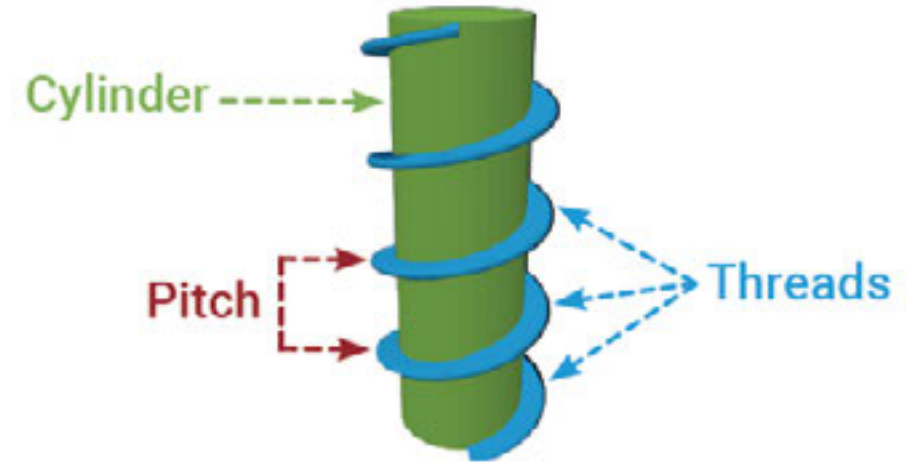


Engineering Discoveries: Screws



The Screw

A screw is an inclined plane wrapped around a **cylinder**. The incline or ridges that wrap around the cylinder are referred to as the **threads**. The distance between the threads is referred to as the **pitch**.



Purposes of the Screw

The screw can be used to push and pull objects, or to hold objects together. This is done by converting rotary motion (circular) into linear motion (in a straight line).

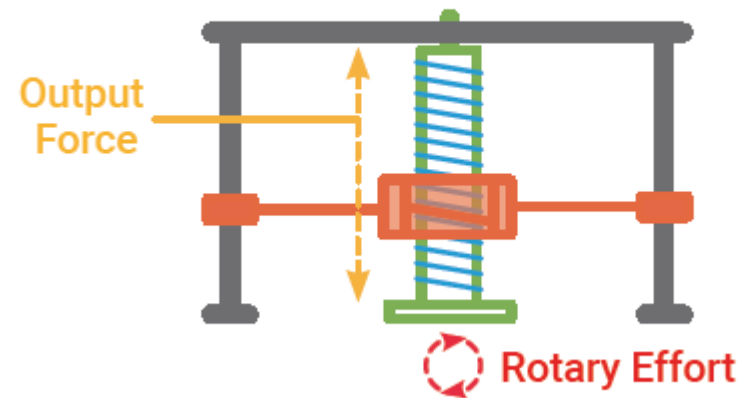
Purposes of the Screw

The screw can be used to push and pull objects, or to hold objects together. This is done by converting rotary motion (circular) into linear motion (in a straight line).

Push or Pull

A screw can be used to push or pull an object. In example 1, when the base of the screw is rotated in one direction, the connected orange box is raised. When the screw is rotated in the other direction, the connected orange box is lowered.

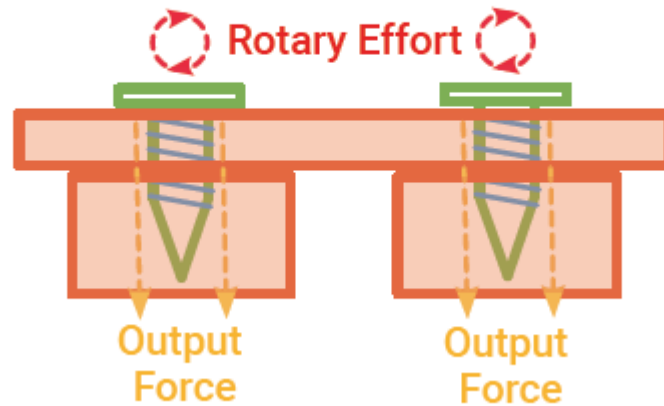
Example 1: Push or Pull



Hold or Fasten

A screw is commonly used to hold or fasten objects together. In example 2, two screws are being used to fasten a large board to two smaller boards. The screws in this example also include a wedged tip, much like a nail. The wedge tip separates the material of the board as the screw is driven inward by the turning threads.

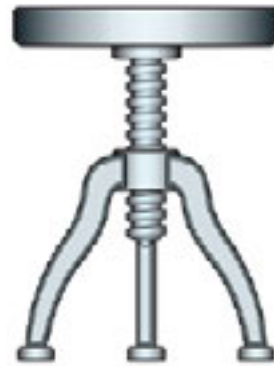
Example 2: Hold



Wood Screw



Adjustable Stool



Bolt and Nut



Scissor Jack



Bench Vise



Drill Bit



Building Basics

Building Basics with Rokenbok

The following tips will be helpful when using the Rokenbok Student Design and Engineering System.

Connecting/Separating ROK Blocks:

ROK Blocks use a friction-fit, pyramid and opening system to connect. Simply press pyramids into openings to connect.

To separate blocks, pull apart.

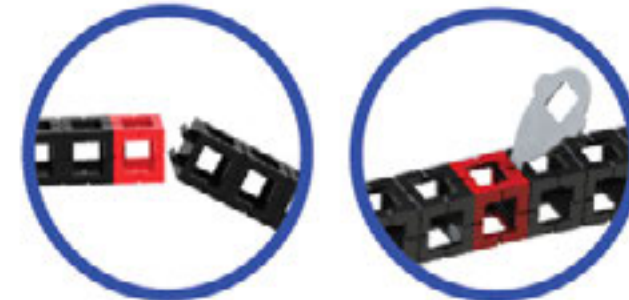


Pyramids or connectors

Connecting/Separating Rokenbok Components

Smaller Rokenbok components use a tab and opening system to connect. Angle one tab into the opening, and then snap into place.

To separate, insert key into the engineered slot and twist.



Snapping Across Openings

The tabs on Rokenbok components can also be snapped across openings to provide structural support to a design. This will also allow certain designs to function correctly.



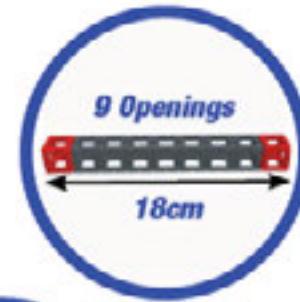
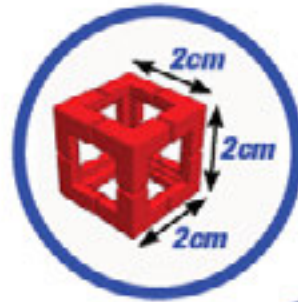
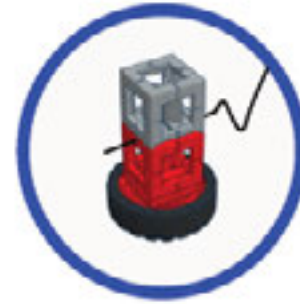
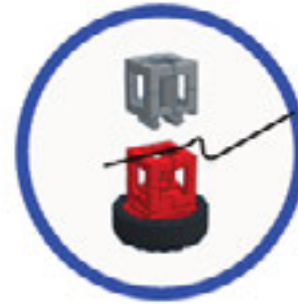
Attaching String:

In some instances, string may be needed in a design. Lay string across opening. Snap any Rokenbok component with tabs or pyramids into opening. Make sure tabs run perpendicular to string for a tight hold.

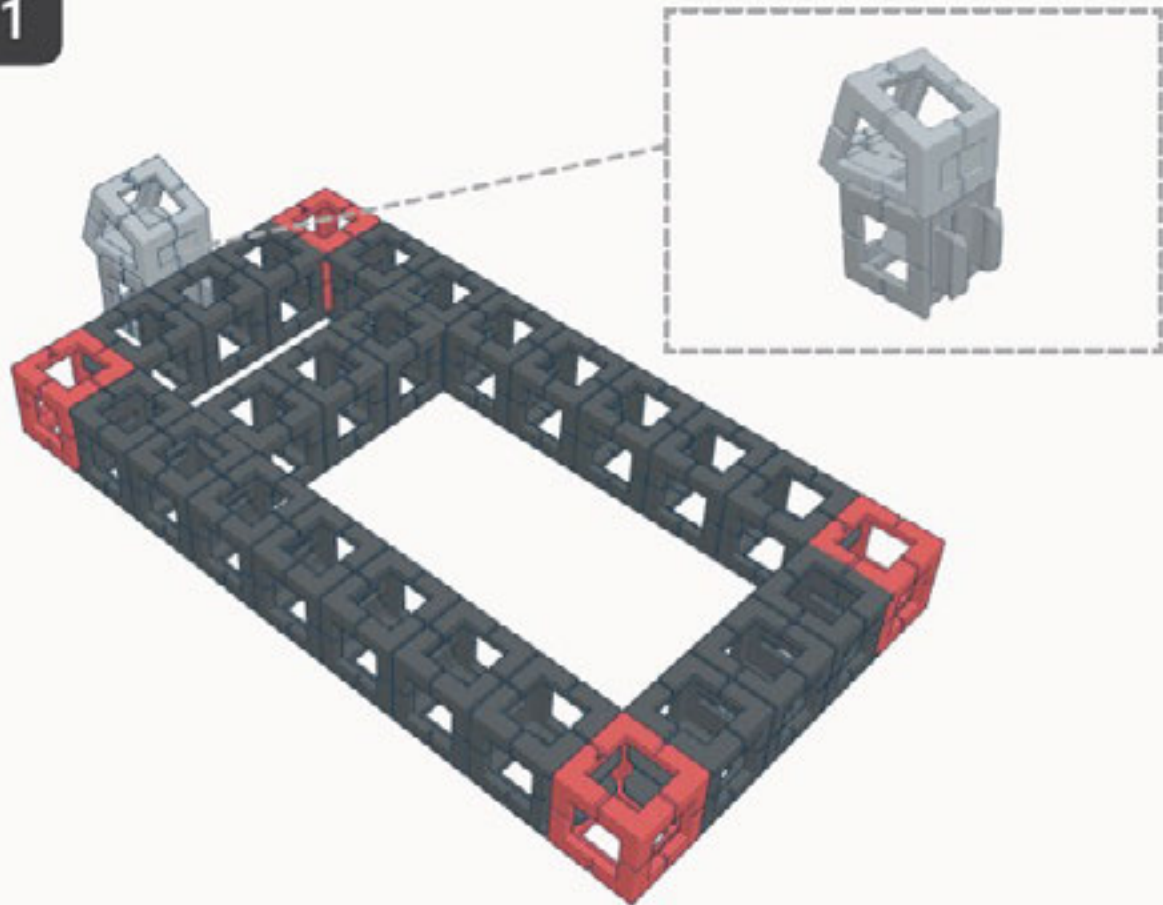
Measuring:

