Engineering Discoveries:

Wedge

The Wedge

A wedge is an inclined plane that moves. A wedge may be a **Single wedge** (one slope) or a **Double Wedge** (two slopes). A single wedge is similar to a right angle triangle and is defined by its **slope** and **rise**, relative to the base which is perpendicular to the rise. A double wedge is similar to an isosceles triangle and is defined by its **slope** and **thickness**.

Single Wedge

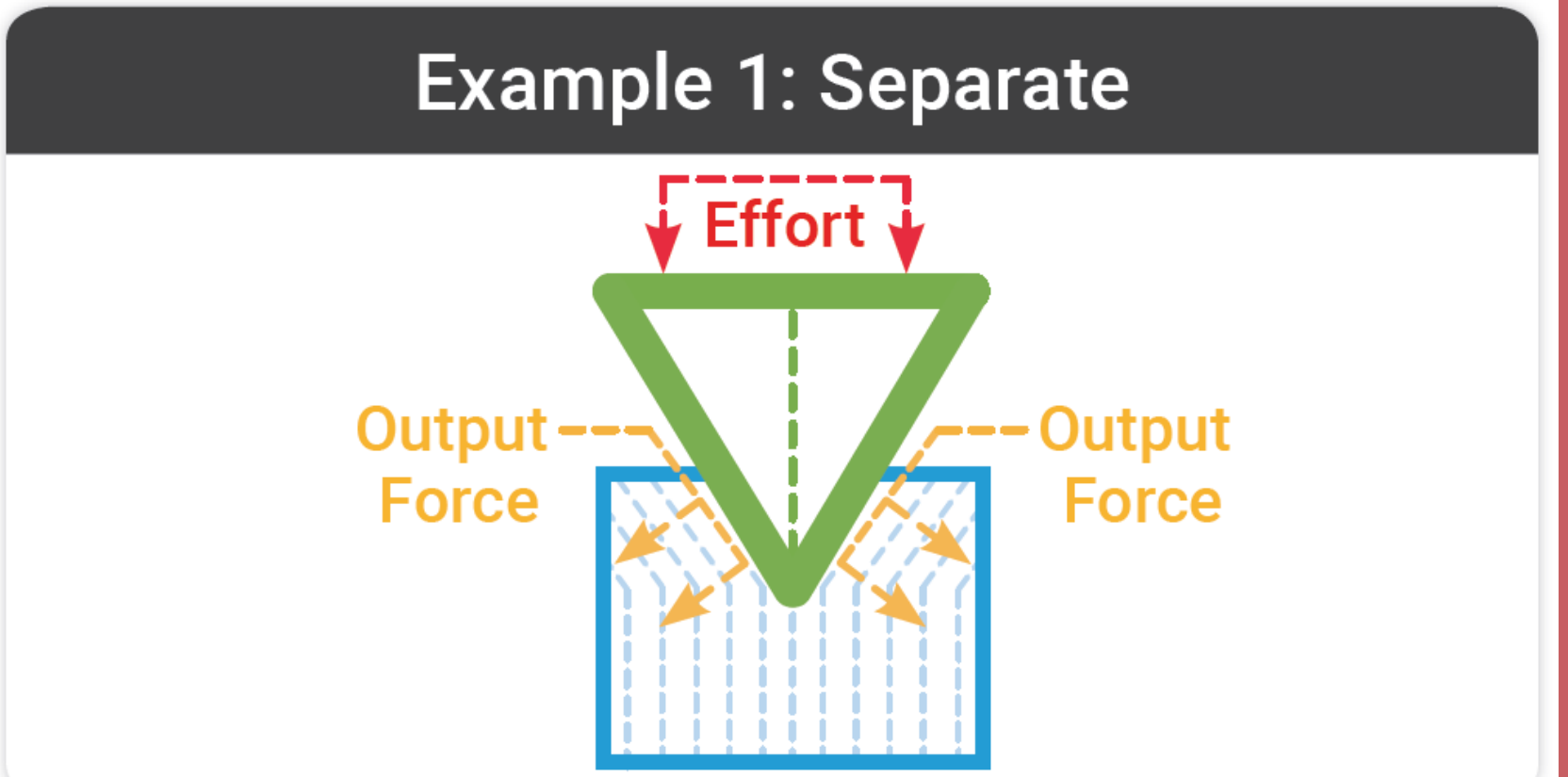
Double Wedge

Purposes of the Wedge

The wedge can be used to separate, raise, and hold objects together. When using a wedge, the amount of effort needed is reduced as the length of the slope (or slopes) is increased.

