

Downhill Dash

Essential Question: How might a vehicle be made to move a precise distance using only gravity as a force?

Students will design and build a gravity powered vehicle that will satisfy rigid design constraints. They will also discover how to build a ramp and investigate the relationships between the height of the ramp, the weight of the vehicle and the distance traveled.

NCSCOS Goals

Second Grade:

COMPETENCY GOAL 3: The learner will build an understanding of changes in properties.

Objectives

3.01 Determine three states of matter:

- Solid.
- Liquid.
- Gas.

3.02 Observe changes in state due to heating and cooling in common materials.

3.03 Determine what can be done to materials to change some of their properties. (buoyancy-float and sink)

3.04 Observe the change in position and motion of objects relative to the strength of the push or pull (force).

Fourth Grade:

COMPETENCY GOAL 4: The learner will build an understanding of technological designs.

Objectives

4.01 Assess the invention of tools and techniques to solve problems.

4.02 Observe the many tools that are based on designs found in nature.

4.03 Determine how people use simple machines to solve problems.

4.04 Evaluate the attributes of simple machines that can be manipulated or combined to affect outcomes.

4.05 Assess the natural resources necessary to construct machines and tools.

Fifth Grade:

COMPETENCY GOAL 2: The learner will build an understanding of forms and sources of energy.

Objectives

2.01 Assess the sources and forms of energy (heat, light, electricity, mechanical motion, and sound).

2.02 Assess the needs, benefits, distribution, pollution, and cost associated with society's use of energy.

2.03 Analyze the interaction and transformation of the forms of energy.

NCSCOS Strands

Second Grade:

Science and Technology - Students develop the ability to explain a problem in their own words, identify a specific task and solve the related problem. Students develop abilities to work individually and collaboratively to use suitable tools and **measurements** when appropriate. Tools help students make better **observations** and **measurements** providing helpful equipment for **investigations**. They help students see, **measure**, and do things that they could not otherwise **observe, measure**, and do. Student abilities include oral, written, and pictorial **communication** of design process and product. The science/technology connection is one way of answering questions and explaining changes in the natural world.

Third Grade:

Science and Technology - Students become interested in technology as they design projects, use tools well, **measure** things carefully, make reasonable estimations, calculate accurately, and **communicate** clearly. They become competent designing, analyzing, and explaining their products. Does it work? Can I make it work better? Would it have worked better if I used different materials? The more experience students have with design, the less direct guidance they need. They should begin to enjoy opportunities to clarify a problem, generate criteria for an acceptable solution, suggest possible solutions, try one out, and then make adjustments or start over with a new proposed solution. It is important for students to find out that there is more than one way to design a product or solve a problem. To accomplish this, have several groups of students design and solve the same problem and then discuss the advantages and disadvantages of each solution. Students see that solving some problems may lead to other problems. Introduce the balance between constraints and social impact.

Fourth Grade:

Science and Technology - Students become interested in technology as they design projects, use tools well, **measure** things carefully, make reasonable **predictions**, calculate accurately, and **communicate** clearly. Students become confident designing and analyzing projects, and the more experience they have with design, the less direct guidance they need. They begin to enjoy opportunities to clarify a problem, generate criteria for an acceptable solution, suggest possible solutions, try one out, and then make adjustments or start over with another proposed solution. It is important for students to find out that there is more than one way to design a product or solve a problem. To accomplish this goal, have several groups of students design and solve the same problem and then discuss the advantages and disadvantages of each solution. Students see that solving some problems may lead to others, and they become able to balance simple constraints in problem solving. Students should analyze and evaluate their own results or solutions, as well as those of other students, by considering how a product or design met the challenge to solve the problem.