The outside dimensions of each Rokenbok connector block is 2cm^3 . This means the length, depth, and height are all the same.

To determine the size of a Rokenbok build in cm, simply count the number of openings and multiply by two. Repeat this process for length, depth and height.



1



4x
Block



1x
Single Snap Block



1x
60° Block



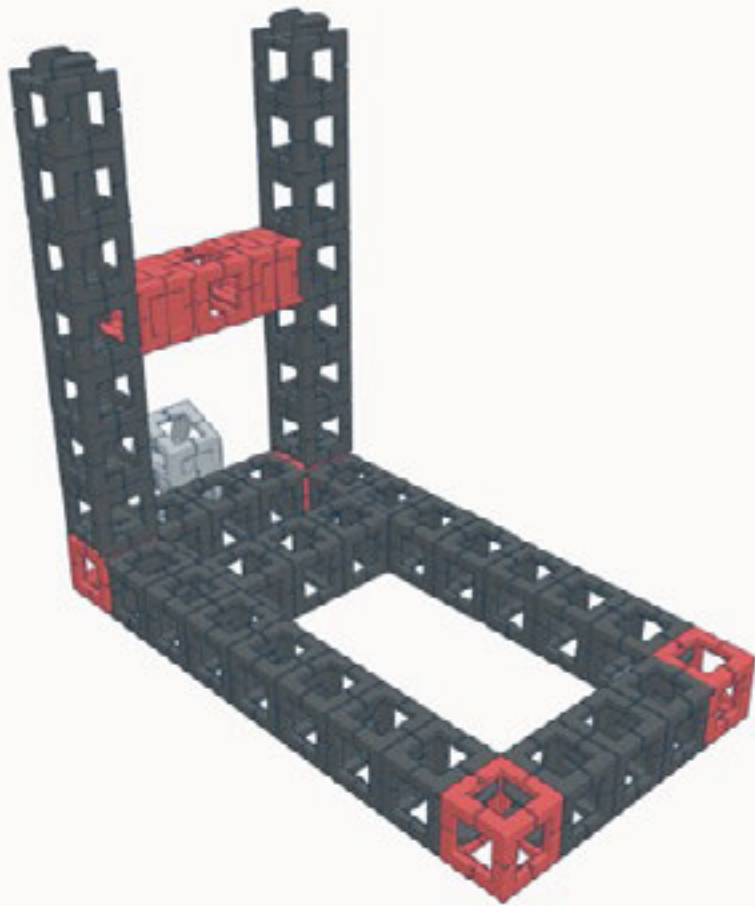
3x
Half Beam



2x
Beam



2



2x
Axle Block



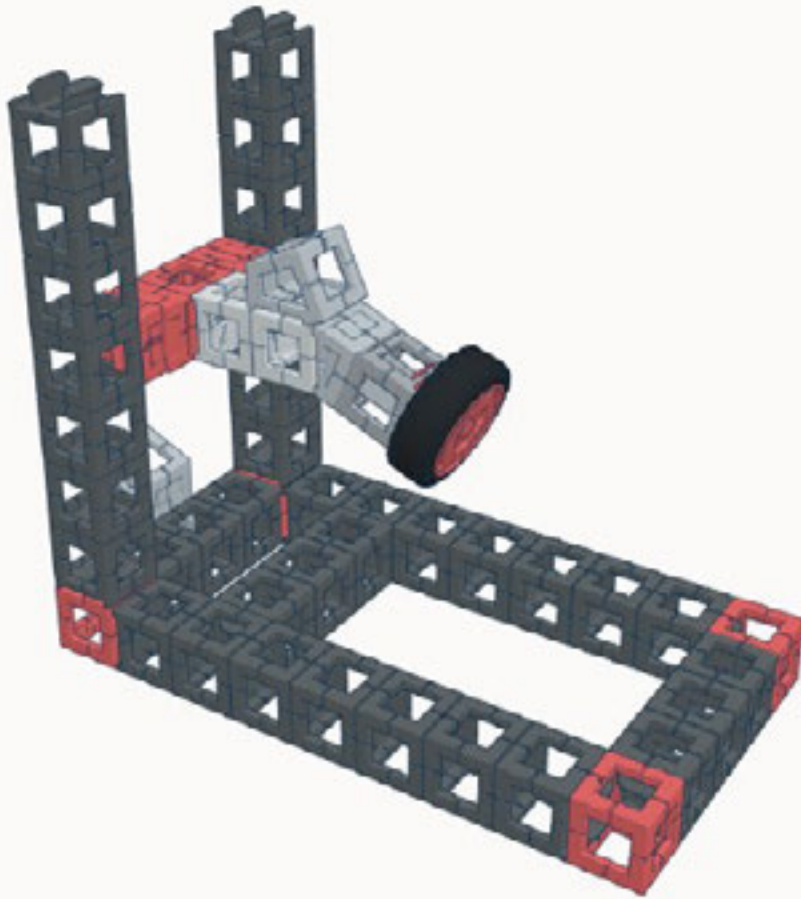
1x
Block



2x
Beam



3



