TIME OUT FOR TRAMPOLINES

Rumble is at it again! This time he's delighting and stunning the crowd with his epic fancy dunks. The Storm Chasers help him really wow with impressive air time using a special tool—a trampoline!

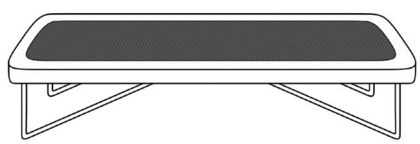
Rumble needs your help, too! You're going to work with a partner to build a miniature trampoline and explore the physics of trick shots. It'll require the best of your engineering skills, communication, persistence, and lots of opportunities for testing. You ready? Away we go!

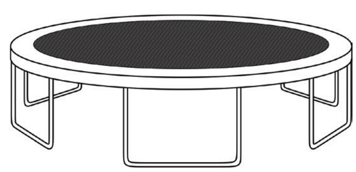
HERE'S WHAT YOU'LL NEED:

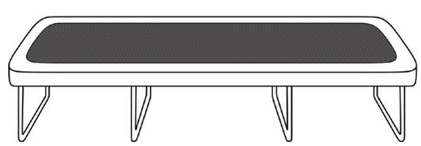
- **Materials to build trampoline frame**
  Examples: skewers, straws, craft sticks, chenille stems/pipe cleaners, rubber bands, masking tape
- **Materials for trampoline bed**
  Examples: pieces of fabric, saran wrap, plastic trash bags
- **Fasteners for the trampoline**
  Clothespins, binder clips, badge clips, string/lacing cord
- **Small bouncy balls**
- **Scissors**
- **Hole punch (optional)**
- **Butcher paper**
- **Small plastic cups or containers**
- **Rulers**
- **Meter stick (optional)**
- **Paper and pencil**
- **Access to an open floor and wall space**

WARMUPS

Pro tip: Before all the students start building their trampolines, set up a testing station covering the lower part of a wall with butcher paper. Make sure that the wall is covered at least 60 cm up from the floor.







Find a partner to work with, and begin by sketching a design of how you're going to build your trampoline. What shape is the base going to be? Square? Circular? Octagonal? Consider what shape will be the strongest and best at supporting the tension of your trampoline bed (that is, the fabric or rubber that you stretch across the top of your trampoline frame). How will you attach your trampoline bed to your frame? Be sure to incorporate ways to clip it to the top of the frame into your sketch design as well as consider the fastener materials you'll need.

As engineers go through their job they must deal with constraints of all kinds—financial, materials available, or limits on the actual project they're building. Your team's constraint in this trampoline design will be its size. The diameter of the base should be at least 15 cm and the legs or platform a minimum of 2 cm tall. Anything much smaller than this size probably won't yield the results you're looking for. Once you've finished brainstorming and sketching out your design, collect the materials you'll need to construct it, and then get to building!

After you've built the frame of your trampoline, choose your trampoline bed material and stretch it across the top, securing it with the fasteners of your choice. Success! You've finished the first step! Now you and your partner get to see how well your trampoline works. Grab a ball and head over to the testing zone.

Before you begin testing, hold your ruler vertically against the paper on the wall making sure the 0 end is touching the floor. Draw a line on the paper at 15, 30, and 60 cm. Place your trampoline on the floor and measure and mark the top of it, as well. Between you and your partner, choose who will be the tester and who will be the recorder of the data.

Start by testing to see how your ball behaves normally versus how it reacts to the trampoline. Drop the ball directly on the ground from 15 cm and mark on the paper how high it bounced. (Remember to just drop it and let gravity do all the work—no need to really put your arm into it!) Repeat the procedure but this time drop the ball directly on the trampoline from 15 cm and make another mark for how high it bounced. What differences did you observe in how the ball behaved normally as opposed to on the trampoline? Why do you think this was the outcome? Record the results in a table.

Gather additional data by dropping the ball directly onto the trampoline four more times from 15 cm. Mark how high it bounces each time and record these measurements.

Next, repeat dropping the ball directly in the center of the trampoline from 30 cm. Do this a total of five times as well, and record the data as you go. How high does the ball bounce off of the trampoline when dropped from 15 cm as compared to 30 cm? Is there a noticeable difference? How consistently does the ball bounce? Does it always bounce back up in a straight line, or does it bounce off at an angle? Why do you think it might be behaving the way that it is? Record these results in your table.

If your trampoline does not hold up as well as you thought it might to these repeated bouncing tests, no sweat! All you've got to do is work with your partner to determine the weak point in your design and rework it! This is part of the design process. Designs often end up being revised and improved.

Repeat the bouncing test five more times dropping the ball from 60 cm, recording your results as you go. How does this data compare to the previous tests?

Now try something a little different. Instead of leaving the trampoline flat on the floor, raise one side up so that the trampoline sits at an angle. Repeat the drop test from the 30 cm mark. How did the height and behavior of the ball compare to the flat tests?

