focus on one variable. As they plan their investigation, they will need to adapt their car for testing or build a test car (part 2 of this lesson). If the learners cannot use their existing car for their investigation, they should make a new car following the standard design and only make modifications necessary for testing their chosen variable.

Show the class a sample test car. You can prebuild a standard mousetrap car, Track 2, Activity 1 (figure 1). Then explain to the class, it is important to have a standardized car to test so that they can focus on changing a single variable, such as the length of the mousetrap lever. If learners have cars that do not work well or they try to change more than one variable at a time, it will be difficult to determine what is causing a change in the distance traveled. Ask the class how they might use this car, or one similar, to test their chosen variable. For example, how could they use it to test lever arm length, drive wheel size, or body weight? What additional modifications would they need to make to the car to test the variable?

Review the list of materials available for testing. You will need to choose from this list.

Car Body	Axles/bushings	Levers	Wheels	String
Precut lengths of different materials (9” 12” 15” 18”) • Double cardboard • Balsa wood • Foam board • Corrugated plastic	• Wood dowels (3/16”) • Brass tubes (3/16”) • steel rod (3/16”) • Straws • Metal Washers, Screw eyes & other bushing materials	• ¼” wood dowels of different lengths • Balsa wood beams (3/16”x ½ ”) of different lengths (8”, 12”, 16”, 20”)	• CD’s • Mini CD’s,8cm • Foam Board & corrugated plastic for cutting custom wheels	• Cotton string • Dental floss • Braided fishing line

Plan the Investigation (10-15 minutes): Review the steps of an investigation with the class. Then have groups write up their investigation plan using the Planning Your Investigation template. As they work, circulate between groups to help with their plans.

Consider each step in an investigation when supporting your learners:

1. What question are you investigating?
    a. Be sure it is scientific – leads to taking an action
    b. Be sure it focuses on a single variable that can be changed
2. What steps will you take to investigate your question?
    a. Help them to make each step very specific
    b. Read each step to see if you can follow it exactly as they intend
3. What materials will you need?
    a. Remind them to include specific amounts
4. How will you measure and record your results?
    a. In most cases, they will test and measure distance traveled, but they will also need to record changes in the variable being tested, i.e. wheel size, lever arm length, etc.
    b. Suggest they make a table to record their data.

Collect a copy of the investigation plan from each groups to review. You can return it at the next meeting. As soon as groups have completed their investigation plan they can begin to adapt or build their test car.

Part 2 – Making a Test Car

Preparation: in this part of the lesson, learners will adapt their mousetrap car for testing. For example, if they are testing the weight of the body they will need a way to add weight to the car between trials. Or, if they are testing lever length they will need a way to attach and try different lever lengths.

In some cases, their existing car may not work to test their chosen variable. In that case, they can build a standard test car with which they can explore their chosen variable. This is not recommended because students can fall into the trap of trying to design a completely new car and wasting precious investigation time.

Work time (20-30 minutes):

Allow time for the teams to prepare their car and collect any needed materials for their investigation. They may need to make small modifications in design to allow for changing variables, like wheel size, or axle material.

Planning Your Investigation Name:______________________________ Date:________________

What question are you investigating?

What is your variable? (What will you change?)

What steps will you take to investigate your question?

What materials will you need?

What will you measure and how will you record your results?

Mousetrap Cars
Track 2 Conducting Investigations with Mousetrap Cars

Activity 4 – Conducting Investigations

Time: 45-60 minutes (1 class period) Grades 6-8 Activity 4 of 7

Brief Activity Description:
Learners will conduct investigations on how changes in a variable like body weight, wheel size, axle or bearing material, lever arm length, etc. will influence the distance a mousetrap car will travel. Investigations are based on the scientific questions they chose in Activity 2.2. Raising Questions.

Specific Learning Outcomes: Youth will practice the following science and engineering practices:
- Conduct investigations on how changes in a variable affect how far a mousetrap car will travel.

Activity Lesson Plan:

Preparation: Learners will conduct the investigation that they planned in the previous activity. They will set-up their tests using available materials, collect and interpret data. For learners who finish quickly, keep them engaged by allowing them to modify their experiment design or question and retest.

Introducing the Lesson:
Reviewing investigation plans: Return the investigation plans to each group with any comments or concerns about their plans. If they need to make any adjustments to their plans allow them time to do so. If the groups have not finished their test cars, allow them time to do so.

Conducting investigations: Once their investigation plans are approved and the learners have a working test car, allow them to get to work. Remind them that they should be recording their results and observations. If they do not have them, provide engineering notebooks or paper.

Be sure they have adequate space to test. If they are successful and build cars capable of traveling farther than 50 feet, you may need to be creative in finding a large enough space (hallway) for testing.

Recording Data: The goal of this project is to learn what specific design and materials changes will improve the performance (distance traveled) of a mousetrap car. It is important that your learners record all data from their investigation. Data should include any changes to the car and any test results. For example, if the learners were testing lever arm length they should have a data table that includes the different length lever arms tested and the distance traveled for each length arm. Learners should also conduct multiple trials for each length lever arm.

Sample Data Table for testing lever arm length

Length of Lever	Distance Trial 1	Distance Trial 2	Distance Trial 3
12”	26’	27’	27’
16”	30’	29’	31’
20”	33’	34’	35’

Questions to consider when collecting data

1. *What variable are you testing?*
2. *What specific changes are you making to the car?*
3. *How many trials for each change will you do?*
4. *What are you measuring? (distance?) What units? (feet? Meters?)*

Concluding Investigations: Once the learners have finished their investigation, be sure they write down any final observations in their engineering notebook. They should look at their data. Did they see any trends? Did any of the changes in the variable make the car travel a farther, or shorter, distance?