1x
Snap-In Wheel



2x
Single Snap Block



1x
30° Block



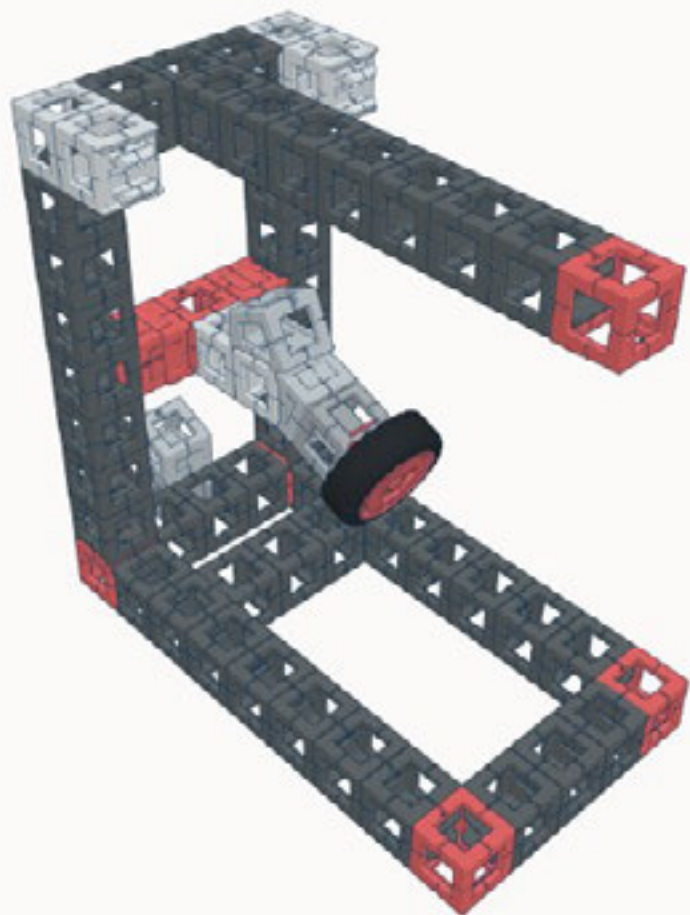
1x
60° Block



2x
Riser



4



1x
Beam



1x
Half Beam



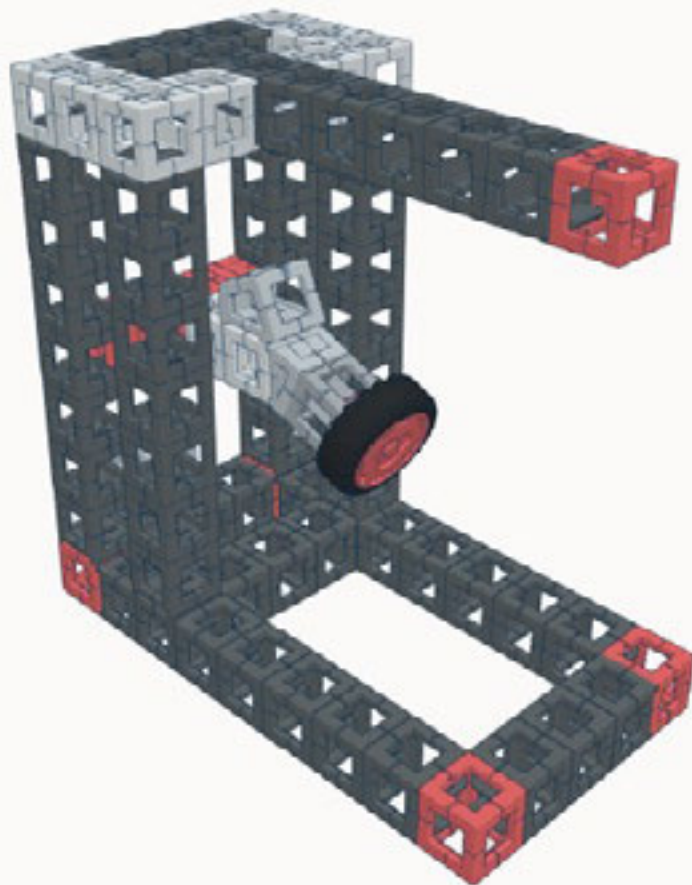
2x
Riser



1x
Block



5



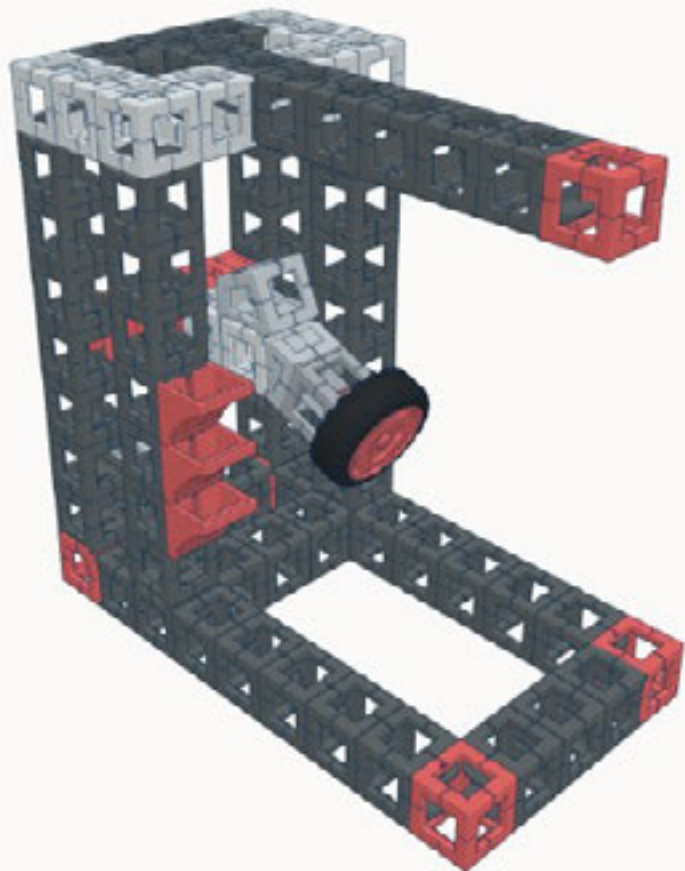
2x
Riser



2x
Beam



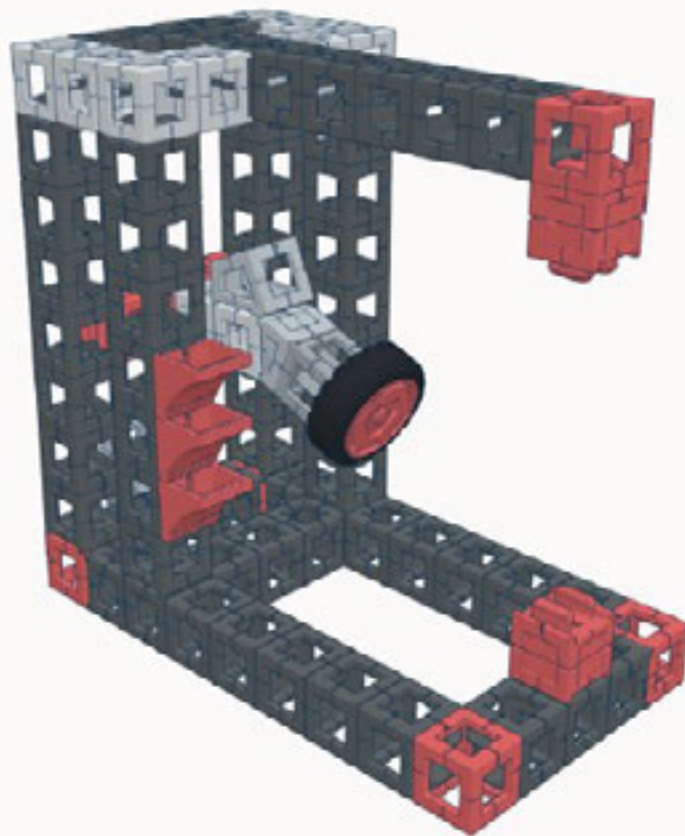
6



3x
Corbel

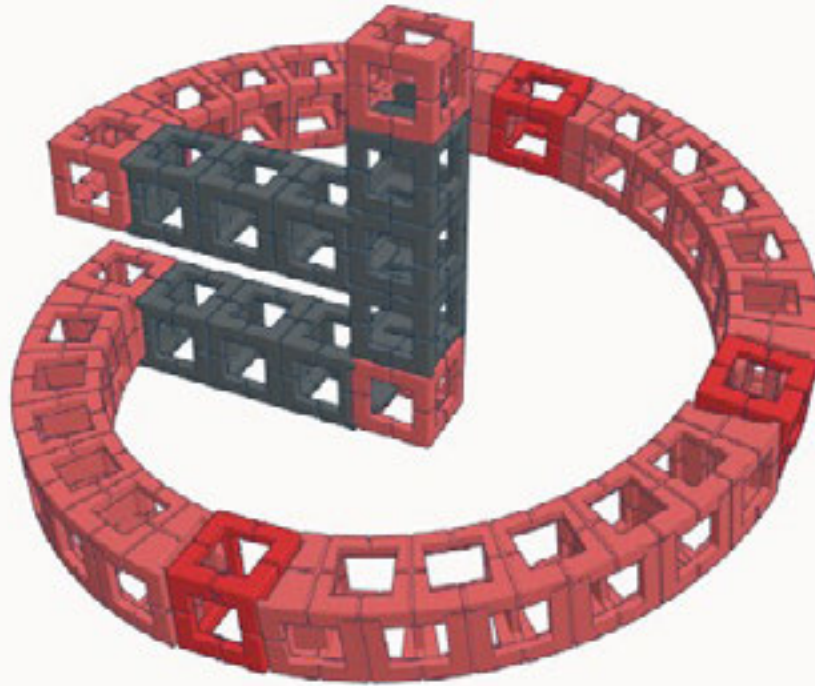


7



2x
Axle Block



**Note:**

Small curved beams will flex as you attach them in the screw configuration.

