Grades
3–5, 6–8

45
minutes

EXTREME TRAMPOLINES

DESIGN CHALLENGE

Participants assemble materials to create a trampoline that can bounce a ball as high as possible.

SUPPLIES AND EQUIPMENT

Per whole group

- ☐ 1 completely assembled trampoline to use as an example
- ☐ Several testing stations: a fabric measuring tape taped vertically to the wall, aligning the zero of the measuring tape with the top of the table
- ☐ Masking tape
- ☐ Fabric cutouts made using an octagon template
- ☐ Hair ties
- ☐ Polyester and cotton loom loops
- ☐ Badge clips

Per team

- ☐ 1 assembled trampoline base
- ☐ 1 golf ball

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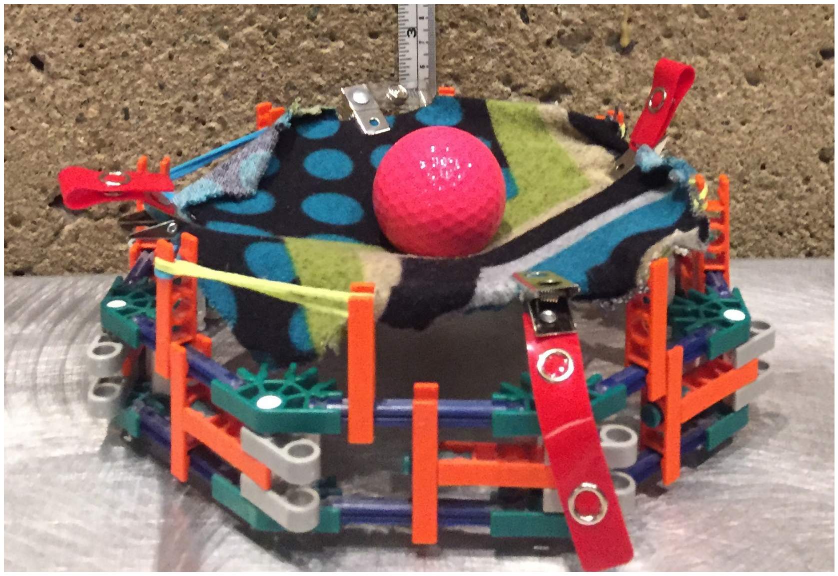
GETTING READY

Make a set of identical trampoline bases. Each base needs to be rigid enough to support the fabric cutouts, as well as have an easy way for participants to attach and adjust the tension of the fabric cutouts. K'NEX pieces work well for this, as it's easy to wrap cloth around K'NEX rods and secure them with clips. The trampoline frame shown below is one example, but you can create a different version. Or, if time allows, you can have participants design their own trampoline frame.



Designate a space where a facilitator can introduce the activity to participants and where participants can receive their trampoline bases and select their fabric cutouts. The hair ties, cloth loops, and badge clips should be available on an array of tables where participants may also construct their trampolines.

Prepare a series of testing stations near a wall. Tape fabric measuring tapes vertically along the wall, aligning the zero of the measuring tape with the top of the table. Mark each tape with the 100cm dropping point.

Assemble one trampoline for participants as an example of what they are about to create.

INTRODUCTION

Introduce the activity to participants by saying the following, adapted for your audience:

Materials engineers explore, test, and document every attribute of the materials that they work with, such as stretchiness or stiffness. What sort of material would you need to design the most bouncy trampoline, making a golf ball rebound as high as possible from a 100cm drop? Put your ideas to the test! Then prototype and test a miniature trampoline, trying out different structural arrangements and different materials.

INSTRUCTIONS

Divide participants into small teams. Show teams the materials. Demonstrate the trampoline testing process with the example trampoline, calling attention to the strategy for recording bounce height and maintaining consistent testing parameters. Distribute one trampoline base and golf ball to each team. Instruct teams as follows:

- **Plan:** Explore the materials available. Which materials are the stiffest or the most flexible? How can you attach materials to the trampoline base? With your teammates, set a goal to achieve the highest or the lowest bounce. Brainstorm different combinations of materials you could use to design your trampoline. Think of many different possible solutions and discuss them with your team. Determine which materials you will use and how you will attach all of your components to the trampoline base.
- **Create:** Construct your design with the materials you have selected.
- **Test:** Bring your trampoline to the testing station and align it under the tape measure. Hold a golf ball at the 100cm mark and drop it. Have a partner observe and record the bounce height of the golf ball's bounce. Test the same design several times.
- **Improve:** How could you make an even better trampoline? Will you change the surface material or the method of attaching the material to the base? Make improvements to your design and test it again.

