Straight to the Rim

You can't have basketball without the basket; after all, it's the whole point of the game! Putting the ball through the hoop is how points are scored. It's thrilling to watch the ball swish through the net as the last seconds of the game tick by or see your favorite Thunder player lay down a rim-rocking dunk. From cleaning up rebounds to catching an "alley-oop" pass, a lot of action happens around the bucket and above the rim.


Photo by Jimmy Do via Thunder IT.

Though we may think about the basket as being just a steel hoop suspended 10 feet (3.048 m) above the court, a lot of amazing engineering has gone into creating a goal that is safe for the players and appealing to the fans.

Welcome to the world of sports engineering! Did you know that sports engineering is not only something that you can study but also follow as a career pathway? Sports engineers solve problems related to a variety of sports, design equipment and even sports facilities, develop training tools, and much more.

For this activity, we are going to focus on what puts the "basket" in basketball and get into the nuts and bolts that is sports

Here's what you'll need:

- **Straws, cardboard, or any material that can be upcycled to be building material**
- **Tape, hot glue, or fasteners such as staples**
- **A rigid round circle, such as the plastic ring found under a bottle cap**
- **Paper**
- **Paperclip or similar item**
- **Ruler**
- **Pencil**
- **Journal**

Pro-tip: This is a tinkering, or a making and engineering, activity. It is designed to use materials that can be claimed before going to the rubbish or recycling bin.

This activity can be done in pairs or alone. It can be done at home or in a classroom

WARM-UPS

There are three parts to a basketball goal: the rim, the net, and the backboard. In the NBA, the height of the basketball rim must be exactly 10 feet (3.048 m) above the floor. Most rims at most parks, gyms, and probably even your school are placed at the same height.

The challenge for sports engineers, basketball coaches, principals, and even families who want a personal basketball hoop is how to put up the backboard, rim, and net at 10 feet.

Most often, a wall sturdy enough to support the location of the basketball hoop will not be available. Even if a wall is available, the following questions should be considered:

- Is the wall made of a material that the basketball hoop can be attached to?
- Would attaching the basketball hoop to this wall be potentially dangerous to any players who accidentally hit the wall when going for a rebound or layup?
- Who or what is on the other side of the wall that might be affected by the constant rebound of a ball?

Many basketball hoops are mounted on a sturdy pole that keeps the basket at the correct height. It also often has an extension arm that provides additional space so basketball players don't hit the supporting structure when running, shooting, and blocking around the hoop.

Keeping the basic parts of a basketball hoop in mind, your first task as a sports engineer is to design and build a basketball hoop with a rim that is level at 10 inches (or 25 cm) high and uses a pole and an extension arm. The basketball hoop must also be able to withstand being hit by a small wad of paper without moving or changing.

Before starting on the basket, first make a ball by using a piece of paper that is about 5.5" by 4.25" (about 14 cm by 11 cm). This is one fourth the size of a typical piece of copy or lined notebook paper. Once you have formed the paper into a ball shape, help it keep its form by taping it. This will be the ball you use to test your basket.

Next, build a basket that has a backboard, extension arm, and rim that is set at 10 inches high and does not move when hit with a paper ball. Because backboard sizes are standardized, the backboard that you create should be about 6" wide by 3.5" tall (about 15 cm by 8 cm).

To do this, a little research will be helpful. Do any of your friends have a basketball hoop outside of their homes? If so, ask them to describe it. What keeps it from moving around? Do you have a basketball goal at your school? Can you describe how it remains stationary? With the permission of an adult, go online and look at different styles of basketball hoops.

Next, draw some designs. The design should be effective. When drawing your concepts, remember that the level of complexity will affect how easy or difficult it will be to build.

Once you have settled on a design, select the materials you will need. Material selection is part of the design process. Try to be resourceful in your material selection. You may want to use certain materials that are not available, in which case you must improvise. Cardboard, straws, plastic-ware, chopsticks, and various product packaging all make great building materials. The plastic ring from a water or soda bottle top can make a great rim. Material from a plastic bag and many types of mesh packaging can make a perfect net. Tape and hot glue are always good fasteners, but you may also find that old twist-ties or other found objects provide the type of attachments you need.

Once you start building, use a ruler to make sure the rim height is correct. Use the sketch of your design to help with the building process. What you build might not look exactly like your drawing, but having the design available will help with decision-making.

Pro-tip: Keep the ruler handy. As you make adjustments in the building process, the rim height will likely be affected.

After construction is complete, test your basket. Is the rim still at the proper height? Can you shoot a basket with the paper ball without moving the basket?

GAME TIME

In the **Warm-Ups** section, you followed a process similar to that of a sports engineer. The problem that you were given was fairly simple—create a basketball goal that was a specific height with certain parts that would not be damaged from expected use.

Sports engineers work to solve complex problems in sports using scientific principles and engineering. Among the problems that they work to solve is how to keep athletes and fans safe. Think about a basketball goal. What safety concerns might an athlete, coach, or sports engineer have?

