sphero

educator guide

blueprint snap™

educator guide

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Welcome to Snap!

Hello! Welcome to the Blueprint Snap Educator Guide. Within these pages, you'll find a treasure trove of information that will help you get up and running with Snap in your classroom. Here at Sphero, we believe in learning by doing, so let's jump right into the challenge cards.

Snap Challenge Cards

The Snap challenge cards are the best way to introduce Snap to students and start building the fluency and confidence they will need to prototype designs with creativity and purpose. They are also an excellent way to familiarize yourself with Snap parts and build principles.

Each of the 15 challenges included in the Blueprint Snap Kit is a short, focused introduction to building with Snap. Each challenge should take about 15 minutes. You can find a digital version of the cards at: sphero.cc/BPsnapcc

Challenge cards 1-12 are divided into three sections:

learn how Snap parts work together.

build a model based on an image on the back of the card.

explore how the model can be improved or changed.

Challenge cards 13-15 are open-ended, giving students an opportunity to flex their creative muscles alongside the engineering design process.

	challenge	key snap parts
1.	Strong	Trusses & Connectors
2.	Stronger	Plates
3.	Move	Hinges & Turntables
4.	More Moving	Gears, Pulleys, Shaft Collars & Capped Shafts
5.	Spin or Lock?	Lock & Baring Plates
6.	Spinning	Hand Cranks
7.	Spin Faster	Gears
8.	Rolling	Pulleys & Tires
9.	Sliding	Linear Motion Brackets
10.	Drawbridge	Ropes & Rope Anchors
11.	Winching	Spools
12.	Clamping Cardboard	Cardboard Clamps
13.	Grounds for Play	Your Choice (open-ended)
14.	Animal Structures	Your Choice (open-ended)
15.	Driving Around	Your Choice (open-ended)

Implementation Recommendations

Challenge cards can be used in a variety of ways in the classroom. Consider the following implementation models:

Whole Group

Project the challenge cards one at a time for **all students** to see. Preview the challenge together, then give students time to **build** their models and follow the **explore** prompts. Make sure to save time at the end of each card to **review** what students have learned and **share** their models.

Small Group

Distribute challenge cards to **small groups** of students and let them work through a set of cards at their own pace. Near the end of your allotted time, bring the groups back together and have students **share** what they've learned, their designs, and generate ideas for future explorations.

Stations

Set up learning stations with challenge cards. Put a different card at each station and give students about 15 minutes to complete each card before rotating to a new station. Since all stations are working on different cards, you can float and support as needed or remain at one station that you feel is more challenging. As with the other models, be sure to save time at the end for reflection and sharing.

Planning & Facilitation Tips

Before

- Take time to complete the challenge cards **on your own**. This will not only help you anticipate challenges your students may face, but it's also the best way to learn how Snap works (it's also fun!).
- Review the information about each challenge in this guide. This guide offers tips, deeper explanations, examples, and more to make facilitation even easier.
- Choose your implementation method. If possible, plan for two students per Snap Kit.
- Decide if and how you want students to **record their learning** (there are tips on how to use engineering notebooks and reflection videos in the FAQ section of this guide).

During

- Encourage **open-ended exploration** and refrain from giving solutions.
- Celebrate effort and risk-taking. Emphasize that students can make mistakes and that it's okay! The real objective of these challenges is **building fluency** with Snap parts and an iterative approach to design.
- Periodically pause the class to let students who have had breakthroughs or unique designs **share** their discoveries with others.
- As students work on the **explore** section, allow them to follow their own lines of inquiry. Encouraging students to come up with their own creative questions and solutions is a great way to develop curiosity and critical thinking skills.

After

- Bring students together to **review** and **summarize** what they have learned.
- Capture questions or ideas that students want to investigate further. Consider making time in the future for them to build on those ideas.
- Once you have finished these challenges, head on over to Sphero Central to discover more lessons: edu.sphero.com/blueprint-snap

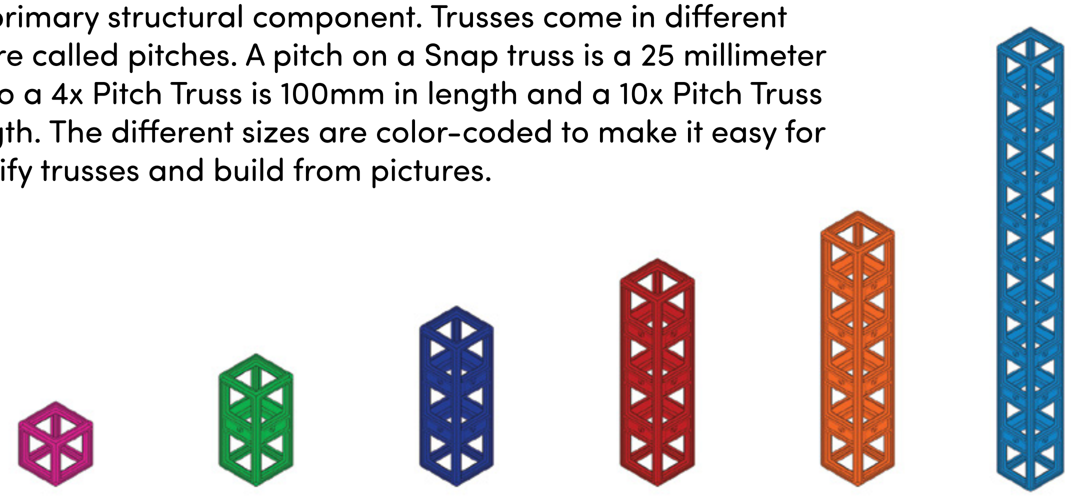
Challenge #1: Strong

Students learn how to use Connectors and trusses to build a simple bridge.

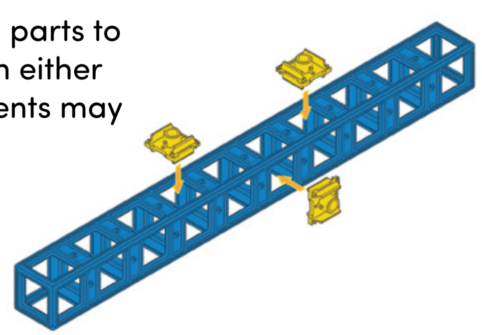
learn

This challenge introduces the two most commonly used parts in the Snap Kit:

- Trusses are the primary structural component. Trusses come in different lengths, which are called pitches. A pitch on a Snap truss is a 25 millimeter (mm) segment, so a 4x Pitch Truss is 100mm in length and a 10x Pitch Truss is 250mm in length. The different sizes are color-coded to make it easy for students to identify trusses and build from pictures.

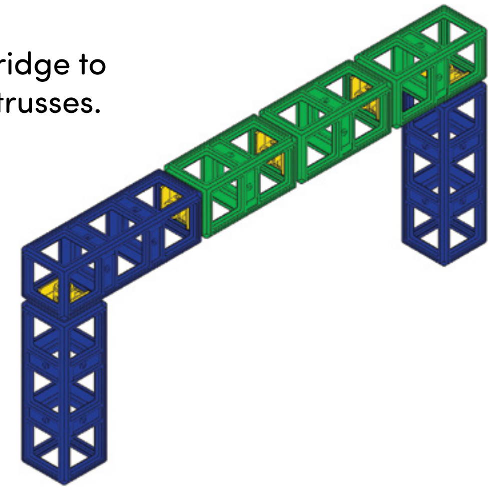


- Connectors are used to attach trusses and other Snap parts to one another. Connectors can be inserted into a truss in either orientation. The orientation shouldn't matter, but students may want to investigate whether they think it does!



build

Students build a very simple, unsupported bridge to give them practice attaching Connectors to trusses.



explore

This bridge is not very sturdy. Add or replace Snap parts to make it stronger.

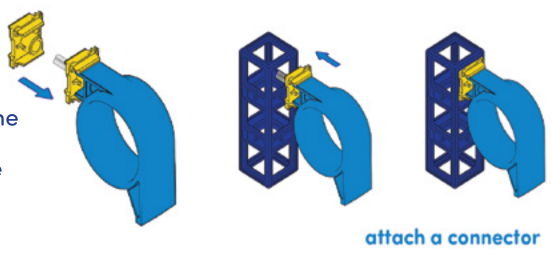
- Students may notice that the top beam could be built with a 5x Pitch Truss and 4x Pitch Truss instead of a 3x Pitch Truss and three 2x Pitch Trusses. The fewer joints, or connections, between trusses, the stronger the bridge will be.
- Students may recommend adding parts to reinforce the joints. Additional trusses and Connectors on the top, bottom, or sides of the bridge will strengthen the joints. Students may also use plates, which are formally introduced in Challenge #2.
- Students may also add trusses to the base of the bridge so it is less likely to tip over.

Try placing a small object on the bridge to see how strong it is. What could make it stronger?

- Encourage students to put the weighted trusses on top of the bridge. They could also place classroom objects like books or pencil boxes on top of the bridge to test.

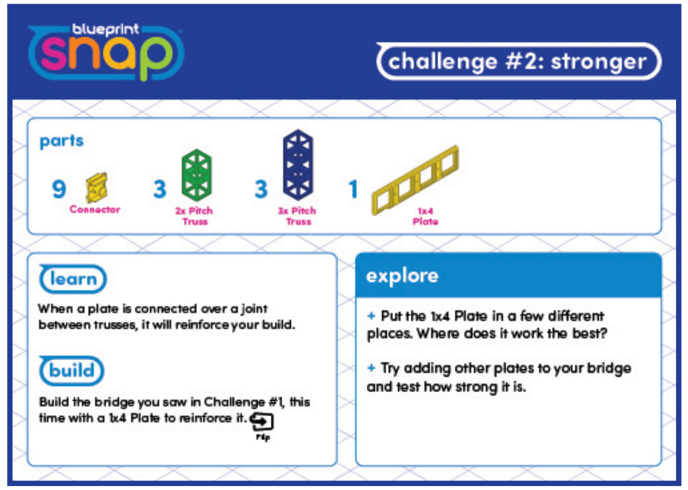
engineering tip

This challenge will also give students lots of practice assembling and disassembling with the Ring Tool. Reinforce some of the ways to insert Connectors, remove Connectors, and separate trusses from the Best Build Practices card.



