



**Mission:** How do layers help things slide?

**Age:** 5+

**Materials:** \$6

**Time:** 25 min

(Set-up: 10 min    Activity: 15 min    Clean-up: 5 min)

## What you need:

### Materials:

- 1-2 sheets of plain paper, cut into bits (~1.5-inch squares)
- Chunky glitter (also called “jumbo glitter”)
- Pencil
- 1-2 sheets of uncut paper
- Gummy bears (fresh and a little sticky)

### Equipment:

- Scissors
- Tape
- 3-inch binder (or build your own similar-sized ramp, 3 inches tall)
- Large baking tray with edges
- Data sheet

## What to do:

1. Rub your thumb and index finger together. How does it feel to rub your skin together? How easily do the surfaces of your fingers slide against each other?
2. Now try it again to test a few different materials. Notice how the materials feel between your fingers as they slide.
  - Hold some paper bits between your fingers.
  - Hold some pieces of chunky glitter between your fingers.
  - Color a piece of paper with a pencil, then press both fingers in the colored area to cover your fingers with graphite.
3. Each test uses materials that are made up of flat, small particles – even the graphite from the pencil, where the particles are too small to see. You’ll measure the slipperiness of these materials by testing how well they help a gummy bear slide down a ramp.
4. Get your ramp ready, using a binder or your own design. Tape a sheet of paper to the top of the ramp. Place your ramp on the baking tray.
5. Put one gummy bear at the top of the ramp. Does it slide down? Try it with two other gummy bears and record your results on the data sheet.
6. Draw two lines from the top to the bottom of the ramp to divide your surface into three equal lanes. Sprinkle paper bits all over the first lane, chunky glitter (about 2 teaspoons) all over the second lane, and color the third lane with pencil (the darker the better).

## What to do:

7. Based on your observations in step 2, record your predictions on the data sheet. Do you think each material will help the gummy bear slide?
8. "Coat" the back of each gummy bear by pressing or rubbing it into the material covering each lane, then place the bear at the top of the ramp. Does it slide? Test each lane 3 times and record your results on the data sheet. Did your results match your predictions? Which slid fastest?
9. Explore further! Look for other materials that might help the bear slide. Test and record your results on the additional rows of the data sheet.

## Clean-up:

Wash your hands with soap to remove graphite from your fingers. Take apart your ramp and throw away used paper, glitter, and gummy bears.

## What's Happening?

Materials that help two surfaces slide past each other are called "lubricants." Lubricants are placed in between two surfaces to reduce friction and heat. You might be familiar with liquid or semi-solid lubricants, like oil or grease, that are often used to make cars and other machinery run smoothly.

In this experiment, you observed the performance of a different type of lubricant--layered materials. Without any lubricants, there is too much friction between the gummy bear and the ramp for the bear to slide down. By adding paper bits or chunky glitter in between, you created layers of these particles that could easily slip past each other. Graphite is a common industrial lubricant that works in the same way, but its flat, layered particles--each just one atom thick--are too small for our eyes to see. Did you try any other layered materials that worked?

## So What?

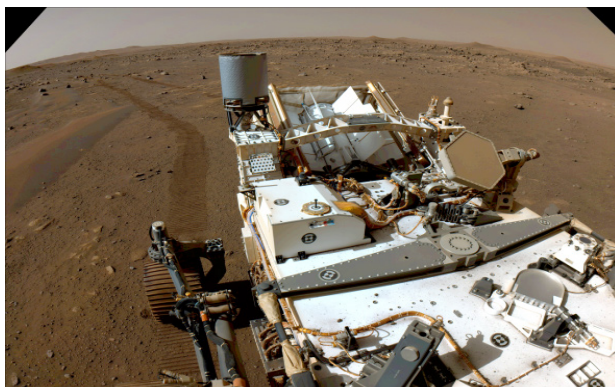


Image credit: NASA/JPL-Caltech

When you pull layered materials apart into individual layers, each sheet is so thin that you see unexpected behaviors. Think about your observations with the gummy bears. Using thin layers of paper, glitter, or graphite as a solid lubricant helped your gummy bear slide.

In the real world, too, solid lubricants are used as coatings to help moving parts slide against each other. You can find them in trains, rockets, and other places where moving parts are exposed to extreme temperatures, dust, or moisture--conditions where liquids just don't work as well. But aside from being slippery, layered materials have other cool properties too. Thin layers can lead to faster chemical reactions and better flow of electricity. Researchers are inventing new ways of making layered materials to help create batteries and fuel cells for longer-lasting, non-polluting energy.

## SLIPPERY SOLIDS

For each material, predict whether it will help the gummy bear slide down the paper surface of the ramp. During your experiment, observe and record your observations for each trial.

|                 |                                               |                                           |              |
|-----------------|-----------------------------------------------|-------------------------------------------|--------------|
| <b>MATERIAL</b> | <b>PREDICTION:</b><br>Will it slide? (yes/no) | <b>RESULTS:</b><br>Did it slide? (yes/no) | <b>NOTES</b> |
|-----------------|-----------------------------------------------|-------------------------------------------|--------------|

|                   |  | TRIAL 1 | TRIAL 2 | TRIAL 3 |  |
|-------------------|--|---------|---------|---------|--|
| No material       |  |         |         |         |  |
| Paper bits        |  |         |         |         |  |
| Chunky glitter    |  |         |         |         |  |
| Pencil (graphite) |  |         |         |         |  |
|                   |  |         |         |         |  |
|                   |  |         |         |         |  |
|                   |  |         |         |         |  |

# NGSS Alignment of Slippery Solids Activity

The information below may not include every area that this activity can be linked to NGSS concepts

## Disciplinary Core Ideas

### PS1.A: Structure and Properties Matter

- Grade 2
  - ◇ Different properties are suited to different purposes.

### PS2.A: Forces and Motion

- Grade 3-5
  - ◇ Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.
- Middle School
  - ◇ The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.
  - ◇ All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.

## Performance Expectations

2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

## Crosscutting Concepts

### Cause and Effect

- Grade 3-5
  - ◇ Cause and effect relationships are routinely identified, tested, and used to explain change.
- Middle School
  - ◇ Cause and effect relationships may be used to predict phenomena in natural or designed systems.

## Crosscutting Concepts

### Stability and Change

- Grade 3-5
  - ◇ Change is measured in terms of differences over time and may occur at different rates.
- Middle School
  - ◇ Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.

## Engineering and Science Practices

### Analyzing and Interpreting Data

- Grade 3-5
  - ◇ Analyze data to refine a problem statement or the design of a proposed object, tool, or process.
- Middle School
  - ◇ Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.

### Planning and Carrying Out Investigations

- Grade 3-5
  - ◇ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials are considered.
  - ◇ Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
  - ◇ Make predictions about what would happen if a variable changes.
- Middle School
  - ◇ Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
  - ◇ Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.
  - ◇ Collect data about the performance of a proposed object, tool, process, or system under a range of conditions.