

Workshop 8.

Bend and Stretch

We all expect a spring to stretch or compress when a force is applied, but forces can even deform solid objects like the floor or the top of a table. In this workshop, students in a high school classroom explore ideas about tension and normal force. By applying a force to a spring and measuring the distance the spring is stretched, the students calculate the force constant or stretchiness of the spring. Lecture demonstrations using student volunteers help illustrate that even rigid objects bend when a force is applied.

On-Site Activities and Timeline

Getting Ready

30 minutes

Poster Session

For homework, you were asked to create a poster of a familiar device that uses electromagnetism. Present your poster to the group and discuss what you have learned.

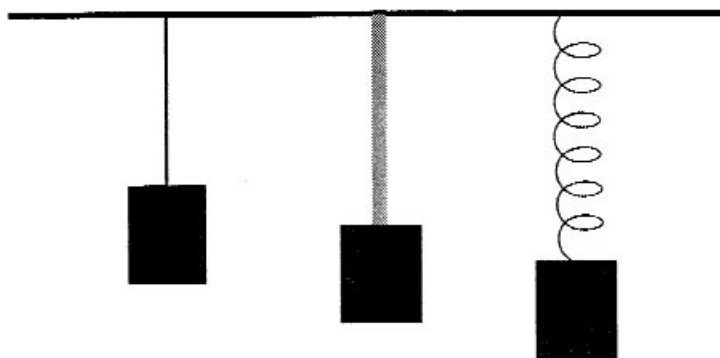
A Penny for Your Thoughts on the 10-Cent Experiment

In the video for Workshop 7, you saw an experiment in which the same set of keys was hung from three different arrangements of rubber bands. Perhaps you tried it on your own. The two rubber bands connected end-to-end stretched twice as much as the single band, whereas the two rubber bands together stretched only half as much as the single band. How can you explain this result? What would happen if you used three rubber bands? Share your ideas with the other participants.

Hanging Force

The diagram below shows three 1-kg masses hanging from supports. The first support is a string, the second is a rubber band, and the third is a spring.

Which support—string, rubber band, or a spring—provides the greatest force? Why did you select this as your answer? Write down your prediction and discuss your thoughts with the rest of the group.



On-Site Activities and Timeline, cont'd.

Watch the Workshop Video

60 minutes

As you watch the video, look for the “10-Cent Experiment.” You may want to try it yourself at home. Instructions can be found on page 62.

On-Site Activities and Timeline, cont'd.

Going Further

30 minutes

How Well Do You Understand Force and Motion Now?

Site Leaders: After participants have completed the questionnaire below, please distribute their original Workshop 1 questionnaires for comparison. At the end of the workshop, please collect both sets of questionnaires and return them to the Annenberg/CPB Channel, c/o Harvard Smithsonian Center for Astrophysics, 60 Garden Street, M.S. 82, Cambridge, MA 02138.

Below are the 10 questions on force and motion that you answered before the first workshop. Again, please answer the questions as best you can. When you are finished, compare it with your original sheet, so you can see what you've learned!

Name

Date

Force and Motion Questionnaire

Please put the letter of your choice in the space provided next to the question.

- ___ 1. You are given two balls. One is twice as big as the other (twice the diameter). What can you say about the two balls?
- a. The larger one has four times the surface area.
 - b. The larger one has eight times the weight.
 - c. The larger one has twice the volume.
 - d. Can't answer without knowing what they are made of.
- ___ 2. You are given two balls made of the same material. One is twice as big as the other (twice the diameter). What can you say about the two balls?
- a. The larger one has twice the surface area.
 - b. The larger one has eight times the weight.
 - c. The larger one has four times the volume.
 - d. None of the above would be correct.

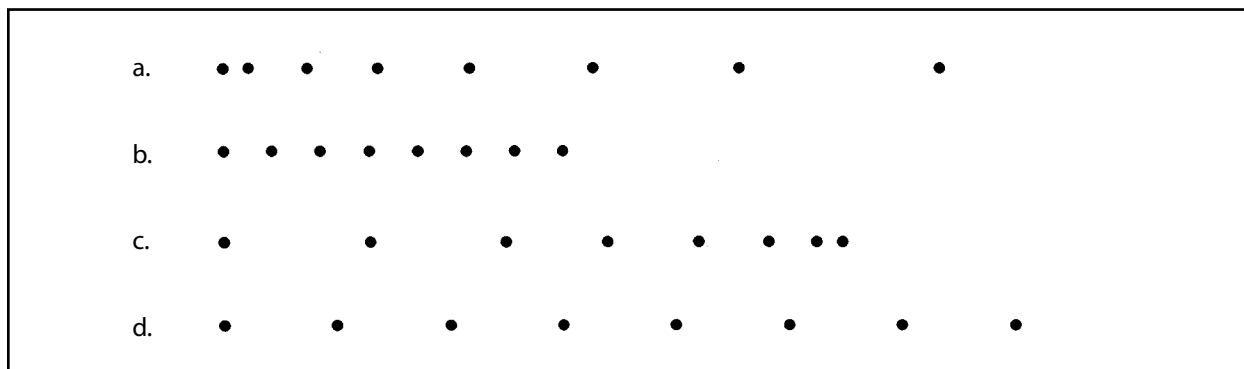
Base your answers to Questions 3 through 6 on the choices a through d on the next page. The graphs represent the position of a moving car after equal time intervals. The cars are moving from left to right, and each travels for the same amount of time.

- ___ 3. Which car travels the greatest distance?
- ___ 4. Which car is slowing down?
- ___ 5. In which car would a speedometer read the highest?
- ___ 6. Which car is moving at the slowest constant speed?

On-Site Activities and Timeline, cont'd.