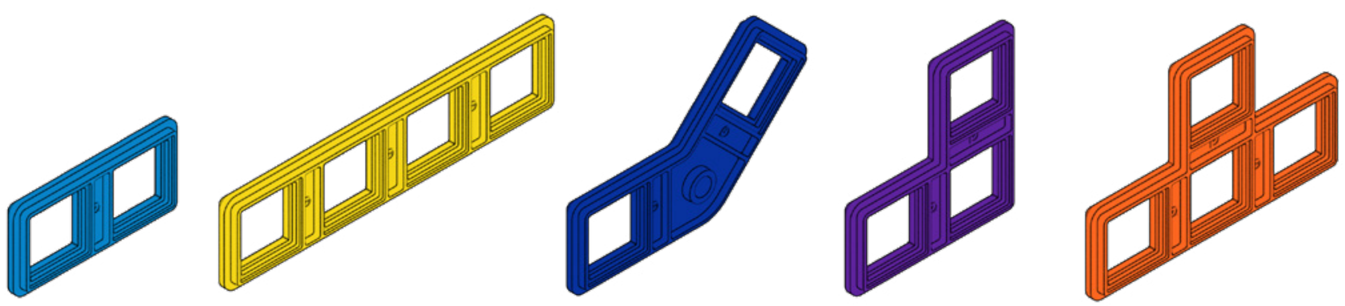
Challenge #2: Stronger

Students learn how to use a plate to reinforce, or strengthen, the bridge they built in Challenge #1.



learn

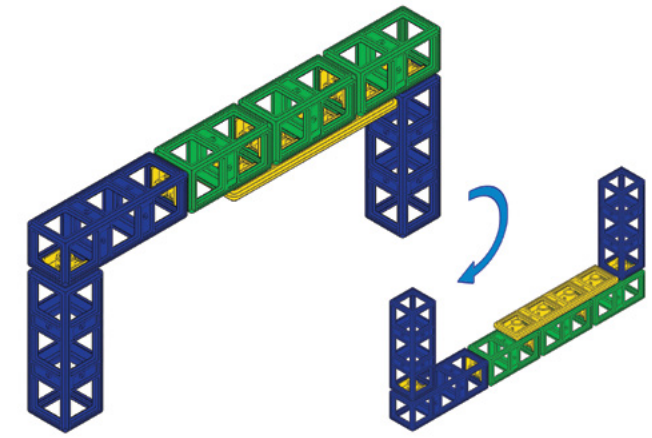
Snap plates can be attached to trusses on either side of a joint to reinforce the connection. Plates come in a variety of sizes and shapes:



Some plates, like the 1x4 Plate, have spots for more than two Connectors. The more Connectors you use to attach a plate, the stronger the connection. Besides using plates for reinforcing joints, they can also be used creatively in builds. Ask your students to think about how they could use a plate to create a flat base for their bridge.

build

Students will support the bridge from Challenge #1 with a 1x4 Plate.



explore

Put the 1x4 Plate in a few different places. Where does it work the best?

- Students can attach the 1x4 Plate in many different spots, including four different spots on the underside of the bridge. They could also attach the plate to the sides or top of the bridge. Generally speaking, the plate will work best when it covers two joints rather than one.

- Ask students to support their findings with evidence. How much weight could be supported with the plate in different locations?

Try adding other plates to your bridge and test how strong it is.

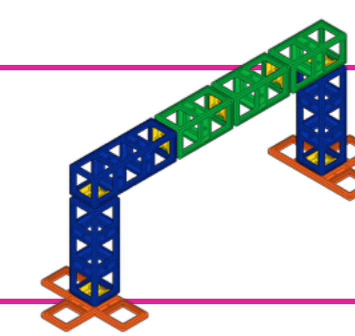
- Students may start adding multiple plates over the same joint to further reinforce the bridge's strength.

- The 2x2 90° Plates can be used to reinforce the corners of the bridge. The 2x3 Tee Plates can also be used on the corners, though part of the plate will extend past the edge of the bridge. The 2x2 45° Plates do not have much purpose in this build and are most useful when trying to build with angles that are not perpendicular.

- Students may start adding multiple plates over the same joint to further reinforce the bridge's strength.

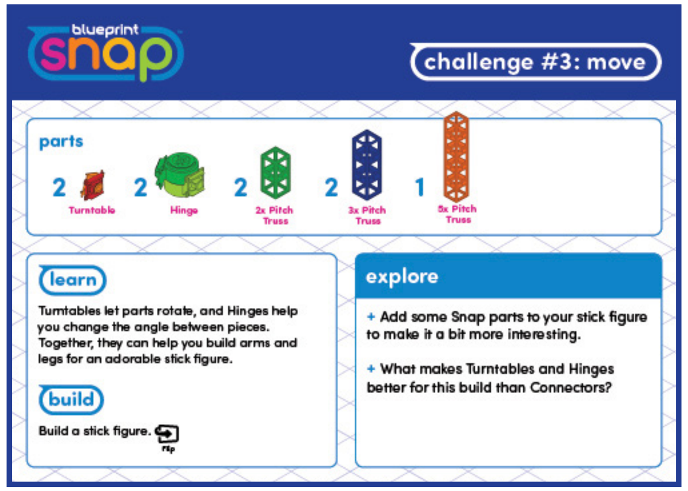
engineering tip

Plates can be used creatively in builds, as well as for reinforcing joints. Ask your students how they could use a plate to add a base to their bridge.



Challenge #3: Move

Students learn how to use Turntables and Hinges to make joints that twist and bend.



challenge #3: move

parts

2 Turntable

2 Hinge

2 2x Pitch Truss

2 3x Pitch Truss

1 5x Pitch Truss

learn

Turntables let parts rotate, and Hinges help you change the angle between pieces. Together, they can help you build arms and legs for an adorable stick figure.

build

Build a stick figure. Flip

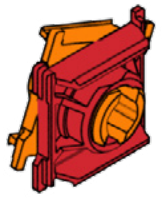
explore

+ Add some Snap parts to your stick figure to make it a bit more interesting.

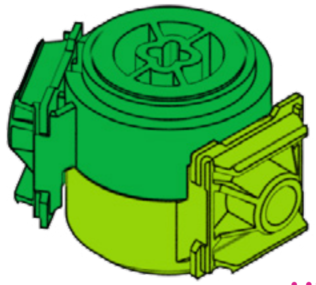
+ What makes Turntables and Hinges better for this build than Connectors?

learn

Turntables connect two trusses or other Snap parts and allow them to rotate or twist, while Hinges connect two trusses or other Snap parts and allow them to bend.



Turntable



Hinge

Look closely, and you'll see that both Turntables and Hinges are made up of two separate parts, hence their two colors. A shaft can be inserted through the center of each.

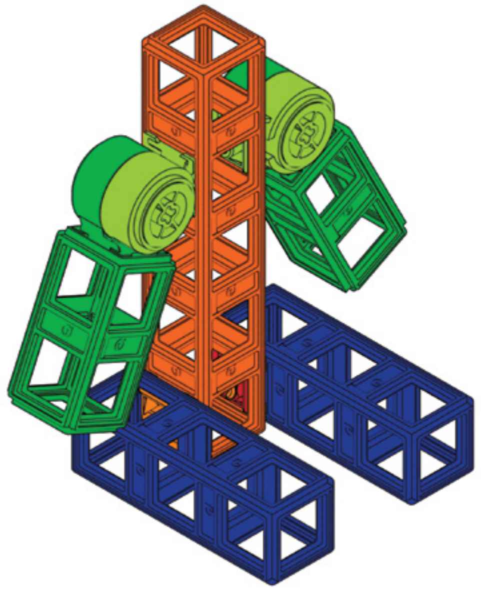
- One side of the hole locks onto the shaft. When you turn the shaft, the part turns with it.

- The other side of the hole lets the shaft spin freely inside it. Look closely and you'll see that the shaft will lock to one side of the joint and spin freely through the other side.

This allows you to drive motion through a Turntable or Hinge with a shaft. If you find that the wrong side of the joint is spinning in your build, simply flip the Turntable or Hinge around.

build

Students build a stick figure.



explore

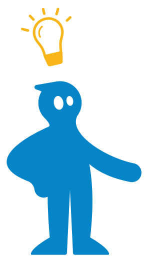
Add some Snap parts to your stick figure to make it a bit more interesting.

- Encourage students to get creative here. They may want to swap out trusses to make their stick figure bigger or smaller. Others may want to make other body parts. For example, the 45mm Pulley will make a great head. They also may want to add objects, like a tool, a hat, or something to carry.

- Students may also want to add more joints to their stick figure. Prompt them to think about the human body and see if they can use more Turntables and Hinges to make their stick figure more realistic.

What makes Turntables and Hinges better for this build than Connectors?

- If possible, discuss this question with students. Connectors are great when you want to lock Snap parts together. However, many builds, like this stick figure, require joints to twist or bend. Hinges and Turntables are just one way to add movement to Snap builds.

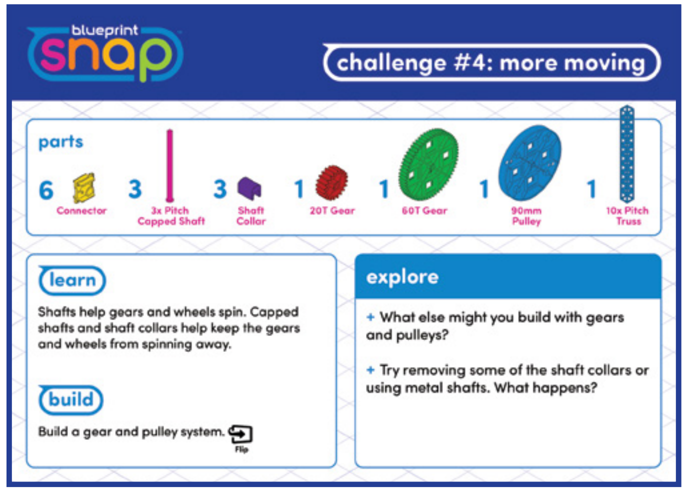


engineering tip

If your students struggle with the names of parts, encourage them to come up with their own names related to a part's purpose or function. For example, at Sphero we often call Turntables "twisties" and Hinges "bendies." As students work through these challenge cards, they will develop formal and informal vocabulary to accurately talk through engineering design challenges with Snap.

Challenge #4: More Moving

Students learn how to use Snap shafts, which act as axles for gears and pulleys, allowing them to spin.



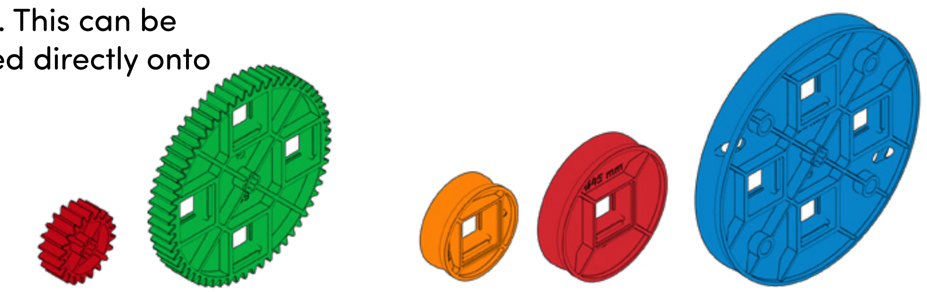
learn

Capped shafts have two ends: one end with a "cap" that acts as a permanent stopper, and another end that slides through Connectors and other Snap parts. Capped shafts come in multiple sizes. Similar to trusses, they are measured in 25mm lengths or pitches. The 2x Pitch Capped Shaft is 50mm and the 4x Pitch Capped Shaft is 100mm.

Gears and pulleys slide onto shafts, which allow them to spin. The smaller 30mm and 45mm pulleys need a Turntable, Bearing Plate, or Lock Plate attached to them to hold a shaft.

2x Pitch Capped Shaft | 3x Pitch Capped Shaft | 4x Pitch Capped Shaft

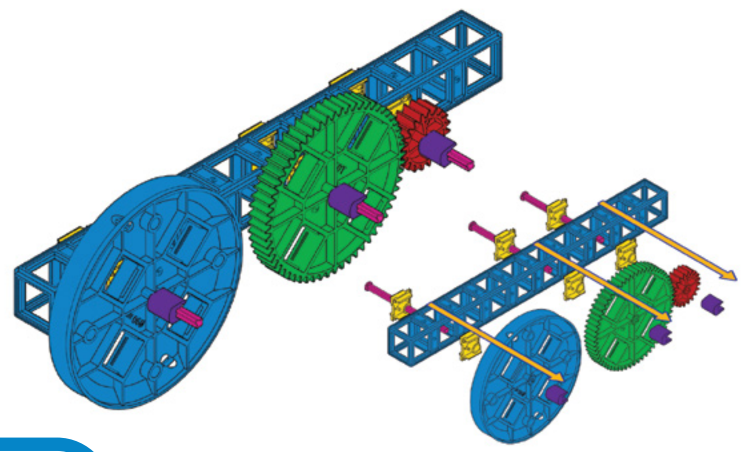
The uncapped side of the capped shaft must be secured with a Shaft Collar. This can be slid on from the end or snapped directly onto the shaft from the side.



