Topsy-Turvy Thunder

Watching a Thunder player defensively spin around opposing players to score points for OKC is a graceful and athletic skill. Explore the physics of spin science in this activity!

HERE'S WHAT YOU'LL NEED:

- **Pencil or pen**
- **Paper**
- **Mathematical compass (or a cup with a 4" diameter)**
- **Stopwatch or timer**
- **Cardstock**
- **Scissors**
- **Pennies, washers, or other small, flat weights**
- **Golf pencil or short pencil**
- **Full size, sharpened pencil**
- **Rubber bands**

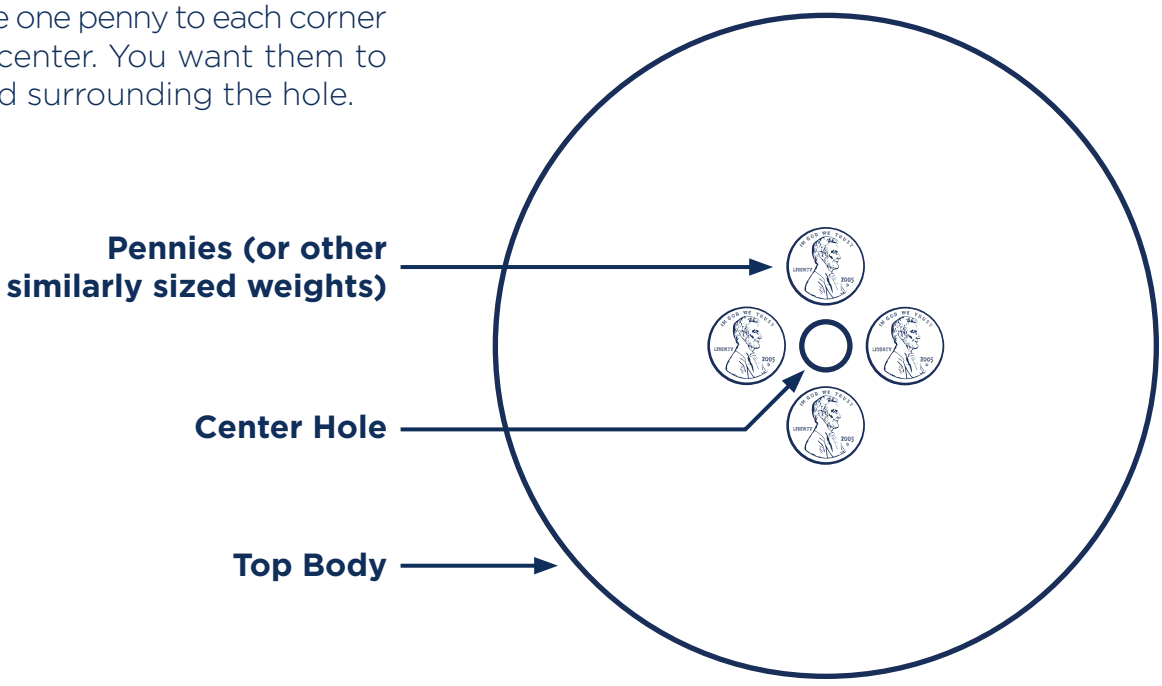
This activity can be done individually or with a partner, as well as in a classroom or at home.

WARM-UPS

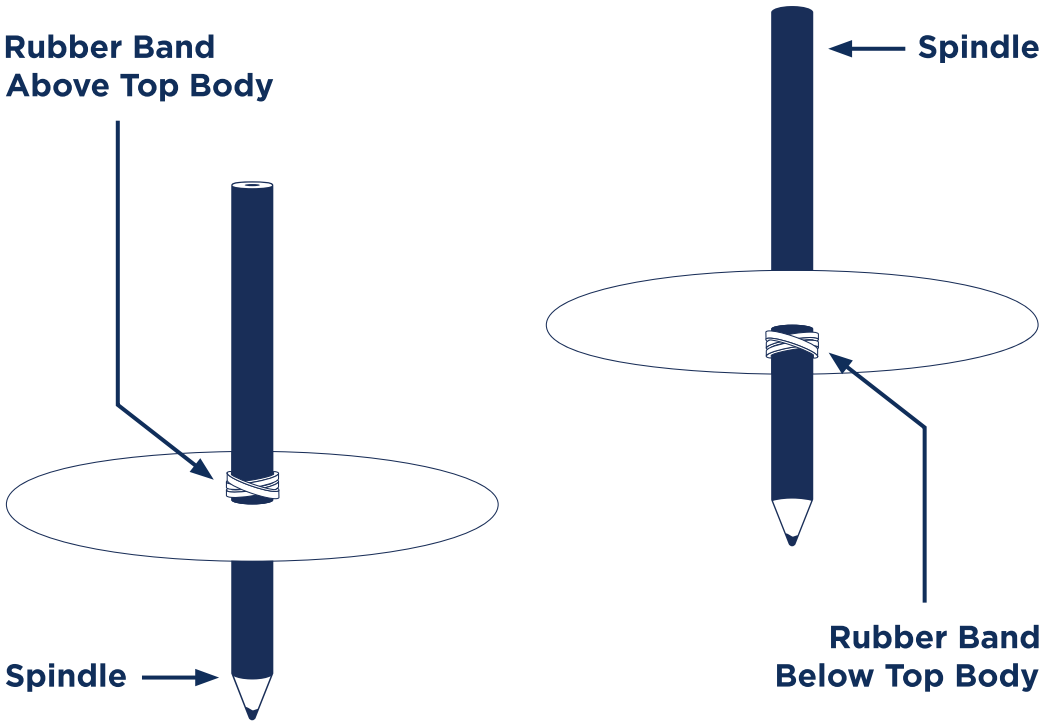
Rotation plays an important part of many athletics, including basketball. Players must remain steady on their feet and they turn and evade opposing players to keep possession of the ball.

