

Honorable Mention King of the Hill

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Teaching Objective:

The King of the Hill project provides an opportunity for students to become engineers through an active learning experience and allows students to use their math and science knowledge for practical applications.

Learning Objectives:

The physical science concepts this project covers are forces and motion more specifically, friction and mass. The goal of the King of the Hill is to design and build a vehicle that moves quickly and has the mass to prevent an opponent from reaching their goal. Students are shown how different materials have different amounts of friction when placed against an object. Students can hypothesize what amount of force will be needed to move their design (see science standards page 2). Once they have a working vehicle they can measure the force used and then calculate how efficiently their design uses energy. Mathematical concepts such as geometry can also be covered in this project. Students are shown how round objects with different diameters can travel at different speeds. Engineering principles include brainstorming of ideas, analyzing, testing, and revision of ideas. Students can work individually or in teams of two. Using creative problem-solving techniques (see page 6), students brainstorm about the best material to use, and then design their solutions based on their brainstorming ideas. By having each team create its own design, each solution can be very unique (see technology standards page 2).

Curriculum Integration:

This project not only shows students how science, technology and mathematics work together, but it also allows them to use their language arts skills. Before the competition begins, each team gives an oral presentation to the class describing how their device works, and the principles of force and motion they are taking advantage of in their solution. The teacher can also have the each team describe what a simple machine is, how many there are, and point out the different ones used in their design. After the competition, each team submits a written report (see page 7) stating what the team did at each step in the problem-solving process (see page 6). This report ends with a conclusion stating why the device was successful or what changes could have been made to make it more successful. Students' art skills are utilized by having them make a drawing of their device to scale with written descriptions placed beside key components.

Assessment:

Individual and team efforts are judged according to the rubric (see page 5). Students are scored in two areas. The first is function. Does the solution move by itself? Does the solution use the required materials? Is the solution's starting size within the specified limits? The second is how the solution finished in the competition. Each student receives a copy of the rubric when the project is assigned.

Curriculum Standards:

Science - National Research Council's National Science Education Standards

- 1) Scientific Inquiry
 - Identify questions and concepts that guide scientific investigation
 - Design and conduct scientific investigations
 - Formulate and revise scientific explanations and models using logic and evidence
 - Recognize and analyze alternative explanations and models
 - Communicate and defend a scientific argument
- 2) Physical Science
 - Motions and forces
- 3) Science and Technology
 - Abilities of technological design
 - Understandings about science and technology

Technology - International Technology Education Association's Standards for Technological Literacy

- 1) Nature of Technology
 - Core concepts of technology
 - Relationships among technologies and the connections between technology and other fields
- 2) Design
 - Attributes of design
 - Engineering design
 - Role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving
- 3) Abilities for a Technological World
 - Apply design processes
- 4) Use and maintain technological products and systems
 - Assess the impact of products and systems
 - The Design World
 - Energy and power technologies
 - Transportation technologies
 - Manufacturing technologies

King of the Hill Activity

Working in teams of two or alone, design and build a vehicle that will climb a hill, cross the crest, stop, and prevent your opponent from crossing in the opposite direction. The objective is to end the match with your vehicle on the other side of the hill, and your opponent's on the same side.

Activity Materials

- 2 coffee cans with plastic lids
- 4 plastic soda bottles (1 or 2 liters)
- 8 rubber bands
- 2 mouse traps
- 4 4-ounce lead sinkers
- 1 12 x 12 x 1/4-inch piece of plywood
- 4 jar lids
- 2 wire coat hangers
- 1 3-foot wooden dowel (any diameter)
- 1 12x12-inch piece of cardboard
- 1 3-foot piece of string
- Any metal fasteners (paperclips, screws, bolts, nails, etc.)
- Any type of glue or chemical bonding agent

You must provide **all** items for your project. If you have difficulty obtaining materials, see your instructor promptly.

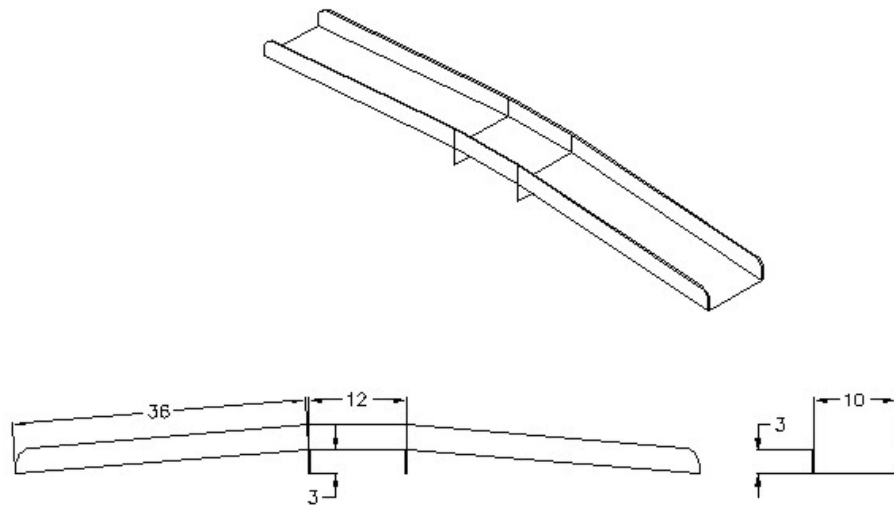
Design Requirements

1. You can only use the materials listed above to build your vehicle. It is not necessary to use all of them. The materials specified may be used in any way. They may be cut, shaped, etc.
2. Your vehicle may use any means you can devise for reaching the other side of the hill and for preventing your opponent from reaching your side. A vehicle may run on wheels and tracks, or it may launch itself through the air. It may extend an arm, throw or drop an object, bulldoze the opponent or take any action to prevent the opposing vehicle from crossing the crest. It must, however, do so automatically, once the device is started.
3. Your vehicle must be self-propelled. You may touch it to start, but you may not give it a push. You may not touch it after the match has begun. It may leave nothing at the starting line.
4. Your vehicle may be no longer than 12 inches and no wider than 8 inches at the moment it starts.