Fifth Grade:

Science and Technology - Students can become interested in technology as they design projects, use tools well, **measure** things carefully, **make** reasonable **predictions**, calculate accurately, and **communicate** clearly. Students explore weather systems by **observing, measuring,** and recording local conditions. They use tools such as thermometers, rain gauges, and barometers to collect data to establish trends. Students become comfortable designing and analyzing their products. The more experience students have with design, the less direct guidance they need. They enjoy opportunities to clarify a problem, generate criteria for an acceptable solution, suggest possible solutions, try one out, and then make adjustments or start over with another proposed solution. It is important for students to find out that there is more than one way to design a product or solve a problem. To accomplish this, have several groups of students design and solve the same problem and then discuss the advantages and disadvantages of each solution. Students see that solving some problems may lead to other problems, and demonstrate the ability to balance simple constraints in problem solving. Students should analyze and evaluate their own results or solutions to problems, as well as those of other students, by considering how a product or design met the challenge to solve the problem.

Set up:

Tools per group:

- scissors
- pencils
- ruler
- meter stick
- box (about 20 cm long by 10 cm tall)
- wedge
- acrylic or masonite sheet

Optional

- hand drills
- hobby hacksaws
- nails to use for hole punch
- soldering iron to use as hole punch

Materials for construction

- masking tape
- plastic spools
- pipe cleaners
- straws
- stirrers
- plastic lids
- construction paper
- tag board
- bamboo skewers
- beads
- paper plates
- K'Nex
- Tinkertoys
- other misc. materials

Use to 7-8 tables, one for each group. On each table place the tools, along with blank paper and the [Design Brief](#). On another table or on a counter, place all of the construction materials. The actual materials don't matter as long as students can make wheels, axles and vehicle bodies out of available materials and as long as they have something that they can use to create a ramp.

Procedure:

Describe task to students. Show the tools that students will find at their tables and stress that the tools are not to be used as part of the vehicle. Let students know what kinds of materials there are to use in construction. Only one group member can go to the materials station at a time, although they can go back as many times as necessary.

Make sure students know that the task is not to make a vehicle that goes fast nor a vehicle that goes far. The task is to design a vehicle that covers a precise distance, no more and no less. Students may not start the vehicle moving nor can they stop it in anyway. Once they set the vehicle down on the table, it must start and stop on its own. DO NOT mention ramps to the students. Allow them to come up with that solution. Later you may want to encourage students to change the ramp, making it higher or lower, to change the distance the vehicle travels before stopping. Introduce students to the design process as listed below. Students will also discover differences between axles that rotate with wheels and axles that allow wheels to rotate independently.

Design Process

- Identify the problem: vehicles are more fuel efficient if they weigh less and can take advantage of gravity to assist their movement.
- Clarify task: design and build a model vehicle that is both lightweight and uses gravity to help it move.
- Design specifications:
 - The vehicle must have at least two wheels and a body (it can't just be a set of wheels).
 - The vehicle must be small enough to fit in a shoe box with the lid on.
 - The vehicle must travel at least 150 cm (1.5 m) but it can't fall off of the table. (Distances can vary depending upon the length of the available tables.)
 - The vehicle must be lightweight (students will use the triple beam balance to weigh it).
 - The vehicle cannot be made of all of one material, i.e., students cannot build a K'Nex or Tinkertoy car.
- Student Procedure
 1. Students will first talk in their group about how they want to design their vehicle. They can use scrap paper for designs.
 2. Students will decide what materials they want to use. They should consider how the vehicle is going to be able to move and how it will stop.
 3. Groups will send one person up to the supply table to get building materials. They can always get more and they can return stuff you don't use.
 4. Students will construct ONE group vehicle, testing it repeatedly as they build.
 5. Groups will fill out the back of the design brief when they're done.

When time is up, have students place their vehicle in the "Downhill Dash" showroom (a counter top) and then clean up their areas. Allow for extra time to fill in design briefs and discuss them as a group.

Group Discussion

Using the design briefs as a starting point, have students discuss important aspects of the process. Have students generate some statements about the ramps. What happens if the ramp is very high? What happens if the ramp is very low? Is there any correlation between the height of the ramp and the speed of the car? Is there any correlation between the height of the ramp and the distance the car travels? Is there any correlation between the weight of the vehicle, the length of the ramp and the height of the ramp?

Also take time to discuss how wheels and axles relate to one another and whether a fixed axle seems to work better or worse than one that is not fixed.

Bring discussion around to real life instances of ramps (or hills) and how they effect moving objects. Can students think of any new applications for what they discovered about ramps?