3x
Half Beam

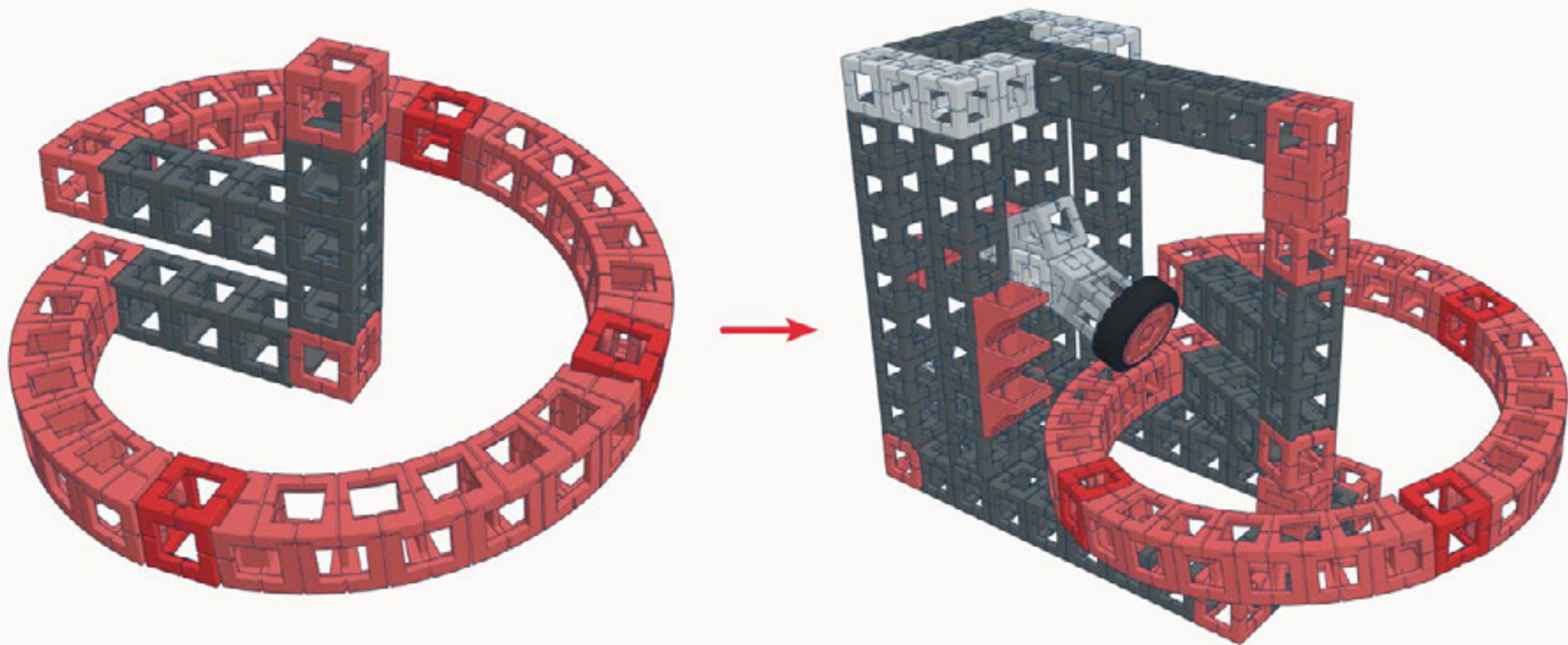


7x
Block

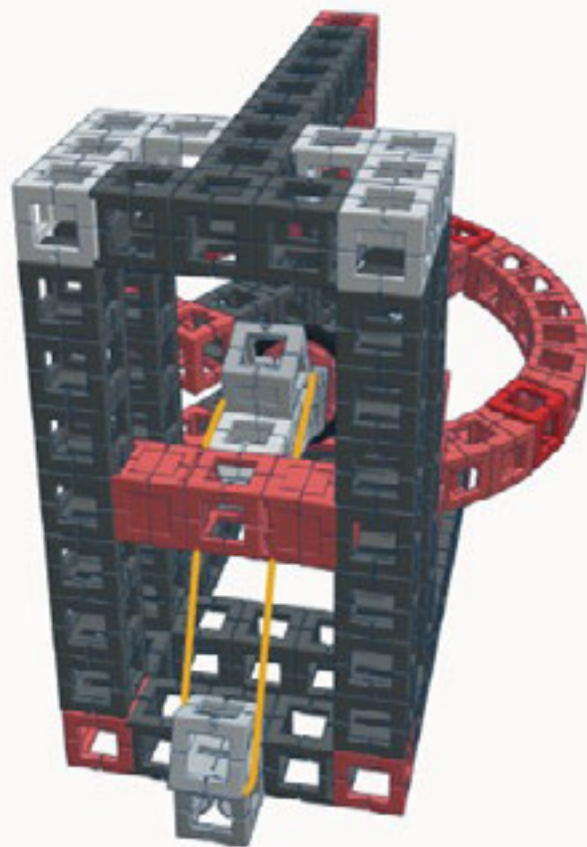


4x
Small Curved Beam





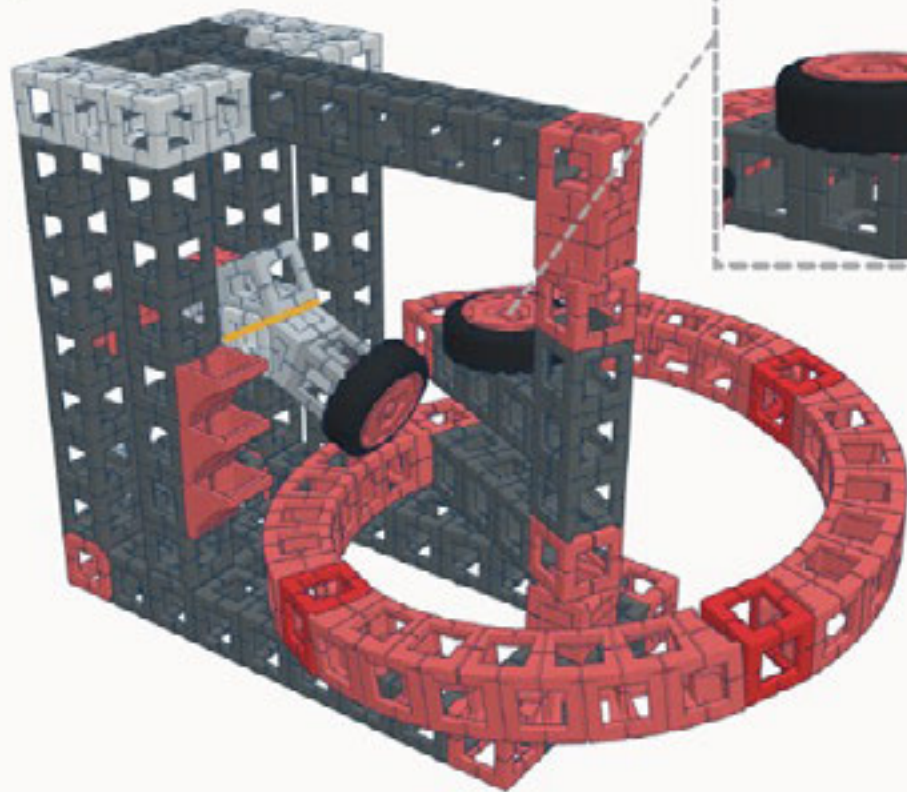
10



1x
Rubber Band



11



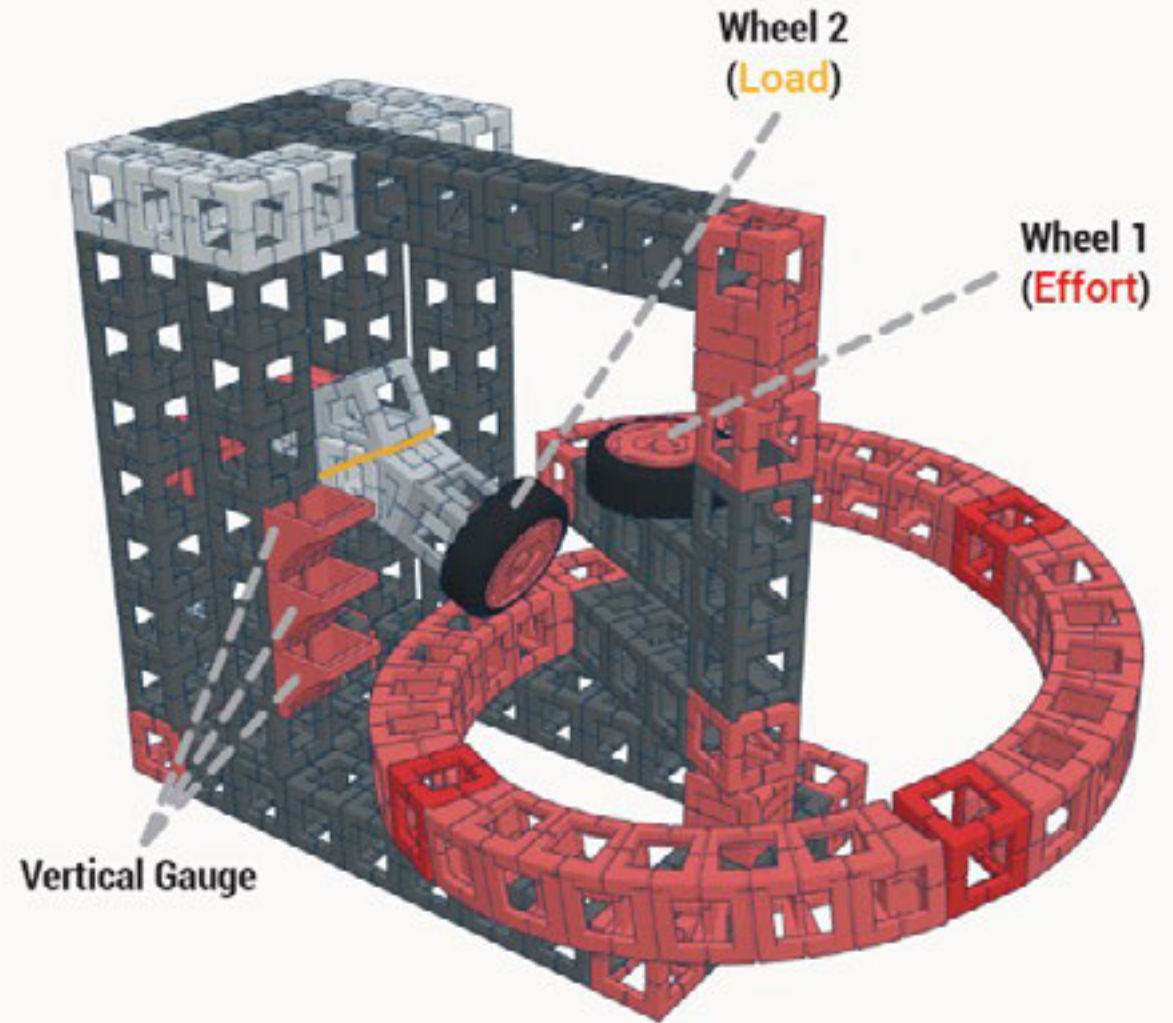
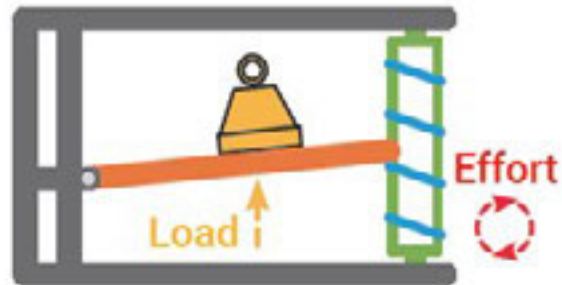
1x
Snap-In Wheel



Testing the Screw

Grab **Wheel 1 (Effort)** and rotate the screw clockwise. Observe how **Wheel 2 (Load)** rolls up the incline of the screw, and the tension from the rubber band becomes greater as the screw is rotated. Notice how **Wheel 2 (Load)** starts at the lowest point on the **Vertical Gauge** and is raised to the top point as the screw completes one rotation.

