Dry Ice Dynamics

Instructor's Handout

1 Educational Objective

This activity is designed to demonstrate frictionless dynamics and demonstrate newtons laws. These are concepts which students likely has heard discussed, but are not often demonstrated. On the ISS, the SPHERES move essentially without friction (air resistance is negligible). This movement is often counter-intuitive because it differs considerably from normal day to day experience where friction quickly dissipates an objects kinetic energy. This activity seeks to familiarize students with low friction dynamics by asking them to predict the path of a block of dry ice sliding across a table.

2 Materials

- 1 10lb block dry ice in cooler
- 1 hammer
- Several Pairs insulated gloves with long sleeves (welding or winter gloves work well)
- 2 1ft pieces of 2x4 lumber
- 1 fan
- 1 dry ice ramp (provided)
- 1 roll poster paper
- 1 large storage tub or laundry basket
- markers (1 color per student)
- 1 pair safety glasses
- 1 flat table

3 Safety

This activity involves dry ice, which is frozen carbon dioxide. While solid, the dry ice has a temperature of −78.5 degrees Celsius. Touching the dry ice with bare skin will cause **frost bite** instantly. As such, only the instructor should handle the the dry ice and only while wearing insulated gloves. Be sure to explain this to the students **before** the activity begins.

4 Introduction

For this activity, students are asked to predict the path a block of dry ice will take when slide off of a ramp. At room temperature, dry ice sublimates directly from a solid into a gas. When a block of dry ice is placed on a flat surface, this sublimation results in a layer of gas between the dry ice and the surface which allows the dry ice to move across the surface with essentially no friction. This effect should be described to students and demonstrated by sliding a block of dry ice across the table before the activity begins.

5 Instructions

1. Unroll a sheet of poster paper onto the flat table and place heavy objects on each of the four corners. Make sure the sheet is completely flat. Wrinkles will cause the blocks of dry ice to stop moving.
2. Set up one of the obstacle courses shown in section 6 below. The distance between items is unimportant, but the relative angles between items is extremely important.
3. Give each student a marker and ask them to sketch the path they expect the dry ice to take on the paper.
4. While the students sketch, chip a piece of dry ice off the larger block using the hammer. The piece should be small enough to fit onto the dry ice ramp. Wear gloves and safety glasses!
5. Smooth any rough edges on the piece of dry ice by rubbing it against a flat surface.
6. Place the laundry basket on the floor where most students predict the dry ice will leave the table.
7. Tell the students to step away from the table. They should be close enough to observe but not close enough to touch.
8. Place the chip of dry ice on the ramp and allow it to gently slide onto the table.
9. Compare the actual path of the dry ice to the students predictions and discuss why the dry ice moved as it did.
10. Repeat for each of the obstacle course.
11. If there is time and dry ice remaining, ask the student to place the fan and two by fours to direct the dry ice to a specific target. Making the dry ice stop on the table is particularly challenging.

6 Obstacles

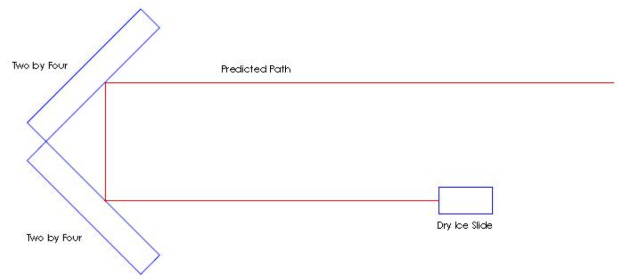

Figure 1: An obstacle demonstrating reflections off barrier at 45 degrees.

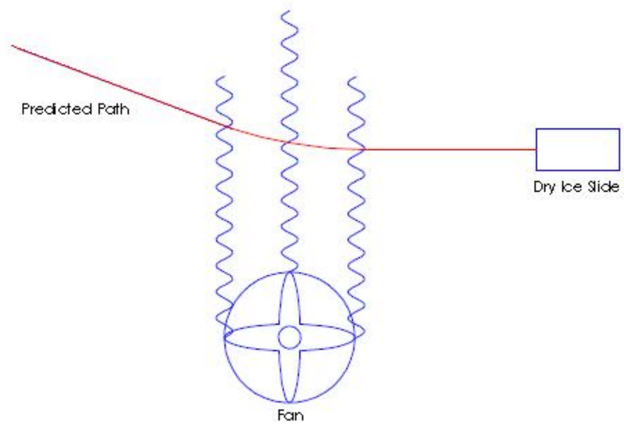

Figure 2: An obstacle demonstrating a particle moving under a constant force.

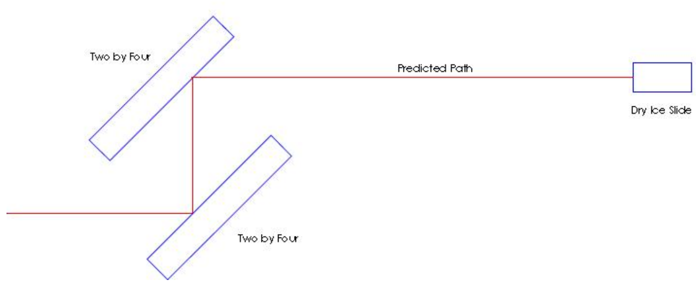

Figure 3: An obstacle demonstrating reflections in a different manner.

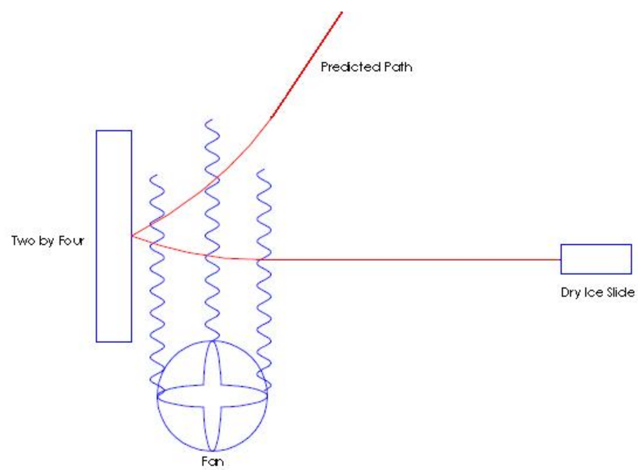

Figure 4: An obstacle demonstrating reflections and a constant force. Note that the outcome of this obstacle is highly dependent on the strength of the fan used.