Compile the information that you collected in these tests into a table that you can share with your classmates at the end of this entire trampoline challenge.

GAME TIME

It's time to conduct some further tests with your trampoline.

Create a simulated basketball court for your testing zone area. Find a space against a wall with at least 1 meter of open space directly in front of it. Place a cup on the floor directly against the wall. Then, measure 45 cm out from the wall (while in line with your cup "hoop") and place your trampoline on that measurement. Think of your trampoline as standing on an imaginary free throw line directly in front of your hoop.

Switch roles with your partner so that whoever tested in *Warm Up* is the recorder of data for this trial, and whoever was the recorder is now the tester. Standing 15 cm behind the trampoline, the tester should drop the ball onto the trampoline, attempting to make the ball into the cup. What happened? Did the ball go anywhere near the hoop? Did it bounce in a straight arc towards the cup on the wall or did it careen off at an angle?

Pro tip: If your cup falls due to the impact of the ball hitting or landing in it, use a little tape on the bottom to help secure it.

This is where you get the chance to really experiment. The tester must remain 15 cm behind the trampoline, and the trampoline needs to stay 45 cm away from the cup. This will limit the variables in the outcome of your experiments. A **variable** is any factor in a test that is likely to vary or change. Your variable will only be the angle of the trampoline.

Experiment with either holding the trampoline at an angle or finding something to prop it up on one side, but remember—one side of the trampoline always has to be on the ground! As athletic as the Storm Chasers are, you won't ever see them holding the trampoline completely suspended before Rumble takes a giant leap off of it!

Measure how high off of the ground you're angling the trampoline with each test and record it along with the success rate of how many times you make the ball into the cup.

ANALYZE THE REPLAY
What happened?

Were you able to achieve repeated success of getting the ball into the cup by bouncing it off of your trampoline? If so, what eventually yielded the most consistent success? Did you angle the trampoline towards the goal or towards where the tester was tossing the ball? If you didn't have time to achieve repeated success of getting the ball in the cup, what other ways were you going to try angling your trampoline?

Taking turns with your classmates, share your engineering design process and test results. Explain why you chose the materials and design that you did, and share any problems you had to troubleshoot to make it work better. Then, explain your steps for trying to bounce the ball into the cup and whether you were able to find repeated success or not.

OVERTIME
Let's take it further

If time and space allow, try making a chain reaction with all of the class' trampolines. Experiment with changing the position and arrangement of the trampolines so that the ball bounces from one to the next to the next until it lands in a cup or goal. Tweak and angle each individual trampoline as needed until success is achieved.

Working together in this way is exactly how the Storm Chasers achieve such thrilling tricks and electrifying stunts with Rumble! They have choreographed routines that rely heavily on knowledge of physics, lots of practice, and each player being in exactly the right spot on the court at the right time to play their role.

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

In this lesson, students tackled the engineering design process and experienced real examples of potential and kinetic energy and how it is stored. The engineering design process is defined by being presented with a problem, designing a solution, building it, testing it, reworking it, and so forth. This is what students were given the opportunity to explore throughout the entire lesson. They collaborated with a partner to tackle two problems *(build a trampoline* followed by *get the ball into the cup via the trampoline)*, considered possible solutions, worked around constraints, and went through the build, test, and rework process. Working in this fashion is important because it is not a linear, step-by-step process with a guaranteed outcome, but rather a circular method allowing for many successes and failures time and time again. It takes the pressure off of one single objectively successful outcome and instead allows for the open-ended exploration and creativity of many different (and equally valid ways) to solve a problem.

Additionally, the trampoline challenge gave students the opportunity to experience how potential and kinetic energy work. There are two different ways in which energy is stored—currently in use, and waiting to be used. We call energy currently in use **kinetic** energy, while energy waiting to be used is **potential** energy.

The trampoline illustrated stored potential energy. When the students stretched their trampoline bed material across the top of their frame, they helped move their kinetic energy of stretching the material into potential energy of it waiting in the trampoline to bounce whatever strikes it. The motion of kinetic energy was clearly demonstrated by both the falling ball and the released energy of the trampoline bed.

The physics lessons that students learned by experimenting with trampolines today demonstrated how the Storm Chasers and Rumble complete such extraordinary tricks and over the top slam dunks during breaks in the game's action. Though the Storm Chasers are athletic and energetic people, they very likely do not possess the physical prowess of Thunder players. They use the potential energy in the trampoline coupled with the kinetic energy they bring to the jump to reach heights achieved by the phenomenal Thunder players.

DO YOU WANT TO LEARN MORE?

Research: kinetic energy, potential energy, gravity, engineering process design, prototype

OKLAHOMA ACADEMIC STANDARDS

STANDARD	4th Grade	5th Grade	6th Grade
SCIENCE			
PS3-1: Energy	●		
PS3-3: Energy	●		
PS3-4: Energy	●		
PS2-1: Motion and Stability		●	
MS-PS3-2: Energy			●