

IF THE SHOE FITS

Have you ever watched a Thunder game and suddenly realized that instead of watching the action, you were staring at the players' shoes? You're not alone! Basketball shoes have become a way for players and all of us to show personal style on and off the court. But these shoes aren't just about fashion. There's a lot of science and engineering that goes into designing features that help protect the player and improve their game. Players aren't just choosing shoes for style. They're choosing shoes to win.

Pro-tip: This activity can be done in a home or in a classroom. It can be done by an individual student, in a small student group or by a family.

HERE'S WHAT YOU WILL NEED PER STUDENT OR STUDENT GROUP:

- **Notebook**
- **Pencil**
- **Scissors and/or a hobby knife**
(with a helpful adult)
- **Tape and/or hot glue** *(with a helpful adult)*
- **Cardboard**
- **Foam, any kind of foam**
- **Cloth, felt, cardboard or any kind of material that you can recycle, upcycle, or reuse**
- **A web-enabled device to look at shoes**



**SCIENCE
MUSEUM!**
O K L A H O M A

WARMUPS

Basketball shoes have been a big part of the game since shortly after the game was invented. In fact, basketball shoes have been around for more than 100 years! The first basketball shoes were quite different than the ones NBA players wear on the court today. For decades the predominant basketball shoes were canvas high-tops with rubber soles, much like the kind that come in a variety of colors and are still popular today. Over the years, basketball players were offered an array of shoe styles made of a variety of materials, as different companies competed for the attention of basketball players and fans.

Let's think about shoes!

Grab your pencil and your notepad. Think about your foot and try to imagine it in detail. If you are in a place where you can, take off your shoes and socks and actually look at your foot.

Draw your foot, labeling as many parts as you can. Think about what all of the parts of your foot allow you to do. Jot down your thoughts on the paper.

Now, look closely at your shoe. Make a separate drawing of your shoe. Don't forget to label the parts.

Think about the shoe that you are wearing and all of the parts that make it up. What does your shoe help you do? Are there things that you can do better, more efficiently, or more comfortably when wearing those shoes? What purposes do the different parts of the shoe serve?

Think about basketball, or choose another sport, and make a list of all the movements you make when you play it.

Next, write down any attributes or features that you would want in a shoe for each required activity. For instance, if your sport requires running, you would need shoes with good traction to keep you from slipping.

Lastly, think about each of the features you want and write down design solutions you could include. For example, to give a shoe more traction, you could include a rubber sole with tread to provide grip.

After you have listed the activities required by the sport, the characteristics needed in the shoe to support those activities, and the adaptations made in the shoe design to provide those characteristics, organize your information into a table.



GAME TIME

With all of this information neatly organized, you have a guide that would be helpful in designing a shoe.

Draw a picture of a shoe that has all the features from your table. It may be helpful to write notes on your drawing to indicate the type of material needed in the different areas of the shoe. You might also include notes on the structural elements that may not be apparent from looking at the exterior of your shoe. If your shoe design requires a lot of interior structures, you may want to draw a cross-section, or an image of what the shoe would look like if it was cut in half.

Now let's use your design to build a shoe. Place your foot on a piece of paper. You can do this with your shoe on or while just wearing socks. Trace your foot. This will be your template for the insole of your shoe.

Gather all of the materials and tools you need to build your prototype or test model. Obviously you won't have all the materials that a professional shoe designer might have but just use what you have available. Cardboard could be used in place of hard leather, foam could be used in place of rubber, etc. Don't forget to include scissors and tape. If you have adult help available, you might consider including hot glue or a sharp hobby knife.

Pro-tip: Before using supplies such as sharp knives and hot glue make sure you have an adult available for supervision and help if needed. Also, this is an activity that they may enjoy as well, so encourage them to design and build alongside of you.

As you are building your shoe, you may want to try it on a few times in the process. You will likely discover that you need to make a few adjustments for comfort. For example, you may find that your foot requires more space than you originally thought.

Refer to your drawing and notes often. If you make a discovery and decide to change your design, remember to note the change on your drawing.

If time allows, make a shoe for your other foot. After you cut out your second insole, remember to flip it over before you get started. You want to make sure you have a shoe for your left foot and your right foot.



ANALYZE THE REPLAY

What happened?

After you have finished designing and making your shoe or shoes, try them on!