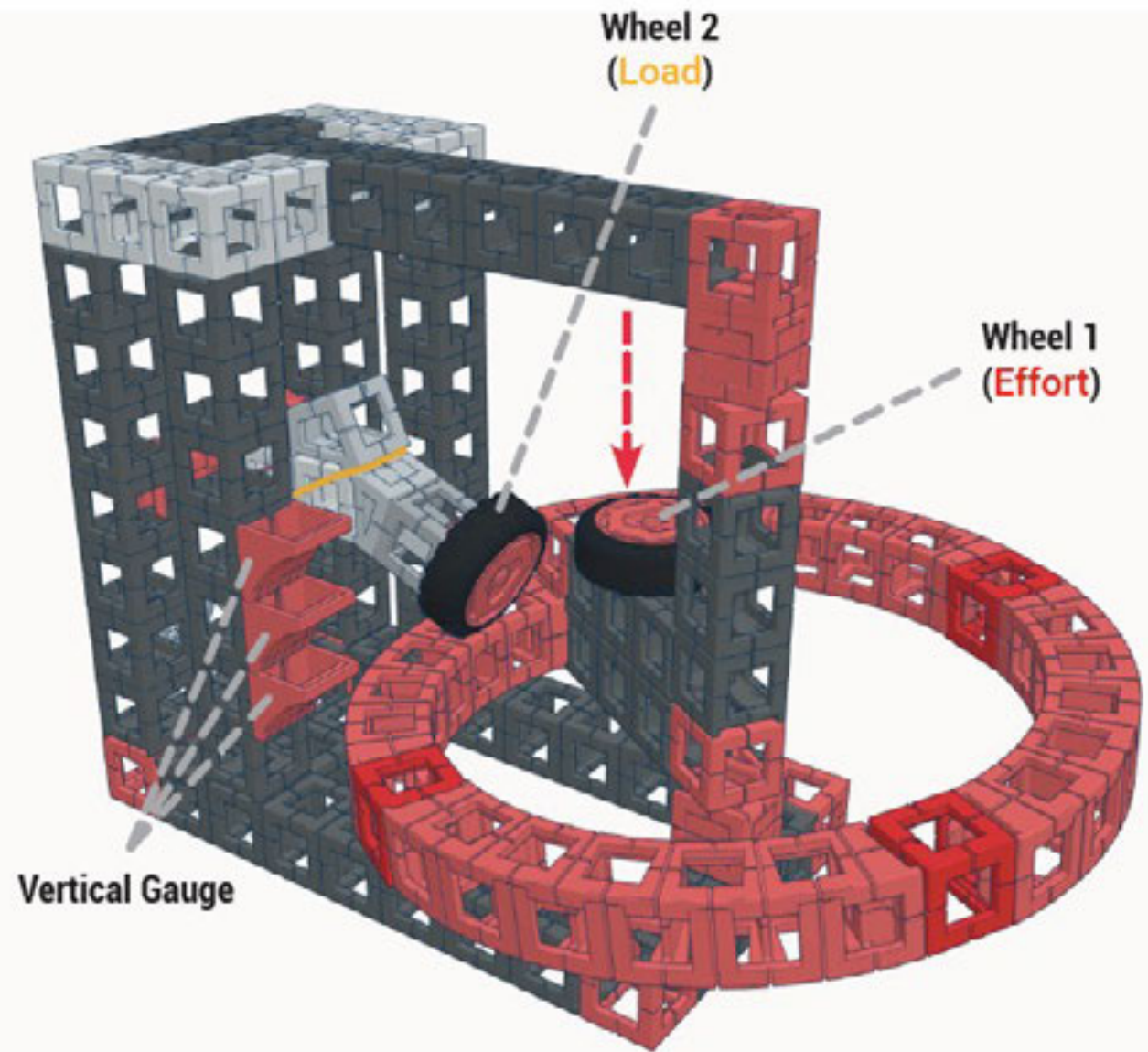
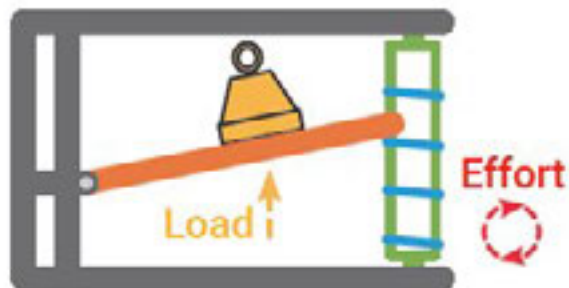
Screw: Raising Load



Modifying the Screw

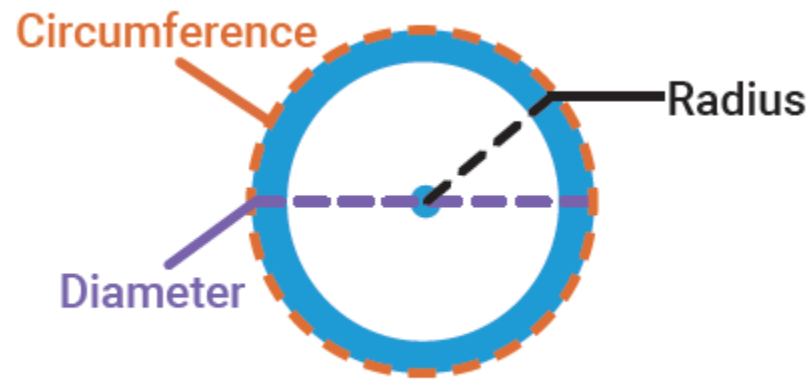
Adjust the pitch of the screw by lowering the top of the incline one block as shown in the figure to the right. Grab **Wheel 1 (Effort)** and rotate the screw clockwise. Observe how **Wheel 2 (Load)** rolls up the incline of the screw, and the tension from the rubber band increases more slowly as compared to the previous model. Notice how **Wheel 2 (Load)** starts at the lowest point on the **Vertical Gauge** and is raised to the middle point as the screw completes one rotation. By lowering the incline, **Wheel 2 (Load)** isn't able to rise to the same height as the previous model, but the amount of effort needed to raise the load has been reduced. There is a noticeable difference in the amount of resistance when rotating the two screws.

Screw: Raising Load



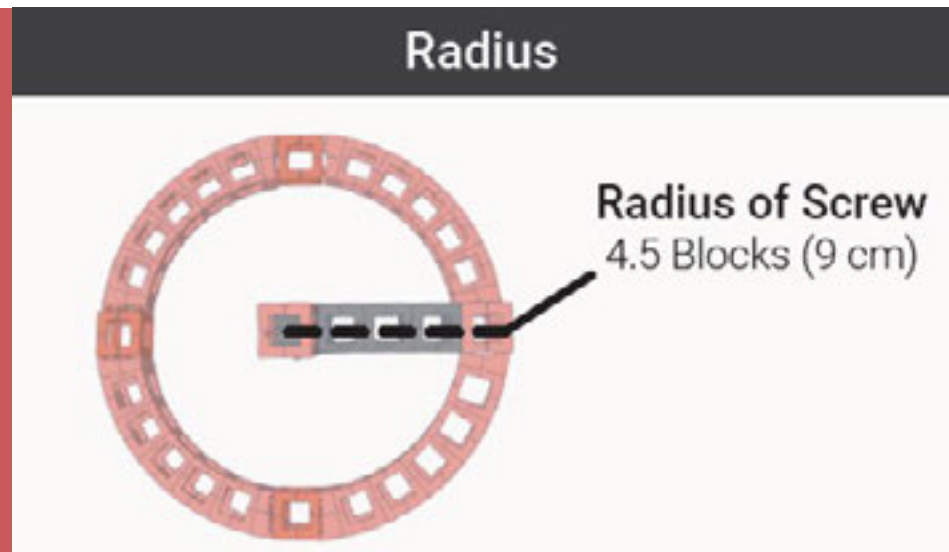
Attributes of a Circle

To have a better understanding of how a screw creates mechanical advantage, it is important to be familiar with the different attributes of a circle. This includes the **radius**, **diameter**, and **circumference**. These attributes will be used to calculate the amount of mechanical advantage that exists within the Rokenbok screw models.



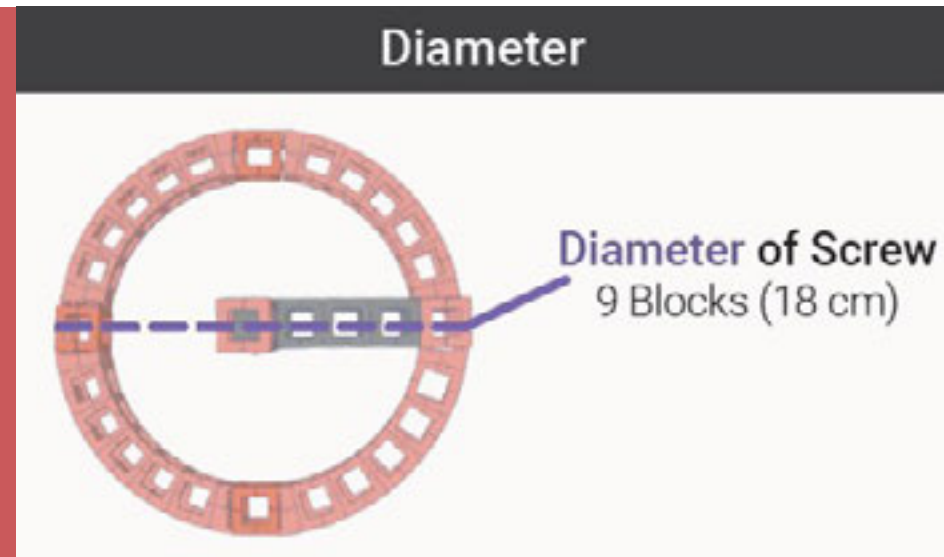
Radius

The **radius** is the distance from the center of a circle to the outside edge. In the Rokenbok model, the **radius** of the screw is 4.5 blocks (9 cm).