20T Gear | 60T Gear | 30mm Pulley | 45mm Pulley | 90mm Pulley

build

Students build a mechanism that will allow them to explore capped shafts, gears, and pulleys.



explore

What else might you build with gears and pulleys?

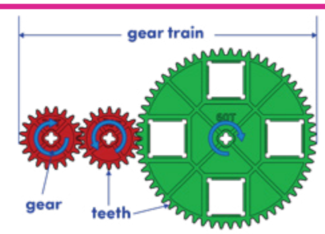
- Students may suggest some of the following mechanisms with pulleys:
  - a car, bicycle, or other rolling vehicle using the pulleys as wheels
  - a well that uses a rope and a pulley to raise a bucket of water
  - a crane for lifting objects at a construction site
- Students may suggest some of the following mechanisms with gears:
  - a merry-go-round that turns with gears
  - a fan that spins trusses very quickly

Try removing some of the shaft collars or using metal shafts. What happens?

- Students will notice a second type of shaft in their Snap Kits: metal shafts. Prompt students to think about the difference. Metal shafts come in longer sizes (5x, 6x, and 10x pitches) and do not have a capped end. This means they are stronger, but they also need to be secured on both ends with a Shaft Collar.

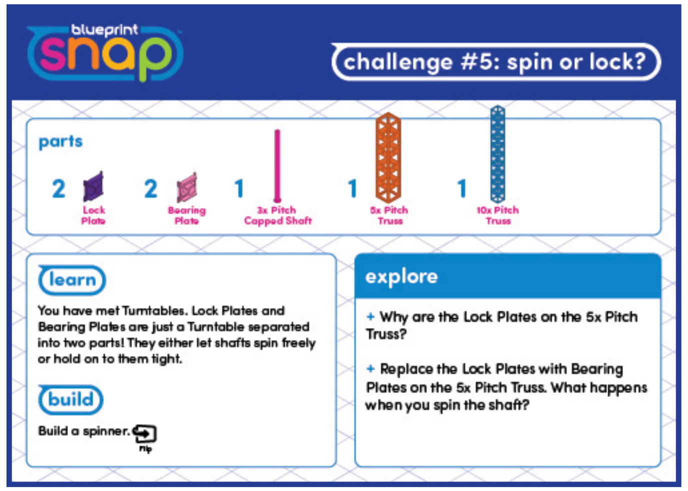
engineering tip

Introduce students to vocabulary that will allow them to talk about gears. Gears have teeth—or cogs—that mesh with other gears. In this build, the 20T Gear is meshed with the 60T Gear to form a series of gears called a gear train. When one gear is rotated, the other gear will rotate as well.



Challenge #5: Spin or Lock?

Students learn the difference between Lock Plates and Bearing Plates by building a simple spinner.


challenge #5: spin or lock?

parts

2 Lock Plate · 2 Bearing Plate · 1 3x Pitch Capped Shaft · 1 5x Pitch Truss · 1 10x Pitch Truss

learn

You have met Turntables. Lock Plates and Bearing Plates are just a Turntable separated into two parts! They either let shafts spin freely or hold on to them tight.

build

Build a spinner. Flip

explore

+ Why are the Lock Plates on the 5x Pitch Truss?

+ Replace the Lock Plates with Bearing Plates on the 5x Pitch Truss. What happens when you spin the shaft?

learn

Lock and Bearing Plates are used with shafts to help make builds with spinning parts. A Lock Plate will hold a shaft in place, not allowing it to rotate. Think about the wheel on a car that you want to be locked to the spinning axle. A Bearing Plate will allow a shaft to spin freely. Think about the axle on a car that you want to spin freely while staying attached to the body of the car.

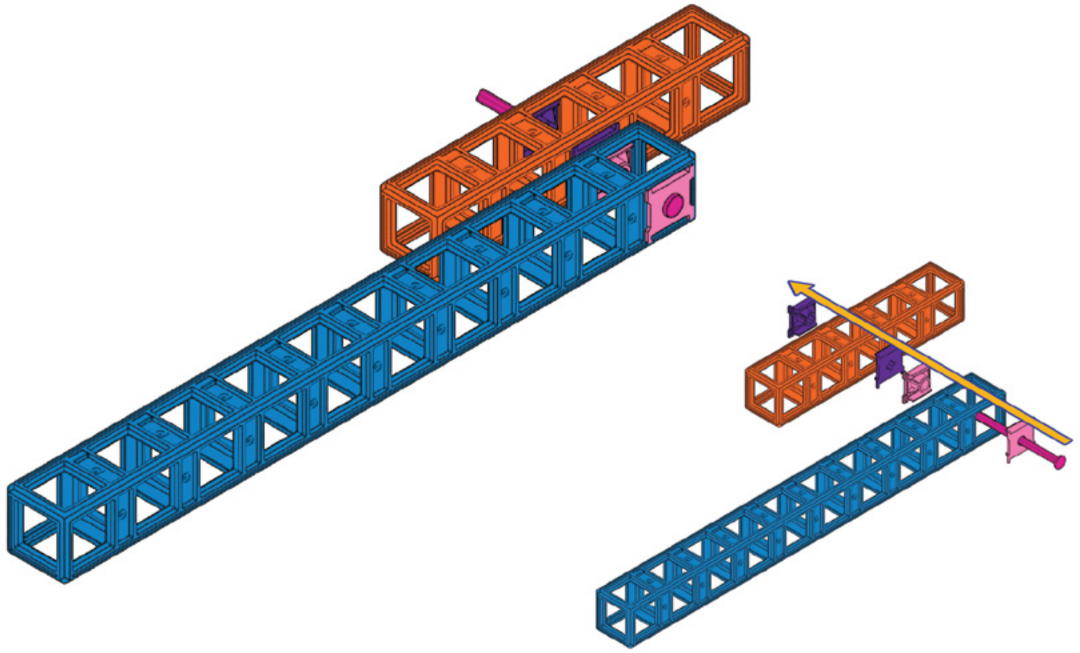

Lock Plate


Bearing Plate

Remember the Turntable from Challenge #2? A Turntable is just a Lock Plate and a Bear-ing Plate fixed together. Turntables are handy because you don't need to use a shaft to connect the part. You'll always need to use a shaft with a Lock Plate and Bearing Plate.

build

Students build a simple spinning mechanism.



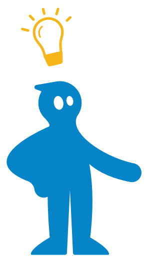
explore

Why are the Lock Plates on the 5x Pitch Truss?

- Ask students to hold the 10x Pitch Truss in one hand and spin the shaft. Students will discover that the Lock Plates on the 5x Pitch Truss hold it to the shaft, causing it to spin as they turn the shaft.
- If they hold the 5x Pitch Truss, they will not be able to spin the shaft.

Replace the Lock Plates with Bearing Plates on the 5x Pitch Truss. What happens when you spin the shaft?

- Students will observe that the shaft spins, but the 5x Pitch Truss does not.
- If they spin the 5x Pitch Truss, they'll notice it spins freely.



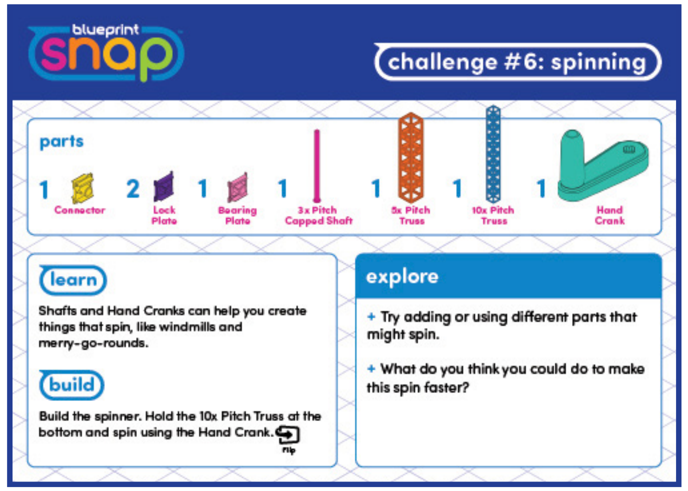
engineering tip

A core job for an engineer is managing friction, a force that slows things down when surfaces rub together. Prompt students to swap out the Lock and Bearing Plates between the trusses with a Turntable and investigate the difference in friction. Which spins better? Which has less friction?

The Turntable has a lot of plastic rubbing together, which slows the spinning down. The trusses spin much more smoothly with less friction with Bearing and Lock Plates. Sometimes, engineers want friction; other times, they don't. Engineers need to select the right parts to get the desired amount of friction for the task at hand.

Challenge #6: Spinning

Students learn how the Hand Crank helps you add motion to builds.


challenge #6: spinning

parts

1 Connector, 2 Lock Plate, 1 Bearing Plate, 1 3x Pitch Capped Shaft, 1 5x Pitch Truss, 1 10x Pitch Truss, 1 Hand Crank

learn

Shafts and Hand Cranks can help you create things that spin, like windmills and merry-go-rounds.

build

Build the spinner. Hold the 10x Pitch Truss at the bottom and spin using the Hand Crank. Flip

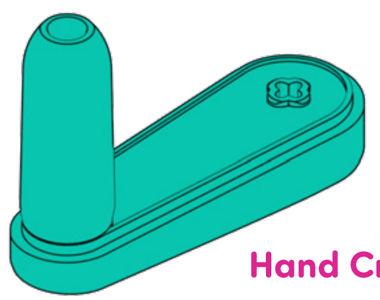
explore

+ Try adding or using different parts that might spin.

+ What do you think you could do to make this spin faster?

learn

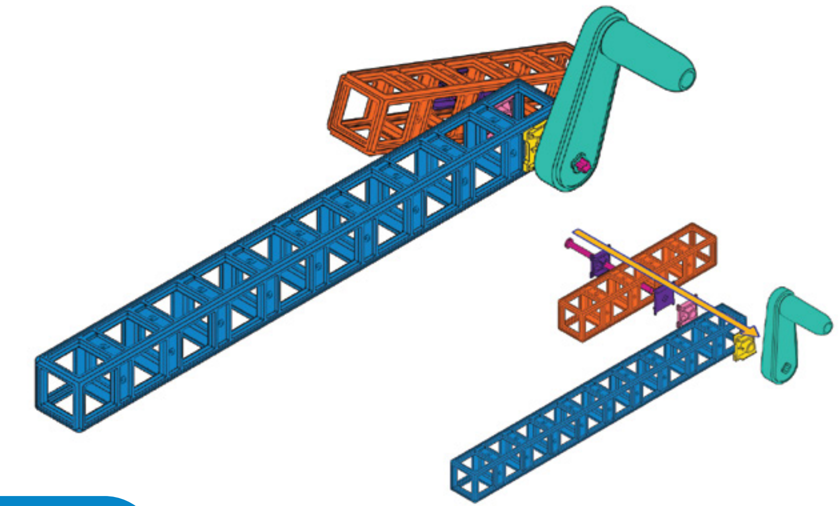
The Hand Crank fits onto shafts and provides a convenient way to power Snap mechanisms by hand.