Did the shoes serve all the purposes you intended them to?

In what way was your shoe design most successful?

In what way was your shoe least successful?

If you were to make your shoe again what changes would you make?

Did you discover that certain parts of the shoe need to be rigid? If so, which parts? What material would be good for this area?

Did you discover that certain parts of the shoe need to be flexible? If so, which parts? What material would be good for this area?

Which parts of the shoe need to provide a way for air to flow through? Are there areas that you would not want anything to flow through?



OVERTIME

Let's take it further

Making a shoe or a pair of shoes out of cardboard, tape, and things destined for the rubbish can or recycling bin can be tough. In fact, it may be the first shoe that you've ever made, but by testing and observing, you've learned a few things about shoe construction. For example, you may have discovered that your shoe needs reinforcement in certain areas.

Using the materials you have available, can you improve your design based upon what you discovered? Even seemingly small changes can make a big difference in shoe design. Because shoes are worn at the extremity of our bodies, if the mass, or weight, of the shoe is decreased even a little bit the effect can be very noticeable.

Are there areas that were too rigid or too flexible that you can improve through some redesign with the left over materials? Was the shoe simply too hot inside? If so, make some small changes to allow more air into the shoe. Make some changes to improve the comfort of your shoe. Make some adjustments to improve the traction that the shoe provides.



The engineering design process is one in which the steps continually repeat with the goal of creating something better.

Finally, think about style. Shoes need to provide support, comfort, and improve performance, but it's much better when they look good, too! Can you adjust your design and improve how it looks? Can you give your shoes style without adding weight? Better yet, can you make the functional design and fashion design work together?

Pro-tip: Ask for an adult's involvement before starting this next optional activity.

You may have some shoes that are worn out completely. Did you know that because of the force that NBA players apply to their shoes, it may take only a couple of games and practices before their footwear is ready to be replaced? Every athlete is different and some players may like their shoes a little broken in, but when you work and play that hard, shoes do get worn out quickly.

If you have a pair of shoes that simply cannot be improved or repaired, maybe they can be dissected! With an adult's help disassemble a shoe to better understand how all of the parts work together to provide support, comfort, and improved performance. Look for details in the composition of the sole, the sides of the shoe, and even the tongue. Make notes of your observations.



COACH'S CORNER

Additional
information and
explanations
for parents and
educators

This activity highlights the importance that research, redesign, and rebuild have in the engineering design process. With a basic need such as protective and performance improving footwear, this engineering design process will likely never end. As long as there are athletes, there will be scientists and designers making advances and new shoe styles. As new materials are introduced or become available, these materials will likely be used in shoe design and production especially if they can make a shoe more durable or lighter. New material or even innovations in design can allow for shoes to provide more cushion or better grip with the floor.

The spark of innovation can come from the seemingly unlikeliest of places. Phil Knight was a business major and an athlete on the track team at the University of Oregon. Bill Bowerman was his coach. Years after graduating, Knight teamed back up with this coach because he thought running shoes could be better. Together they created a company that became Nike. In the early 1970s, Bowerman transformed the shoe industry when he discovered he could improve the traction that shoes provide by shaping the rubber of the soles in a waffle iron from his kitchen!

A few years later, a NASA engineer introduced the concept of a sole with encapsulated bubbles of air. This breakthrough became Nike Air in the late 1970s.

In the mid-1980s Adidas created a shoe with a flexible bar that provided more support for the front and back of the foot. Also during the 1980s Asics introduced the concept of improving comfort and safety of athletes' feet by introducing a gel to provide more cushion.

There have been many other shoe advancements both big and small. Nearly 100 years ago vulcanized rubber soles were invented. Today, many shoe companies are experimenting with 3-D printing technologies. Another very exciting advancement, that brings us back to this month's activity, is recycling material. Many shoe companies including Adidas, Converse, and Nike are producing shoes made from recycled plastics.

Do you want to learn more?

Research: Engineering design process, prototype, recycling, sustainability

OKLAHOMA ACADEMIC STANDARDS

SCIENCE STANDARDS	4 th Grade	5 th Grade	6 th Grade	7 th Grade
4.PS3.3 Energy	●			
5.PS1.3 Matter and Its Interactions		●		
6.PS3.3 Energy			●	
7.PS3.2 Energy				●