The next lesson will focus on presenting their findings, so if there is any time left have them begin to prepare their presentations. Review Lesson 2.5- Analyzing and Presenting my Findings.

Mousetrap Cars

Track 2 Conducting Investigations with Mousetrap Cars

Activity 5 – Analyzing and Presenting my Findings

Time: 45-60 minutes (1 class period) Grades 6 – 8 Activity 5 of 7

Brief Lesson Description: Learners will prepare a presentation about their mousetrap car describing the car design, the design process, including what they learned about performance and the results of their investigations. Groups will share their presentations with the group/class. Depending on the size of your group you may want to dedicate one class period to planning presentations and one for giving presentations.

Specific Learning Outcomes: Learners will

- Analyze data from their investigation and interpret the results of any changes to the variable tested.
- Construct explanations about how different variables affect a car's performance based on testing and evidence.
- Communicate scientific and technical information orally and in written format using various forms of media.
- Present an oral argument and support it with evidence and scientific reasoning.

Activity Lesson Plan:

Preparation: Review the criteria for a basic presentation and make any necessary modifications. Learners should have their cars including any early models.

Determine what type of presentation the learners will give. Presentations can be

- Simple Show & Tell presented to the class
- Presentations at an afterschool parent evening
- A formal presentation given to the class and teacher for assessment
- A demonstration for 4-H County or State Activities Day

Introducing the Lesson:
Explain to your group that they will be preparing presentations about their investigations, which they will deliver to the class or group. There are 2 major parts to a presentation. The first part - What you did, explains the steps you took to conduct your investigation and the second part explains what you learned with evidence-based reasons.

Focus: In most cases, learners will need help to focus their presentation. Depending on the learners' age and experience the type, length and content of the presentation will vary.

Analyzing what you learned:
Before your learners can plan their presentations they need to consider what they learned from their investigation. Have the groups review their results and any changes they made to their variable. Did the change affect the distance the car traveled? Have the groups make a claim about the effect of changing their variable, give the evidence that supports the claim and state their reasoning. While they are working, circulate among the groups to check in and see if they need any help.

Definitions

Claim: A statement or fact.

Evidence: data or information that supports a claim

Reasoning: An explanation or scientific principles that connect evidence to a claim.

For example, in the table below the length of the lever arm was increased from 12" to 16" and 20". As the lever length was increased the average distance the car traveled also increased. Thus a claim can be made as follows. Claim: Increasing the length of the Mousetrap Lever arm from 12 to 16 to 20 inches makes the car travel farther. Evidence: The car with a 12" lever traveled an average distance of 26.6 feet, while the car with a 16" lever traveled an average of 30 feet and the car with a lever of 20" traveled an average distance of 34 feet. Reasoning: The cars with the longer lever arms consistently traveled farther than the cars with shorter lever arms.

Sample Data Table for testing lever arm length

Length of Lever	Distance Trial 1	Distance Trial 2	Distance Trial 3	Average Distance
12"	26'	27'	27'	26.6'
16"	30'	29'	31'	30'
20"	33'	34'	35'	34'

Planning my presentation:
Once learners have analyzed their data and made any claims supported by evidence, help them plan a presentation. Below is a list of what they might want to include in a presentation. Since they are the experts in what they did to build a car, your role as facilitator is to help them plan. They should organize their thoughts in a series of short points they want to make and copy their main thoughts onto numbered notecards..

A Mousetrap Car presentation should:

- Tell and show **what you did** and how you did it. – Include
  - How you built your car, What materials you used and how it works
  - How you tested and modified your car – what worked and what didn't work?
  - Include models of your car both first and final models

- Tell and show **what you learned** from your investigation
  - What variable(s) did you test, what were the results?
  - Show any data you collected in your investigation as a table or graph (Poster)
  - What claim can you make, what evidence supports your claim and what is your reasoning that connects the evidence to your claim

After each team has completed their outline and any notes for a short presentation, have them practice with each other.

Presenting my Mousetrap Car

Dedicate a time for youth to give their presentations. This could be a series of classroom presentations, or a Show and Tell for your 4-H club. After you have established and announced a time for presentations You should have a discussion and establish norms for watching presentations. How should the presenters act? How should audience members act? Write the norms on a poster and hang them up on the wall. Establish time after each presentation for questions and compliments.

When this is done allow each group to present their cars.

Mousetrap Cars
Track 2 Conducting Investigations with Mousetrap Cars

Activity 6 - Building a Race Car
(Optional)

Time: 60-90 minutes (1-2class periods) Grades 6-8 Activity 6 of 7

Brief Activity Description:
Sometimes it is fun to take knowledge that's been learned and use it to build something completely new. In this optional activity, youth use new knowledge and understanding about mousetrap cars to build a mousetrap racecar to compete in a distance contest.

Specific Learning Outcomes: Learners will
- Explain what design elements helped their prototype cars perform well
- Elaborate on how design elements will be used to design and build a new car for competition
- Design and build a new car for competition

Activity Lesson Plan:

Preparation: The learners should now have built, tested, modified and retested one or more mousetrap powered cars. They should be able to describe some of the variables/features that make the car travel farther. Using knowledge about mousetrap cars that they have gained from their prior experience, observing peers, and perhaps researching online, they will design and build a mousetrap powered car for a maximum distance contest. You should have chart paper to record ideas for best design features and have lots of materials on hand for building new cars. Review the contest rules (page 37) and determine where and how you will run your contest. Consider if the contest will be for the group or classroom or if they will attend a local community event.

