MOUSETRAP POWERED RACER: WELCOME TO THE RAT RACE

Written by Rachel M. Baxter

Instructor Section

Estimated Time for Activity

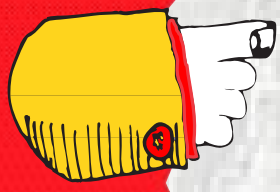
Learning Objectives

TEKS Covered

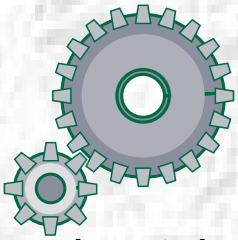
Related Concepts/ Courses/Supporting Information

Key Terms with Definitions

Resources Needed to Teach this Unit

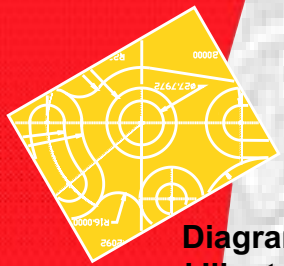


Introduction to the Activity



Procedures to be Used by theTeacher

Suggested Evaluation



Diagrams and Illustrations

Additional References

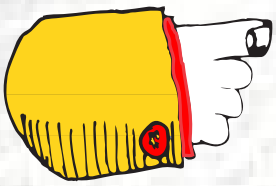
Extension Activities

MOUSETRAP POWERED RACER: WELCOME TO THE RAT RACE

Written by Rachel M. Baxter

Student Section

Challenge/Problem

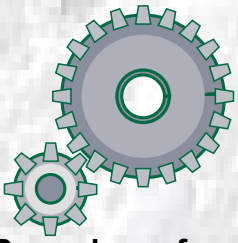


Introduction/
Background

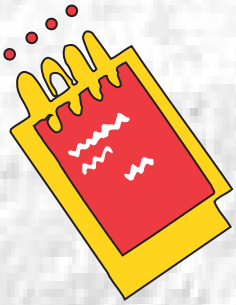
Learning
Objectives

Resource List

Key Terms



Procedures for
this Activity



Work Sheets/
Lab Sheets

Follow-up

Evaluation

Mouse Trap Powered Racer: Welcome to the Rat Race

Estimated Time for Activity

- Distance Challenge - 7 to 10 Days
  Speed Challenge - 7 to 10 Days
  Braking Challenge - 7 to 10 Days

Learning Objectives

After completing this activity, the student will be able to:

- Explain how aerodynamics or fluid friction affects a car's performance
- Identify the parts of a basic car
- Explain at least 2 different ways to reduce friction
- Explain how Newton's Law of Motion affects a car
- Identify and explain what kinds of wheels and rotational inertia are needed for the different challenges
- Explain the difference between potential and kinetic energy as it relates to their car
- Define associated key terms

TEKS Covered

§123.15.1	The student describes how a systems model can be used to describe energy, power, and transportation activities.
§123.15.2	The student applies energy, power, and transportation technology to specific tasks.
§123.15.3	The student designs energy, power, and transportation products or services using appropriate design processes and techniques.
§123.15.5	The student describes quality and how it is measured in energy, power, and transportation.
§123.15.6	The student builds energy, power, and transportation devices using the appropriate tools, equipment, machines, materials and technical processes.
§123.15.7	The student works safely with energy, power, and transportation technology.
§123.15.9	The student manages an energy, power, and transportation technology project or system.
§123.15.14	The student describes the economic factors related to energy, power, and transportation technology.
§123.15.15	The student applies his/her communication, mathematics, and science knowledge and skills to energy, power, and transportation activities.
§123.15.18	The student describes the importance of teamwork, leadership, integrity, honesty, work habits, and organizational skills.

