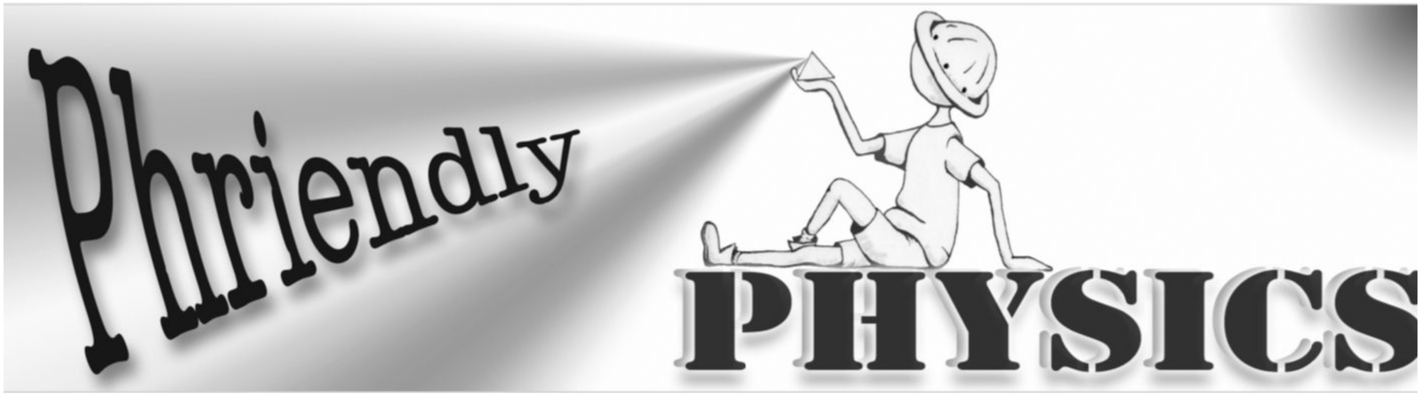


Phriendly Physics

Physical Science Workshop and Field Trip for Grades K-5

Sampler

Office of Education and Public Outreach / Fermi National Accelerator Laboratory
U.S. Department of Energy's Office of Science / Managed by Fermi Research Alliance, LLC.
Kirk Road and Pine Street / M.S. 226 / P.O. Box 500 / Batavia, IL 60510 / 630.392.3092 / www.ed.fnal.gov

This sampler contains some of the content from the *Phriendly Physics Teacher Workshop*

INTRODUCTION

Phriendly Physics

Phriendly Physics is a Next Generation Science Standards-infused physical science program including field trips to the Lederman Science Center for elementary students and a professional development program for teachers. Physical science concepts are presented in an exploratory environment designed to focus on qualitative data instead of quantitative formulas and calculations.

About the Teacher Workshop

The workshop helps K–5 teachers understand and feel comfortable with concepts of physical sciences through facilitated exploration of a series of simple, open-ended experiments, and through discussion and reflection with master elementary school teachers and Fermilab scientists. Participants will learn how to align their science instruction to the Next Generation Science Standards with a focus on force and motion, electricity and magnetism, light, and heat. Through this process participants gain a deeper understanding both of the science content and of new approaches in teaching and learning using the science and engineering practices, crosscutting concepts, and anchoring phenomena throughout their unit of instruction. Equipment and supplies will be provided so participants can continue to explore these concepts with their students. Discussion will also focus on the importance of storylining and using literacy to link your science instruction.

In the Classroom

Phriendly Physics focuses on the classroom. Participants not only learn concepts, but also start to think like scientists. All of the activities from the workshop can be done in the classroom, many with inexpensive and/or household materials. The most important thing participants will do is learn how to help students frame and explore their own questions, just like real scientists.

About the Field Trip

Teachers may schedule one or more of the four available Phriendly Physics field trips—electricity & magnetism, light, heat, and mechanics—at Fermilab. Each of the field trips features special activities at the Lederman Science Center. The field trips can kick off a unit of study with exciting activities that will serve as focal points for the exploration of a topic.

Please see the yellow pages at the end of this sampler for more information on Fermilab teacher workshops and field trips.

Next Generation Science Standards addressed by Phriendly Physics

Next Generation Science Standards

Disciplinary Core Ideas (DCIs)

PS1 Matter and Its Interactions

PS2 Motion and Stability: Forces and Interactions

PS3 Energy

PS4 Waves

Science and Engineering Practices (SEP)

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Crosscutting Concepts (CCCs)

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and Quantity
4. System and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change

ROLLIN', ROLLIN', ROLLIN'

BACKGROUND

The most basic aspects of physics contain a richness and depth that can be appreciated and explored without mathematics, or with very minimal math. This activity encourages exploration and careful observation of an event that appears simple, but is actually quite complex.