Force and Motion Questionnaire, p. 2

Name _____



- ___ 7. If a ball is dropped from the window of a building to the ground,
- it speeds up because of the downward force of the air pushing it.
 - it falls because it is natural for objects to rest on the Earth.
 - it speeds up because the gravity gets stronger as the ball gets closer to the ground.
 - it falls at a constant speed.
 - it speeds up because of the constant force of gravity.
- ___ 8. While you are driving on the highway, a bug collides with the windshield of your car. What can you say about the forces involved in the collision?
- The windshield exerts a greater force on the bug than the bug exerts on the windshield.
 - The bug exerts a greater force on the windshield than the windshield exerts on the bug.
 - The forces of the bug on the windshield and the windshield on the bug are the same.
- ___ 9. A small car is used to tow a broken-down truck to the service station. What can you say about the force provided in this situation?
- The small car exerts a greater force on the truck than the truck exerts on the car.
 - The truck exerts a greater force on the small car than the car exerts on the truck.
 - The forces of the car on the truck and the truck on the car are equal.
- ___ 10. Two balls of equal size are rolled down a ramp. One ball is twice as heavy as the other. What can you say about the motion of the two balls?
- Both will reach the end of the ramp with about the same speed.
 - The heavier ball will reach the higher speed.
 - The lighter ball will reach the higher speed.

Force and motion questionnaires such as this are based on ideas taken from Physics Education Research, especially the "Force Concept Inventory," originally published by Hestenes et al. in *The Physics Teacher* (March 1992).

Optional Activities

The Bucket of Nails Fable

Bob and Joe, two construction workers on the roof of a building, are about to raise a bucket of nails from the ground by means of a rope passing over a pulley on the roof. The nails weigh more than Bob or Joe individually, but less than Bob and Joe together. However, the following unfortunate sequence of events happens:

1. While both Bob and Joe are holding the rope, they slip off the roof and fall to the ground, causing the bucket of nails to fly up in the air.
2. Just as they hit the ground, Bob lets go of the rope. The bucket of nails falls, dragging Joe up to the pulley, where he cracks his head against the pulley but gamely hangs on.
3. However, when the bucket hits the ground, the nails fall out, causing Joe to come plummeting back to the ground.
4. Having had enough of this ordeal, Joe lets go of the rope and remains on the ground, only to be hit on the head by the empty bucket.

Discuss with your partner what is providing the force in each of these four sequences.

The 10-Cent Experiment

Materials:

A coiled spring

A ball (of proportionate size, to rest on top of the spring)

Instructions:

1. Balance the ball on top of the spring.
2. Compress the spring by different amounts, with the ball on top. Release the spring and see how high the ball goes up.

Questions:

Is the spring pushing harder on the ball, or on the table?

Why?

Appendix

Video Credits

Produced by the Harvard-Smithsonian Center for Astrophysics

Series Producer

Clive A. Grainger

Producer

Veda C. Reilley

Series Content Guides

Dr. Jennifer Bond Hickman
Paul Hickman

Commentators

Katy Abel
Dr. Sallie Baliunas

Classroom Interviewers

Ingrid N. Allardi
Joyce Gleason
Judith Peritz

Featured Classrooms

Karen Spaulding, Grade 7 Science Class
Morse School, Cambridge, Massachusetts

Barbara Mitchell, Grade 5
Armstrong School, Westborough, Massachusetts

Joanne Aguiar, Grade 1
Laurel Lake School, Fall River, Massachusetts

Janet Smithers, Grade 4
Harwich Elementary School, Harwich, Massachusetts

Paul Martenis, Grade 11
Newton North High School, Newtonville,
Massachusetts

Advisors

Dr. Sallie Baliunas
Dr. John Clement
Hal Coyle
Dr. Eugenia Etkina
Dr. Julie C. Libarkin
Sam Palmer
Judith Peritz
Dr. Phil Sadler
Dr. Bonnie Shapiro

Science Visualizations Producer

Alex Griswold

Videotape Editors

Steven J. Allardi
Sandeep Ray

Additional Editing

John D. Doan
Tom Lynn
Julie Mallozzi
Stephen Osciak

Videographer

David Rabinovitz

Additional Videography

Clive A. Grainger
Vilma Gregoropoulos

Science Visualizations Videographers

Clive A. Grainger
Alex Griswold
Tobias McElheny

Audio

Charlie Collias
Tobias McElheny
Charles Rosina

Video Credits, cont'd.

Science Visualizations Narrator

Bev King

Original Music

Alison Reid
Treble Cove Music

Animation/Graphic Design

Mary Kocol

Graphic Design

Alicia Staples

Associate Producers

Nancy Fliesler
Karen S. McMillen

Production Assistants

John Doan
Lauren Peritz
Ross Weinberg

Instructional Materials

"Asteroid!," an Event-Based Science module,
published by Dale Seymour Publications

"Motion and Design," a Science and Technology
for Children unit, published by Carolina Biological
Supply Company

"Balls and Ramps," an EDC, Insights module,
published by Kendall/Hunt Publishing

"Magnetism and Electricity," a FOSS module,
published by Delta Education, Inc.

Physics: Principles With Applications, by Douglas
C. Giancoli. (Fifth edition, Prentice Hall, 1997).

Additional Images

NASA

Channel Operations Manager

Bev King

Director of Outreach

Joyce Gleason

Outreach/Scheduling Consultant

Dana Rouse

Outreach Coordinator

Amy Neill Bebergal

Outreach Assistants

Amy Barber Biewald
Lillian Lai

Director of Education Research

Dr. Michael Filisky

Education Coordinator

Alexander D. Ulloa

Web Design

Alison Reid

Financial Manager

Oral Benjamin

Administrator

Linda P. Williamson

Project Manager

Nancy Finkelstein

Executive Producer

Dr. Matthew H. Schneps