While not in the build picture, you can secure the Hand Crank by attaching a Shaft Collar to the end of the 3x Pitch Shaft. Both the Hand Crank and Shaft Collar are 0.5x pitch (12.5mm) in width, making just enough space on the end of the 3x Pitch Capped Shaft.

build

Students modify the spinner from Challenge #5 by adding a Hand Crank.



explore

Try adding or using different parts that might spin.

- Students may notice that some parts, such as the 20T Gear, 60T Gear, and 90mm Pulley, are fixed with locking shaft inserts. Remember that other parts, such as the 30mm Pulley and 45mm Pulley, need to be fitted with a Lock Plate to hold onto the shaft.
- Use this exploration as a starting point for a mini engineering design challenge. Ask students to brainstorm Snap parts that might be fun to spin, prototype their ideas, then test and improve their builds. Make sure to provide time for sharing. Students could invent anything from a hand mixer to a hypnotizing machine.

What do you think you could do to make this spin faster?

- The obvious student suggestion here is to turn the Hand Crank faster. Prompt them to think about how to use additional Snap parts to make the spinner spin faster while turning the Hand Crank at the same speed. This previews the learning in Challenge #7.

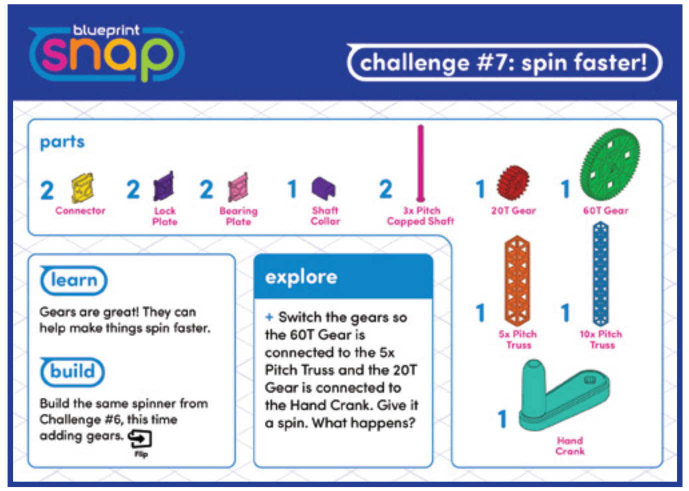
engineering tip

Use the Hand Crank to introduce or reinforce the concept of inputs and outputs in mechanical systems.

- **Input:** The effort used to power a machine. Here, the input is the force a student uses to turn the Hand Crank.
- **Output:** The action or result that the machine produces. Here, the output is the motion of the spinning truss.

Challenge #7: Spin Faster

Students learn how to make their spinner spin faster with gears.


challenge #7: spin faster!

parts

2 Connector
2 Lock Plate
2 Bearing Plate
1 Shaft Collar
2 3x Pitch Capped Shaft
1 20T Gear
1 60T Gear
1 5x Pitch Truss
1 10x Pitch Truss
1 Hand Crank

learn

Gears are great! They can help make things spin faster.

build

Build the same spinner from Challenge #6, this time adding gears.

explore

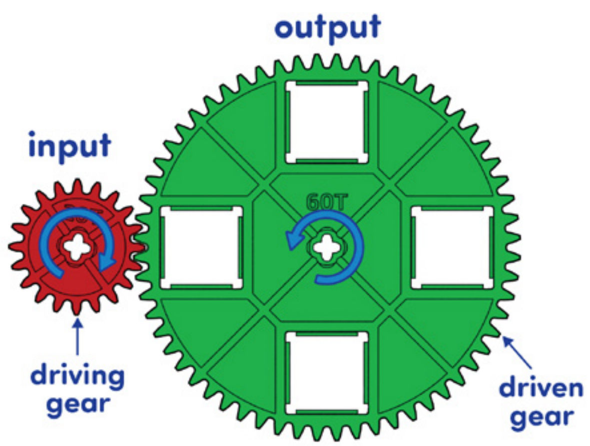
+ Switch the gears so the 60T Gear is connected to the 5x Pitch Truss and the 20T Gear is connected to the Hand Crank. Give it a spin. What happens?

learn

This challenge card does not introduce new parts. Instead, students learn to use a gear train to speed up their spinner.

Different gears in a gear train serve different purposes:

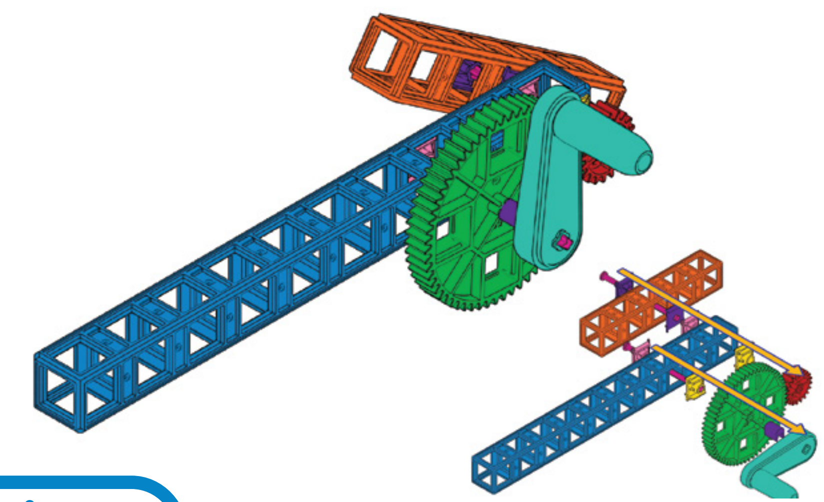
- The gear with the Hand Crank is the input, or driving gear. Force is applied to the driving gear.
- The gear attached to the 5x Pitch Truss is the output, or driven gear. Its movement represents the machine's final work or output.



The driving gear has 60 teeth and the driven gear has 20 teeth. For every rotation of the driving gear, the driven gear spins three revolutions. This gear train is geared to increase the speed of the output.

build

Students modify the spinner from Challenge #6 by adding a gear train.

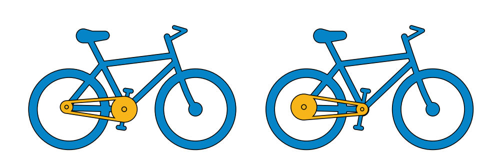


explore

Switch the gears so the 60T Gear is connected to the 5x Pitch Truss and the 20T Gear is connected to the Hand Crank. Give it a spin. What happens?

- Students will discover that when they switch the gears, the spinner will rotate much more slowly.
- Prompt them to consider why. The driving gear now has 20 teeth and the driven gear has 60 teeth. This means that the Hand Crank needs to be rotated three times to make the spinner complete one revolution.
- This gear train increases the output's torque, or turning power. It is slower to spin, but it is hard to stop!

engineering tip



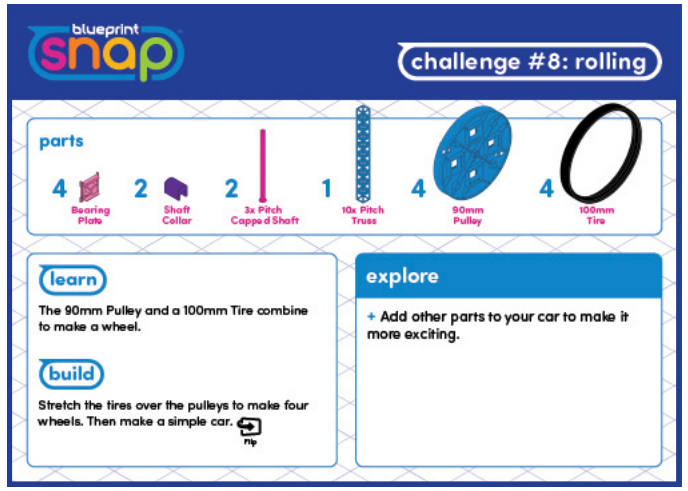
Using gear trains to your advantage, either to gear a mechanism for speed or for torque, is one of the most important concepts in mechanical engineering. Make it relatable to students by discussing gearing on bicycles.

When do you want a large gear on the front crank and a small gear on the back crank? *When you want to go fast!*

When do you want a small gear on the front crank and a large gear on the back crank? *When you want to go up a steep hill!*

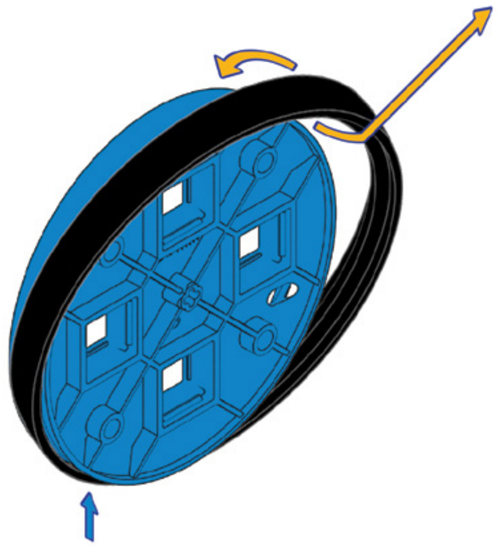
Challenge #8: Rolling

Students learn how to turn a pulley into a wheel for vehicles and other creative builds.



learn

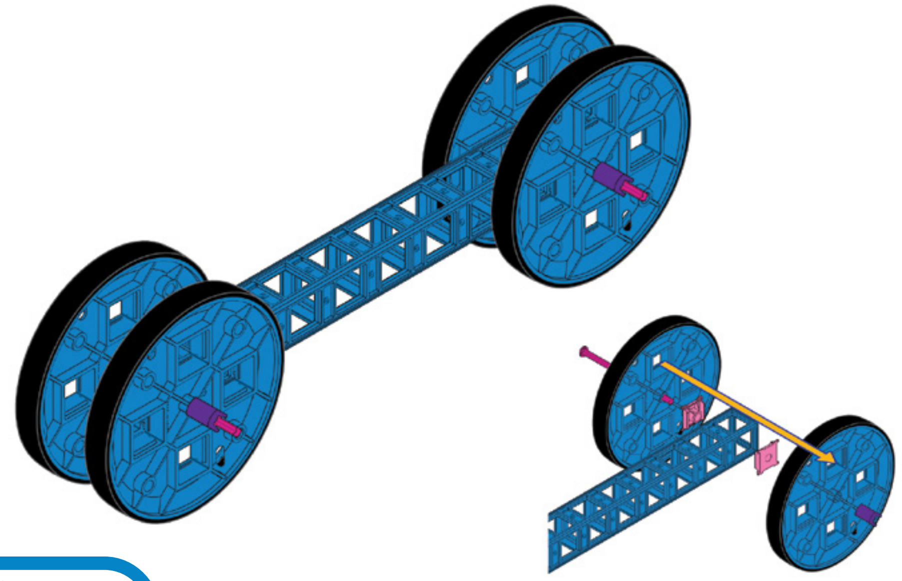
Only one new Snap part is introduced in this challenge card: the 100mm Tire. The tire is stretched over the 90mm pulley to make a wheel. The bump inside the tire fits into a groove on the pulley to make a wheel with a diameter of 100mm. The tires are meant to be durable, but remind students not to stretch them.



This challenge card reinforces the difference between Bearing Plates and Lock Plates. What would happen if the Lock Plates were used instead?

build

Students build a simple car.

