Activity
15

Air Ball!

Do you ever wonder how the National Basketball Association (NBA) decides how much air should be in the basketballs used during a game? The NBA measures the pressure inside the ball in units of pounds per square inch, or psi. In this activity, you will experiment with the amount of air in a basketball, but you will use the units scientists use to measure pressure called kilopascals, or kPa. We will vary the amount of pressure in the ball, then use Go! Motion to measure how high the ball bounces.

OBJECTIVES

In this activity, you will

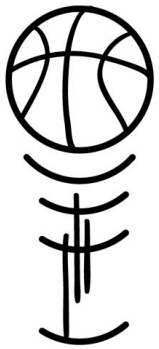
- Record what happens to the bounce height of a basketball as you vary the pressure of the air inside it.
- Graph your data.
- Draw conclusions based on your data.

MATERIALS

computer with Logger Lite software installed
Go! Link interface
Vernier Gas Pressure Sensor
Go! Motion motion detector
basketball
stopper with needle, stopper stem and tubing attached
meter stick

KEY QUESTION

How does the amount of air in a basketball affect how high it bounces?



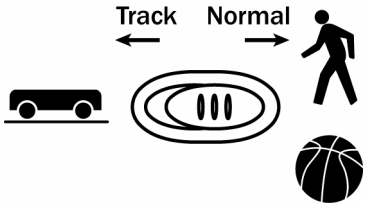
HYPOTHESIS

As I let air out of the ball, the ball will bounce

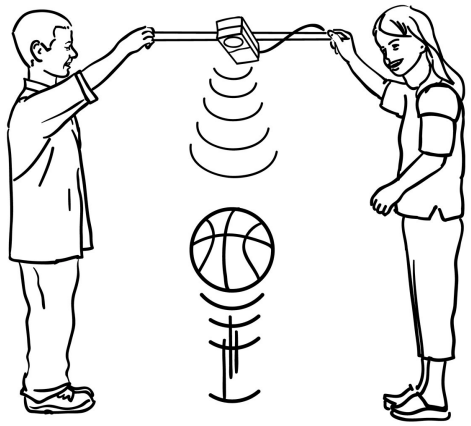
_____ (higher or lower).

PROCEDURE

1. Do the following to set up the sensors for data collection:
   a. Make sure the Go! Motion is connected to the computer.
   b. Set the switch on the Go! Motion to the Normal setting as shown here.
   c. Make sure the Pressure Sensor is connected to the Go! Link and that the Go! Link is connected to the computer.

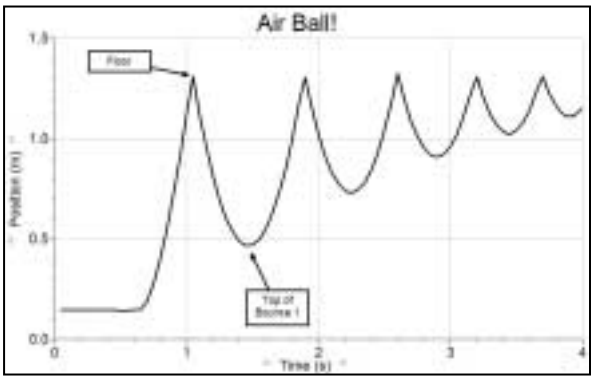


2. Start Logger Lite on your computer.
3. Do the following to open the file for this activity:
   a. Click the Open button, .
   b. Open the folder called "Elementary Science."
   c. Open the file called "15 Air Ball."
4. You will now get everything ready to do this activity..
   a. Obtain your basketball.
   b. Zero the Pressure Sensor by clicking the Ø Zero button on the toolbar. This will make it measure pressure the same way the gauge on a bicycle pump does.
   c. Wet the needle attached to the Pressure Sensor and insert it into the ball.
   d. Look at the pressure reading on the screen and record it in the first row in the Actual pressure column in the Data Table on the next page.
5. Use masking tape to attach the Go! Motion to the middle of a meter stick with the sensor facing away from the stick. **Caution**: Do not put tape over the detector (gold circle) of the Go! Motion!
6. Have two students hold the ends of the meter stick approximately 1.5 meters above the floor with the sensor facing down. Hold it still during data collection.



7. Do the following to collect data:
   a. Hold the ball directly below the sensor with about 15 cm of space between the ball and the sensor.
   b. Click ▶ Collect. When you hear the sensor clicking, let the ball drop and bounce on the floor. Do not throw it down!

c. If your graph does not look something like the graph at the right, line up the ball and click ▶ Collect again.



