

## Activity Steps:

### Day One:

1. Tell the students they will be working in groups to design and build sleds using only cardboard and duct tape and that to help decide how to design their sled we will be thinking about different properties and concepts of physics.
2. Show students the sledding diagram on the board and explain the forces in play at each phase of going down the hill. Provide a definition and context for each of the **bolded** terms and add to the diagram as you go:
  - a. At the top of the hill, you are just sitting. You have **inertia**. There are two main forces at play here, **gravity** and **natural force**, which are equal to each other, therefore you remain in place. In order to get going down the hill from a flat surface you need a **force** exerted upon you to overcome your inertia (a friend pushing you). At the top of the hill you have **potential energy**.
  - b. Going down the hill, gravity takes over and the incline of the hill reduces the natural force, allowing you to continue going down the hill. The force opposing you now is **friction** and you will continue going down the hill so long as the force of gravity overcomes the force of friction. There is another kind of friction at play called **drag**, which is the friction between a surface/object and the air. Going down the hill you have **kinetic energy**.
  - c. At the bottom of the hill, when you stop, the force of gravity and natural force are again equal.
3. Ask students how they might use this knowledge to design an effective sled? They may mention things such as making an aerodynamic design, weighting the sled, putting wax paper on the bottom of their sled to reduce friction, etc.
4. Remind students that anything they do to their sled to reduce drag, reduce friction, increase kinetic energy, etc. are some variables that they can control. But there are other factors that will affect our sled's performance that are outside of our control- ask students what they think some of these factors are. They may come up with answers such as the characteristic of the snow, the angle of the incline of the hill, etc. Ask students to consider how weather in the weeks preceding our sled test run could affect the sleds' performance. (For example, snow has different characteristics at different temperatures, warm days and cold nights can cause snow to melt during the day and then freeze into a very slick surface over night!)
5. Introduce the students to the weather chart on the board. Explain that each day, you will write the high and low temperatures and the general weather conditions and ask students to fill in the section labeled "Hill Conditions." We will do this to track how the weather leading up to our test run affects the condition of our hill.
6. Finally, introduce the students to the sled design planning form and allow them to split up into groups to begin designing their sled. Remind students that they will need to work together and to attend regularly to be able to finish their sled. Also remind them the width of the door the sled needs to fit through to get outside!

**Following days:** allow students to pick up their work from where they left off, reminding them of vocabulary/concepts as needed and assisting with construction. Remind students daily of safety

when working with scissors and to ask staff to assist with cutting when needed. Once students have their basic design completed, have them think about how they want to paint their sleds and provide them with the materials and time to complete that part of the lesson.

**Student Reflection:**

**Instructor Reflection:** This lesson is always a big hit and the students come up with some seriously creative designs. It's a longer term project and really gets students to think about design and weather as they obsess over every little change in our sledding hill. This year, we brought the sleds to the Carly's Hill Cardboard Classic (community event) so parents didn't have to transport them and we could support the students in the race!

**Additional instructor reflection or comments:** Here a few things you should also do in advance of this project to prepare:

1. Start collecting cardboard about a month in advance. We always have good results when we ask the school cafeteria to send us all their cardboard boxes. Maintenance sometimes gets really big boxes too, so you may want to ask your maintenance person at your school. Some parents have also brought some in when they see the project getting started.
2. Alert your friendly custodial staff that your room may be a bit messier than usual during this project. I always check in if there are special concerns and let them know they don't have to worry about moving sleds if they are in the way, just to clean around stuff.
3. Think about storage. Have a plan for where to keep the sleds as the students continue working on them, including where to put them on days when they won't be working on them to make room for other activities.

## Attachment 2- FA Sled-Building

Day of the week:	Weather:	Hill Conditions:
Monday	High: 16 F Low: 3 F Abundant sunshine	Slippery Icy Solid Like concrete
Tuesday	High: 23 F Low: 20 F 1-3 inches of snow	Fresh snow on top Icy underneath
Wednesday		
Thursday		

\*Here is what our "SLED CHART OF SCIENCE" looked like. We drew this on the board and kept it up for the month, filling it out each week and then erasing and starting again the next. We talked about weather conditions each day at dinner, and wrote the descriptive words students used to describe the conditions of the sledding hill each day. Monday and Tuesday are filled out with examples of what you and students may write.

**Attachment 3- FA Sled-Building**

**SEEDS Forest Area Sled Design Planning Sheet:  
(print two-sided on graph paper)**

**This is what the sides of my sled will look like:**

**Dimensions:** \_\_\_\_\_

**This is what the bottom of my sled will look like:**

**Dimensions:** \_\_\_\_\_

**Layout of the Sled including both sides and bottom:**