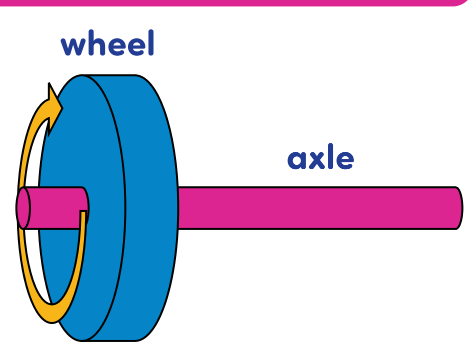


explore

Add other parts to your car to make it more exciting.

- This is a purposefully open-ended prompt. Building cars and other vehicles is fun, and the build in this challenge is pretty basic. Students can try some of the following:
  - add trusses to make the car wider or longer
  - add features like a driver's seat, doors, or a trunk
  - add gears to be able to turn the wheels with the Hand Crank
- As time allows, turn this prompt into a design challenge and ask students to brainstorm ideas for their car, prototype their ideas, then test and improve their builds.
- Look ahead to Challenge #11. It asks students to attach a winch to the front of their car.

engineering tip



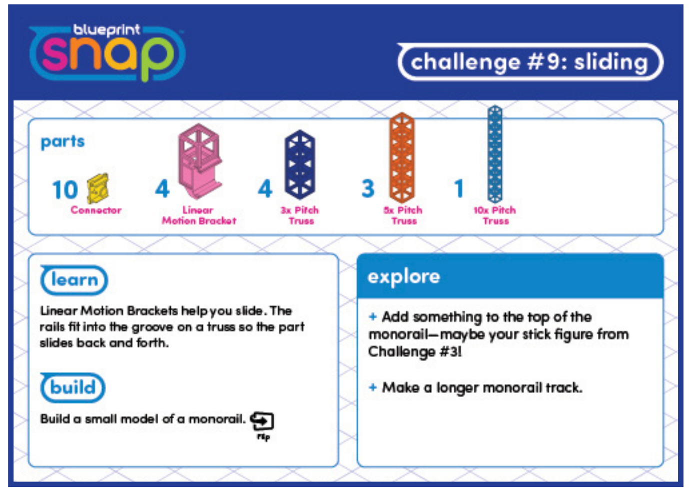
The wheel and axle is a simple machine that allows objects to roll instead of being dragged. This reduces friction and makes the objects easier to move.

Discuss other common examples of wheels and axles in the real world:

- Steering wheel: The driver holds the wheel, which spins the steering column or axle and turns the car.
- Doorknob: The knob is the wheel and the small shaft that opens the latch is the axle.
- Pizza cutter: The cutting blade is the wheel and the pin that holds it in place is the axle that the blade spins around.

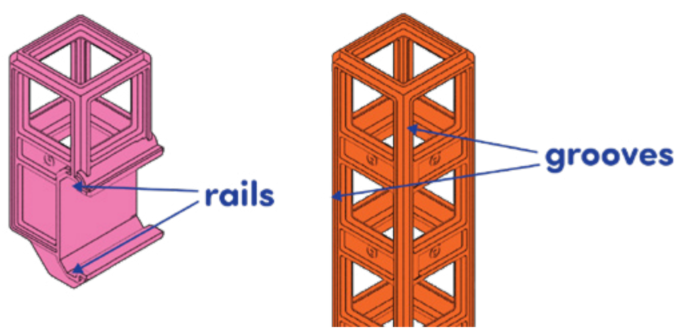
Challenge #9: Sliding

Students will learn how to use Linear Motion Brackets to add sliding motion to their builds.

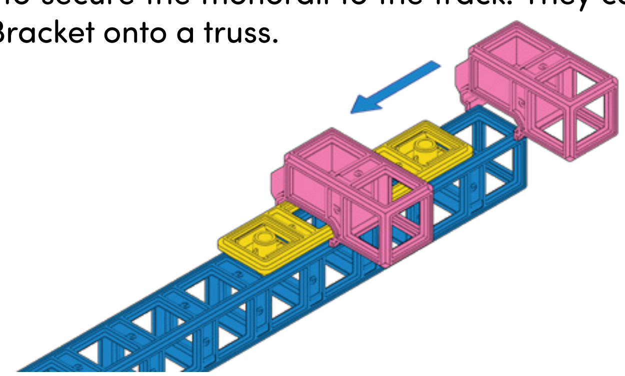


learn

The rails on the Linear Motion Brackets fit into the grooves on a truss and slide back and forth with minimal friction. This motion is similar to drawers in a dresser or a train on a track.



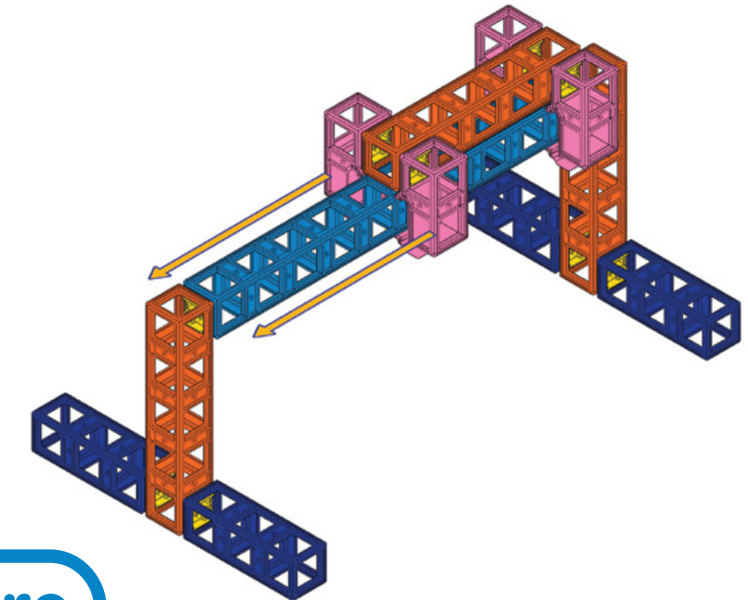
Linear Motion Brackets are often used in pairs, one on each side of the object. In this challenge card, students will place the monorail on the 10x Pitch Truss and then add the Linear Motion Brackets to secure the monorail to the track. They can also use plates to lock the Linear Motion Bracket onto a truss.



Note that the name, Linear Motion Bracket, is a mouthful. At Sphero, we often call them "slides."

build

Students build a monorail that slides back and forth on a 10x Pitch Truss.



explore

Add something to the top of the monorail—maybe your stick figure from Challenge #3!

- Besides their stick figure, students may want to build onto the car to make it look more like a monorail.
- As students add on, prompt them to think about stability. How can they ensure their monorail maintains balance and slides smoothly on the track?

Make a longer monorail track.

- With six 10x Pitch Trusses in each Snap Kit, students can build a track that is 60 pitches in length. Incorporate measuring by asking students to calculate the length of their tracks. Remember, each pitch on a Snap truss is 25mm.

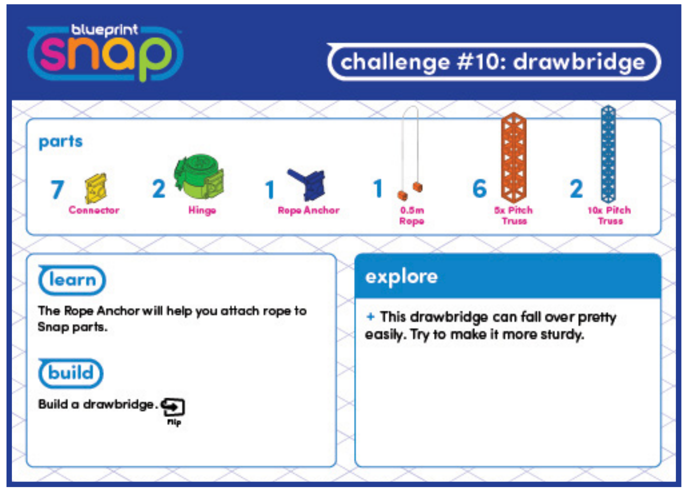
engineering tip

In this build, the track is just as important as the monorail that slides. The main job of the truss track is to be straight, stable, and smooth. Structural engineers spend a lot of time making sure tracks for things like elevators or high-speed trains are smooth and supported.

Students will discover that longer tracks require more structural support to prevent them from breaking. Encourage them to reinforce their tracks with plates and add extra truss supports.

Challenge #10: Drawbridge

Students learn how to secure rope to their builds with Rope Anchors.


blueprint snap

challenge #10: drawbridge

parts

7 Connector · 2 Hinge · 1 Rope Anchor · 1 0.5m Rope · 6 5x Pitch Truss · 2 10x Pitch Truss

learn

The Rope Anchor will help you attach rope to Snap parts.

build

Build a drawbridge. Flip

explore

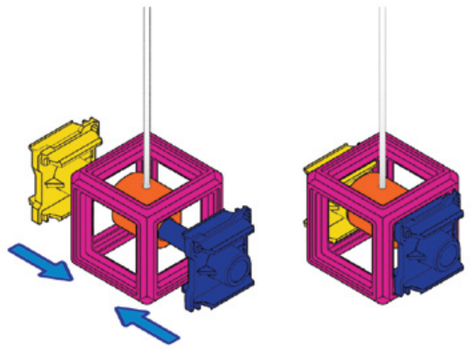
+ This drawbridge can fall over pretty easily. Try to make it more sturdy.

learn

The 0.5m and 1m Ropes in the Snap Kit are identifiable by the color of the ends: the 0.5m Rope has orange ends, and the 1m Rope has blue ends. These ends allow the rope to be easily connected to trusses with a special connector called a Rope Anchor.

To use a Rope Anchor:

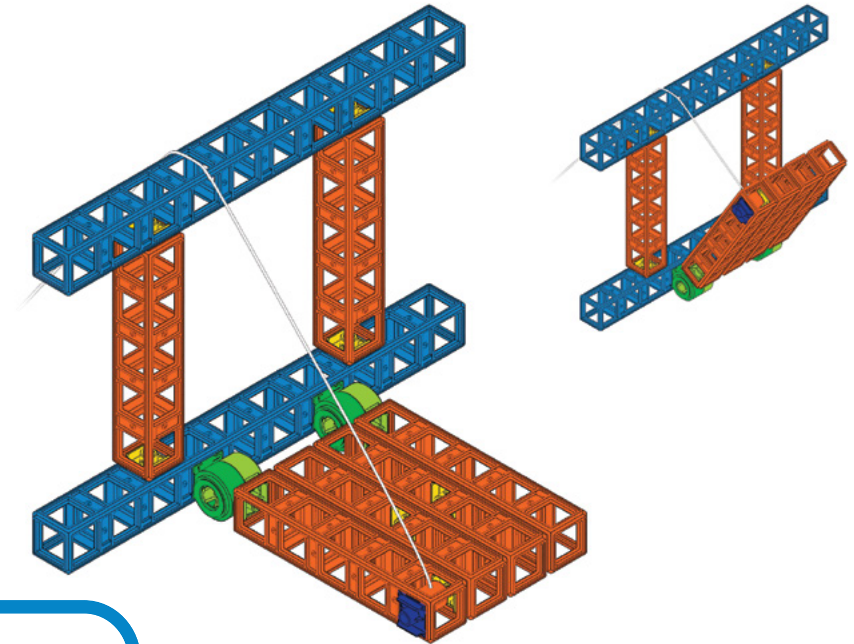
- drop the rope end inside a truss
- insert the Rope Anchor into the rope end
- click the Rope Anchor into the truss
- secure the other side with a Connector



Keep in mind that Rope Anchors can secure ropes to other Snap parts. For example, imagine attaching a rope to a Linear Motion Bracket in Challenge #9 and using the rope to move the monorail.

build

Students build a drawbridge that can be raised and lowered with a rope.



explore

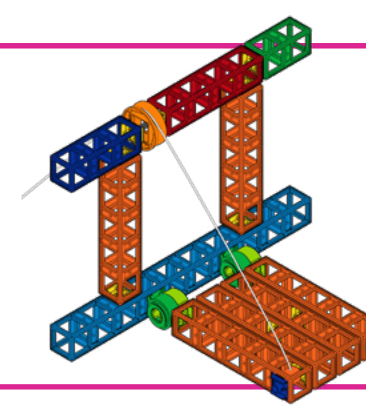
This drawbridge can fall over pretty easily. Try to make it more sturdy.