Separate

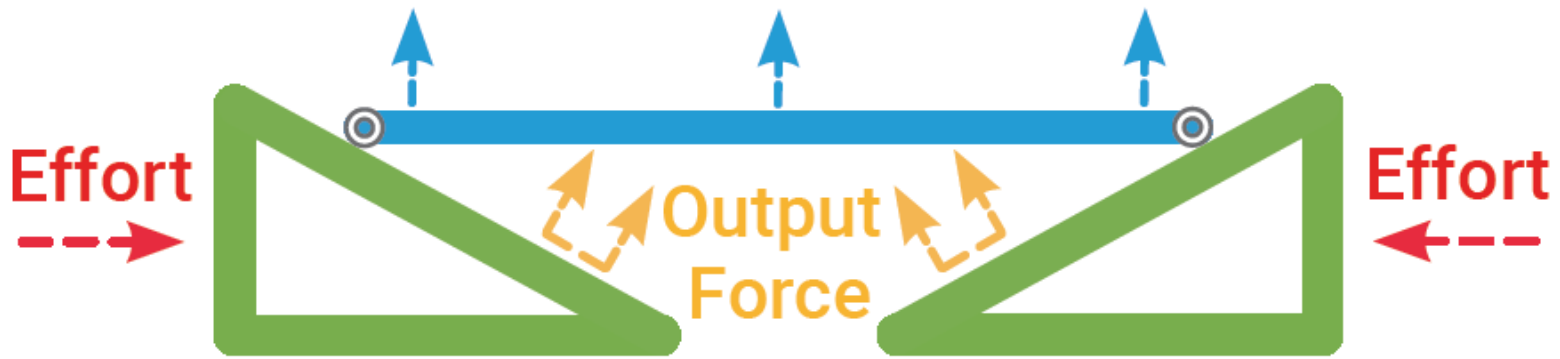
A wedge can be used to separate portions of an object.
In example 1, a double wedge is being forced into an object to separate the object into two pieces. As the effort is applied to one end of the wedge, the other end drives through the object and forces the object to separate.