To start this dizzying activity on physics, you're going to build a spinning top. Start by grabbing the mathematical compass, scissors, pen or pencil, tape, small weights, golf pencil, and cardstock. Using the compass, draw a 4-inch circle onto the cardstock and cut it out with scissors. (If you don't have a compass, trace the mouth of a cup with a 4" diameter.) Then, poke a hole through the cardstock in the center of the circle. This is going to be your spinning top body.

Next, take four pennies or similar small weights. You're going to tape one penny to each corner of the hole in the center. You want them to look like a diamond surrounding the hole.



Once you have completed this, take a golf pencil and stick it through the hole in the center of the top body. This is going to be the spindle of your top. Wrap a rubber band around the top side of the pencil (the side with the pennies taped to it). Repeat this step with a rubber band on the bottom side of the pencil. This will secure it as you spin and test it.



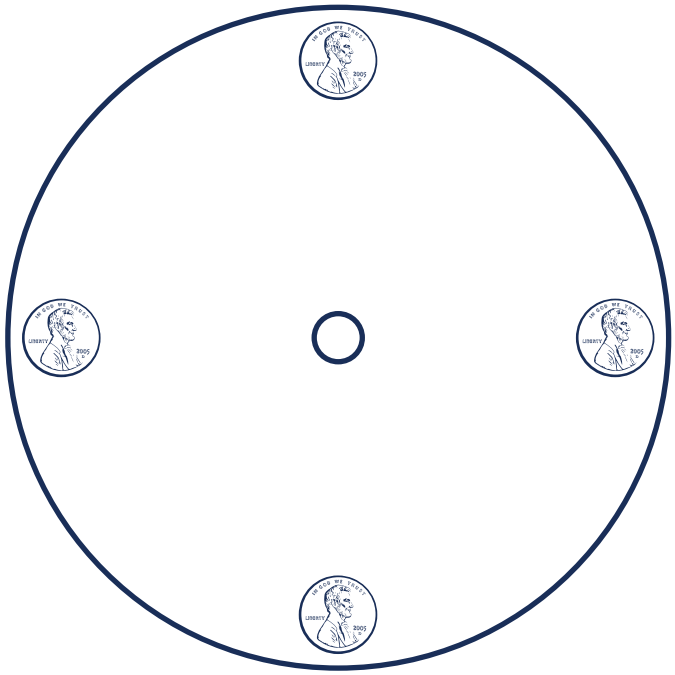
Get a piece of paper and create a chart to write down the results. This first test is to see how well the top spins with the pennies at the center of it. You might make your chart look similar to this:

Test #1: Pennies Near the Center of the Top Body

	1st Spin	2nd Spin	3rd Spin
Spin Time			

Use a stopwatch or timer to time three separate spins of your top and record this data in your chart.

Now, you're going to slightly change your top and see if that changes how long it spins. Carefully un-tape the pennies from the center of the top, and move them to the edge of the top, like this example:



Top Body With Pennies Placed Near the Edge

Double check both rubber bands holding the pencil in place too. Then, create a new chart to record the data from the next test.

Test #2: Pennies Near the Edge of the Top Body

	1st Spin	2nd Spin	3rd Spin
Spin Time			

Use the stopwatch or timer again to time how long the top stays spinning as you test it three separate times. Record this data in your chart.

How does the placement of the pennies affect how well the top spins?

GAME TIME

Using the skills you gained in Warm-ups, you're going to change the design of the top in different ways while continuing to test its ability to spin. Make sure you have the same cardstock, rubber bands, tape, and pennies, and this time, grab a ruler and a full-sized pencil, too.

If the 4-inch circle that you cut and used for the first top is a little tired after going through six spinning tests, use the mathematical compass to cut a new 4-inch circle out of cardstock. Then, use the compass to poke a hole in the center of the circle where the spindle will go.

During the Warm Ups, you built tops with the weights in specific places to learn how weight distribution would affect the ability to spin. In the Game Time challenges, you'll be able to experiment freely with the amount of weights and where you place them on the top. However, there are specific guidelines for the spindle this time around.