- If students have completed the other challenge cards, they will understand the importance of considering stability.
- Some students may attach trusses or weighted trusses to the base, like in Challenge #9. Some might get creative and build a castle to hold the bridge frame. This might be the most sturdy of them all.
- The picture only includes two Hinges. Increasing the number of Hinges to four will connect the bridge to the frame more securely.
- For students who need an extra challenge, prompt them to build a latch that will hold the bridge upright.

engineering tip

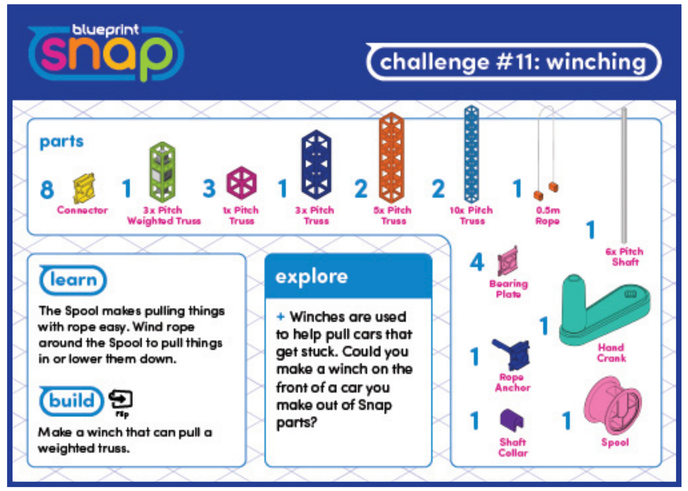
When the rope in the drawbridge is dragged over the corner of a truss, friction makes it harder to lift the bridge. A pulley is a simple machine designed to solve this exact problem.

The pulley in this adapted drawbridge allows the rope to change direction smoothly. As the pulley spins, it replaces high-friction dragging with low-friction rolling. Give it a try!



Challenge #11: Winching

Students learn how to use a Spool to wind rope.

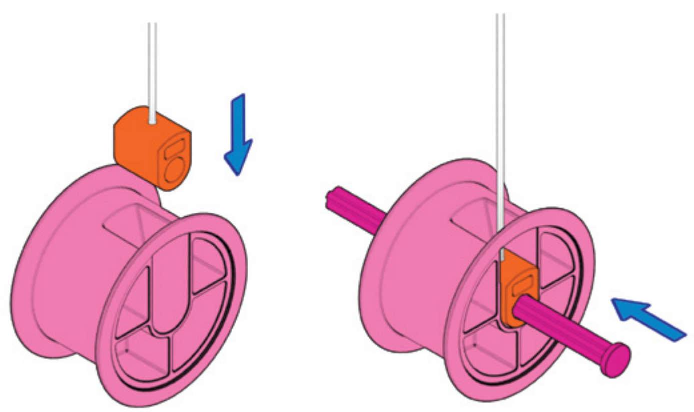


learn

The Spool allows you to wind and unwind the rope. In this challenge, students use the Spool to raise and lower the load or 3x Pitch Weighted Truss. Spools have many uses; you can find them in fishing poles, sewing machines, and 3D printer filament.

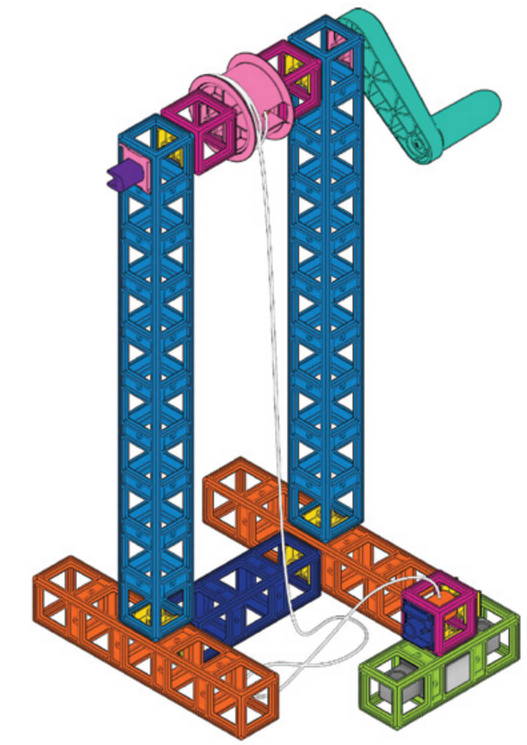
To attach a rope to the Spool:

- drop the end of a rope into the center of the Spool
- insert a shaft through the rope end and Spool to secure the rope



build

Students build a winch that raises and lowers a 3x Pitch Weighted Truss.



explore

Winches help pull cars that get stuck. Could you make a winch for the front of a car out of Snap parts?

- Students can use the car they built in Challenge #8 as a starting point, but they will need to make modifications to be able to fit their winch. To attach it to the front of the car, they will need to make the wheelbase wider. Another option is to build up and attach the Spool above the wheel.
- If the winch pulls something heavy, the car will roll forward. Ask students to design a solution to prevent the car from rolling.

engineering tip

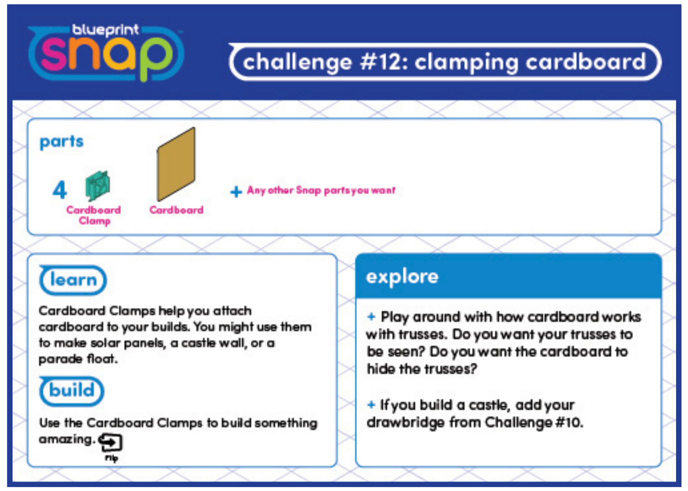
In engineering, there are two main types of motion or ways things can move.

- Rotational motion is movement in a circle around a central point. Think spinning and Hand Cranks.
- Linear motion is movement in a straight line. Think sliding and Linear Motion Brackets.

The winch build combines both. The Spool showcases rotational motion to wind the rope, and the load showcases linear motion as it rises into the air.

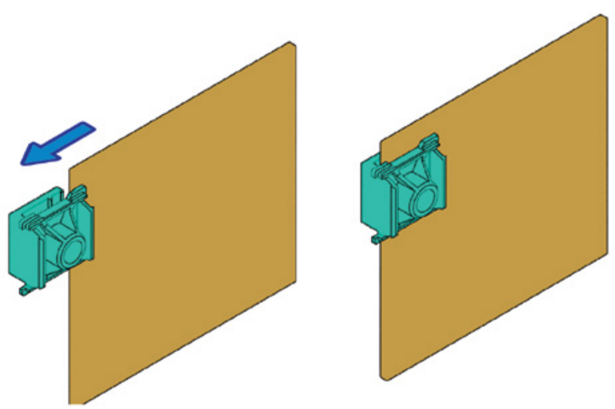
Challenge #12: Clamping Cardboard

Students learn how to attach cardboard to the Cardboard Clamps to add creativity to their builds.



learn

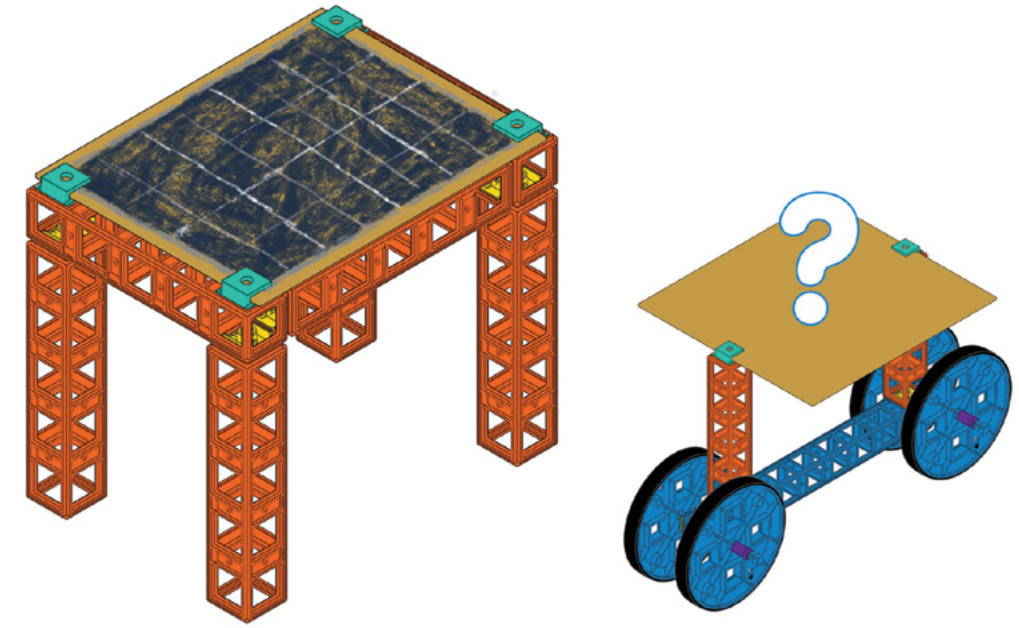
Cardboard Clamps snap into trusses like Connectors and have a flexible slot that securely grips pieces of cardboard. The clamp can hold cardboard of varying thicknesses and other craft materials like pipe cleaners or popsicle sticks.



Cardboard is a common classroom engineering tool, but building strong structures can be challenging. With Snap, students can build the frame with trusses and add the fun details with cardboard.

build

Students build something to showcase their creativity with Cardboard Clamps and craft materials.



explore

Play around with how cardboard works with trusses. Do you want your trusses to be seen? Do you want the cardboard to hide the trusses?

- Students will need practice cutting cardboard to fit their builds. If they use rectangular pieces of cardboard, the edges of the trusses may be seen. To avoid this, they can cut notches in the cardboard to fit the Cardboard Clamps.

If you build a castle, add your drawbridge from Challenge #10.

- Revisit all the builds from the challenge cards and discuss how Cardboard Clamps could be used. For example, students might want to add a face to the stick figure in Challenge #3 or frame out the car in Challenge #8.

engineering tip

An inclined plane, or ramp, is a simple machine that helps move objects to a different height with less effort. Ask students to prototype different cardboard ramps with Snap and explore how a car rolls up and down.