8. Click the Examine button, , to find the position of the floor, relative to the Go!Motion and the position of the ball at the top of Bounce 1. Record these values in the Data Table, below.

Data Table				
Target pressure	**Actual pressure**	**Floor**	**Top of Bounce 1**	**Height of Bounce 1 = Floor-Bounce 1**
80 kPa	**kPa**	**m**	**m**	**m**
70 kPa	**kPa**	**m**	**m**	**m**
60 kPa	**kPa**	**m**	**m**	**m**
50 kPa	**kPa**	**m**	**m**	**m**
40 kPa	**kPa**	**m**	**m**	**m**
30 kPa	**kPa**	**m**	**m**	**m**
20 kPa	**kPa**	**m**	**m**	**m**
10 kPa	**kPa**	**m**	**m**	**m**

9. When you are done recording your data, click the X in the corner of the Examine box to close it.

10. Decrease the pressure in the ball by doing the following:

    a. Wet the needle attached to the Pressure Sensor and insert it into the ball.

    b. Look at the pressure readings on the screen.

    c. Very slightly, loosen the connector on the plastic valve sticking into the stopper. You do not want to disconnect the tubing, you simply want to slowly release a little air.

    d. Continue watching the pressure on the screen until the pressure has decreased by 10 kPa (the first time you do this, the pressure will go from 80 kPa to 70 kPa).

    e. When the pressure has decreased by 10 kPa, tighten the connector so no more air escapes. **Note:** It is okay if the pressure goes down by a bit more than 10 kPa, but try to get as close as you can. If you accidentally lose a lot of air, tell your teacher.

    f. Record the pressure in the data table in the next row of the Actual pressure column.

11. Repeat Steps 7-10 for 60 kPa, 50 kPa, etc. until you have completed the 10 kPa trial.

ANALYZE YOUR DATA

1. You will now graph your results by doing the following:
   a. Fill in the Height of Bounce 1 column in the Data Table.

      Height of Bounce 1 = Floor – Top of Bounce 1

   b. Click the Page button,  , on the Logger Lite toolbar to view Page 2 of the Logger Lite file. You should see a table and a graph labeled Pressure *vs.* Bounce Height.
   c. Type the data from your Data Table in Step 8 into the table on the computer. Make sure you are typing data from the correct columns. The columns you should be using, Actual pressure and Height of Bounce 1, have a dark box around them.

2. Describe any pattern you noticed about the heights of the bounces as the pressure in the ball was decreased. Was the first decrease the same size as the last decrease?

3. Based on your graph from Question 1, how high do you think the basketball would bounce if its pressure was 90 kPa? How about 100 kPa?

4. What would be the lowest pressure in the ball you would want to use for playing basketball? Explain your answer using the data you collected.

Good job!

TEACHER INFORMATION

Air Ball!

BACKGROUND INFORMATION

In this activity, students will work in groups to explore how air pressure affects the height of the first bounce of a basketball (or some similar type of ball) after it has been dropped. According to the regulations on the National Basketball Association's website (www.nba.com), a basketball should be inflated to 7.5-8.5 pounds per square inch (psi). In this activity, students will use a Gas Pressure Sensor to measure the pressure in the ball in kilopascals (kPa), the SI unit for measuring pressure. The Logger Lite file for this activity is already set up to measure pressure in kPa, and they will not need to convert pressure values between kPa and psi. The conversions are found below, if you would like to help your students make the connection between kPa and psi (a unit they, if living in the United States, are more likely to be familiar with):

$$\text{pressure in kPa} = (\text{pressure in psi}) \times 6.89 \frac{\text{kPa}}{\text{psi}}$$

$$\text{pressure in psi} = (\text{pressure in kPa}) \times 0.145 \frac{\text{psi}}{\text{kPa}}$$

TIME FRAME FOR ACTIVITY

This activity will take about 60 minutes.

CURRICULAR CONNECTIONS

Science – The scientific process, air pressure.

Math – Graphic analysis & statistics, line graphs, measurement, differences.

HELPFUL HINTS

1. This should probably not be the first Go!Motion activity your students do. Begin with Activity 11 Learning to Use Go!Motion.

2. This activity is written to use a Go!Motion and a Gas Pressure Sensor with a Go!Link at the same time. This requires two USB ports on your computer. If you do not have two USB ports, you have several options:
   - Use a USB hub. A USB hub plugs into the USB port of your computer and has several ports into which you can plug additional USB devices.