For the first test, take the 4-inch cardstock circle and a sharpened, full sized pencil to use as the spindle. Using your ruler, measure so that the full-sized pencil sticks out 1.5 inches (4 cm) below the top. Grab a friend to help if you need an extra set of hands. Then use two rubber bands to secure the pencil in the middle, just like you did during the Warm Ups. Re-measure to make sure the pencil is still sticking out 1.5 inches below the top, and adjust if needed. Try spinning it without any weights. What happens? Drawing on your experience from Warm-Ups, choose an amount of weights that you'd like to add to this top and decide where you'd like to place them. Are you going to put them close to the pencil in the center of the top, or out on the edges of it? Maybe you'll do a combination of both!

Once you have your weights taped on the top with a 1.5-inch spindle, create a new table to record your results. You can use this one as a guide:

Test #3: Top Body Placed 1.5" from Bottom of Spindle, Pennies Varied

	1st Spin	2nd Spin	3rd Spin
Spin Time			

How did the results of this test turn out? Did the top spin with more ease or more difficulty than the first two tests? Are you satisfied with where you placed the pennies, or would you have chosen differently? Continue to keep in mind everything you're learning about spinning tops and motion as you move onto the next test.

This top is going to get really unusual. Using your ruler, adjust the pencil so that it sticks out 3 inches (8 cm) below the top. That's a really long spindle! What do you think will happen when you try to spin this top?

Choose the placement for the pennies and tape them to the top. Create one more table before you start testing the spin-ability of this one. Maybe it'll look like this:

Test #4: Top Body Placed 3" from Bottom of Spindle, Pennies Varied

	1st Spin	2nd Spin	3rd Spin
Spin Time			

How did this top spin during your test? What level of difficulty did you find in spinning it compared to the top with the 1.5-inch spindle, or the top made with a golf pencil spindle? Where did you place the pennies on this top, and do you think it helped it spin better or made it more difficult? If you have a limited number of weights (4, for instance) and you had a spindle that was 3-inches long, where would you place the 4 weights to maximize weight distribution and help the top spin successfully?





Rotation happens when parts of an object move in circles around its axis. While your top was rotating on its point of axis (the spindle), it was also tilting slightly, adjusting, and re-centering all throughout a successful spin. Weight distribution—how an object's weight is spread out to different areas to keep the object balanced —can also affect a top's ability to spin successfully. You experimented with both weight distribution and length of the spindle in the top challenges. What did you notice happen to the spinning top when the pennies were moved?

The same physical adjustments at work in a top spinning successfully are at work in keeping your favorite Thunder player on their feet as they weave, dodge, and rotate to keep possession of the ball. Next time you're watching a game and see a player doing a spin defense, notice how they will often keep the ball close to their chest as they whirl around the opposing player. They do this to keep the ball secure and make sure the other team doesn't snag it. Players also need to stay compact and lower their center of gravity so they can move swiftly without falling over. What do you think might happen if they spun around another player while holding their arms straight above their head and the ball up in the air? Connecting these moves to the spinning tops, how does the weight distribution or spindle length of the tops relate to how the player moves during their spins?

OVERTIME
Let's take it further.

You're a pro at building tops following directions—what if you tried building a top from anything you can imagine? Think about what you've learned about spinning tops regarding weight distribution, spindle length, and spin factor when designing your previous tops. You can use practically any materials you have available. Try looking for recyclable or reusable materials that could gain new life as a top. Here are just a few suggestions:

- **Paper plates**
- **Cardboard**
- **Tape**
- **CDs, plastic lids, assorted other flat, round recyclables**
- **Skewers**
- **Marbles**
- **Modeling clay**

COACH'S CORNER
Additional information and explanations for parents and educators

Rotation and weight distribution are a few physics principles explored by students in this activity. Rotation is an agility skill needed in basketball as well as many other athletic endeavors. For example, figure skaters and ballerinas spin rapidly, and gymnasts rotate through the air on a vault or during a floor routine. Baseball players use rotation as they wind up for a pitch or to swing a bat, using the momentum of their body's rotation to further power their strength. Quarterbacks will perfect the spin of the football as they launch it across the field. Rotation is everywhere in sports!

Thunder players use rotation to evade opposing team members. By swiveling their hips and turning quickly on the balls of their feet all while remaining compact and holding tight to the ball, movements that are some of the most exciting moments in a game.

DO YOU WANT TO LEARN MORE?

Search terms: Rotation, Weight Distribution, Moment of Inertia, Angular Momentum

STANDARDS ALIGNMENT

This activity can be used to support students with developing the skills and/or content associated with the areas listed below.

Science Skills	3rd Grade	4th Grade	5th Grade
Planning and Carrying Out Investigations • 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 is considered. • Make predictions about what would happen if a variable changes. • Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.	●		●
Developing and Using Models • Use a model to test cause and effect relationships or interactions concerning the functioning of natural or designed systems.		●	
Patterns • Patterns of change can be used to make predictions. • Patterns can be used as evidence to support an explanation.	●	●	
Cause and Effect • Cause and effect relationships are routinely identified, tested, and used to explain change.	●	●	●