- Ramps with steeper slopes will make the car roll faster on the way down, but will be harder to push back up.
- Ramps with less steep slopes will make the car roll more slowly on the way down, but will be easier to push back up.

You can also explore the same principles with a Sphero robot, like BOLT+. What is the steepest inclined plane that students can program the robot to roll up before it slips and loses traction?

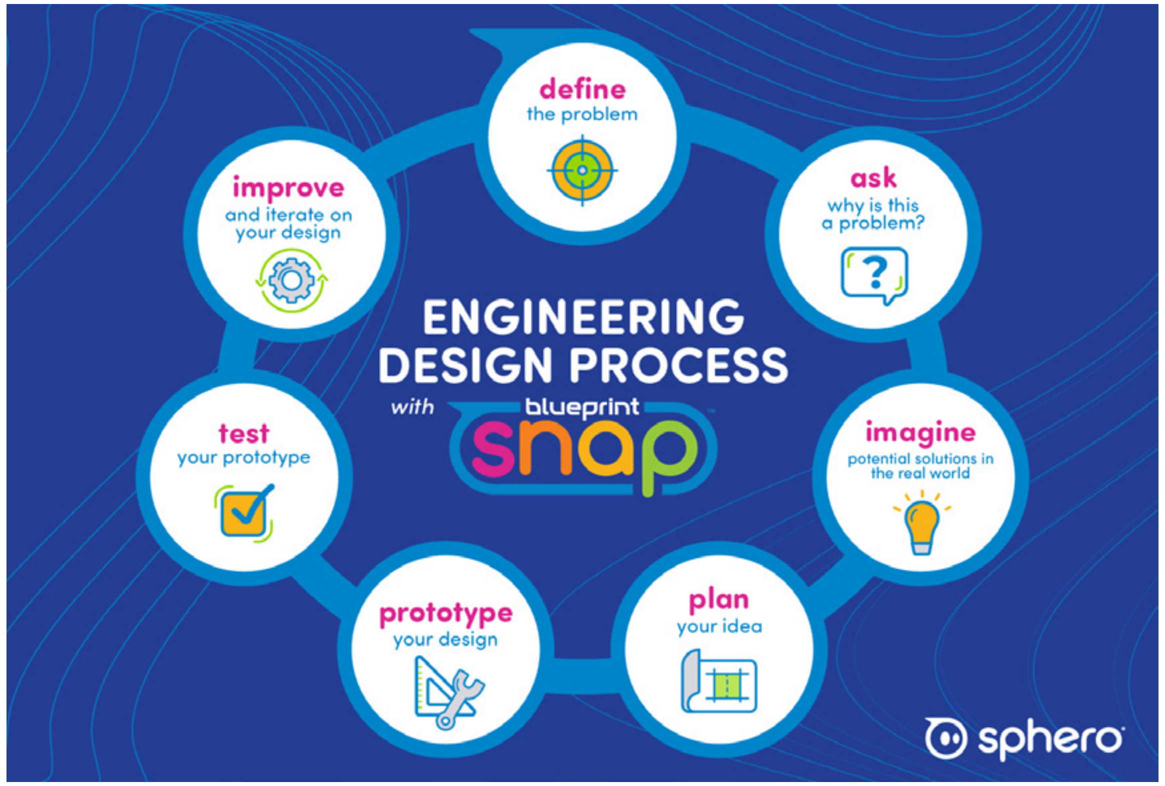
challenges #13-15

Challenges 13-15 are open-ended and do not require a prescribed set of parts or a predetermined final build. Here are a few ideas that might be useful when completing these challenges:

- Encourage students to sketch their ideas before building. This initial planning stage helps them visualize the final structure, consider constraints, and think through the assembly process, mirroring how engineers create blueprints before construction.
- Encourage students to share designs that did not work as expected and discuss how they improved them. This highlights that iteration and problem solving are necessary parts of the engineering design process and a step towards a better solution. This helps students build persistence and authentically models the work of engineers.
- Combine individual builds to promote collaborative learning. If the whole class is working on the same challenge, groups can bring their designs together in a shared space to create, for example, one big park. Consider a "gallery walk" for students to present their work, observe different solutions, and learn from their peers.
- Formally introduce the engineering design process to add structure and deepen the learning. Guiding students through the distinct stages of this process provides a valuable framework for their work and reinforces critical thinking and problem-solving skills.

engineering design process

Each lesson is structured around the Engineering Design Process, and Snap is the tool that brings it to life. Because the components easily click together and pull apart, students are empowered to quickly test ideas and troubleshoot when things don't work. This iterative cycle of building, testing, and refining helps students embrace failure not as an endpoint, but as a crucial part of developing innovative solutions. This process allows them to productively struggle with real-world problems and discover that the best answer is usually not the first answer.

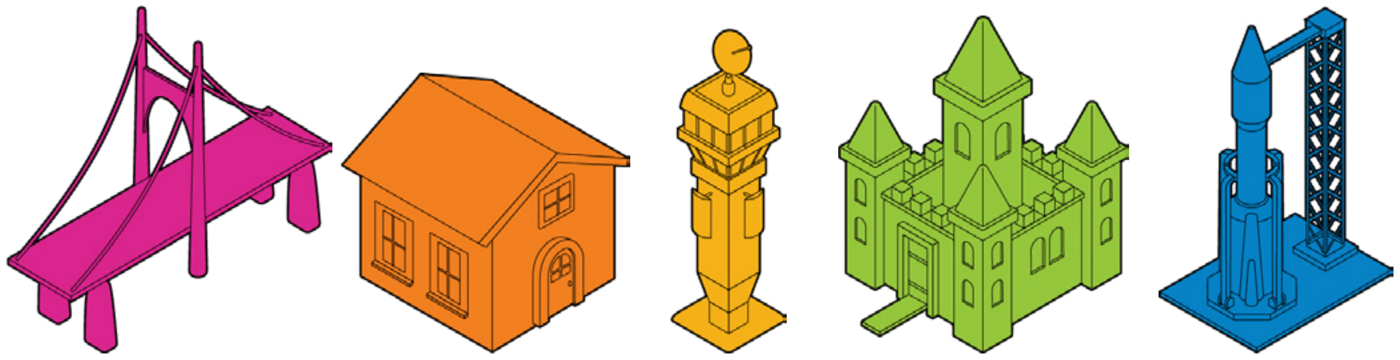


next steps

The challenge cards are great for introducing Snap, but what's next? Head over to Sphero Central to find more Snap lessons:

edu.sphero.com/blueprint-snap

the **Strong Structures** collection is a great place to start!



lesson 1: a bad bridge

lesson 2: welcome home

lesson 3: toppling towers

lesson 4: castle defense

lesson 5: ready, set, launch!

Student Outcomes

Next Generation Science Standards (NGSS)

Blueprint Snap aligns closely to the NGSS 3-5 Engineering Design standards and their Science and Engineering Practices (SEPs).

science and engineering practices:

- Asking Questions and Defining Problems
- Planning and Carrying out Investigations
- Constructing Explanations and Designing Solutions

performance expectations:

- **3-5-ETS1-1**: Define a simple design problem reflecting a need or a want that includes specific criteria for success and constraints on materials, time, or cost
- **3-5-ETS1-2**: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- **3-5-ETS1-3**: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Standards for Technology and Engineering Literacy (STEL)

The International Technology and Engineering Educators Association (ITEEA) established STEL with a focus on transferable skills that set students up for success in STEM fields. Blueprint Snap offers opportunities for students to engage with and work towards mastery of the following STEL standards:

- 7H: Illustrate that there are multiple approaches to design
- 7I: Apply the technology and engineering design process
- 7J: Evaluate designs based on criteria, constraints, and standards
- 7K: Interpret how good design improves the human condition
- 7L: Apply universal principles and elements of design
- 7M: Evaluate the strengths and weaknesses of existing design solutions, including their own solution
- 7N: Practice successful design skills
- 7O: Apply tools, techniques, and materials in a safe manner as part of the design process

Career and Technical Education (CTE)

CTE offers practical training and education for students, setting them up for success when they enter the workforce. While CTE programs typically begin after elementary school, Snap lays the foundation for those programs by offering creative opportunities to develop necessary skills for any profession. Advance CTE has outlined Career Ready Practices that are essential for students from Pre-K onward. Blueprint Snap provides activities specifically designed to help students develop and strengthen these critical skills in the classroom.

CTE career ready practices:*

- Communicate clearly, effectively, and with reason
- Think critically to make sense of problems & persevere in solving them
- Manage time & space effectively
- Demonstrate a creative & innovative mindset
- Apply appropriate academic & technical skills

*More on Career Ready Practices from Advance CTE can be found at careertech.org

FAQs (frequently asked questions)

How do I take care of Snap parts?

Snap parts are durable, but we know classrooms can put even the strongest materials to the test. With that in mind, we recommend the following best practices to help keep your Snap Kit in tip-top shape:

- Create designated workspaces to avoid dropping parts, especially large builds. Lab tables, desks joined together, or even building on the floor, work well in some classroom environments.
- Remind students about the best build practices while taking apart builds. Using the Ring Tool will help prevent damage.
- Routinely check the floor around workspaces so parts are not stepped on or lost.
- When possible, keep small parts like Connectors in the Snap bin or tray until they're needed.
- Always put away parts and secure bins at the end of a lesson.
- If your Snap parts are dirty, use a wipe or towel with an alcohol-based cleaner to make them sparkle again.

How many students does a Blueprint Snap kit support?

We recommend two students per kit.

How can my students document their learning?

The student handouts that come with each lesson are a great place to start. If you'd like to take things further, consider having students keep an engineering notebook during the school year to document their thinking, models, and mistakes. Consider having students record reflection videos as an alternative or complement to pen and paper responses.

If you're unsure how to structure the notebooks or reflection videos, the engineering design process is a great framework to encourage consistent and clear documentation. Below are some prompts for each stage in the engineering design process that can help students get started.

define the problem

- What are you trying to build or create?
- What does your design need to do?
- What makes a design successful?

ask why is this a problem?

- What makes this challenge tricky?
- Why does the problem need a solution?
- What might go wrong with your design?

imagine potential solutions in the real world

- What is a wild idea that might solve your problem?
- Can you sketch three different possible solutions?
- Are there solutions to this problem already out there? What can you learn from them?

plan your idea

- Which solution are you going with?
- Which parts will you need?
- Draw a picture of your design.

prototype your design

- What does your finished prototype look like?
- What was the hardest part to build?
- How is your prototype different from your plan?