**** Note:** be creative in developing design ideas. ******

The Contest

1. The hill will be a double inclined plane with a 3-inch rise from its base. The 3-inch rise may sound slight, but it is an 8% grade - a good hill on any highway. Each inclined plane will be 10 inches wide and 3 feet long. There will be sides 3 inches high to prevent either vehicle from falling off the hill. These sides will be securely fixed to prevent either vehicle from going over the edge. This will eliminate steering problems and will facilitate "bulldozing." A one-foot platform will separate the two ramps at the top.
2. Vehicles will compete 2 at a time. The winner will advance to the next round with the other winners. The competition will continue on to a championship round.
3. After 15 seconds or when all motion has stopped, whichever comes first, the vehicle that remains on the opposite side of the hill from its start will be declared the winner. If neither vehicle has crossed the crest or both finish on the side opposite of the side they started on, a draw will be declared and both vehicles will be disqualified.



Questions to Consider

1. How can I design my vehicle to move up the hill and cross the crest?
2. What can I design and build into my vehicle to prevent my opponent from reaching my side of the hill first or pushing my vehicle backward?
3. What mechanism can I use to start my vehicle at the beginning of the contest?
4. How can I use the energy stored in rubber bands and/or mousetraps to power my vehicle?

Helpful Hints

1. Design for speed. The most successful vehicles are usually those that reach the crest first.
2. Design for offensive and defensive strategies.
3. Design for durability. Opposing vehicles and accidents can damage a fragile design.
4. Design for easy repair. Keep the design simple. Complex designs are more prone to breakdowns and are difficult to repair.

You are to complete and submit an engineering report at the end of this activity (see below).

Time Line:

Introduction	day 1
Science, tech, and math principles	days 2 - 3
Preliminary ideas due	day 4
Final design idea due	day 6
Vehicle construction	day 7 - 9
Vehicle Testing	days 10 – 12
Vehicle modifications	day 13
King of the Hill competition	day 14
Engineering Report due	day 15

Rubric for King of the Hill

Score	Design	Finish Position
100	<ul style="list-style-type: none"> Only those materials listed were used in the vehicle. Vehicle is self-propelled. Vehicle's starting size is within limits. 	<ul style="list-style-type: none"> First Place Finish
96		<ul style="list-style-type: none"> Second Place Finish
92		<ul style="list-style-type: none"> Third Place Finish
88		<ul style="list-style-type: none"> Fourth Place Finish
84		<ul style="list-style-type: none"> Fifth Place Finish
80		<ul style="list-style-type: none"> Sixth Place Finish
76		<ul style="list-style-type: none"> Seventh Place Finish
72		<ul style="list-style-type: none"> Eighth Place Finish
68		<ul style="list-style-type: none"> Ninth Place Finish
64	<ul style="list-style-type: none"> Used materials in the vehicle that was not on the list. Vehicle is not self-propelled. Vehicle's starting size is outside the limits. 	<ul style="list-style-type: none"> Tenth Place Finish
50	<ul style="list-style-type: none"> Did not meet deadline for Preliminary and Final design ideas. Did not have a project for testing. 	<ul style="list-style-type: none"> Did not meet deadline for Preliminary and Final design ideas. Did not have a project for testing.
0	<ul style="list-style-type: none"> No Project 	<ul style="list-style-type: none"> No Project

Problem-Solving Process:

The following format is to help you work your way through a problem-solving activity. This work is to be submitted in your engineering report on the assigned date.

- 1) Define the problem in your own words.
- 2) Sketch your solutions (minimum of one thumbnail sketch of three different ideas). This is the brainstorming step.
- 3) Select the best solution and develop a final sketch including the following:
 - a) Dimensions.
 - b) Justification of why this solution is the best.
 - c) List the resources needed to complete this solution.

Teacher approval needed before proceeding

- 1) Build your prototype (model).
- 2) Test your prototype (testing of your prototype can only be done on the assigned dates).
 - a) Does your prototype meet the design criteria?
 - b) If a new solution is needed in order to meet the design criteria, go back to your thumbnail sketches, and start the process over at step 3.
 - c) Teacher approval is needed for any new solution idea.
- 3) Evaluate your model in your engineering report.

Engineering Report Criteria:

A part of engineering is documenting your progress, solutions, and results. The major components of this reporting system include:

- 1) TITLE PAGE - report must include a title page (see Appendix I for an example).
- 2) PROBLEM - in your own words, state the problem you are trying to solve.
- 3) MATERIAL LIST - list all the materials used in your solution. This should include glue, fasteners, and the amounts used.
- 4) PROBLEM SOLVING PROCESS - give a brief summary for each of the six design steps (see page 5 for a description of each step).
- 5) BUILDING PROCESS - give a brief summary of how you built your solution. This should be stated so that some one else reading it can build your solution.
- 6) PRELIMINARY TESTING - give a brief summary of any testing you preformed prior to the due date. Be sure to describe any changes you made to your solution as a result of this testing.
- 7) SUMMARY - explain what happened to your solution on the due date. State whether it was successful or unsuccessful and why.
- 8) DRAWINGS - include thumbnail sketches of preliminary ideas (brainstorming), and a formal drawing of your final solution.

Other Notes about the Engineering Report:

If you need to include additional material in your report, which is not listed here or in the design brief, feel free to do so.

ALL REPORTS MUST BE TYPED. Computer or typewriter can be used. You must write your own report, but it may be typed by someone else.

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