Diameter

The **diameter** is the distance through the center of a circle from one side to another. In the Rokenbok model, the **diameter** of the screw is 9 blocks (18 cm). The **diameter** of any circle is always twice the distance of the **radius**.



Circumference

The **circumference** is the distance around the circle. For any circle, dividing its **circumference** by its **diameter** will give the exact same number of 3.141592... The greek letter **Pi (π)** is used to represent this value. Pi is an irrational number, meaning it is a real number that cannot be expressed as a ratio of integers, i.e. as a fraction. Irrational numbers, when written as decimals do not terminate, nor do they repeat. To simplify calculations, Pi is represented as **$\pi=3.14$** .

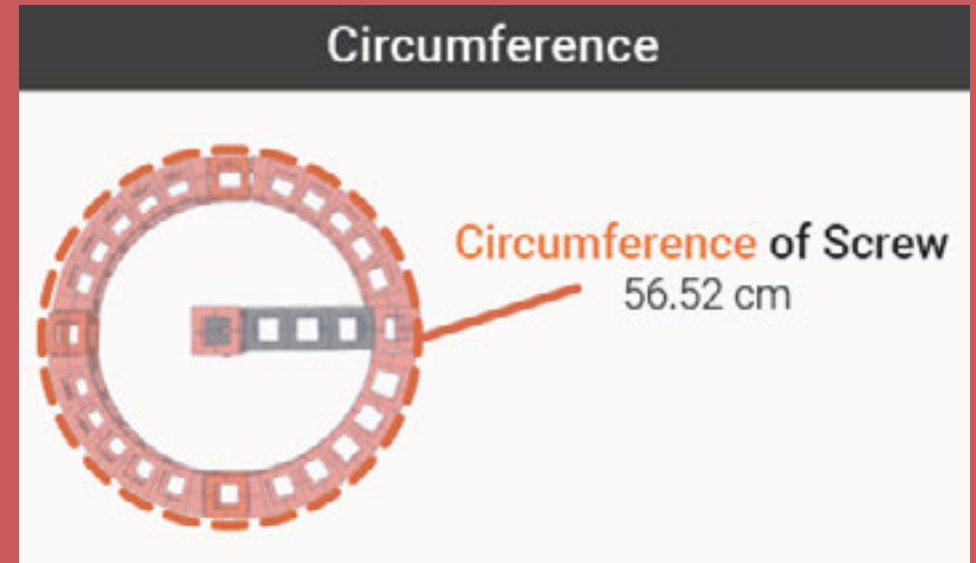
To calculate the **circumference** in a circle, the constant pi (π) is used in the following formula:

Circumference Formula

$$C = 2 \pi r$$

$r = \text{radius}$

In the Rokenbok model, the **radius** of the screw is 9 cm. To determine the **circumference**, multiply ($2 \times 3.14 \times 9 \text{ cm}$) to get 56.52 cm. This means the **circumference** of the screw is 56.52 cm.



Calculating Mechanical Advantage

The screw reduces the amount of effort needed to push, pull, or hold objects by creating mechanical advantage. The amount of effort needed to rotate a screw is reduced as the pitch of the screw is reduced. The following formula can be used to calculate the mechanical advantage in a screw:

Formula

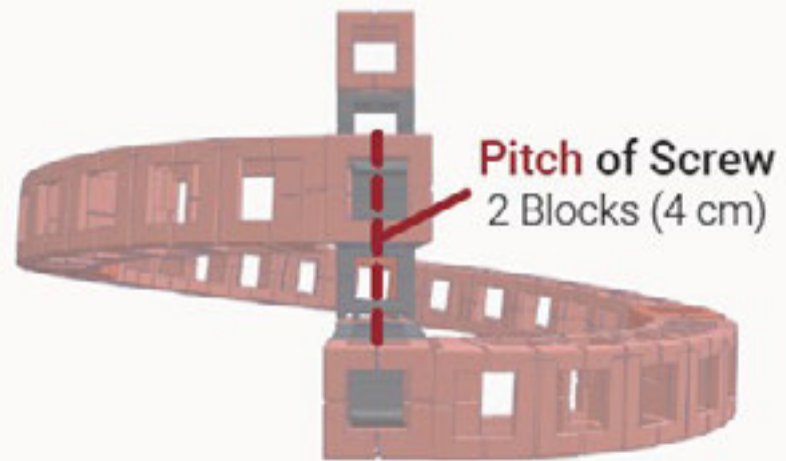
$$\text{Mechanical Advantage} = \frac{\text{Circumference of Screw}}{\text{Pitch of Screw}}$$

Understanding The Screw Model

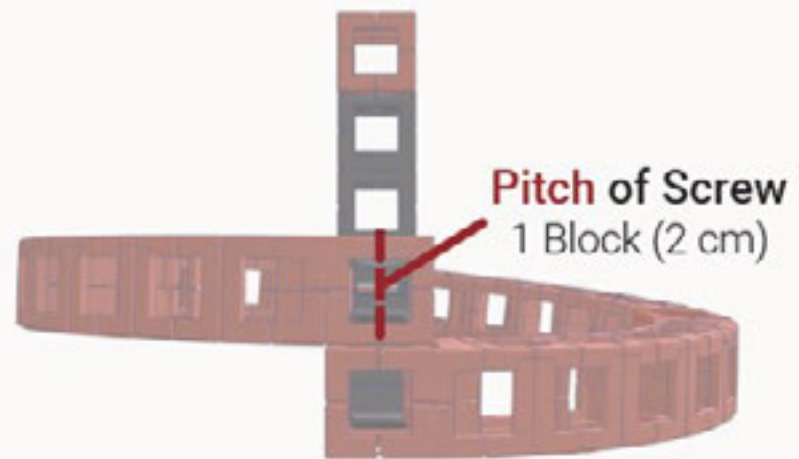
The Rokenbok model that was built demonstrates how a screw can be used to reduce the amount of effort needed to raise an object. In the first screw that was built (Example 1), the **circumference** of the screw was 56.52 cm, and the **pitch** of the screw was 4 cm. Divide 56.52/4 and this will give a mechanical advantage of 14.13:1. This means as the screw is rotated, **Wheel 2 (Load)** will rise 1 unit of measurement for every 14.13 units of measurement it travels along the thread of the screw.

In the modified screw(Example 2), the **circumference** remained 56.52 cm, but the **pitch** was lowered to 2 cm. Divide 56.52/2 and this will give a mechanical advantage of 28.26:1. This means as the screw is rotated, **Wheel 2 (Load)** will rise 1 unit of measurement for every 28.26 units of measurement it travels along the thread of the screw. By lowering the incline, **Wheel 2 (Load)** isn't able to rise to the same height as the previous model, but the amount of effort needed to raise the load has been reduced. There is a noticeable difference in the amount of resistance when rotating the two screws.

Example 1: Screw



Example 2: Modified Screw



Nails vs. Screws

The most common use of the screw is to hold or fasten objects together. Unlike the nail, a screw has threads around the shaft. It is harder to drive a screw into a piece of wood because the ridges on the screw create a lot of friction and resistance. This results in a much tighter and stronger hold as compared to the nail.

To drive a screw into a piece of wood, an effort force is applied to a screw by turning a screwdriver. That force is then transmitted down the thread to the tip of the screw. The movement of the screw tip into the wood is the resistance force. Each complete turn of the screwdriver produces a movement of only one thread of the screw tip into the wood.



Nail



Screw



Extension Activity

Design Brief: Scenario

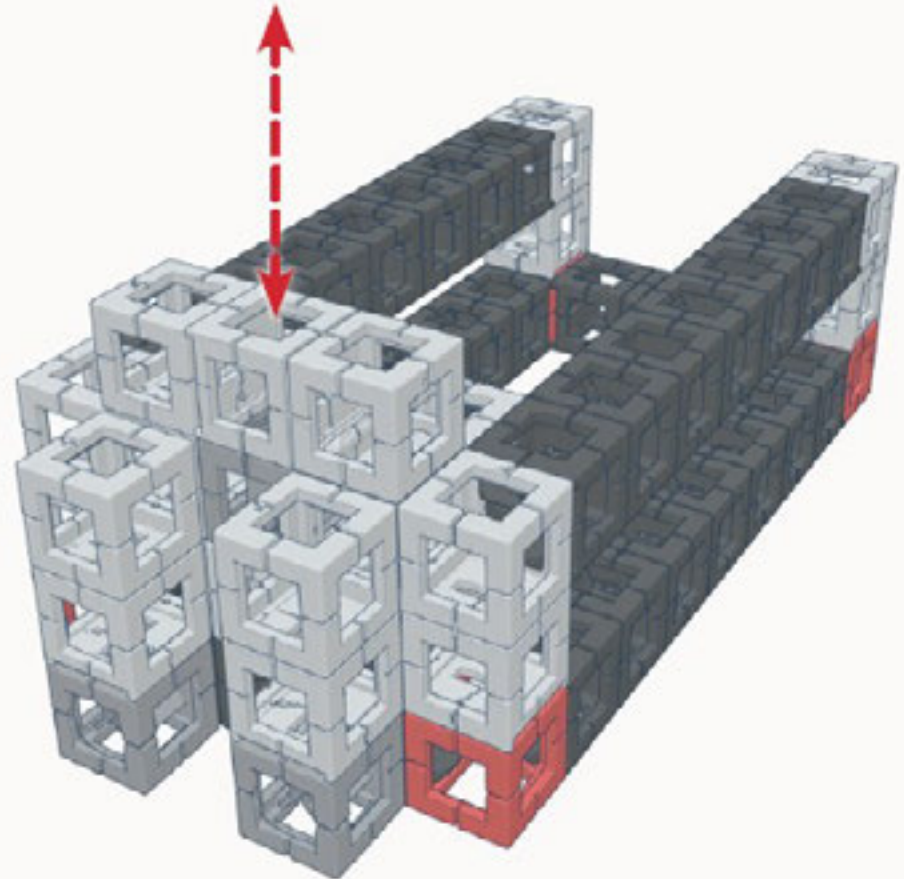
There is a lake just outside of ROK City that overflows frequently due to the high amount of rainfall. City workers are required to open a sluice gate to redirect some of the excess water when the lake begins to overflow. A sluice gate is a sliding gate for controlling the flow of water, especially in a lock, dam, or reservoir. The sluice gate can be dangerous and difficult to open due to high water pressure. The city is looking for ways to make this process safe and easy for its workers.