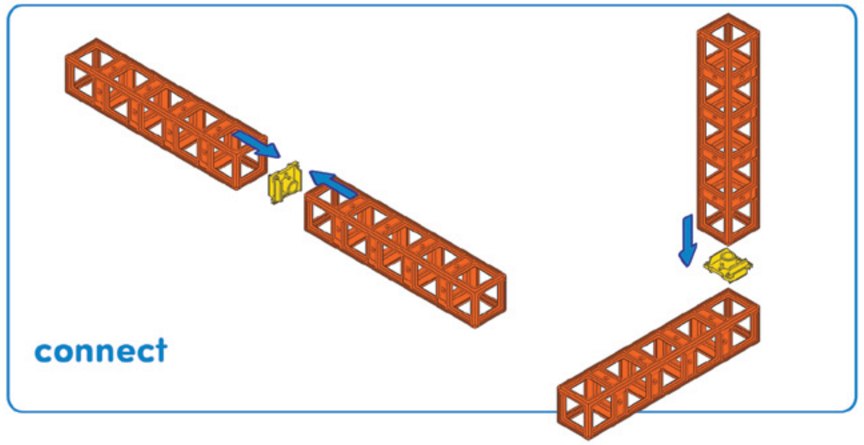
test your prototype

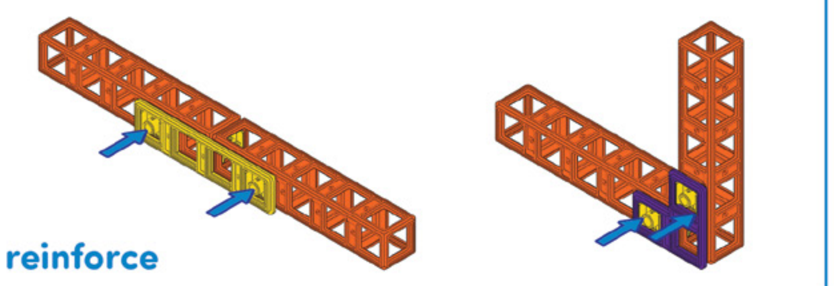
- How will you test your design to see if it works?
- What happened when you tested it?
- Did anything break or fail during your testing?

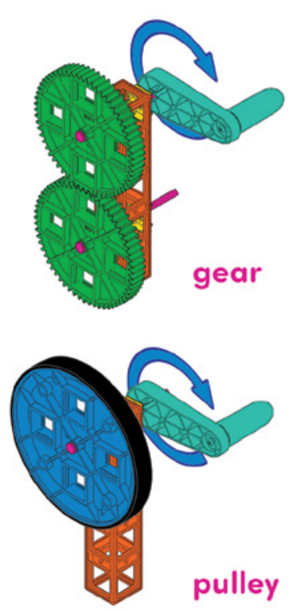
improve and iterate on your design

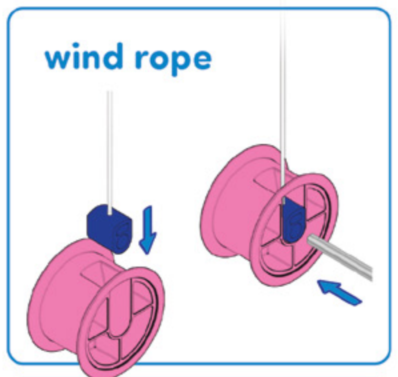
- What is one thing you would change to make it better?
- What did you learn from your testing?
- Draw a picture of your design.

Key Building Practices

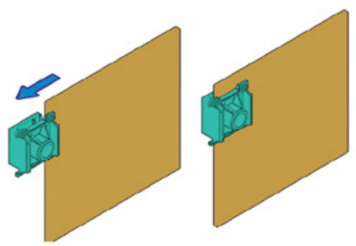

connect

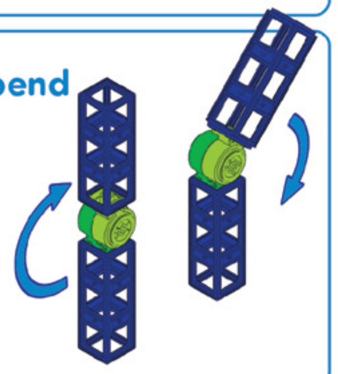

reinforce

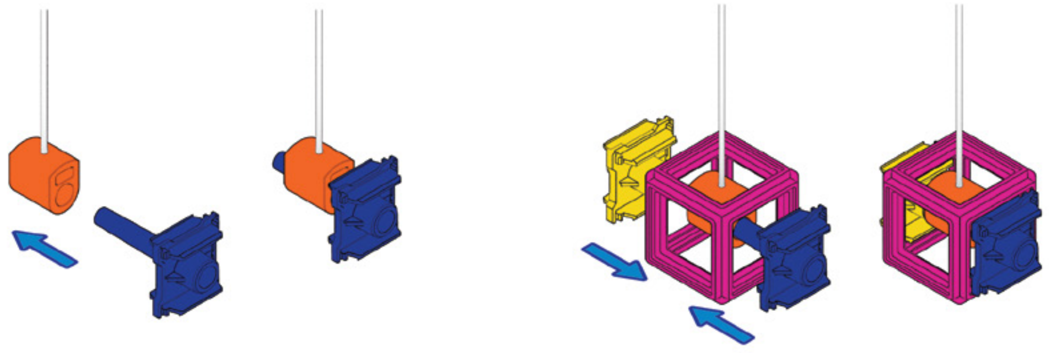
create motion


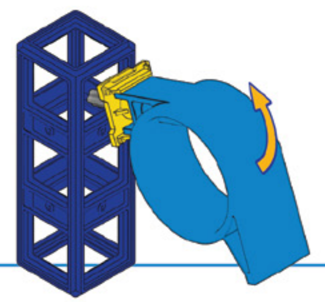
wind rope


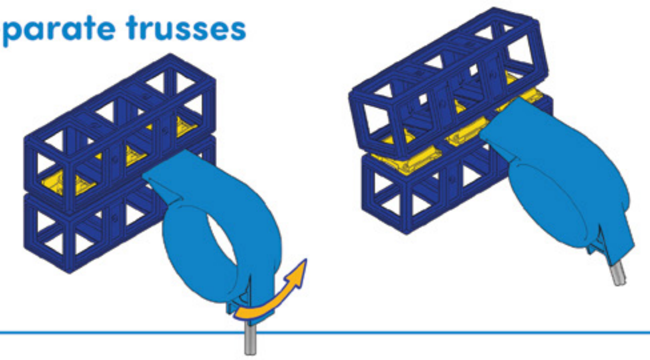
twist

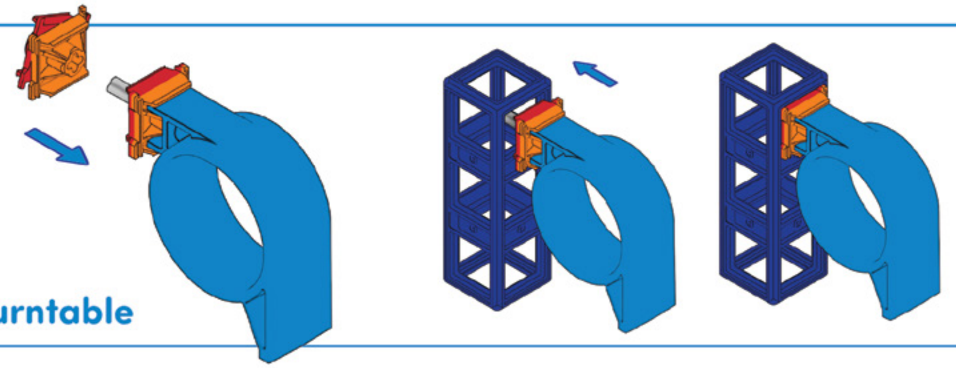

craft


bend


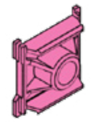
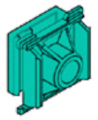
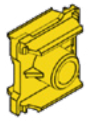
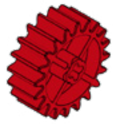
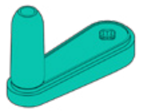
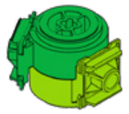
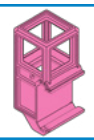
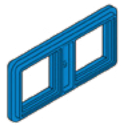

attach rope

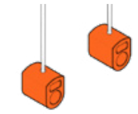
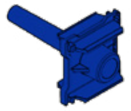
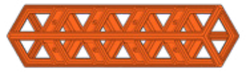
remove connector


separate trusses



attach a turntable

Snap Parts Glossary

	**Bearing Plate**	Bearing Plates click into trusses and other Snap parts. They hold shafts while allowing them to rotate.
	**Capped Shaft**	Plastic-capped shafts fit through Lock Plates, Bearing Plates, and Connectors, allowing things to spin. One side is capped so it won't slide all the way through another Snap part. The other side can be secured with a Shaft Collar. **Varieties**: 2x Pitch Capped Shaft | 3x Pitch Capped Shaft | 4x Pitch Capped Shaft
	**Cardboard Clamp**	Cardboard Clamps snap into trusses and are used to attach cardboard and other craft materials to Snap builds, facilitating the addition of creative elements.
	**Connector**	Connectors click into openings on Snap parts and allow you to connect two parts.
	**Gear**	Snap gears have teeth, or cogs, that mesh with other gears and help make motion. **Varieties**: 20T Gear | 60T Gear
	**Hand Crank**	The Hand Crank allows you to spin a shaft or other Snap part by hand.
	**Hinge**	Hinges click into trusses and other Snap parts to allow connections at angles other than 90° and 180°.
	**Linear Motion Bracket**	Linear Motion Brackets help add sliding motion to Snap builds. The rails fit into the groove on trusses, allowing the part to slide back and forth.
	**Lock Plate**	Lock Plates click into trusses and other Snap parts, stopping them from rotating.
	**Plate**	Plates reinforce connections between trusses and other Snap parts and come in a variety of straight and angled arrangements. They help add strength and stability to builds **Varieties**: 1x2 Plate | 1x4 Plate | 2x2 45° Angle Plate | 2x2 90° Angle Plate | 2x3 Tee Plate
	**Pulley**	Pulleys are wheels with grooved rims that work with ropes to change the direction of force. The large 90mm Pulley can also be converted into a wheel by adding the 100mm Tire. **Varieties**: 30mm Pulley | 45mm Pulley | 90mm Pulley

	**Ring Tool**	The Ring Tool is a multi-purpose tool for inserting Connectors, removing Connectors, and prying trusses apart.
	**Rope**	Rope can be used with the Spool and pulleys to help add movement to your builds. **Varieties**: 0.5m Rope | 1m Rope
	**Rope Anchor**	Rope Anchors secure rope to trusses and other Snap parts by attaching the end of the rope to the anchor.
	Shaft	Metal shafts fit through Lock Plates, Bearing Plates, and Connectors, allowing things to spin. They need to be secured on both sides with Shaft Collars. **Varieties**: 5x Pitch Shaft | 6x Pitch Shaft | 10x Pitch Shaft
	**Shaft Collar**	Shaft Collars attach to shafts and help keep them in place.
	**Spool**	Wind rope around the Spool to pull things in or lower them down. Secure rope to a Spool by sliding the shaft through the end of the rope in the center of the Spool.
	**Tire**	The Tire wraps around the 90mm Pulley to create a wheel with a diameter of 100mm that can be used in cars, trucks, and other vehicles.
	**Truss**	Trusses are the primary structural part in any Snap build and have openings on all six faces for Connectors, Lock Plates, and Bearing Plates. Each pitch, or unit on a truss, is 25mm long. For example, a 3x Pitch Truss is 75mm in length and a 5x Pitch Truss is 125mm in length. **Varieties**: 1x Pitch Truss | 2x Pitch Truss | 3x Pitch Truss | 4x Pitch Truss | 5x Pitch Truss | 10x
	**Turntable**	Turntables combine the Lock Plate and Bearing Plate. They hold shafts and allow one connection to spin while the other remains stationary.
	**Weighted Truss**	Weighted trusses are similar to regular trusses but have additional mass. Each pitch on a weighted truss weighs 25 grams (g). Therefore, the 1x Pitch Weighted Truss weighs 25g, and the 3x Pitch Weighted Truss weighs 75g. **Varieties**: 1x Pitch Weighted Truss | 3x Pitch Weighted Truss

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