Investigating Static Forces in Nature: The Mystery of the Gecko
Lesson 2: What Do We Mean When We Speak About Surfaces in Contact?
Explore

Student Learning Objectives:

- Compare the amount of surface contact (real contact) to total unit area (apparent contact) at the macro level
- Understand that different textures of surfaces have different contact ratios

At a Glance for the Teacher:

- Observe and quantify surfaces, textures, surface contact, and total surface area
- Student Activity: "Sole Impression"

Note: Some questions in the Student Journal are underlined as formative assessment checkpoints for you to check students' understanding of lesson objectives.

Estimated Time: 45–75 Minutes

Vocabulary: Area, Contact, Pressure, Ratio, Surface
Refer to the end of this Teacher Guide for definitions.

Safety Note

Have students wear safety goggles in accordance with district safety policy.

Materials:

- PowerPoint for Lesson 2
- Student Journals for Lesson 2
- Computer with LCD or overhead projector

For each group of students for student activity: *Sole Impressions*

- Tempera paint and rollers, or finely ground dark sidewalk chalk (purple or blue work best), or ground-up charcoal
- Original graph paper (not photocopied) or graph paper on goldenrod
- Tray or container to hold chalk (old baking trays, kitty litter boxes)
- Old shoes (or students' shoes that they don't mind getting dirty)

Slide # Student Journal Page #	*Teacher Background Information and Pedagogy* **"Teacher Script"**
Slide 1 Title	*In this lesson, students will explore how the relative amount of surface contact observed depends on the scale that one is using.* *1) Review "Making Connections" questions from the PowerPoint in Lesson 1.* **"In the last lesson, we made observations and interpretations about how geckos adhere to surfaces."** Review Lesson 1 "Making Connections" questions. **"In this lesson, we will study how much contact is actually made between a shoe and a solid surface."**
Slide 2 Student Journal Page: 2–1	*2) Display slide 2:* **"This first slide shows an image of three shoes taken from a distance. Indicate the relative amount of contact between each shoe and the surface. For each shoe, circle one answer and provide a reason for your answer. Why are the details difficult to observe? How is this similar to observing an object under a microscope under low power?"** *While students may be frustrated with making observations from a distance, allow students to struggle with this first image. Some students might state that they are all in contact with the floor. Other students will say that the shoes on the left and right have about the same amount of contact with the floor, but the one in the middle would have less.* *3) Have students respond to the questions at the bottom of their Student Journal. For the first question, students might state that this was difficult because of the view of the images is at a distance. For the second question students may suggest "getting a picture that is closer to the objects being observed." This type of thinking will focus students about the need for closer observations and the need for instrumentation which will be discussed later.*
Slides 3–4 Student Journal Page: 2–2 2–3	*4) Display slide 3 and 4:* **"Take a closer look at the surfaces of these shoes. Indicate the relative amount of contact between each shoe and the surface. For each shoe, circle one answer and answer the questions that follow."** *Slide 3 shows the same side view. Slide 4 shows the bottom (sole) of each shoe. These views represent a closer, more detailed view similar to viewing smaller details of an object through an instrument. If your students don't mention it, you might want to point out that the cleats (images 2.3 and 2.6) will penetrate into turf providing more surface contact than when walking on a hard surface such as sidewalk.*

Slides 5–6 Student Journal Page: 2–3	*5) Display slide 5 and 6:* **"These two slides show a method for determining the ratio of contact area of a shoe to the total surface area that is walked upon."** *6) Lead students through the Student Activity "Sole Impression." Allow students to determine the ratio of the contact area of their shoe to the total area. Using something like finely ground sidewalk chalk, charcoal, or tempera paint, have students make an imprint of a shoe's sole on a sheet of graph paper. See Student Journal. Students can then compare the ratio of contact area to total area of shoes typically worn by students in class.* *7) Field test teachers noted that some students with the same type of shoe had different ratios of contact area to total area. Use this as an opportunity to discuss the reasons for these differences. The discussion might include differences in the amount of chalk/paint applied to the shoe, differences in the amount of pressure of the shoe to the paper, or inconsistencies in counting squares or variations in the methods used.* *8) Allow students to speculate about the advantages of high ratio vs. a low ratio (a high ratio should provide better traction when playing on a slippery surface, a low ratio is helpful when one is interested in sliding such as when skating). What are circumstances when each is desired? As extensions, students could design and test their own related questions.* *Pilot teachers time-saver suggestions:* *Students can use the "count-the-squares" method to determine the amount of contact area. When using this method, students will need to determine what counts as a covered square. One method might be to count all squares that are half covered or more, and not count them if are less than half covered. Students can count intersections; there is less uncertainty about whether to count them.* *Teach students to count squares by using large blocks of squares instead of individual squares.*
Slide 7 Student Journal: Pages: 2–4 2–5	*9) Display slide 7. Solicit from the students the differences they can note between the images. Draw out from them the idea of surface contact (real contact) to total unit area (apparent contact).* **"This slide shows two images at different scales. The image at left shows a shoe that appears to have a large percent of contact between the sole and the floor. The diagram at right illustrates that two hard surfaces (like the shoe and the floor) actually have less actual contact when observed up close. Based on your examination of different shoe soles, what are your ideas about the surface of a gecko's foot, and what makes you think that way?"**
Slide 8	*10) Ask students to answer the "Making Connections" questions as a discussion or in their journals. Draw their attention to question 2. Prompt students to think about what would happen if a heavy person were wearing the shoes verses a lightweight person. Students might also suggest the variable of hard sole vs. deformable shoes, or hard floors vs. carpeted.*

Slide 9 	*11) The pilot-test teachers highly recommend using this flow chart at the end and/or beginning of each lesson. The end of each lesson contains this flow chart that provides an opportunity to show students the "big picture" and where they are in the lesson sequence. The following color code is used:* *Yellow: Past Lessons* *Blue: Current Lesson* *Green: Next Lesson* *White: Future Lessons*

Appendix: NanoLeap Physical Science Vocabulary for Lesson 2

Area
1. A part of the surface of an object
2. The amount of space of a two-dimensional object (length times width for a rectangle)

Contact (macroscopic)
1. The union or junction of surfaces
2. The state or condition of touching: the mutual relation of two bodies whose external surfaces touch each other

Force
A push or a pull that acts on an object

Ratio
The relative quantities, amounts, or sizes of two things. It is usually expressed by dividing the first quantity by the second, or the fraction or quotient expressing this.

Surface
The exterior or boundary of an object, immediately adjacent to the air or empty space, or to another body