Raise

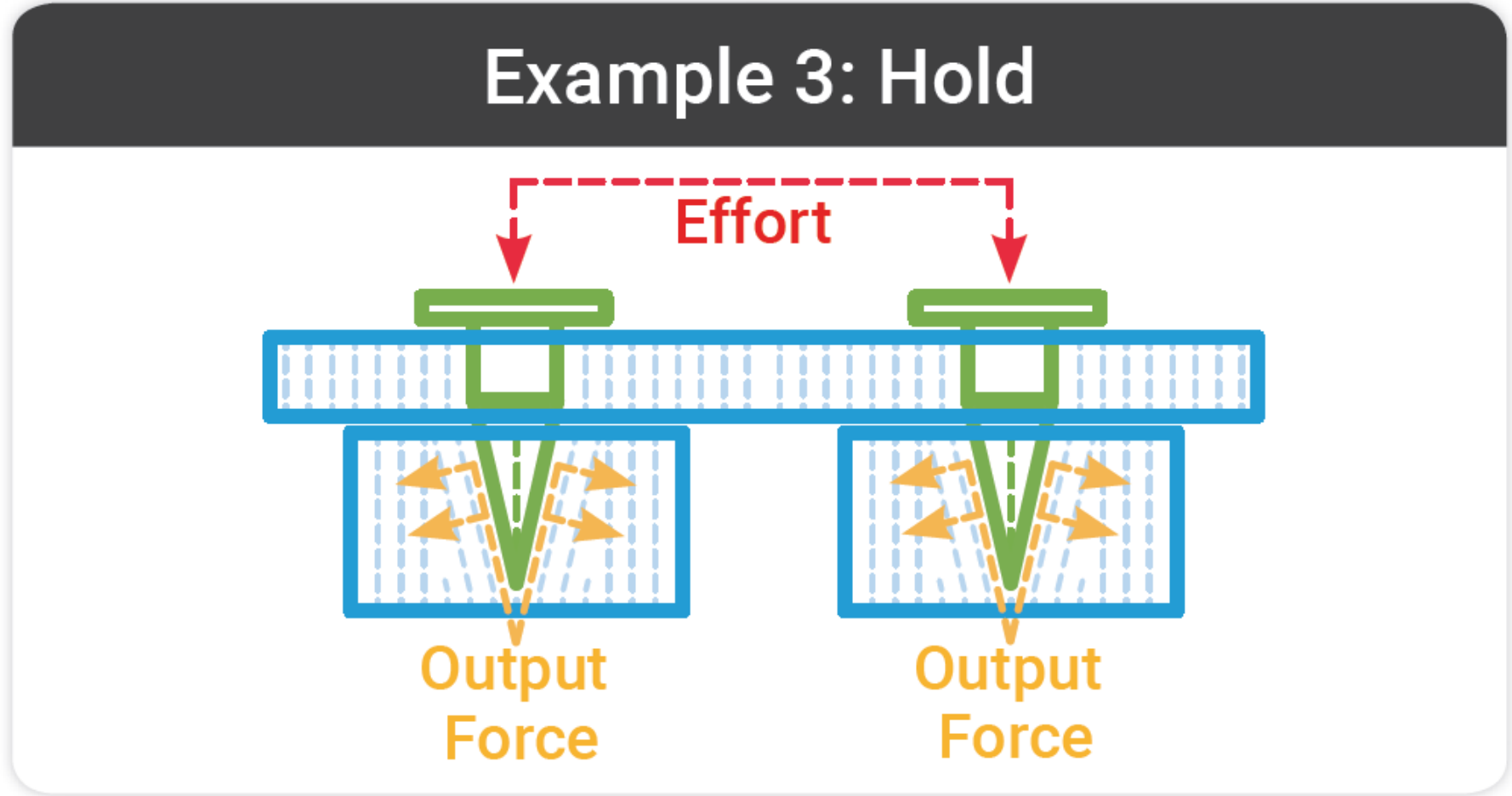
A wedge can be used to raise an object. In example 2, two single wedges are pushed towards each other in order to raise the platform. As effort is applied to the wedges, the slopes of the two wedges force the platform to raise vertically.

Example 2: Raise



Hold

A wedge can be used to hold objects in place. In example 3, two nails (double wedges) have been driven through two boards to hold them together.



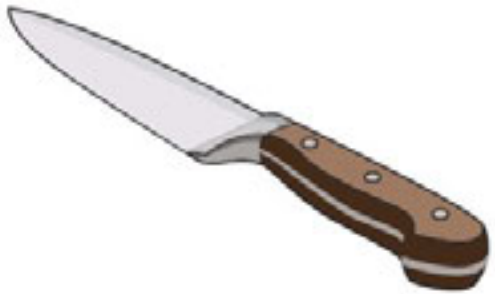
Axe

Chisel

Nail

Spatula

Knife



Doorstop

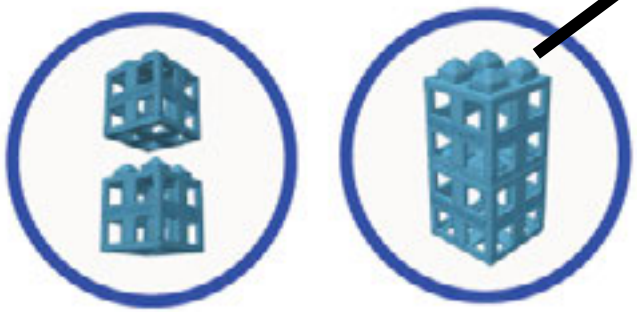
Building Basics

Building Basics with Rokenbok

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

Connecting/Separating ROK Blocks:

