Introduction

Phriendly Physics presents physical science topics at a conceptual level in an exploratory environment. The workshop revolves around experiments done by the participants with emphasis on qualitative concepts instead of quantitative formulas and calculations. Since most of the participants in the workshop are new to conducting experiments and taking data, the role of facilitators and visiting physicists is to help them focus on the excitement of the discovery process.

The principal goals of the workshop are:

- Introducing and applying the scientific method.
- Reducing apprehension about physical science (especially physics).
- Exploring classroom-ready experiments.
- Recording information and reflections about experiments in a logbook or journal just as students can do.

The two activities that follow are representative of the *Phriendly Physics* workshop. Since *Phriendly Physics* is dedicated to exploration and inquiry, we avoid pre-constructed, or "cook- book" activities. In the workshop, we present a situation to explore or problem to solve. Participants describe it and their work in as much detail as possible. One of the features that arise from this approach is that participants' logbooks are their primary record of the workshop as students' logbooks should be their primary record of learning science by doing science.

Standards addressed by
Phriendly Physics

Common Core English Language Arts

CCSS.ELA-LITERACY.W.2
Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
CCSS.ELA-LITERACY.SL.1
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade level appropriate topics and texts, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.4
Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.

Common Core Mathematics

Measurement & Data
1. Solve problems involving measurement and estimation.
2. Represent and interpret data.

Next Generation Science Standards

PS.1. Matter and Its Interactions
PS.2. Motion & Stability: Forces & Interactions
PS.3. Energy
PS.4. Waves
ESS.1. Earth's Place in the Universe
ESS.2. Earth's Systems

Science and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
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 (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

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.

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 teacher's 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.

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.

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."

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.

They can have their choice of where to place it, and what to put it in. 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.