For this activity, let's focus on the basketball goal's ability to support weight without breaking or falling over. A basketball rim must support not only the weight of an NBA athlete, but the additional significant force of an amazing dunk. If the basketball hoop falls, players, referees, and fans could be hurt. If a basketball rim and backboard breaks, it would need to break in the safest way possible. These are concerns that a sports engineer would be tasked with solving.

To begin this challenge, create a device that you can use to measure the effects of gravity on the basketball hoop. You will want to make reinforcements and improvements to the basketball hoop later, but for now, let's focus on making the device to help perform the tasks.

Pro-tip: If you are participating in this activity in a class or small group, you can make one device that everyone uses. This will help make sure that measurements are equally comparable.

There are many ways to create this measuring device. Here is one option. With a small piece of plastic (about 6" x 6" or 15 cm x 15 cm), gather the corners and tape them together so that it forms a bag shape with small openings on the side. With a paperclip or similar item, poke a hole through the taped portion of the plastic. This can serve as the hook to attach to the basketball hoop. Next gather several equally sized objects. These can be pennies, marbles, or even small candies. These will be your measurements for how much weight the basketball goal can support. Put one object at a time in the bag. See how many objects the bag can hold.

It is time to make adjustments to the basketball hoop that you created in **Warm-Ups**. You made a goal that met the correct rim height requirement and that would not move when hit by the ball.

Now, using the design process and scientific understanding that would be used by a sports engineer, make improvements, reinforcements, or revisions to the basketball hoop so that it meets these requirements:

- **The rim is level at 10 inches (or 25 cm) high**
- **The basketball goal does not move when hit with the ball**
- **The basketball goal can support weight without falling over**

Pro-tip: If you are participating in this activity in a class or small group, set a minimum standard of weight that the basketball goal must support to be considered effective. For example, to succeed at this challenge, assume the basketball goal must support at least six marbles.

Thinking like a sports engineer, look at your original research. If you still need more information, stop and do more research on basketball goals and their parts. Sports engineers use the **engineering design process**. This tool for innovation is one that you have likely used before, possibly in another Devon Thunder Explorer activity. The engineering design process includes steps of identifying the problem, researching, brainstorming, creating, testing, and repeating these steps in a variety of orders until the desired product is created or outcome is achieved.

ANALYZE THE REPLAY

What adjustments did you need to make from the basketball hoop used in the **Warm-Ups** to be effective in **Game Time**?

Write your findings and observations in your journal. Was your basketball goal a success? Think about how and where basketball goals are used. Some basketball goals are indoors and some are outdoors. Some are mobile and can be moved. Others never move. Where would you imagine your basketball goal being used?

TAKE IT FURTHER

The basketball goal you created addressed several needs: maintaining the correct rim height, remaining stationary, and not crumbling when weight was added.

A sports engineer faces many other challenges when designing a basketball goal. Safety is always a primary concern. For example, what happens if the rim becomes unattached from the backboard when a certain amount of weight or more is added?

Another challenge that a sports engineer may face when designing a basketball hoop is mobility. Basketball hoops must be mobile at the arenas. Not only do they have to be able to be moved easily, but they may have to move through small doorways. When they are put back in place, they must be just as safe and stable as they were before the move. A basketball goal used on a street, driveway, or parking lot may need to be mobile as well.

Select one more challenge to address with your basketball goal. Think like a sports engineer. Be creative. Solve problems. Test and revise.

COACH'S CORNER

A basketball goal may seem like a relatively simple device, but it has gone through many changes over the years. Did you know the first basketball goal was an empty peach basket nailed to the railing of a gymnasium balcony? Some years later, the basket was replaced by a metal rim and netting. At first the baskets and netting were closed at the bottom. This of course would change. The first backboards were wire mesh and would get dented by the basketball. Wood made a sturdier replacement to the wire, but blocked the vision of the watching fans. Tempered glass then came into use as a backboard material.

Other improvements to the basketball hoop had to be made to promote the safety of the players. At first some basketball goals were attached directly to walls. Players would get hurt when they slammed into the walls when running for layups and rebounds. The goals were then moved to allow space between the wall and the basket.

In the 1970s, as dunking became an exciting part of the games, breakaway rims were invented and soon became part of the game. Breakaway rims contain a spring and hinge. These devices allow flexibility while still snapping back in place to be horizontally level. This improvement allowed basketball players to dunk the ball without shattering the backboard while reducing the chances of wrist injuries.

In the 1980s and 1990s, the tempered glass of the backboards shattered more often due to the intensity of athletic dunks. Shattered backboards not only cause delays in games but also present physical dangers. Sports engineers again went to work to make the equipment and the game safer.

Safety is the main concern in this activity and a priority of sports engineers. Innovations to the hoop components continue to be added to improve the game. For example, have you ever noticed that the backboard lights up when time expires?

WANT TO KNOW MORE?

Research: Engineer, Engineering Design Process, Force, Gravity, Measurements

OKLAHOMA ACADEMIC STANDARDS

STANDARD	4th GRADE	5TH GRADE	6TH GRADE	7TH GRADE
Science				
PS2.1: Forces	●	●	●	●
PS3.3: Energy transfer in collisions	●	●	●	●
Math				
GM.2.5: Measurement	●	●	●	●