

## If the Shoe Fits—Athletic Shoe Activity for Multiple Grades

For many kids, summer activities involve athletics. Most of your students probably watched the Olympics on TV and/or were active themselves in sports. At every grade level, sports make a great springboard into science. Through sports, students who might not otherwise be interested can see how science and technology play a large role in their daily lives.

The design of athletic shoes is one example in which chemistry and biomechanics are employed to help minimize strain to the lower body and enhance athletic performance. A shoe should not only provide support and protection to the foot and ankle, but must also provide maximum traction and flexibility and, above all, be lightweight. In track and field sports, for example, a few ounces of extra weight can reduce a runner's speed enough to lose a race. To this end, Nike recently introduced an ultralight shoe that uses thin, liquid-crystal polymers that act like suspension bridge cables to resist shoe stretching and maintain stiffness without adding weight. For cushioning and support, many shoes employ lightweight gel cavities or air pockets.

All modern athletic shoes have at least four components: the **upper**, the **insole** or insert, the **outsole**, and the **midsole**. The upper holds the shoe together and protects the foot. The insole lies directly beneath the foot and provides cushioning and arch support. Insoles are removable in many shoes, and extra insoles called inserts can be added for comfort or moisture control. The outsole is the part of the shoe in contact with the ground; it's usually made of rubber or a synthetic polymer and has treads or cleats for traction. The midsole is the hidden layer between the outsole and the insole, mainly designed for shock absorption. Other specialized athletic shoe terms include wedge, heel counter, and toe box.



Figure 1

In this activity, students explore shoes to gain an appreciation for the technology involved in shoe construction and to practice gathering and analyzing scientific data. The activity is divided into three parts based on grade level. Part A has two parts: one for younger students and another for older students. Depending on the student level of abilities, you may want to incorporate elements of various parts into a single classroom activity.

### Materials

- metric rulers
- computer with Internet access (for Part C)
- old, worn athletic shoes and other shoe types

👉 You should have at least one other type of shoe (dress shoes, sandals) for comparison. One shoe per four students should be adequate. You may wish to have students bring an old pair of shoes from home, so they can be free to disassemble the shoe to examine the insole and other interior parts of the shoe. If you have access to a band saw, you may wish to saw the shoes in half lengthwise.

### Procedure

#### Part A: Comparing, Sorting, and Graphing Activity

Introduce the activity by asking students what scientists do. One thing that scientists do is sort and classify objects and phenomena by similar characteristics. Sorting and classifying help scientists simplify the natural world. Explain that scientists also observe, measure, predict, do experiments, and make conclusions based on their findings.

For grades K–3:

Tell students that they are going to sort a group of objects in the class. (The youngest students may need an example of what sorting is.) Have students remove their shoes and sort the shoes based on common characteristics. Characteristics might include shoe type, color, size or shape, and degree of wear. Let students try several different ways, but make sure they can explain the method used to sort the shoes. Ask them how many of the shoes are athletic shoes. Have them compare the characteristics of athletic shoes with other types of shoes.

*For grades 4–6:*

Have students explore the shoes as scientists might, asking questions and gathering, graphing, and analyzing data as appropriate. For example, students might measure shoe length and work to answer questions such as the following: What is the average (mean) shoe length for the classroom? What is the most common (mode) shoe size? Are boys' and girls' shoe sizes different? How? Are all girls' size 4 shoes the same length? If they're different, how might these differences be explained? For another activity that deals with athletic shoes, see the "Science of Athletic Shoes" at [www.terrificscience.org/ncw](http://www.terrificscience.org/ncw).

***Part B: Dissected Shoes (grades 7 and up)***

Have students examine an athletic shoe to find the various parts of the shoe labeled in Figure 1. Then have students measure thicknesses of the insole, midsole, and outsole at various points along the length of the shoe (toe, arch, and heel). Have students create and fill out a data table that contains these measurements. The table can also include descriptions of tread design and the color and textures of various parts of the shoe.

Have students answer the following questions:

- Can you tell which of the shoes have traveled the furthest (have the most miles on them)? Explain. Describe at least three features that support your answer.
- Do the insoles of the older shoes look different than the insoles of the newer shoes? Explain.
- Does the thickness of the insole change depending on its location in the shoe? How?
- Do you see visible wear patterns? Discuss.
- Are air pockets present? What purpose do air pockets serve?

***Part C: Brand Comparison and Shoe Design (advanced project)***

Have students compare different brands of athletic shoes and use the Internet to explore each manufacturer's claims. Have them research the ideal features of an athletic shoe for a given sport. Let students select a sport and then design a shoe they think would be ideal for that sport. Have them draw and label the shoe. Students should show and describe at least three features that apply to the chosen sport.

*Activity adapted from Athletic Shoes: Studies in Compounding Polymers; Carolina® Active Science™ Series: Burlington, NC, 1999.*