Mouse Trap Powered Racer: Welcome to the Rat Race

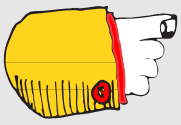
Instructor Section

Related Concepts/Courses/Supporting Information

- Mathematics
- Science
- Physics

Key Terms with Definitions

1) **Friction:** The resistance or force that happens when 2 objects or materials come into contact with each other, or when their surfaces slide over one another.
2) **Fluids:** The term used for liquids and gasses as a collective whole.
3) **Aerodynamics:** The study of the forces of air on an object as it moves through the air.
4) **Surface friction:** Most commonly found between the axle and the chassis.
5) **Bushing or bearing:** An object that reduces surface friction by acting as a smooth sleeve. This helps stabilize the wheel and provides a smaller area for surface friction.
6) **Lubricant:** Oily compound used to reduce friction.
7) **Traction:** A "good" type of friction. This is what keeps tires from slipping when in contact with the road.
8) **Fluid friction:** The drag created by tires or wheels.
9) **Newton's First Law of Motion:** States that an object will continue moving just like it is, until acted upon by an outside force.
10) **Newton's Second Law of Motion:** States that the acceleration of an object is directly proportional to the force acting on the object, the direction of that force, and the object's mass.
11) **Chassis:** The most important part of a car, it is the underlying structure, body, or spine of the car.
12) **Rotational inertia:** The resistance that an object has to changes in its rotation. Wheels that have large rotational inertia will coast farther, but for speed, less rotational inertia is ideal.
13) **Potential energy:** The spring on a mousetrap holds this stored energy.
14) **Kinetic energy:** The energy that is created by releasing the mousetrap spring.
15) **Power:** Equal to the amount of work done and the amount of time it is done in.
16) **Power output:** Power created by shortening or lengthening the pulling arm.
17) **Torque:** A force produced by a leverage that results in a turning motion.



Introduction to the Activity

A basic mousetrap car is constructed by attaching one end of a string, rubber band, fishing line, etc. to the metal "U" shaped lever on the mousetrap, and the other around an axle. When the trap is sprung, the string pulls the axle and propels the car. The design and materials should be left to the imagination of the students. The only rule should be that all of the students get the same type of mousetrap.

Students will need to plan, research, and think critically to solve the given problems. They must also decide how to reduce friction at the wheels and axles, how to keep the chassis air-streamed, and what kind of axles and tires they will use. Remind students that every time they make a change and test their design, they must record the result data so that they can compare the data and decide which is the best design to solve the problem.

Mouse Trap Powered Racer: Welcome to the Rat Race

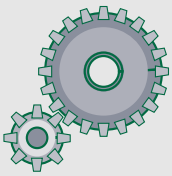
Instructor Section

Resources Needed to Teach This Unit

1) Standard mouse traps (1¾" by 3 7/8")
   - Never use a rattrap because they are too powerful and can break fingers.
2) Chassis materials
   - Wood scraps
   - Balsa wood
   - Ice cream sticks
   - Stiff wire, etc.
3) Axle materials
   - Wooden dowel rods
   - Metal tubes
   - Axles from old toys
   - CO^2 car axles, etc.
4) Wheel Materials
   - Metal lids
   - CDs
     - ✓ CDs make great wheels, but they are hard to attach to the axle. Try using a ¼ "L" sink washer, fit to into the wheel and press the axle securely into it. Records
   - Old toy wheels
   - Anything disc shaped
5) Pull cord materials
   - String
   - Rubber bands
   - Fishing line, etc.
6) Hobby or X-acto knife
7) Files (round & square)
8) Sandpaper
9) Power drill
10) Dremel
11) Glue
    - Wood glue
    - Hot glue
    - The glue has to be strong enough to withstand the force of the mousetrap when released.
12) Coping saw
13) Hack saw
14) Pliers
15) Soldering iron
16) Wire cutters