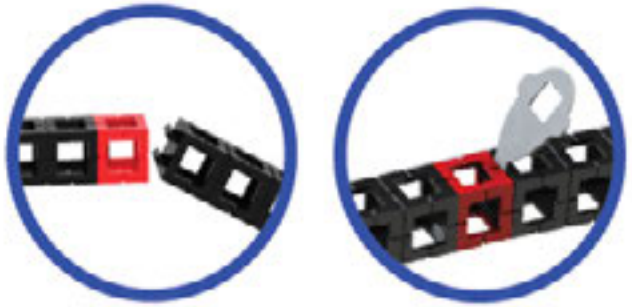
ROK Blocks use a friction-fit, pyramid and opening system to connect. Simply press pyramids into openings to connect.
To separate blocks, pull apart.



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.

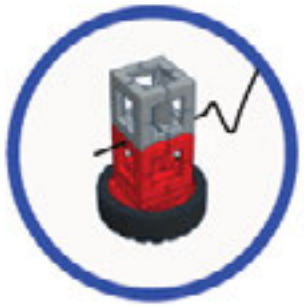


Snapping Across Openings

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.

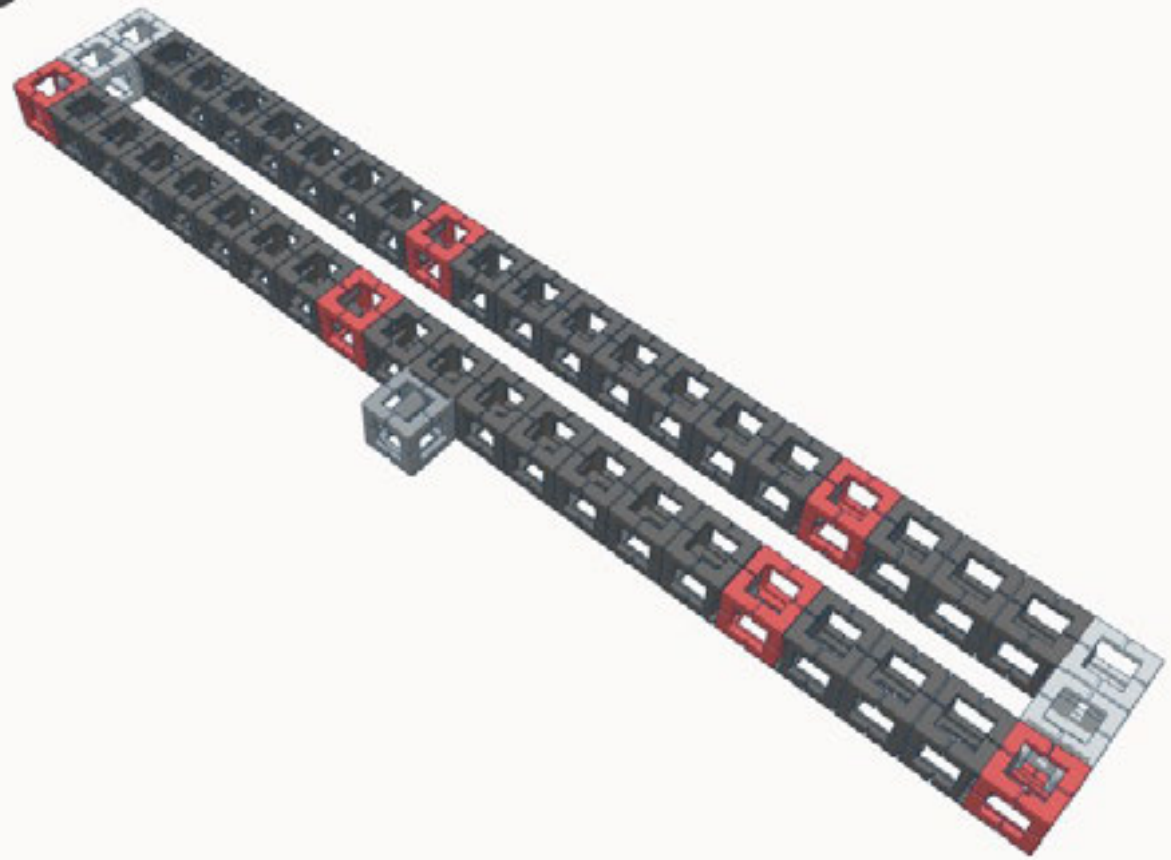


Measuring:

The outside dimensions of each Rokenbok connector block is 2cm³. This means the length, depth, and height are all the same.

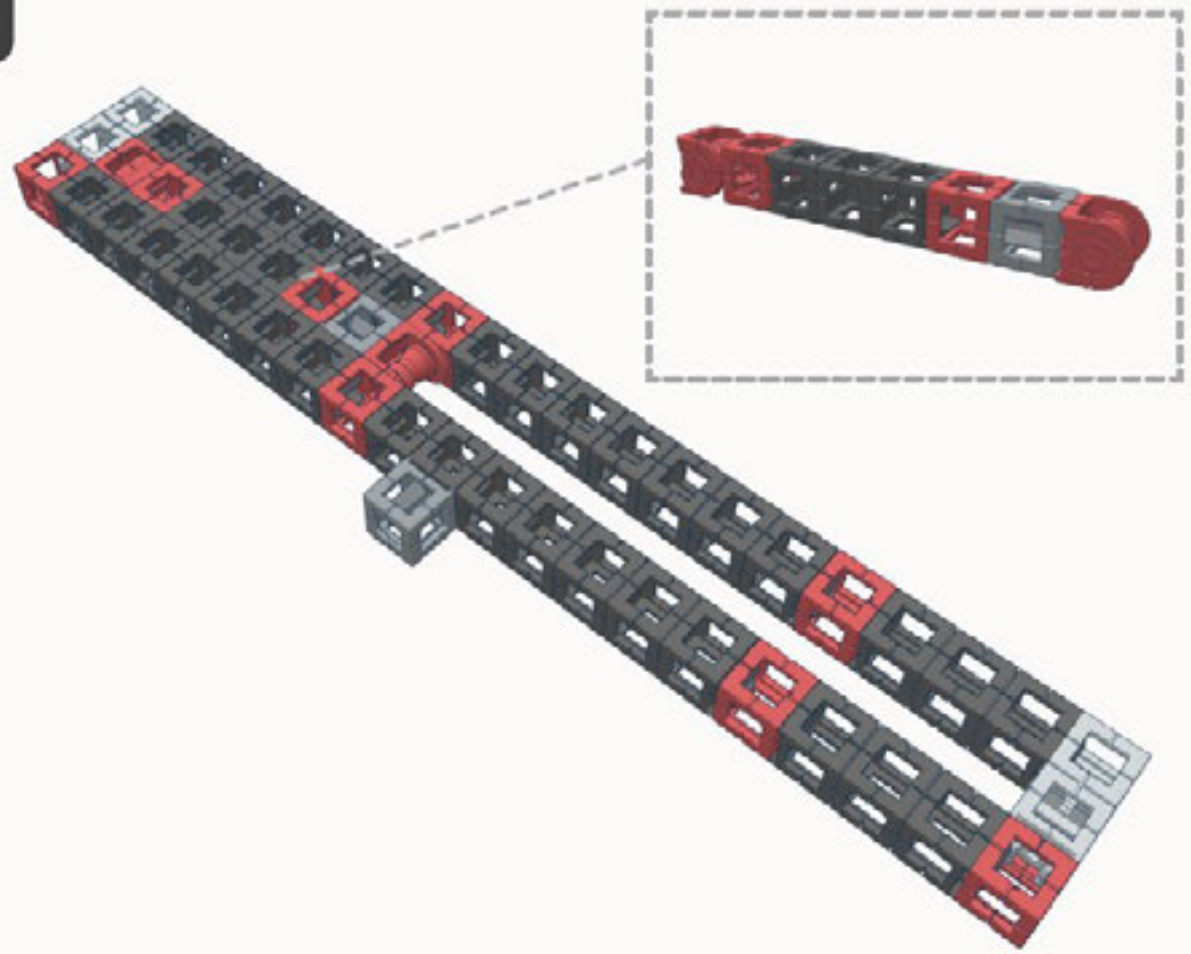
To determine the size of a Rokenbok build in cm, simply count the number of openings and multiply by two. Repeat this process for length, depth and height.