Introducing the Lesson (5 minutes):
Tell your learners that they will now begin work on a new car to race in a mousetrap powered car distance challenge. Share the contest rules (page 37) and then review what they have learned about building a mousetrap car optimized for distance.

Engage & Explore:

Challenge: Build a racecar using any available materials and powered only by a mousetrap that will travel as far as possible. Race the car in a contest. (all cars must follow the contest rules provided)

Contest Rules:

9. Vehicle must be powered by one Victor brand mousetrap measuring: 1 ¾ " x 3 7/8 ".
10. The mousetrap cannot be physically altered except for the following:
    a. holes can be drilled only to mount the mousetrap to a frame
    b. the mouse trap's snapper arm may be cut and lengthened
11. Vehicles must be self-starting. They may not start with additional potential and/or kinetic energy other than what can be stored in the mousetrap's spring.
12. The spring from the mousetrap cannot be altered or heat-treated.
13. The mousetrap's spring cannot be wound more than its normal travel distance or 180 degrees.
14. The vehicle must steer itself and may not receive a push in any direction in order avoid a collision.
15. The greatest linear distance will be the total distance a vehicle travels measured perpendicular from the front of the starting line to the point of the vehicle that was closest to the start line and will not "angle" to where the vehicle comes to rest.
16. The Judge has the final decision as to the appropriateness of any additional items that might be used in the construction of the vehicle.

<u>Discussion</u>: (10 minutes) Hold a discussion with the class and give a brief review of all the discussions, findings & flip charts from activities one and two. Ask questions like, *What makes a good car? What's better? Big or small wheels? Large or small diameter axles? Long or short levers? Heavy or light cars?* Etc.

<u>Planning</u>: (10 minutes) Form groups of 2 and have each group talk about & design a new car to enter into a contest. What qualities do they want to carry over from their last car? What design elements do they want? They may want to consider wheel and axle size, frame/body construction, etc. As they design, learners should sketch their model in their engineering notebooks. Once their designs are complete and they sketched their designs in the engineering notebooks allow them to proceed with building.

<u>Build</u>: (60+ minutes) Allow learners time to build a new car. You may want to make new materials available and encourage youth to research design ideas online at home and bring in other materials. Ultimately, this may take more than one class/meeting session. But you should give a general time limit and keep them appraised of how much time they have.

<u>Closure</u>: Possible contest ideas:

4. Hold a contest within your group, club or class
5. Contact your county 4-H Staff to see about any local contests coming up
6. New Hampshire 4-H State Activities Day, held in late spring. (Contact your local 4-H Staff for details.)

Mousetrap Cars

Track 2 Conducting Investigations with Mousetrap Cars

Activity 7 - Holding a Distance Challenge

Time: 45-60 minutes (1 class) Grades 6-8 Activity 7 of 7

A Mousetrap Powered Car Distance Challenge can be a fun way to conclude your mousetrap car project. Holding a distance challenge contest can be a simple affair for your class, club or afterschool group or it can be a big contest for multiple groups or individuals, like 4-H County or State Activities Day. These rules and contest guidelines offer a template for any group to hold a distance challenge contest. Remember, this is a celebration of creativity, ideas, science, engineering and Making. It is meant to allow youth to test their cars and ability as Makers.

Distance Challenge Rules

The objective of the 4-H Maker Mousetrap Powered Car Challenge is for individuals and teams of 2 or 3 to build a vehicle, powered solely by a standard-sized mousetrap to race in a greatest distance contest.

These basic rules allow for a fair and consistent contest.

12. Vehicle must be powered by one Victor brand mousetrap measuring: 1 ¾ " x 3 7/8 ".
13. The mouse trap cannot be physically altered except for the following:
    a. holes can be drilled only to mount the mousetrap to a frame
    b. the mousetrap's snapper arm may be cut and lengthened
14. Vehicles must be self-starting. They may not start with any additional potential and/or kinetic energy other than what can be stored in the mousetrap's spring.
15. The spring from the mousetrap cannot be altered or heat-treated.
16. The mousetrap's spring cannot be wound more than its normal travel distance or 180 degrees.
17. The vehicle must steer itself and may not receive a push in any direction in order to avoid a collision.
18. All vehicles will go through a compliance check to be sure that it meets all the rules.
19. Each participant may have up to three trials to race their car. The best of measured distance will be scored.
20. The greatest linear distance will be the total distance a vehicle travels measured perpendicular from the front of the starting line to the point of the vehicle that was closest to the start line and will not "angle" to where the vehicle comes to rest.
21. The Judge has the final decision as to the appropriateness of any additional items that might be used in the construction of the vehicle.
22. Vehicles may <u>not</u> be altered during the contest between trials. Repairs may be made as long as they do not include any design changes.

Space

Well-constructed mousetrap powered cars can easily travel 100' – 200' (distance records approach 300') so you will need a space to accommodate at least that distance. A school gymnasium or cafeteria can work great or even a hallway is suitable for a smaller contest.