Design & Engineering Challenge

Your challenge is to design and engineer a custom lift that can raise and lower the sluice gate.

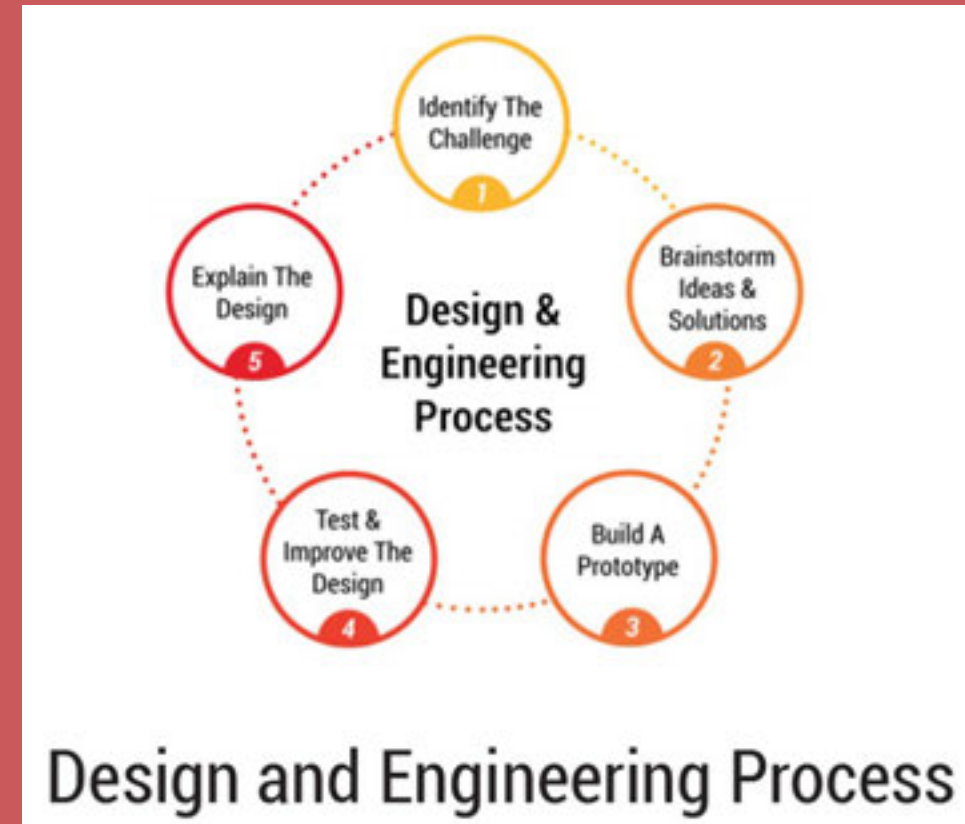
***Instructions to build the sluice gate are on page 11.**

Sluice Gate

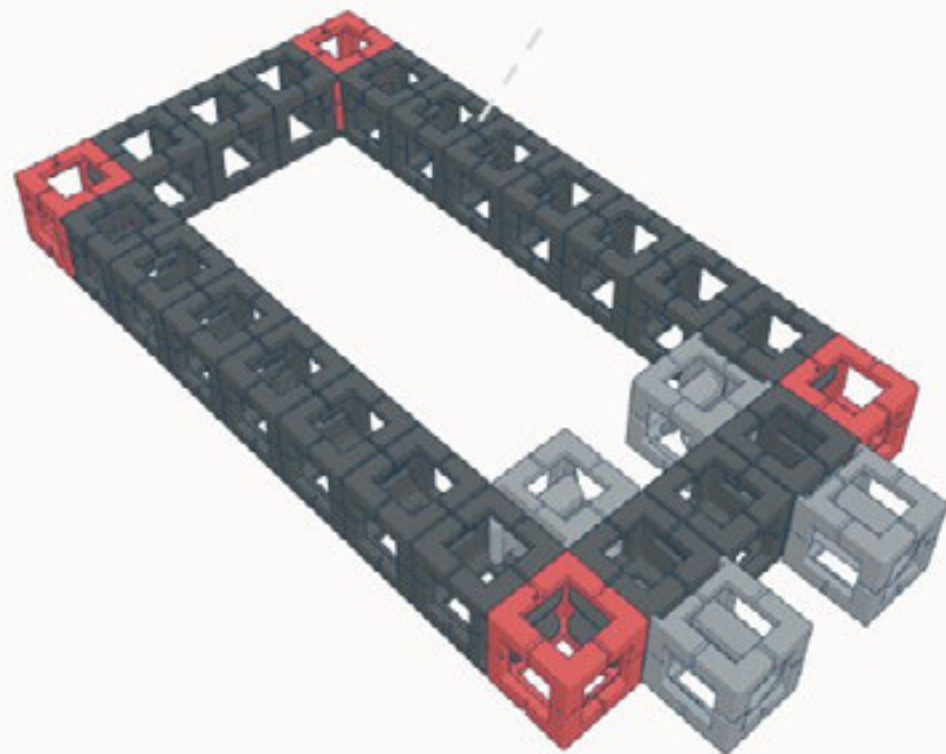


Specifications

- Students will work in teams to complete this challenge
- Teams must work through each step of the design & engineering process to design, prototype, and refine a custom inclined plane.
- With each building component costing \$2, the lift must cost less than \$180. Components that are used to build the sluice gate do not count towards the budget.