Next Generation Science Standards

Science and Engineering Practices 1, 2, 3, 4, 5, 6, 7, and 8
Crosscutting Concepts 1, 2, 4, 6, and 7
Disciplinary Core Ideas PS1, PS2, and PS3

MATERIALS (for each pair or group of students)

1. 2 (or more) one-meter ramps: It is helpful to have a slight depression, or "track" down the center of the ramp. A three-dollar molding strip will serve this purpose.
2. Books or blocks of wood on which to set one end of the ramps.
3. A wide variety of spheres: These should be of different sizes and materials: large and small; heavy and light; hollow and solid; smooth, rough, and fuzzy.
4. Lab notebooks or journals and writing utensils.
5. Stopwatches (optional)

PROCEDURE

1. Each pair or group of students should find a place on a table or the floor where they can set up their ramps.
2. They should then begin using the materials they have at hand to investigate different areas of study. It is very important that they write down everything they do.
3. If you feel it is appropriate to the groups, you may want to provide specific tasks, one of which would be the group recorder, who would write down everything the group does.
4. The teachers should circulate among the groups with two objects in mind: making sure that students are writing down results from all of their experiments, and encouraging them to find a direction for their investigation.

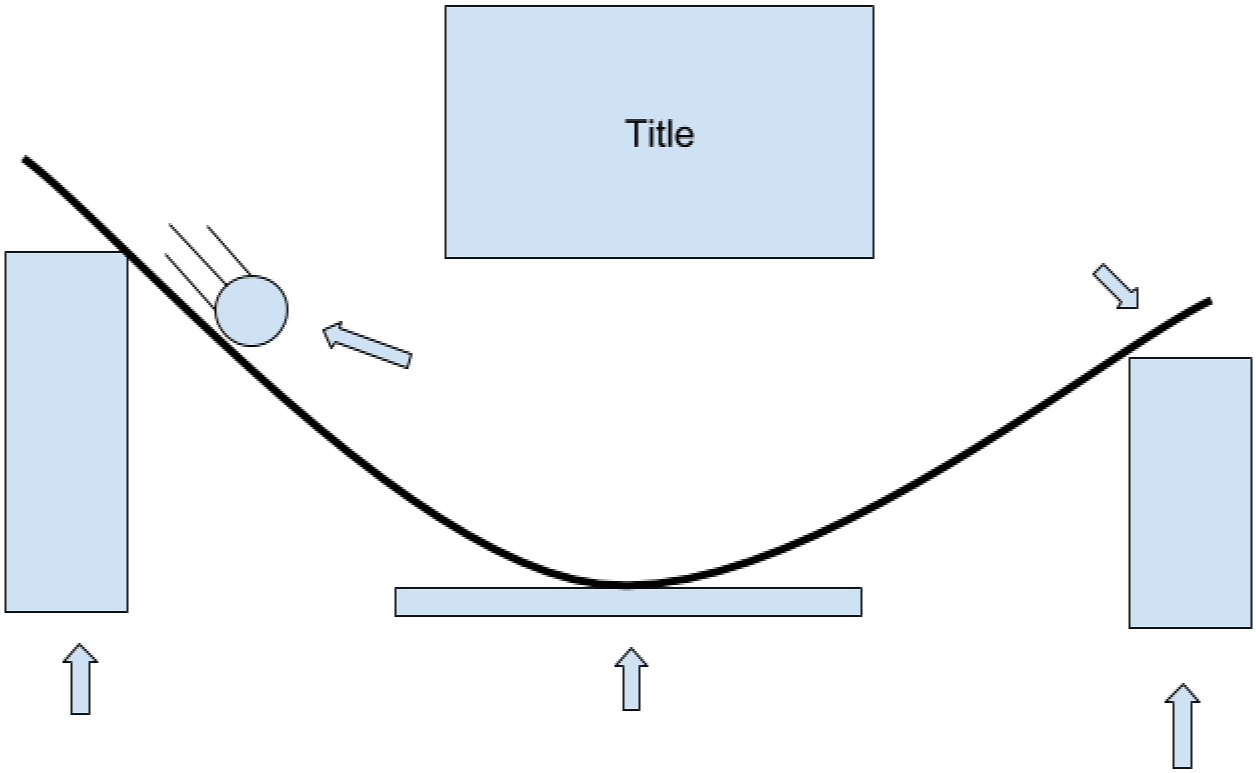
If students are having trouble focusing their investigation, the teacher could prompt them by offering questions to investigate. Possible examples include:

- Is it easier to observe the behavior of the balls if the pitch of the ramps is steep, or shallow? Why? Can you think of a situation that would make shallow preferable to steep? What about the other way around?

