The Pressure's On

Target Grade Levels
Sixth - Twelfth

Time
One hour

Materials
- basketballs (one per group)
- meter sticks or tape measure
- tire pump with needle for inflating balls
- large rubber bands (if students choose sling-shot approach)
- ramp (if students choose this approach)
- tape or chalk
- stop watch
- overhead of research question

Knowledge and Skills (TEKS)
- Science:
  - Conduct field and laboratory investigation; and
  - Use scientific inquiry methods to plan and implement investigative procedures including asking questions, formulating testable hypotheses, collecting data, making measurements with precision, organize, analyze, predict trends, and communicate valid conclusions.
- Language Arts:
  - Plans, prepares, organizes, and presents oral messages with attention to thesis statement, valid evidence, effective appeals, appropriate language, and purpose fitted to the audience;
  - Organizes and records new information in systematic ways; and
  - Uses effective listening strategies to provide appropriate feedback in a variety of situations such as informal conversations; formal debates; class discussions; and informative, persuasive, or artistic presentations.

Overview
Students will observe how friction changes with the pressure in an inflated ball. This example will then be applied to the desired tire pressure in an automobile.

Background Information
Students may not realize it, but the pressure in a car's tires plays a big role in fuel efficiency. In this activity, students will discover the relationship between tire pressure and fuel efficiency. Rather than using an actual car, the situation can be simulated using a ball. Place a copy of the research question on the overhead or chalkboard.

Procedure
1) Vocabulary
   a) fuel efficiency
   b) pounds per square inch (psi)
   c) tire pressure

2) Activities
   a) Research question: How does the amount of air pressure in a ball affect its speed when rolled across the floor?
   b) For Students:
      i) We call this a research question, because you will need to conduct your own research to discover the answer. Your teacher may give you a few hints about how to control variables in your experiment. However, the main design for the experiment is your job. Not everyone will come up with the same design. This is good. There is no one right way to answer the research question. Lots of different experimental designs will help to answer the question.

ii) Your first job is to discuss possible plans with your partners. Once your group has decided on a plan, make a list of the materials you will need for your experiment. Draw a picture of your experimental set-up. The picture should show how you will be collecting data. Describe the steps you will follow in collecting data for your experiment. To keep your thoughts straight, here are a few headings you should have on your paper.

(1) Materials

(2) Drawing of experimental set-up

(3) Steps in our experiment

iii) Once you have written down your ideas, ask your teacher to check your plan. Your teacher will then help you to gather the materials you will need to collect your data.

iv) Use a table to collect your data. Label the first two columns with headings that fit your experimental design. Notice that the third column should contain room for conducting three trials. It is a good idea to perform an experiment more than one time so that you may then average your results, or even omit data that you can see is "way off".

c) If time permits, it would be desirable for students to set up their own experimental design for answering this question. The degree of direction you wish to provide will be up to you and will be dependent upon the expertise of your class in controlling variables. The paragraphs that follow contain one possible approach to organizing this activity.

d) Hold up a ball and tell students they will be using balls like this one to find the answer to the research question. Also show students a bike tire pump and show them how you can add air to the ball:

i) Unscrew the needle.

ii) Insert it into the ball and show students how air can be removed from the tire.

iii) Ask for their ideas on how they might go about collecting data.

iv) There are a number of variables that must be controlled. Throughout the discussion, as students share their ideas, be sure to question their control of variables along the way. In this manner, the class is likely to devise a relatively controlled experiment that will provide sufficient data to answer the question.

e) A sample design might go as follows: (You may wish to simply provide students with the directions below if time does not allow you the opportunity for class discussion of experimental design.)

i) Use a meter stick or tape measure to mark off a straight distance of 10 meters. Mark the start and end points with tape or chalk.

ii) Unscrew the needle of a tire pump. Push the needle into the ball and release enough air to allow the ball to still roll, but with some difficulty.

iii) Prepare a rubber band slingshot by tying several rubber bands together. While your partners hold the sides of the slingshot, carefully pull the ball back with the stretched rubber band.

