Heating up with Soda Cans – Solar Energy Heaters

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Target Grade: 3rd-4th grades

Time Required: Three 40-minute sessions

Standards:

- MP.5 Use appropriate tools strategically. (3-PS2-1)
- .3-PS2-1: Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Lesson Objectives:

- Students will be able to measure the speed of various objects using the SI Units of meters/seconds.
- Students will be able to demonstrate that the force of friction is a powerful stopping force that is proportional to the surface area of the object contacting the floor.
- Students will recognize that air resistance is a type of friction and that it has an effect on the speed of an object.
- Students will create graphs to present results.

Central Focus:

The central focus will be learning how to measure speed and surface area, and appropriately document measurements.

Background Information:

In order for students to be successful in this lesson, students need to understand the following:

Speed is a concept that even young children understand. "I can go faster than you," is common to any group of youngsters. At its most basic, speed is simply distance divided by time – any time and any distance. Most students are familiar with the idea of miles per hour from riding in their parents' car. The international unit for science is meters per second, so that is how we will measure in this activity.

Friction is a powerful force that stops objects from moving. Friction is the resistance that one object gets from moving over another object, so it is directly related to how

much surface area is in contact between two objects. When an object is in contact with the floor, the surface area touching the floor is rubbing and causing friction. When air is blowing across an object, the friction of the air and the object can slow down or stop it altogether. This is called air resistance. The force of friction is measured in Newtons, but for this lesson, we will simply measure the surface areas that are in contact and use that number to demonstrate how much friction is affecting the movement of the objects.

When testing out ideas, we need to measure very carefully and record our data so that we have evidence to prove our ideas are right or wrong. Data can be recorded on a table to help organize the information. It can be put into a graph so that we can picture the information more clearly.

Time: This lesson comes in three segments – Learning to measure Speed, A Great Race, and Friction Force. Each segment usually takes a class period of 40 minutes.

Materials

Learning to Measure Speed:

- Ramps for rolling objects
- Small cars, marbles, anything that will roll
- Meter stick
- Paper rulers with metric units
- Timing devices
- Handout – Speed
- Pen/Pencil
- Clipboards
- Graph paper
- Graph display board (optional)

A Great Race

- Area for students to race
- Start and stop lines
- Meter stick or tape measure
- Timing devices
- A Great Race handout (3)
- Clip boards (3)
- Pens/pencils
- Graph paper

Friction Force:

- Ramp for rolling objects
- Hot Wheel cars

- Piece of wood with same surface area as the cars
- Items with different types or numbers of wheels (i.e. skates, rolling chairs)
- Meter stick
- Paper rulers with metric units
- Timing devices
- Handout – Friction
- Pen/Pencil
- Clipboards
- Graph paper
- Graph display board (optional)
- Small fan(s)
- Strings
- Tissue paper

Instruction

Learning to Measure Speed:

Introduction

Discuss with students what they know about speed. Most are familiar with riding in cars and traveling in miles per hour. They usually all know who is the fastest in the classroom.

Define Speed: Speed = Distance divided by Time. Speed is a division math problem. Hand out "Speed" worksheets. Demonstrate how to measure the speed of two objects using the small cars and the ramp with a one-meter distance. Use the words "Beginning position" and "Ending position" in the demonstrations. Explain that in science we use the unit meters/second to record speed. Have the students assist in the demonstration, making sure all students can see that you have documented the distance and the time. Then have a student use a calculator to measure the speed. Ask the students which object had the fastest speed.

Activity

Split students into groups of three: One to release an object, one to time it, and one to record the data. They will rotate those jobs for each new item. They should pick their own items to measure for speed. Give time for the groups to do several measurements of speed. Check to see they are doing this correctly.

Closure

Stop the activity

Explain again that speed is officially measured in meters/second. (International System of Units)
Discuss average speed versus instantaneous speed and how we could test it.

Homework option: Each student will get another Speed worksheet. They go home and measure the speed of any six items at their home. They can take one of the paper rulers with the metric units, so they have the correct units.

Review homework:

Discuss the students' homework on measuring speed. They may not have the units in meters, since the rulers only go to 30 cm. Discuss and help them convert if necessary. Also, give them time to tell the class the fast/slow/funny things they measured at home. Have them select their object that had the greatest speed and write that on a board/display device. Pull out the three of the fastest objects. Graph the three objects. Show the students how we put the different objects (Independent Variable) on the x-axis and the speed (Dependent variable) on the y-axis. The students should be able to see which object had the greatest speed. Have students graph their 6 objects from the homework handout.

A Great Race

Introduction

Hook: We have learned how to measure speed, now let's see who the fastest student is in the 5th grade.

Activity

Step 1: Have students measure the distance of the race area: 20 meters or more. Mark the start and finish line. Separate students into those who want to race and those who don't. Those who don't want to race can help organize the activity. There should be three timers for each runner, three recorders with separate sheets, and students who will start the runners. If everyone wants to run, then the jobs will have to be rotated. If only a few want to run, just have the others do the starting, timing, and recording. When everyone who wants to run has done so, go back to the classroom with the data.