You will want the following materials to help you hold the contest

3. Blue Painters Tape – to mark a starting line on the floor
4. 100' Tape measure

Holding a large contest

If you are holding a larger contest for several afterschool groups or 4-H clubs you should also consider space for the registration, compliance checks, spectators and testing and fixing vehicles

Set-up and Materials

Registration

- Have a table and chairs set up for someone to check in participants as they arrive
- You may want to have a chart to collect youth name, vehicle name, club name and three blank spaces to record distance traveled for each vehicle (see appendix)

Compliance check in

- Have a table set up for volunteers to check to see that all participating vehicles meet the rules and requirements as written
- Have a copy of the rules as a checklist for each vehicle. You may want to have stickers to mark any vehicle that has been checked

Volunteers

You will need volunteers for the following roles. (Some roles can be combined)

- Registration – check-in and record all participants and set up a score sheet with participant names
- Compliance check - make sure all cars meet specifications and construction rules
- Judge - oversee trial runs and measure distances
- Score Keeper - keep score
- Demonstrations Judges (optional, if you are having a demonstration/presentation exhibition)

Presentations: Participants in 4-H clubs, 4-H SPINS or afterschool programs will have the option to also give their presentation at 4-H County Activities Day as a 4-H STEMonstration. If they plan to give their presentation as a 4-H Demonstration at 4-H County Activities Day you may want to review the 4-H Demonstration Requirements and Score sheet on the NH 4-H Website http://extension.unh.edu/NH-4-H-State-Activities-Day.

Recognition: It is important to plan for recognition of achievement in this contest. Since it is a contest, recognition should go to the overall top three finishers, based on distance traveled. You may wish to add categories based on age such as Elementary, Middle and High School. In 4-H, Juniors are 8-13 and Seniors are 14 – 18. Awards can consist of ribbons, trophies or prizes, science books or kits make great prizes. Demonstrations should be recognized with participation ribbons or Danish ribbons (Blue, Red or White ribbons based on scores).

Mousetrap Cars

Appendix

1. Working in the Classroom

Creating a Positive Learning Environment and Establishing Rapport

The process of tinkering, designing and building is often best done in a collaborative environment. Engineers can do their best work when thoughts and ideas are encouraged and shared. It is important to create an environment where learners are part of a team where everyone is respected and has a role.

Groups – Create student groups of 2 or 3. While friends often want to work together, it can sometimes be advantageous to assign groups based on individual strengths instead of close friendships. Be mindful of which individuals work well together. Assign each member, or have them, choose jobs so that everyone knows their role. Jobs can include

- Designer – takes the lead in assembling the ideas of the group members
- Builder – takes the lead in building and assigns specific building tasks to others
- Tester – takes the lead in testing
- Ambassador/recorder – takes the lead in observing other groups for new ideas to share and records key observation and testing results.

These jobs are suggestions and no one person is expected to do all of any one task. When appropriate the jobs can be changed over the course of the project to engage all learners in all the skills.

Holding Discussions: T-charts -- *What Works & What Doesn't Work*

Discussing what works and what does not work is a critical part of the design process. It allows learners to reflect on their observations and make sense of what they observe. These discussions are also a good opportunity to break up the building sessions into smaller manageable chunks. Once learners have been working for a while or after you notice some groups getting frustrated (15-20 minutes), ask the group to stop building. Have them leave their cars and come to the discussion circle. A "T Chart" is a chart divided into 2 columns by a large T drawn on a chart paper or chalkboard, it is used to list two contrasting ideas, such as what's working and what's not working. It is a convenient way to get learners to focus on and share what has worked and not worked in the construction of their cars. Ask the learners to share and list their responses on the T-Chart (see example below).

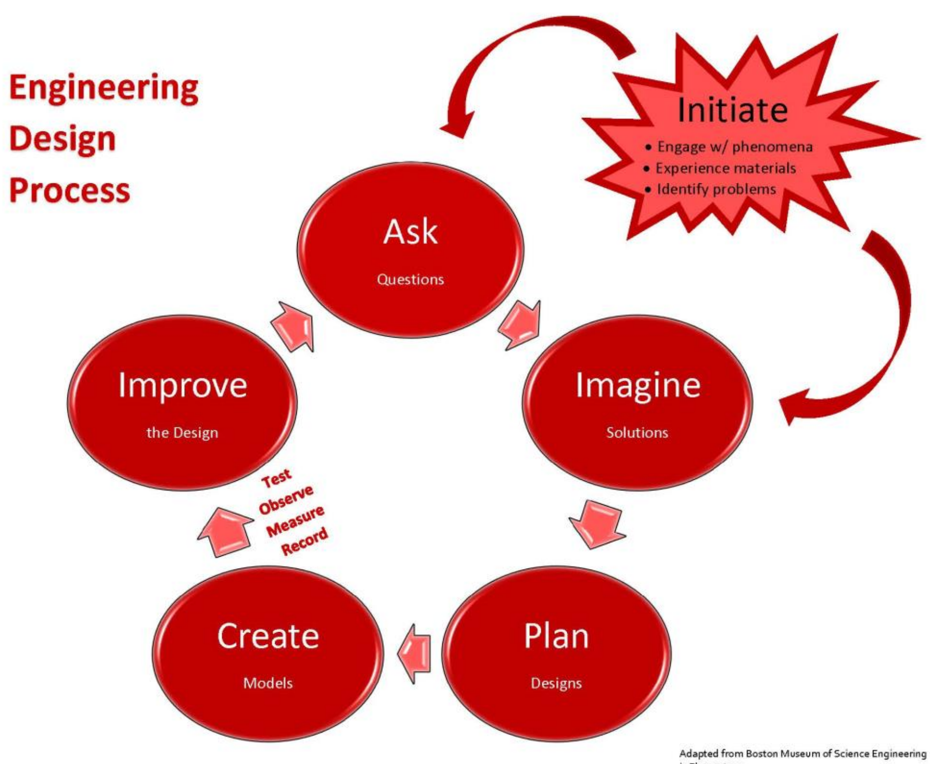
What's Working	What's Not Working
• Straight Wheels • Double thick cardboard • Triple thick cardboard • Making sure Wheels don't rub on car body	• Clay hubs • Taping axels to cardboard • Tape hubs • Sloppy glue on axles

Record their responses about things that are working on the left side of the chart and things that are not working on the right side of the chart. As they share their thoughts, ask for examples or observations that support their claims. Ask if anyone else made similar observations. Allow this discussion to go on only long enough to gather their thoughts and experiences (about 3-5 minutes) and then send them back with the reminder to focus on things that seem to be working and to move on from ideas that are not working so well.