ACTIVITY VARIATIONS

Have students assemble their own trampoline bases.

Use digital sensors to read bounce heights.

Give options for the objects being dropped on to the trampolines.

TROUBLESHOOTING

If participants are having trouble getting their balls to bounce, make sure the fabric is not way too loose or way too taut.

RELEVANT TERMINOLOGY

Elasticity: The ability of a material to return to its original shape after being stretched or pulled. Rubber bands have elastic characteristics.

Kinetic energy: The energy of motion.

Iteration: The process of repeatedly testing and refining to reach a desired target or result.

Potential energy: Stored energy. Anything that isn't moving but can has potential energy.

Prototype: An initial model of something from which other variations or innovations are developed.

GUIDANCE FOR YOUNGER CHILDREN

QUESTIONS TO ASK AFTER THE ACTIVITY

- Which materials reminded you of the material of a trampoline you have bounced on?
- How many loops did you use for your trampoline?
- What made some designs bouncier than others?

ENGINEERING CONNECTIONS

Engineers love to experiment with different materials as they invent new products or improve products we already have. For example, the material used in real trampolines is a result of engineering experiments to discover plastics that are strong, stretchy, and resilient. Most trampoline mats—the part represented by fabric in your prototype—are made out of synthetic woven fibers of polypropylene. This material is good for all kinds of things, not just trampolines—everything from loudspeakers to thermal underwear!

SCIENCE CONNECTIONS

The science of bounce is really the science of energy. A trampoline without anybody bouncing on it has some stored energy—called potential energy—in the loaded springs and stretched fabric. Once you get on the trampoline and start bouncing, the potential energy turns into the energy of motion, also called kinetic energy. You are moving, so you are using kinetic energy, and the trampoline itself is moving as it bounces, so it has its own kinetic energy.

GUIDANCE FOR OLDER YOUTH AND ADULTS

QUESTIONS TO ASK AFTER THE ACTIVITY

- How did you decide to arrange your loops?
- How did you decide on which fabric to use?
- What made some designs bouncier than others?
- Did the golf ball ever bounce off to the side instead of straight up while you were testing your trampoline? If so, what did you do to correct this?
- Did any of your tests have a bounce height that was significantly higher or lower than the rest? If so, why do you think that happened?

ENGINEERING CONNECTIONS

Trampolines are really fun, but they are also really dangerous. Every year at least 90,000 children are injured on trampolines! Engineers are working hard to find a way to make trampolines safer but still as fun as ever. An engineer in New Zealand, Dr. Keith Alexander, analyzed data and discovered that there are 3 main impact zones to address: the springs connecting the bounce mat to the frame, the metal frame, and the ground.

It took years and many prototypes, but finally Dr. Alexander arrived at a really innovative solution: move the frame below the jumping surface, give the mat a soft edge, and surround the whole thing with a net so that you'd bounce back to the center rather than off the trampoline if you went off-kilter. Studies show that Dr. Alexander's new, improved trampoline is much safer—and maybe even more fun—than traditional trampolines.

SCIENCE CONNECTIONS

The science of bounce is the science of energy. Scientists think of energy in two different forms: in use, and waiting to be used. Potential energy is the waiting, or stored, kind. Trampolines store potential energy for us to bounce with. The in-use kind of energy is called kinetic energy. Anything in motion is demonstrating kinetic energy. How much kinetic energy you have is a combination of your weight (mass) and your speed (velocity). When you are bouncing on a trampoline, your total amount of energy is equal to the combination of your kinetic energy and your potential energy.

$$\text{Total Energy} = \text{Potential Energy} + \text{Kinetic Energy}$$

$$E = PE + KE$$

The total amount of energy in the world stays the same! It just goes back and forth between kinetic and potential energy. Your motion on the trampoline, gravity, and the movement of the trampoline itself convert kinetic and potential energy back and forth.

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ACKNOWLEDGMENTS

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