Step 2: In the classroom, separate into three groups to divide the distances and times to see who was the fastest. Each group should graph the data. If there are multiple classes, keep the data to show to the other classes so that the fastest person in the entire grade level can be determined.

Closure

Have students look up the speed of the fastest person in the world in the 100 meters dash so they can compare their times. Discuss. The best graphs can be displayed.

Friction Force

Introduction

Step1: Have a student roll a Hot Wheels car down the ramp. Measure the speed.

Step 2: Have a student try to get the small piece of wood to go down the same ramp. It won't. Ask why, allowing the students to bring in the idea of friction. Emphasize the surface area contacting the ramp.

Step 3: Measure the length and width of the board and write that on the display.
To measure the surface area of the wheels, draw with a marker on the bottom of the wheel. Press that against a piece of paper and a rectangle will show. On a Hot Wheel car, the width of the tires is around 3.0 mm. Depending on how hard you have to press to get the mark to show, the length of the mark will be 0.5 – 4.0 mm. It won't matter, because the piece of wood has so much more surface area contacting that the difference should be obvious to the students. Remember to multiply that by four because there are four wheels touching the ramp.

Activity

Step 4: Split students into groups. Each group will have a Friction handout. They should select items from the collection and measure their friction force.

Step 5: After several minutes, stop the activity and get everyone's attention. Without explanation, ask a group to roll a Hot Wheel car down the ramp and measure the speed. Then bring out the fan, have it blow against the course, and ask them to measure the speed again. Discuss air resistance and the surface area the wind is hitting. Ask how we could slow the car down even more. Each group should attempt to create a parachute that will slow the car down.

Closure

Ask the student which item in the collection had the least amount of friction. They must prove this with their data. There should be disagreements on the items because students will make mistakes or won't be as meticulous as another group. When there are disagreements, get two separate groups to measure the same item again. They should measure it in the same way (to make it fair). Explain that doing a measurement more than once increases the reliability of the data.

Explain that friction is normally measured in Newtons. (International System of Units)

Differentiation

Each of these lessons are group divided so the students will be able to assist each other during the course of the labs. If students don't want to participate in some portions of the lab they have the option to be data collectors. The teacher will model the labs before letting students work independently.

Assessment

Formative

Classroom participation and completion of handouts and graphs.

Name ______________________________

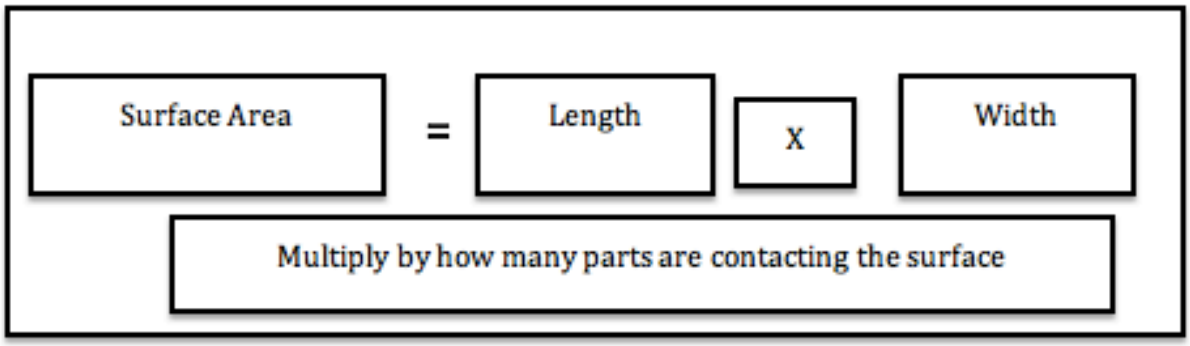
A Great Race

Data Sheet

Name	Distance (m)	Time (s)	Speed (m/s)

Name_____

Friction Worksheet

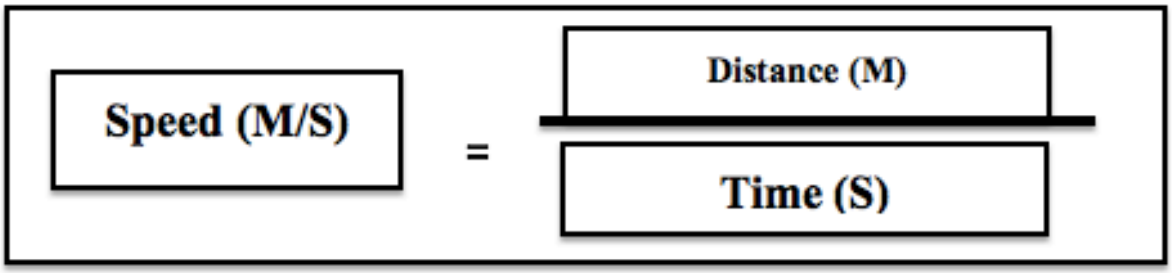


Item	Length (cm)	Width (cm)	Multiply points of contact	Total Surface Area (cm^3)

Work Space

Name_____

Speed Worksheet



Item	Distance (M)	Time (S)	Speed (M/S)

Work Space