2. Engineering Design Process

The Engineering Design Process is a cyclical process of design that involves questioning and imagining solutions to a problem followed by steps to plan, build, test and improve the design as an effective solution to the original problem. This model also includes a step for educators, Initiate. This step helps educators be intentional about how to introduce problems and engaged learners. When building mousetrap cars, the problem or challenge is to build a car powered by a single mousetrap that can go as far as possible, the engineering design process might look something like this:

1. Initiate – Identify the problem.– Present the challenge to build a car powered by a mousetrap.
2. Ask - Allow learners to play with and "mess around" with the materials. As learners explore the materials they should be making observations, asking questions and identifying problems driven by prior experience and the nature and availability of given materials.
3. Imagine – Having time to build and interact with materials will give learners ideas to start with, but discussing other solutions and taking time to process what's working and not working will help them to imagine practical solutions to the problem.
4. Plan – After an adequate amount of time building and testing learners will begin to gain the experience needed to plan for building a car that can go as far as possible.
5. Create – Giving learners ample time to create and test different model cars will help them form ideas and build understanding.
6. Improve – Having regular opportunities to test designs and interact with materials will likely inspire ways to make a design better. By sharing with their peers new ideas and improvements will help develop solutions to problems.



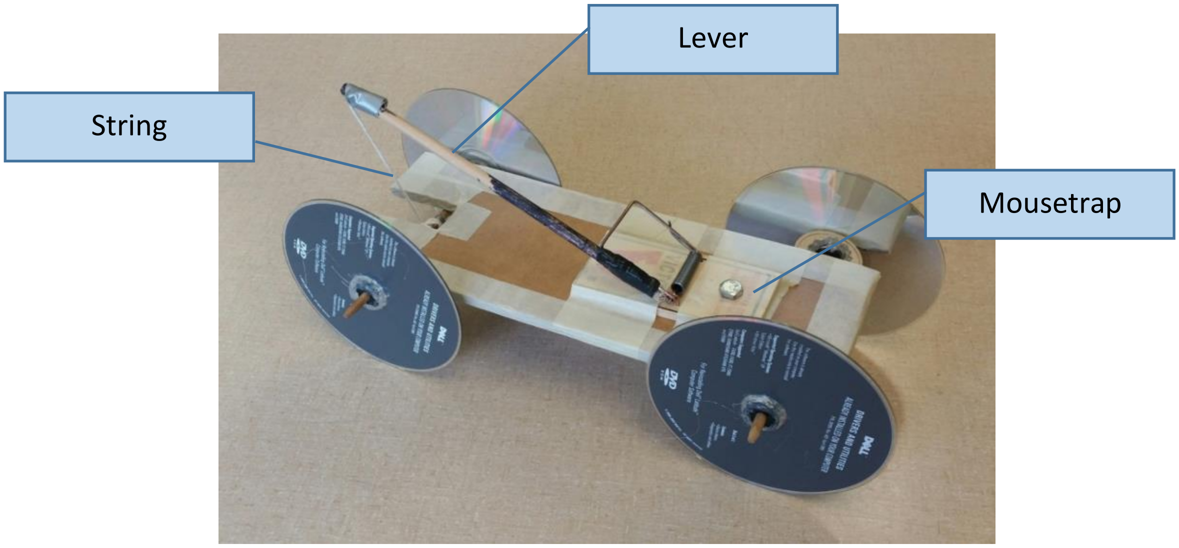
3. Next Generation Science Standards (NGSS) Performance Expectations

For classroom teachers and afterschool staff who would like to to align their lessons with Next Generation Science Standards, the following NGSS Performance Expectations are covered in these lessons. For evidence statements for specific Disciplinary Core Ideas, Cross Cutting Concepts and Science and Engineering Practices go to http://www.nextgenscience.org/evidence-statements and copy the specific standard into the search bar.

4-PS3-4.	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
3-5-ETS1-1.	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2.	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3.	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-ETS1-1.	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2.	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3.	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4.	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

4. Some Basic Science About Mousetrap Cars

A mousetrap powered car works by using the energy stored in the spring of a mousetrap to turn the wheels of a small car. This is usually accomplished by attaching a rod (aka 'lever arm')to the snap arm of the mousetrap, a string on the end of the rod is wound around the axle of the car pulling the snap arm back and putting tension on the mousetrap spring. When the snap arm is released the lever pulls the string, turning the axle on the car, driving the wheels and propelling the car. This is a good example of both potential and kinetic energy.



Potential Energy – Potential energy is often described as the energy stored by an object due to its position. When the mousetrap lever is pulled back it has potential energy stored in the spring.

Kinetic Energy – Kinetic Energy is often described as energy of motion. It is the energy of a moving object. Releasing the mousetrap lever is moving the car is an example of kinetic energy.

For example, a skateboard standing still at the top of a ramp has high potential energy (stored energy) and no kinetic energy (motion energy). As the force of gravity pulls it down the ramp it loses potential energy and gains kinetic energy. In a mousetrap car when the mousetrap lever is pulled back, winding the spring, the potential energy is increased. When the lever is released and the arm begins turning the wheel, moving the car, the potential energy is converted into kinetic energy.

Converting Energy – Energy can be converted from one form into another. Stored potential energy can be converted to kinetic energy.