- Instead of using the Gas Pressure Sensor, you can you a pressure gauge to measure the pressure in the ball. Pressure sensors for measuring air pressure in a ball are available at most places where sports equipment is sold.
- If no Gas Pressure Sensor or gauge is available, you can do a qualitative study in regards to the air pressure in the ball (you will still be collecting quantitative data with the Go! Motion). Start with a ball that seems fully inflated. For each trial, use the needle to let air out of the ball for a given period of time. For a standard-size ball, 3 seconds works well.

3. Assemble the Gas Pressure Sensor equipment ahead of time. In order to use the Gas Pressure Sensor to measure the pressure in the ball, you will need to insert a pump needle into one of the stoppers that comes with the Gas Pressure Sensor. Ideally, you will use the smaller, 1-hole stopper found in the Pressure Sensor Accessories Kit, and leave it set up for when you do this activity in the future. This stopper should already have a plastic valve extender inserted in the hole. Using pliers to hold the pump needle, insert the threaded end into the other end of the stopper. The hole is quite a tight fit for the needle, but this ensures that it stays in. Remind students that when they pull the needle out of the ball, they should reach around the stopper and grab hold of the needle, rather than pulling only on the stopper.

4. Before giving the balls to your students, pump them up so the pressure is at 80 kPa. During the activity, students will decrease the pressure in the ball, incrementally, until they reach 10 kPa. To do this, they should slightly untwist connection between the tubing and the plastic valve extender, allowing air to escape while watching the pressure readings on the computer screen. When the pressure has dropped by 10 kPa, the students should tighten the connection. It is okay if the students release a little too much air. In the student version of the activity, students are told to record the exact pressure in their data table. When they enter their data on Page 2 of the Logger Lite file, students will enter the actual values they recorded during data collection.

5. In this activity, students should work in groups of four or five: two hold the meter stick with the Go! Motion taped to it, one drops the ball, one starts the collection on the computer, and one can be the data recorder.

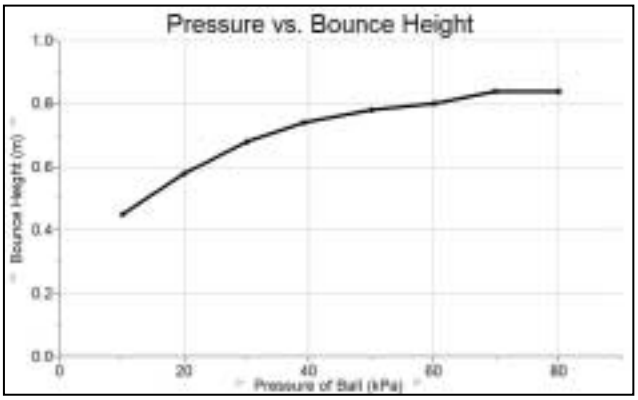
6. Be sure that the students start with the ball at least 15 cm from the Go! Motion. If they start with it touching the detector, they could get faulty data. Instruct them to drop the ball straight down so that it bounces directly below the Go! Motion and remind them not to throw it down. If their graph does not look similar to the sample on their worksheet, have them click ▶ Collect again to repeat the data collection.

SAMPLE RESULTS

In this sample activity, data, graphs, and answers have been omitted to prevent students from downloading sample results. In all printed versions of Vernier lab books, the Teacher Information Section includes complete sample data, graphs, and answers to analysis questions. For a complete Teacher Information Section for this activity, please contact us by telephone at 1-888-837-6437.

ANSWERS TO THE ANALYZE YOUR DATA SECTION

1. Students fill in the last column of their Data Table and then enter their data on Page 2 of the Logger Lite experiment file.



Graph on Page 2 of the Logger Lite experiment file created from data in the Data Table

2. Answers will vary, but students should identify that the bounce height decreases more at lower pressures and less at higher pressures. Using the sample data above, when the pressure decreased from 80 kPa to 70 kPa, there was no change in bounce height. When the pressure decreased from 20 kPa to 10 kPa, there was a 0.13 m change in bounce height.

3. Answers will vary, but it should be about the same as the 80 kPa bounce.

4. Answers will vary, but it should be the lowest pressure before the bounce height began to drop off.

ASSESSMENT

1. Lead a discussion about how the amount of pressure in a ball affects how high the ball bounces.

EXTENSIONS

1. Students could test the bounce heights on volleyballs, soccer balls, or playground balls.

2. Have students learn about the regulation ball pressure for game play of different sports. Why might the pressure in a soccer ball differ from that of a basket ball?