Build Your Own Ice Skater

-->The Workshop

-->*Introduction*

Overview: In this workshop, 8-10 students between the ages of 10 and 15 build miniature ice-skating vehicles which they can test on a table-sized ice rink. Through this process, they learn about the laws of physical motion through direct experience and free experimentation.

Timeline: The workshop lasts approximately two hours. It begins with an introduction during which we introduce the problem in broad terms, providing the students with enough flexibility to build whatever type of vehicle suits them. A typical introduction would be something like the following:

> *"We've got legos, string, styrofoam, (list of materials) and we want you to experiment with building something that moves on the ice. It can be fast like a bobsled or artistic like a figure skater. Feel free to work together and share ideas, and at the end, we'll all get back together to demonstrate all of the vehicles on ice."*

After this short introductory period, we allow up to 90 minutes for building and experimenting. Ideally, the rink is prepared, and the kids are free to test and play as soon as the workshop begins.

We then spend 15 minutes demonstrating the vehicles. Watching them move on the ice typically elicits observations and comparisons, and this then evolves into the final 15 minutes of reflection, whereby the students think about what worked and what didn't, and build intuition about the laws of motion.

Space: There are two key space constraints. First, there must be an area and table large enough to support the ice rink. Ideally, it should be accessible from all sides. Second, there should be enough work stations that the students can access the lego bricks while still having room to work and experiment on their own. Finally, the room should be ventilated enough that the sublimation of the dry ice will not cause a problem (we found that a typical classroom had more than enough ventilation).

Materials: The students basic building blocks are lego bricks, wheels, gears, and other assorted pieces. We also provide easy-to-use materials such as styrofoam, string, paper, duct tape, and velcro.

Of course, the rink and the propulsion devices are also critical for the students to build with. They are covered in much more detail in the other sections of this page.

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-->*The Rink*

The rink structure is made of unfinished wood and is three feet wide, four feet long, and seven inches high. It is designed to fit on medium sized table. The bed of the rink lies three inches above the table and is made of wire mesh, supported by wooden cross beams. On top of this mesh will be places several one-inch thick sheets of dry ice. On top of the dry ice will be placed a continuous sheet of plastic, which will also cover the walls of the rink. Water will then be poured onto the plastic and left to freeze. This freezing process takes approximately one to two hours. Once the water is frozen, it should continue to stay frozen for several hours. In the final configuration, the dry ice is totally hidden, so that it cannot be touched, but is allowed to breath through the wire mesh. Additionally, there will be a two wall around the ice so that the ice skaters do not escape.

Multimedia

Pictures

- A mechanical view of the rink [Gif, 1K]
- The rink with dry ice slabs [Jpeg, 100K]
- The frozen rink with dry ice pellets [Jpeg, 64K]

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-->Propulsion

There are four primary modes of propulsion across the ice. Each one is designed to allow the students to test some aspect of propulsion when building their skaters. The devices have been built into a somewhat-extensive lego "cradle" to allow the builders to circumvent some of the more troublesome mounting issues that arise.

	Low weight	High weight
Low force	Rubber band motor	CPU fan
High force	Dry ice rocket	Polaroid motor

Rubber Band motor: This device creates a small amount of angular force (torque) by winding the rubber band around a shaft and releasing. This "spring-loaded" mechanism will then deliver a steadily-decreasing amount of force for a short time. It does have the advantages, though, of being very simple and very light.

CPU fan: The CPU fans (powered by two 9V batteries rigged up to provide a more powerful 18V) offer a similar low-torque output to the rubber band while providing more weight and stability. The fans also allow the builder to apply a force to his or her creation without needing to touch the ice in any way.

Dry ice rocket: The most dangerous and powerful (and, in my estimation, likely to be the most popular), this device offers a large amount of torque in a relatively small package. Unfortunately, because of the dangers involved with dry ice, the students will have to be closely supervised when using this method. The rocket is constructed using a film cannister with a hole punched in the lid. If dry ice and water are then mixed and the top applied, a small rocket can be made (with the pleasant safety feature of blowing the lid before the container explodes, thereby lessening the potential for injury).

Polaroid motor: A simple motor attached to a lego gear train provides the students with a very standard robotic option for creating motion as well. While this type of propulsion most logically drives a wheel, students will probably need to find alternative uses for this motor to get maximal benefit.

Batteries and Connectors: Everything is powered by some flavor of 9V battery, hooked up using simple 1/8"" headphone jacks to allow for easy replacement with a potentiometer in series).

The batteries are then connected to the motors and fans in a variety of ways. Presented below (under connectors) are some of the options presented (from right to left): two batteries and a three-position switch, for reversible control of the motors, standard single battery configuration, battery with 100 ohm potentiometer in series for adjustable voltage, two batteries hooked up in series to crate an 18V power source.

Multimedia

Pictures

- The rubber band motor [Jpeg, 68K]
- The CPU fans [Jpeg, 44K]
- The dry ice rockets [Jpeg, 37K]
- The Polaroid motors [Jpeg, 68K]
- A battery (with connector) [Jpeg, 12K]
- The connectors [Jpeg, 61K]