For example, in a flashlight the chemical energy (potential) of a battery can be converted to light energy (kinetic) when it is turned on. In our mousetrap cars, the potential energy stored in the wound spring is converted to kinetic energy as the mousetrap arm pulls the string to turn the wheels. This is turning mechanical energy into energy of motion.

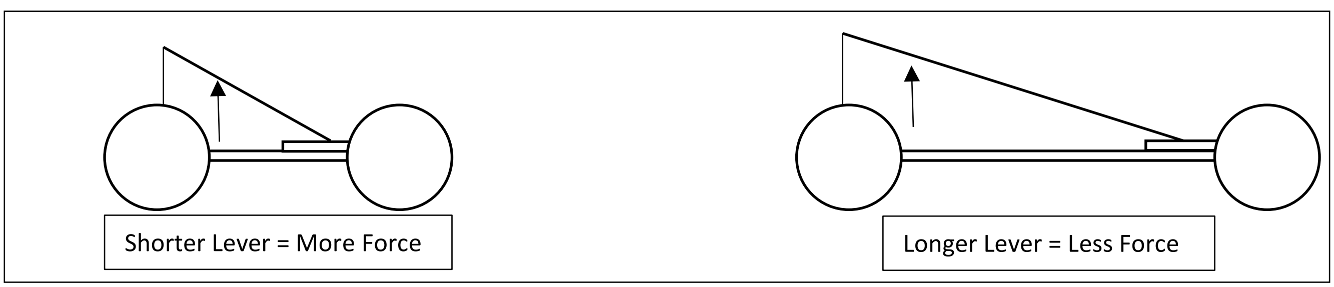
Some Common Observations and the Science behind Successful Mousetrap Cars

There are many factors that influence the distance a Mousetrap Car can travel. Three scientific concepts consistently come up in learner observations, though are not always clearly named and identified. A better understanding of these concepts by both learners and mentors can help design and build cars that travel father. These concepts are friction, torque, and inertia.

Friction – Friction is the resistance that occurs when two surfaces rub against each other. Friction can be a major impediment to a well performing car. Significant sources of friction in a mousetrap car include the friction between axles turning in the bearings and poorly aligned wheels rubbing on different parts of the car. Examples of situations that cause more friction include:

- Wobbly wheels rubbing on the ground slowing the rolling
- Wheels pinching and rubbing the body of the car
- The different surfaces of the axle/bearing combination – different materials create different amounts of friction. i.e. wooden axles turning in plastic straws have a different amount of friction than brass axles turning in steel bearings.
- Lubrication of axle & bearing surfaces – WD-40, Graphite or silicone lubricant can affect friction.

Torque – Torque is the measure of force needed to rotate an object around an axis. The amount of force needed to turn an object is dependent on the size and mass of the object and the amount of leverage that can be applied to turn the object. For example, it is harder to start a larger wheel spinning than a smaller one. In a Mousetrap Car torque most commonly comes into play in the length of the lever used to turn the axle and in the size of the wheels. Since the amount of energy in a mousetrap spring is fixed, you can change the amount of force it applies by changing the length of the lever. A short lever will apply more force and a longer lever will apply less force. You may notice that cars with shorter levers travel faster and not as far and ones with longer levers travel more slowly but farther. Also, cars with larger wheels are harder to turn (require more force) than ones with smaller wheels.



Inertia – Inertia is the tendency of an object to resist moving or changing direction unless acted on by another force. In mousetrap cars, this is most evident in the energy needed to get a car to roll. Since the energy of the mousetrap spring is fixed, certain factors will make it easier (require less energy) to get the car to roll.

- Lighter cars take less energy to roll.
- Less friction in the wheels & axles make it easier to roll
- While a longer lever, and string, can make a car travel farther, if the lever is too long it will not have enough force to get the car to roll.

There are several other science concepts that can be applied to make mousetrap cars travel farther, The Doc Fizzix website has lots of super helpful information on the science, building and racing of Mousetrap Cars. They also sell Mousetrap Car kits. http://www.docfizzix.com/. A quick Internet search for “Mousetrap Cars” will also turn up dozens of other videos and websites that can be useful when building mousetrap cars.

5. Materials for Mousetrap Cars

Track 1 - Exploring Engineering Design with Mousetrap Cars
Materials for 16 Cars

Item	price	qty/pck	price/ea.	Qty/Car	Total Qty	Total cost
Mouse Trap	$ 1.98	4	$ 0.50	1	16	$ 7.92
DVD's	$ 19.99	100	$ 0.20	4	64	$ 12.79
Straws	$ 8.31	500	$ 0.02	2	32	$ 0.53
3/16 dowel (6")	$ 0.65	8	$ 0.08	2	32	$ 2.60
Cone washers	$ 1.99	10	$ 0.20	4	64	$ 12.74
1/4"dowel (12")	$ 0.85	4	$ 0.21	1	16	$ 3.40
Total Cost						**$ 39.98**
					cost/car	**$ 2.50**

Additional materials to complete a basic car
Cardboard for body Hot Glue
Tape (masking or Duct) string
extra zip ties

Additional Items for modification and adapting cars
The idea here is to allow learners to create build and adapt they should look for anything they can to improve their design

Wheels - anything round, like jar lids, foamboard or corrugated platic to cut discs, Chinet plates
Car bodies - foamboard, balsa wood, paint sticks, 1/2 "pvc pipe **Axles -** steel wire, different size dowels, brass or steel tubing etc. **Hubs** - Soda bottle caps
Bushings - Straws, brass or steel tubing, plastic tubing **Lever Arms** - extra 1/4 in dowels cut at 9", 12", 15" & 18" Balloons or Rubber bands for "tires"

Track 2 - Conducting Investigations with Mousetrap Cars

You will need many different materials & dimensions for learners to investigate and test. Have a broad variety of materials on hand to encourage learners to investigate different variables that might affect a cars performance.