Mouse Trap Powered Racer: Welcome to the Rat Race

Instructor Section



Procedures to be Used by the Teacher

1) Run the races on any smooth level floor, gym, hallway, etc., but not on a carpeted surface.
2) Give each car 3 attempts.
3) Rank the students' cars based upon whose car went the greatest total distance, or at the greatest speed. If there is a tie, have a tie-breaking run to determine which car is the best.
4) Instruct the students to follow these rules during the construction of their car.
   - The mousetrap provided by the teacher must power the car.
   - You may not make any physical treatments (like heating the rods).
   - You may only drill 4 holes for mounting.
   - You are only allowed to remove the spring to adjust the length of the lever arm. You can not add any extra potential or kinetic energy to the car; other that what can be stored in the trap it self.
     - ✓ No pushing it, blowing it, using CO^2 cartridges, etc.
   - You cannot alter or heat-treat the trap's spring.
   - The spring can not be wound more that it's normal distance of 180 degrees.
   - The vehicle must be self-starting; you can not assist it in any way.
   - The car needs to be self-steering and must travel in a straight line, plus or minus a few inches.
     - ✓ You will be measured in a straight line from the starting point to the ending point, not the actual distance it may have traveled, if at an angle.
   - During the Speed Challenge, the time will start when the car passes the starting point and will end when it passes the distance mark.
   - The instructor makes all final decisions as to what items or materials can be used to create your vehicle.

Suggested Evaluation

It is recommended that students be evaluated on the following items:

- Daily participation and work
- Accurate records of different experiments
- The length or speed that the car traveled and its accuracy of a straight line of travel, or its ability to brake efficiently
- Originality
- Class rank based upon length, accuracy, speed, braking abilities and originality

Mouse Trap Powered Racer: Welcome to the Rat Race

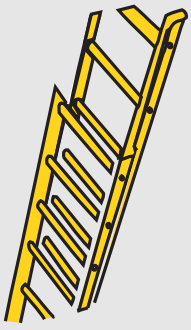
Instructor Section

Additional References

1) Balmer, A. (1997). Mousetrap cars: a teacher's guide. Austin, TX: Armstrong Printing.
2) Balmer, A. (1997). Mousetrap cars: a student's guide. Austin, TX: Armstrong Printing.
3) Balmer, A. (1997). Armstrong Printing Austin, TX.:
   - The Ultimate DISTANCE Car
   - The Ultimate SPEED Car
   - The Ultimate BRAKING Car
4) Balmer, A. Lab and Formula Guide Package software.

Diagrams and Illustrations

None



Extension Activities

None

Mouse Trap Powered Racer: Welcome to the Rat Race

Student Section

Student Challenge

Your challenge will be to design and construct a mousetrap car with the goal of having your car travel the greatest distance in a straight line, plus or minus a few inches. Your teacher will provide a single mousetrap, which must power the car. The supplies and design will be up to you; however, you must use recycled materials whenever possible and you will be given a price limit.

HINT: Larger wheels will have more rotational inertia and will coast farther. Keep in mind that 3 wheels work best for any design. For a slower car that has more pulling distance, move the trap away from the pulling axle and lengthen the lever's pulling arm. Do not forget about friction. Air drag is not desired, but having the wheel grab the floor is good.

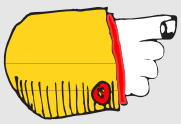
STUDENT CHALLENGE: SPEED

Your challenge will be to design and construct a mousetrap car with the goal of having your car travel 5 meters or 15 feet in the shortest amount of time possible. Your teacher will provide a single mouse-trap, which must power the car. The supplies and design will be up to you; however, you must use recycled materials whenever possible and you will be given a price limit.

HINT: Smaller and lighter wheels will have less rotational inertia and will move faster. For a faster car that has less pulling distance, move the trap near the pulling axle and shorten the lever's pulling arm.

STUDENT CHALLENGE: BRAKING

Your challenge will be to design and construct a mousetrap car with the goal of having your car travel as closely as it can to the 5 meter or 15 feet mark, without actually going past the mark. Your teacher will provide a single mousetrap, which must power the car. The supplies and design will be up to you; however, you must use recycled materials whenever possible and you will be given a price limit.