- Does a stopwatch help you observe? Is there information you can get with a stopwatch that you can't get any other way? What is it? Is there information that you can get without using the stopwatch? What is it?
- Would you be able to get more information if you made pencil marks on the ramp? What sort of information? Where would you place the marks? Would you get a different kind of information if you placed the marks differently? How?
- Examine (look at, touch, squeeze, smell, bounce, etc.) a tennis ball and a steel ball. List all of the similarities and differences you can notice between the two balls. Roll the two balls down the ramp at the same time. Look back at your lists of similarities and differences. Which of those do you think were responsible for determining how the balls rolled down the ramps? Decide how you would test to see if you're right. Carry out your tests.

Possible modifications and extensions:
It is strongly recommended that you make up your own questions to fit the level of the group and the direction in which they are steering themselves. As a concluding activity, the groups could present their information to the rest of the class, or come up with some other way of sharing what they have learned.

Cut out the words and label the diagram.



Energy Sphere	Ramp System	Block
Block	Base	Ramp

SAVE THE ICE CUBE

BACKGROUND

This exploration encourages thinking about how heat transfers between objects, using ice cubes as examples. As heat gets transferred to the ice cube, it melts. Heat comes through whatever it is touching, from air that it contacts, and through the sides of its container.

Different materials have different properties of transferring heat. For example, hot coffee in a metal cup will hurt your hand, but in a Styrofoam cup it can be handled. The molecules in the metal are all packed closely together. The Styrofoam is light and full of air -- its molecules are often separated from each other.

This activity could involve planning for an event that would cause an extended power outage–a tornado or an earthquake, perhaps. Without power to the freezer, a family would have to come up with a way to keep food cold for as long as possible. This would involve keeping a maximal amount of ice frozen over a long period of time. If you like, you could have the students practice and try different methods with several ice cubes before the “competition.”

Next Generation Science Standards
Science and Engineering Practices 1, 2, and 3
Crosscutting Concepts 5 and 6
Disciplinary Core Ideas PS3

MATERIALS (for each pair or group of students)

- Ice cubes (as close to the same size as possible)
- Styrofoam cups (with lids)
- Plastic wrap
- Aluminum foil
- Cotton balls
- Paper bags
- Plastic bags
- Other materials as desired (consider encouraging kids to bring in materials they think will be interesting)

PROCEDURE

This exploration has a very direct and simple purpose: The participants each try to make a container which will keep an ice cube from melting for the longest time. The groups can use whatever method they want to keep the ice cube cold–except they can’t use a refrigerator, freezer, or more ice. Encourage the group to think about how heat gets to the ice cube and plan how to insulate it.

Throughout the design process, students will create an expense sheet including materials and the calculation of the time spent on the design process.

Materials from an ice keeper “store”, which is manned by the teacher. An optional addition is to hand out play money to the groups for purchases at the store.

They can have their choice of where to place their ice keeper during the challenge. Remind them of how heat gets to it–i.e. Is it better to put it in the light or in the dark?

After some set period of time (which could be one or two hours), the groups should all collect their ice cube savers. To make the activity competitive, pour off the melted water, and weigh each partially melted ice cube in the same container. The heaviest remaining ice cube is the winner.

After the activity, the students should discuss what properties make a container a better insulator. They can then think about the situation posed above: in the event of a prolonged power outage, what would be the best thing to do with frozen and refrigerated food? This may lead to an associated project in which they design or build larger insulators.

Sample Engineer’s Warehouse		
Foam Sheet	1 sheet	$ 300
Ziplock Bags	1 bag	$ 200
Peanuts	1 bag	$ 350
Coffee Cup	1 cup	$ 400
Styrofoam Bowl/Cup	1 bowl	$ 575
Aluminum Foil	1 sheet	$ 525
Bubble Wrap Sheet	1 sheet	$ 275
Bubble Wrap Envelope	1 envelope	$ 400
Black Foam Board	1 piece	$ 325
Blue Tape	30 cm	$ 500
Clear Tape	15 cm	$ 475
Masking Tape	30 cm	$ 300

Sample Cost Sheet

Project Title:____

Design Team:____

Engineer's Materials List and cost proposal

Item	Specifications (Material Dimensions)	Item cost	Quantity	Total
			Total material cost	