Materials for Activity 1 (30 Students/15 Cars)

		price	qty/pck	price/ea.	Qty Needed	Total cost	Vendor
Wheels							
CD's		$25.00	100	$0.25	60	$15.00	docfizzix.com
Doc Fizzix wheel spacers		$25.00	100	$0.25	60	$15.00	docfizzix.com
or 1/4L cone washers (19/32" OD)		$2.99	10	$0.30			
Body							
Corrugated Cardboard		Recycle				0	
4 1/2" wide cut to (9", 12", 15", 18")							
Axles							
6" wooden dowels (buy 3/16" x 48")		$0.68	8	$0.09	30	$2.55	Home Depot
6" brass tubing 3/16" OD		$24.95	40	$0.62	30	$18.71	docfizzix.com
Note: tubing from Doc fizzix comes in 6" & 12" and may need to be cut to length							
bearings							
straws		$ 1.00	100	$0.01	30	$0.30	walmart
Lever arm							
wooden dowels ~ 12 -1/4" x 48"		$0.78	3	$0.26	15	$3.90	Home Depot
cut to different lengths (9, 12, 16, 18") have 10 of each available							
Mousetraps		$ 1.98	4	$ 0.50	15	$7.43	Walmart
					Price/Car	$4.19	

Optional Materials for Investigation

For planning and conducting investigations, you will need a variety of materials on hand. See activity 2.3 Planning Investigations for suggestions. Depending on time, resources and goals the materials mentioned here are optional.

		price	qty/ pck	price/ ea.	Qty Needed	Total cost	Vendor
Wheels these optional materials can support exploration on wheels							
Mini CD's (8 cm)		$25.99	50	$.52	50		amazon
Doc Fizzix DVD Layers (1/2 thickness DVD's)		$30.00	100	$0.30	100	$30.00	docfizzix.com
1/4" Foam board (20x30) for large wheels		$3.00	6	$0.50	5	$15.00	walmart or staples
4 mm corrugated Plastic 30x36 for wheels		$10.00	9	$1.11	2	$20.00	walmart or staples
Body							
If you want to explore other body materials							
1/4" Foam board (20x30) (10 4x15 cars)		$3.00	10	$0.30			
4 mm corrugated Plastic 30x36 (18, 4x30”)		$10.00	18	$0.56			
Balsa Wood (mixed dimensions)							
3/16 x 3" x 36 (body platform)		$1.50	2	$0.75	10	$15.00	balsawoodinc.com
3/16 x 4" x 36 (body platform)		$2.16	2	$1.08			
3/16 x 1" x 36 (rails)		$0.74	2	$0.37	10	$7.40	balsawoodinc.com
5mm Birch Plywood (mixed dimensions)							
1/4" x 2'x2' (body platform)		$4.00	16	$0.25	1	$4.00	Home Depot
1/4" x 2'x4' (body platform)		$6.00	32	$0.19			
1/4" x 4'x 8' (body platform)		$17.00	120	$0.14			
1/4" Foam board (20x30) (10 4x15 cars)		$3.00	10	$0.30			
4 mm corrugated Plastic 30x36 (18, 4x30 cars)		$10.00	18	$0.56			
sandpaper for smoothing rough edges							
Axles							
6" wooden dowels (buy 3/16" x 48")		$0.68	8	$0.09	30	$2.55	Home Depot
6" brass tubing 3/16" OD		$24.95	40	$0.62	30	$18.71	Docfizzix.com
steel rod (1/8" x 36")		$2.19	6	$0.37	5	$10.95	Home Depot
Bearings							
washers (different materials w/ hole 1/4")		$10.00			1	$10.00	Home Depot
brass tubing 1/4" ID		$5.92	50	$0.12	1	$5.92	onlinemetals.com
screw eyes (1/4 " hole)		$3.50	10	$0.35	4	$14.00	Home Depot
Lubricant such as WD 40, powdered graphite or veggie oil?							
Levers							
Balsa Beams (3/16 x 1/2 x 36")		$0.38	2	$0.19	10	$3.80	balsawoodinc.com
different lengths (12, 16, 20, 24")							

6. Building a Simple Mousetrap Car

The following steps are a guide to build a simple mousetrap car.