Introduction/Background

A basic mousetrap car is constructed by attaching one end of a string, rubber band, fishing line, etc. to the metal "U" shaped lever on the mousetrap, and the other around an axle. When the trap is sprung, the string pulls the axle and propels the car. The design and materials are left to your imagination. You will however, have to use the same standard mousetrap that your classmates use.

You will need to plan, research, and think critically to solve the given problems. You must also decide how to reduce friction at the wheels and axles, how to keep the chassis air-streamed, and what kind of axles and tires to use. Remember that every time you make a change and test your design, you must record the results so that you can compare the data and decide which is the best design to solve the problem.

Mouse Trap Powered Racer: Welcome to the Rat Race

Student Section

Learning Objectives

After completing this activity, you will be able to:

- Explain how aerodynamics or fluid friction affects a car's performance
- Identify the parts of a basic car
- Explain at least 2 different ways to reduce friction
- Explain how Newton's Law of Motion affects a car
- Identify and explain what kinds of wheels and rotational inertia are needed for the different challenges.
- Explain the difference between potential and kinetic energy as it relates to your car
- Define associated key terms

Key Terms

1) Friction:
2) Fluids:
3) Aerodynamics:
4) Surface friction:
5) Bushing or bearing:
6) Lubricant:
7) Traction:
8) Fluid friction:
9) Newton's First Law of Motion:
10) Newton's Second Law of Motion:
11) Chassis:
12) Rotational inertia:
13) Potential energy:
14) Kinetic energy:
15) Power:
16) Power output:
17) Torque:

Resource List

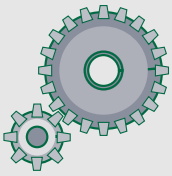
1) 1 standard mouse trap
2) Chassis materials
   - Wood scraps
   - Balsa wood
   - Ice cream sticks
   - Stiff wire, etc.
3) Axle materials
   - Wooden dowel rods
   - Metal tubes
   - Axles from old toys
   - CO^2 car axles, etc.

Mouse Trap Powered Racer: Welcome to the Rat Race

Student Section

Resource List (cont)

4) Wheel materials
   - Metal lids
   - CDs
     - ✓ CDs make great wheels, but they are hard to attach to the axle. Try using a ¼ "L" sink washer, fit it into the wheel and press the axle securely into it. Records
   - Old toys wheels
   - Anything disc shaped
5) Pull cord materials
   - String
   - Rubber bands
   - Fishing line, etc.
2) Hobby or X-acto knife
3) Files (round & square)
4) Sandpaper
5) Power drill
6) Dremel
7) Coping saw
8) Hack saw
9) Pliers
10) Soldering iron
11) Wire cutters
12) Glue
    - Wood glue
    - Hot glue
    - The glue has to be strong enough to withstand the force of the mousetrap when released.



Procedures for This Activity

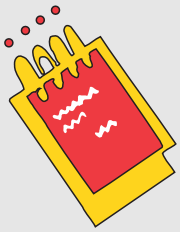
1) Consider each challenge and answer the questions on the attached worksheets.
2) Build your mousetrap car.
3) Test and record the car's data.
4) Complete the worksheet for each challenge.
5) Begin the next challenge.

Evaluation

- Refer to the attached Challenge Worksheets:
  - ✓ Braking Challenge Worksheet (Provided - Click Here)
  - ✓ Speed Challenge Worksheet (Provided - Click Here)
  - ✓ Distance Challenge Worksheet (Provided - Click Here)

Mouse Trap Powered Racer: Welcome to the Rat Race

Student Section



Worksheets/Labsheets

- Distance Challenge Worksheet (Provided – Click Here)
- Speed Challenge Worksheet (Provided – Click Here)
- Braking Challenge Worksheet (Provided – Click Here)
- Material Data Tracking Sheet (Provided – Click Here)
- Experience / Test Data Tracking Sheet (Provided – Click Here)