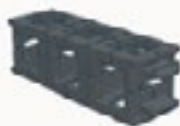
1



4x
Block



2x
Half Beam



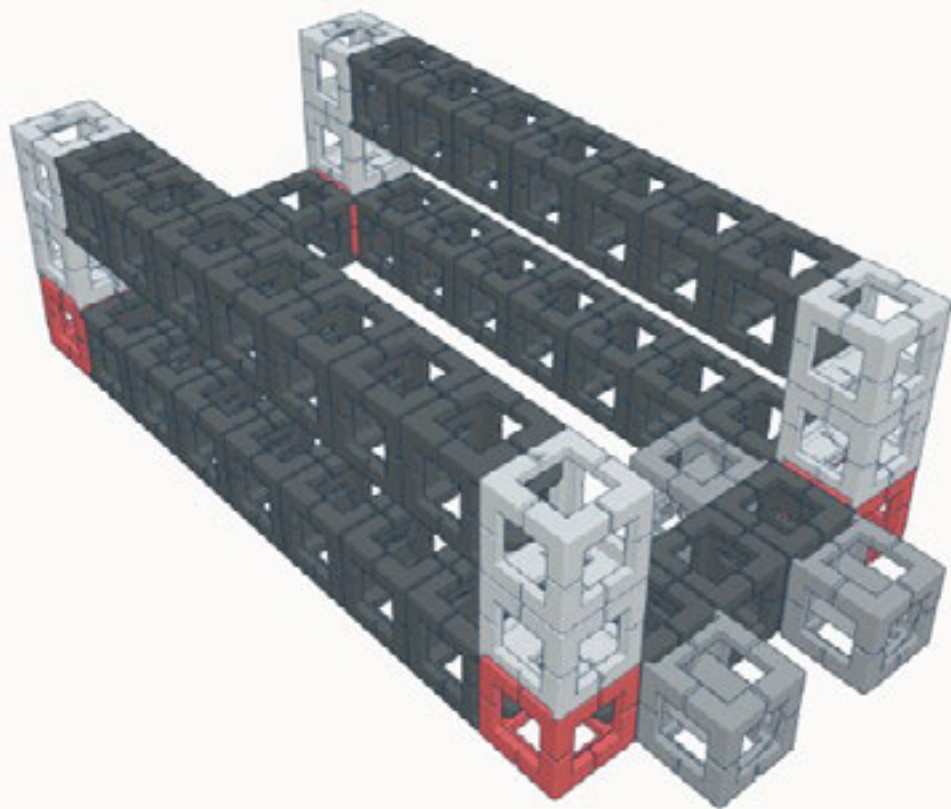
2x
Beam



4x
Single Snap Block



2



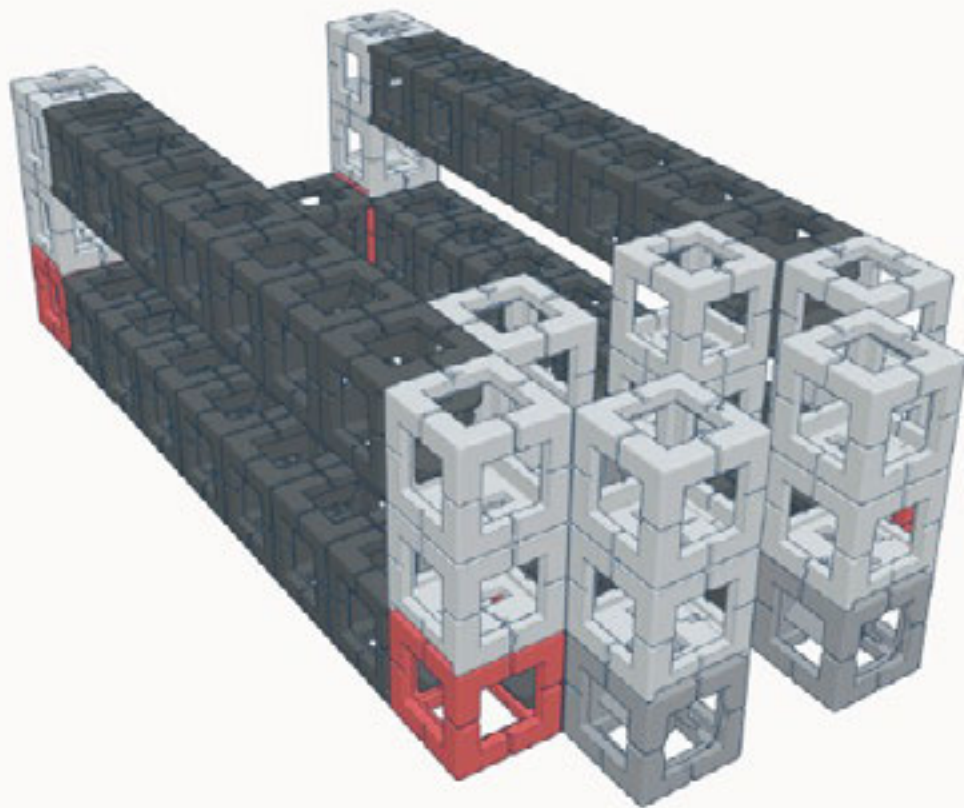
2x
Beam



4x
Riser



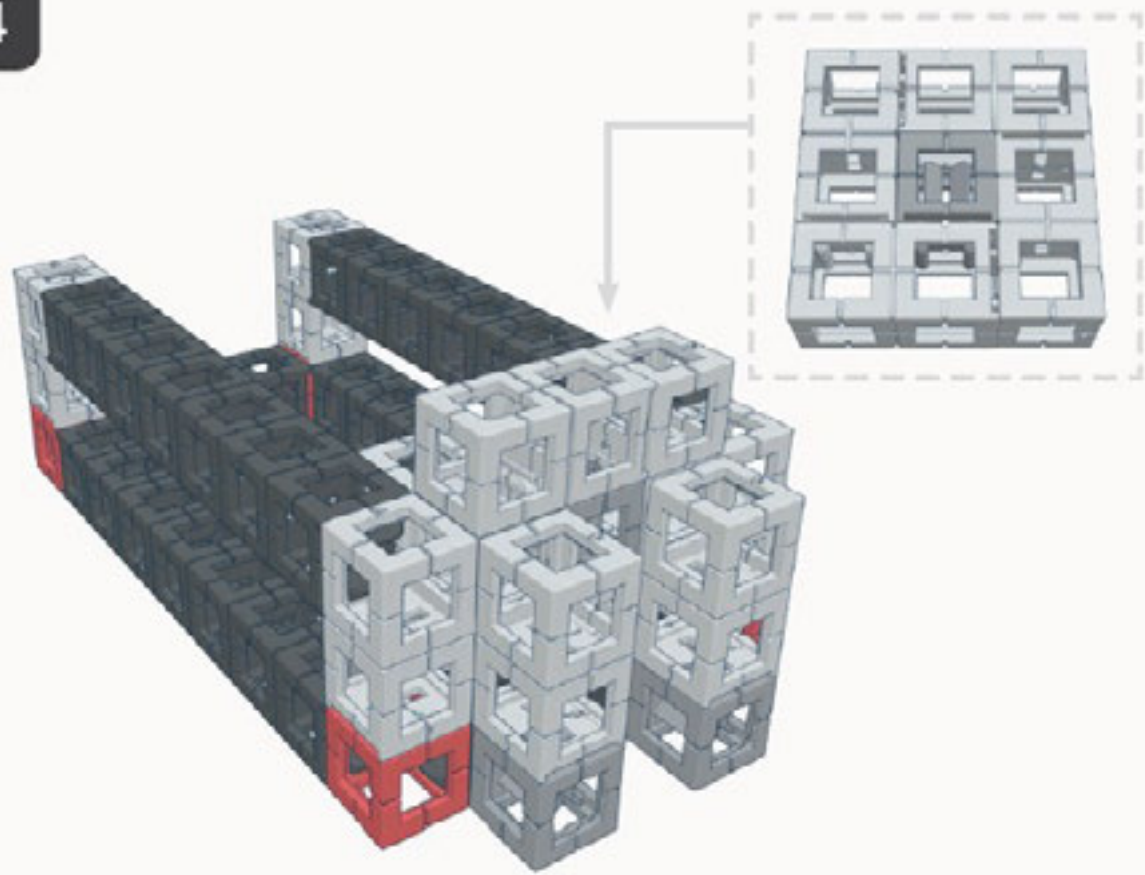
3



4x
Riser



4



4x
Riser

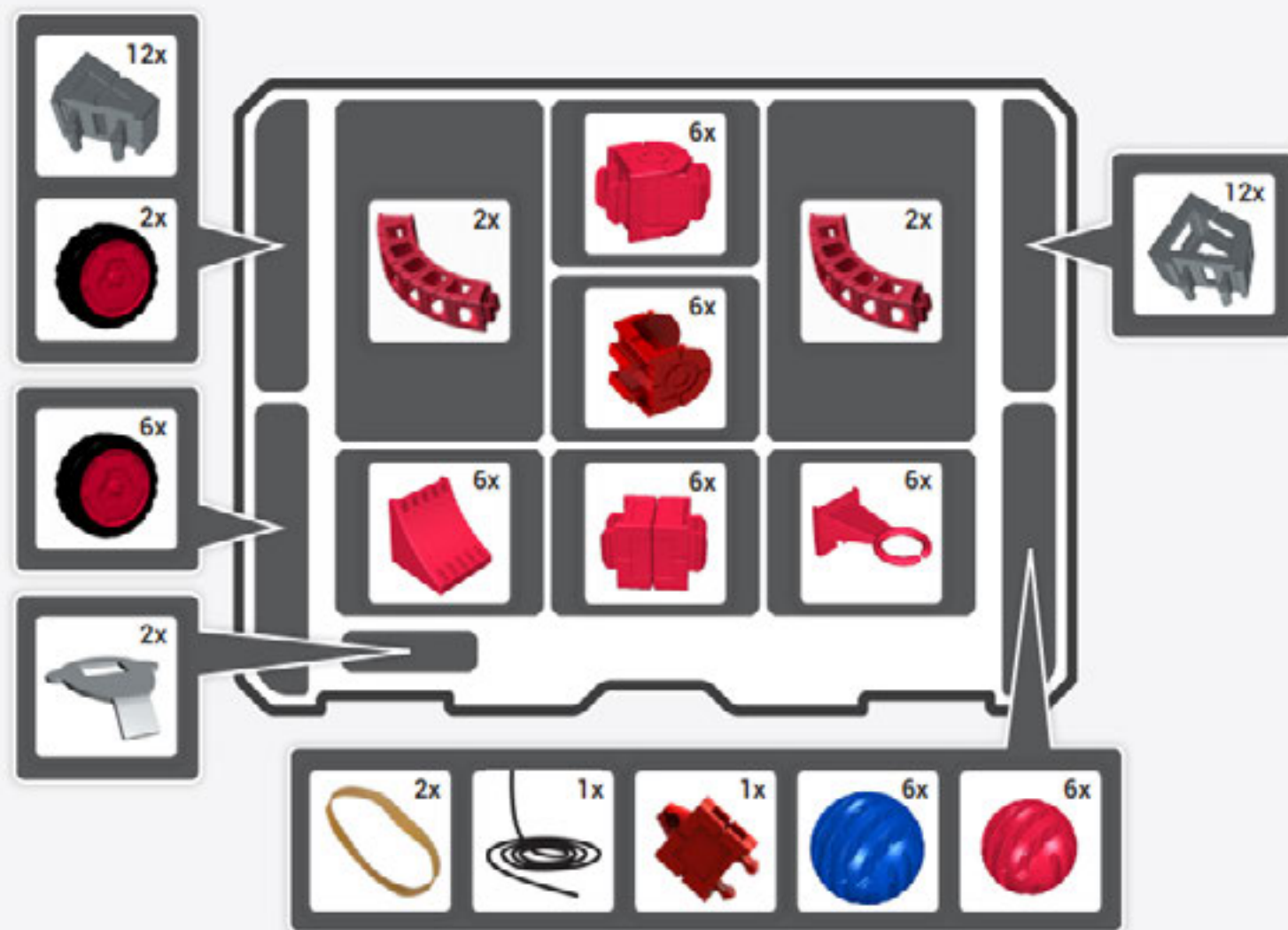


1x
Single Snap Block



Clean Up

**BOTTOM OF
MODULE**



REMOVABLE
BINS