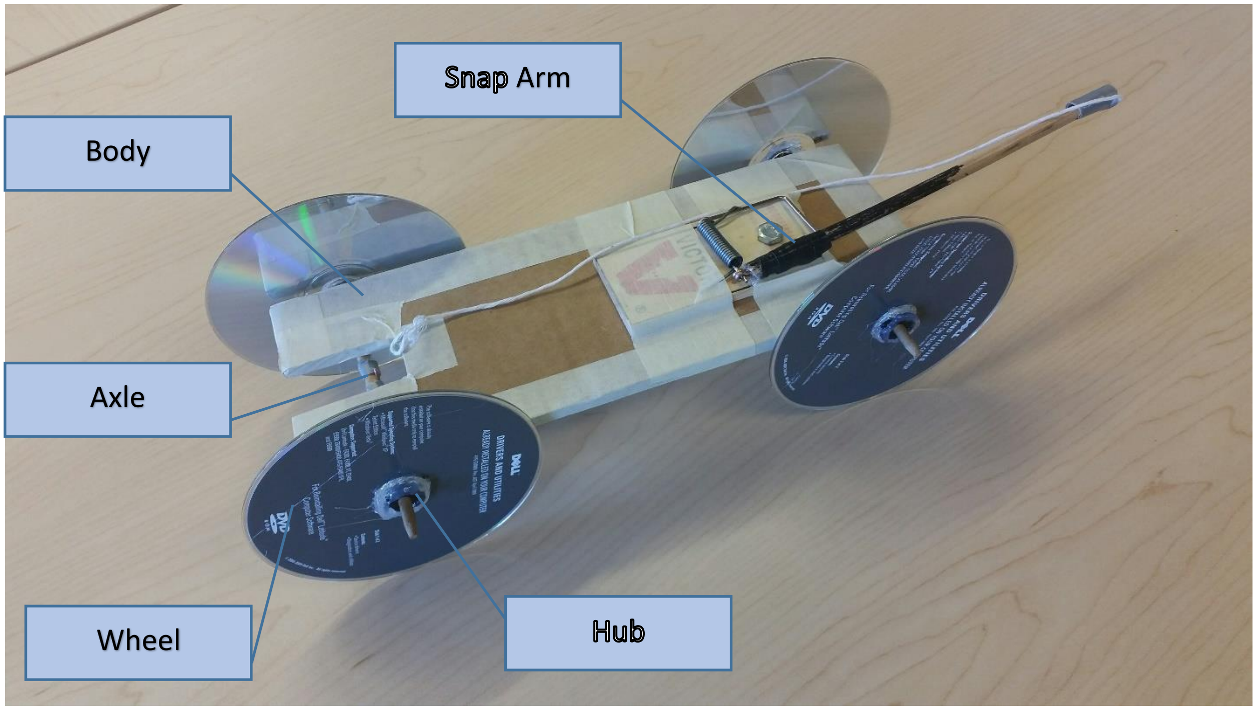


Figure 1 Basic car design

Materials (for a single car)

- 2 pieces of Cardboard (4" x 10") many dimensions will work, but this is a good starting place.
- 4, DVD's (old used ones work great or new black ones from an office supply store)
- 4, 1/4L (19/32") Beveled Faucet Washers (found at most hardware stores in the plumbing dept.)
- 2, 3/16" Dowels - 6" long (these will need to be longer if you use wider pieces of cardboard)
- 1, ¼ inch dowel, 6 – 12 " long
- 2, Straws
- Tape – Masking & Duct
- zip ties (an assortment of 4" & 8" works well)
- String
- Hot Glue
- Scissors
- Something to cut wooden dowels

Step 1 – Cut a rectangular notch (about 1" x 2 ") on the short side of each piece of cardboard so that the notches overlap (Figure 2).

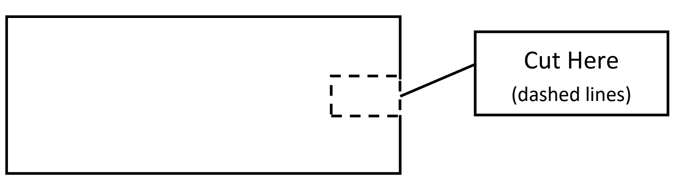


Figure 2 Cutting the cardboard pieces

Step 2 – Place the two pieces of cardboard on top of each other and tape them together to make a double thick piece of cardboard. Make sure the notches line up as in Figure 2.

Step 3 – Cut 3 sections of straw to fit on the body of the car like in the illustration below. Glue them in place using a glue gun (Figure 3). This will be the underside of the car.

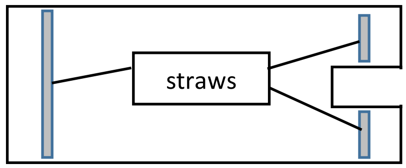


Figure 3 Attaching the straws

Step 4 – Glue the mousetrap in place on the topside of the car with the glue gun. Be sure the closed snap is facing away from the notch in the cardboard. See Figure 1 for placement.

Step 5 – Use 2 zip ties to secure the ¼ inch dowel to the snap arm and reinforce with tape or hot glue (Figure 1).

Step 6 – Glue the faucet washers into the center of the DVD's. Be sure to use a generous bit of glue to make sure they hold.

Step 7 – Place the 3/16" dowels into the straws and press the wheels onto each end.

Step 8 – Attach a 4" zip tie to the center of the axle exposed by the notch in the cardboard, and cut it short, about ¼ inch. This is the hook for the string. A dab of glue will help keep it in place.

Step 9 – Tape a piece of string to the end of the ¼ inch dowel. On the other end tie a small loop. It should be long enough to reach the hook on the rear axle.

Your car should look something like Figure 1. Hook the Loop over the zip tie hook on the rear axle and wind the wheel up. Place the car on the floor and let it go. You will likely have to tinker a bit with it to make it run smoothly.

Additional Materials

Once you have built a basic car you will find that there are dozens if not hundreds of variations on this design. A quick internet search will offer many websites and YouTube videos with car designs. But the best thing for your learners is to give them a chance to explore. Provide a variety of materials to experiment with. Below are some suggestions for materials but use your, and your learners', creativity in collecting and using all kinds of materials. Try some of the following materials:

Body – Balsa wood, paint sticks, Blue board (foam), pvc pipe, foam board etc.

Wheels – DVD's, Jar lids, wooden wheels, Lego Wheels, cut discs from foam board or corrugated plastic, you may want balloons or rubber bands to serve as "tires" to enhance grip.

Hubs – Rubber faucet washers, soda bottle lids (poke a hole in the center and glue it to the wheel)

Axles – Try different size dowels, stiff wire. Axels can spin in straws, plastic pen casings even metal eyehooks

Snap arm levers – Anything strong and straight. Wooden dowel