Follow-Up

None

Distance Challenge Worksheet

GRADING:

1) Daily participation and work
2) Accurate records of different experiments to see what works best
3) The length that the car travels and its accuracy traveling in a straight line
4) Originality
5) Documentation (Attach this sheet)
6) Class rank based upon length traveled, accuracy, and originality

JUDGING:

Rank will be based upon:

30% Originality _____

35% Distance _____

35% Accuracy _____

PROOF OF "BRAIN STORMING":

1) Access the problem. What do you think will work the best? _____

_____

_____

_____

2) Why? _____

_____

_____

_____

Sketch out your design/ideas:

Speed Challenge Worksheet

GRADING:

1) Daily participation and work
2) Accurate records of different experiments to see what works best
3) The speed that the car travels to the 5 meter or 15 feet mark
4) Originality
5) Documentation (Attach this sheet)
6) Class rank based upon speed, accuracy, and originality

JUDGING:

Rank will be based upon:

30% Originality _____

35% Speed _____

35% Accuracy _____

PROOF OF "BRAIN STORMING":

1) Access the problem. What do you think will work the best? _____

_____

_____

_____

2) Why? _____

_____

_____

_____

Sketch out your design/ideas:

Braking Challenge Worksheet

GRADING:

1) Daily participation and work
2) Accurate records of different experiments to see what works best
3) The ability of your car to stop as close to the 5 meter or 15 feet mark as possible
4) Originality
5) Documentation (Attach this sheet)
6) Class rank based upon braking ability, accuracy, and originality

JUDGING:

Rank will be based upon:

30% Originality _____

35% Stopping Ability _____

35% Braking _____

PROOF OF "BRAIN STORMING":

1) Access the problem. What do you think will work the best? _____

_____

_____

_____

2) Why? _____

_____

_____

_____

Sketch out your design/ideas:

Mouse Trap Car: Welcome to the Rat Race

Material Data Tracking Sheet

Name: _____ Period: _____

Date: _____ to _____

Subject: Exploring Energy, Power, & Transportation Technology

Teacher: _____

You must list all of the materials or parts used to make your car. If there is more than one of any item used, you must list the quantity used. You must also list the cost of the part. If it was given to you, you must give an estimated cost. If it is a recycled material, it is free, but you must state where you got it. You will find it is easier if you share the cost on any materials that you buy.

YOUR TOTAL COST CAN NOT EXCEED: **$_____**

Part	Material	Approx. Size	Quantity	Bought or Recycled	Cost "$"
			Total Cost		$

Mouse Trap Car: Welcome to the Rat Race

Experiment/Test Data Tracking Sheet

Name: _____ Period: _____

Date: _____ to _____

Subject: **Exploring Energy, Power, & Transportation Technology**

Teacher: _____

SKETCH THE BASIC DESIGN:

DATA TRACKING CHART:

Car's Mass		Friction Force of Non-Drive Wheel(s)	
Car's Weight		MAX Acceleration	
Force on Drive Wheels		Drive Wheel Axle Radius	
Center of Mass from Non-Drive Wheels		Drive Wheel Radius	
Rotational Inertia of Drive Wheels		String Tension at Start	
Rotational Inertia of Non-Drive Wheels		Potential Energy of Trap	
Wheel Grip or Traction Force		Predicted Distance of Travel	
		Actual Distanceof Travel	

Mouse Trap Car: Welcome to the Rat Race

Experiment/Test Data Tracking Sheet

QUESTIONS AND ANSWERS:

1) What is the result of the data collected from the test? _____

_____

_____

_____

_____

2) Did you car work as expected? _____

_____

_____

_____

_____

3) Why do you think it did what it did? _____

_____

_____

_____

_____

4) What can you do to improve it? _____

_____

_____

_____

_____

5) Sketch any design changes here, and test your car until you get it right.