iv) Mark the exact point at which the ball is released, so that it may be released from this same spot for each trial. Using the stopwatch, determine the amount of time it takes when the ball is released until it crosses the finish line. Do several trials and average your results.

v) Now repeat the same procedure, but inflate the ball by two pump strokes. Record the results of several trials and determine the average time required to cross the finish line.

vi) Add two more pump strokes of air and repeat the procedure. Keep testing different inflation levels until the air pressure indicates the ball is "full."

f) Home/Community Connection:

i) Challenge students to find out how often the tire pressure is checked on their family vehicles and if there is a tire gauge at their home. Also ask students to read the recommended tire pressure rating on the tires of their family vehicle. If they have a tire gauge, ask their parents to help them check the air pressure. Students should always check with their parents before checking the tires.

ii) Help students to find out what happens to used tires in your community. Have them summarize their findings in a poster or with a short paragraph.

iii) Set up a "tire check" service at your school. Invite an individual from a local automotive garage or car dealership to speak to the class about tires and tire pressure. He or she may also give a short lesson on how to detect weak spots in tires and how to tell if new tires are needed. Issue tickets to teachers in your school. If they want their tires checked, they can place their ticket under the windshield wiper blade on the designated day. This will show students which cars in the parking lot to check. Students should create a summary sheet to record their findings and to give to those whose tires are checked. This sheet might contain a diagram of the car and a place to record the pressure that was measured in each tire. It might also have a place for students to comment on the general state of the tire treads and whether to recommend new tires be purchased. As part of this effort, students could also design an informational brochure about tire pressure and fuel efficiency. The brochure could be given to those whose tires have been checked.

3) Review

After discussing student findings and their answers to the first two Summing Up questions, ask students if they know how often the tire pressure is checked on their family vehicle. How many know if they have a tire gauge at home? Encourage students to find out and to share what they have learned with their parents.

4) Evaluation

a) Questions for Summing Up

i) Study your data. What is your conclusion about how the amount of air pressure in a ball affects its rolling speed?

ii) Apply your findings to car tires. What affect do you think the air pressure in car tires has on fuel efficiency? Explain your answer.

iii) Devise a plan to convince the drivers in your family of the importance of keeping the correct air pressure in their tires. Write a summary of your ideas. Be sure to include any reasons you might provide for wanting to drive with the correct amount of air in the tires.

b) Sample Answers to Summing Up:

i) Students should have data supporting the conclusion that the lower the air pressure, the slower the ball moves. With higher air pressure, the ball should roll faster.

ii) Students will likely conclude that the fuel efficiency will improve as tire pressure increases. This is true because tires low on air pressure will have greater friction between the pavement and the tires, causing an increased drag on the car.

iii) Student plans will vary. Encourage creativity in student writing. Insist that students include a logical rational for driving with the correct tire pressure.

5) Extension

a) Use acrylic paint to paint the ball, then examine marks made by painted ball on paper. Compare total area of paint marks and draw conclusions re: friction and its relationship to drag, engine strain handling, and safety.

b) Find out how often the pressure in the bus tires are checked. What is the recommended tire pressure for school bus tires? Write a persuasive letter to your school's transportation director informing him or her of the relationship between tire pressure and fuel efficiency. Use some of the ideas from question #3 of the Summing Up questions to help you make a strong case for keeping tire pressure at the recommended level.

c) The recommended tire pressure for most cars is in the 25 to 35 pound range. Based on this figure, predict the amount of pressure that would be recommended for a bicycle tire. How much tire pressure do you think is recommended for large tractor tires? What about airline jet tires? After you have made your predictions, do some research to discover the answers.

d) Do some research to discover if there is a relationship between the recommended pressure in the front and rear tires and whether the vehicle is a rear-wheel drive or a four-wheel drive vehicle.

Adapted from: “Hop on the Bus, Gus!” *Department of Earth Science at the University of Northern Iowa.* www.earth.uni.edu/EECP/mid/mod3_sc.html.