1



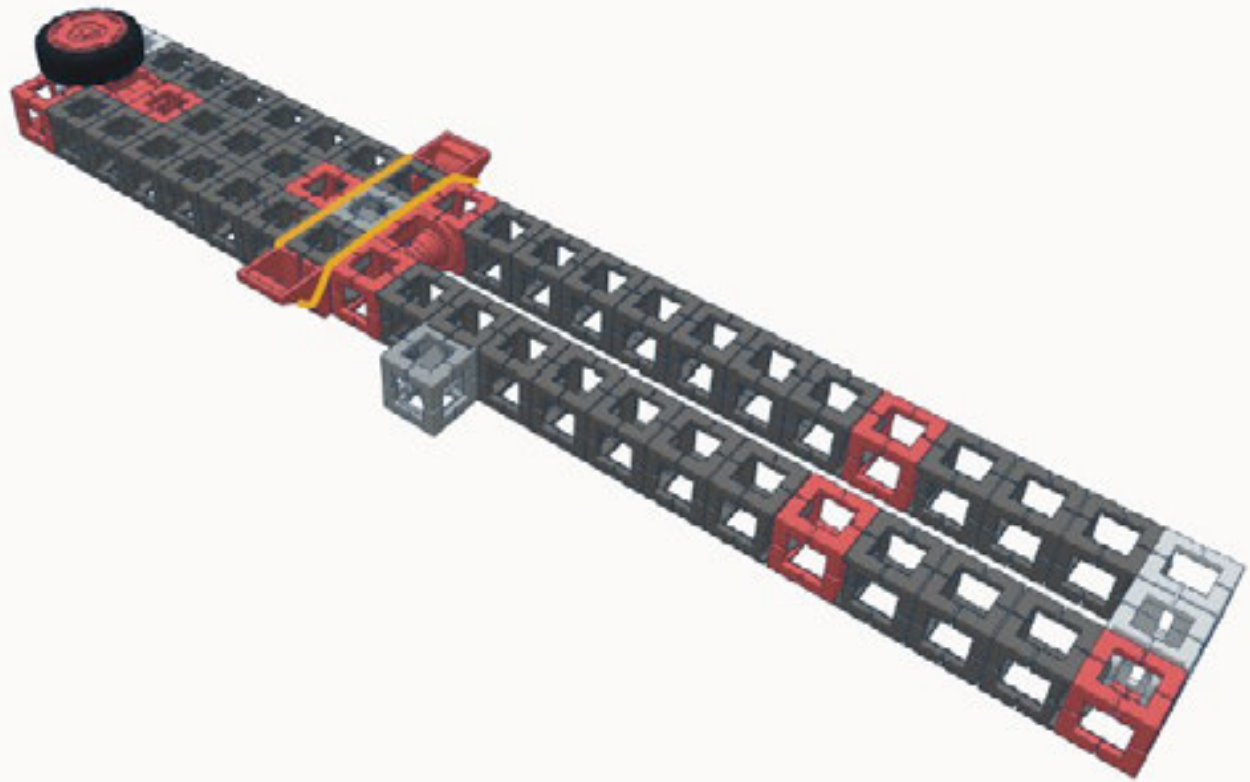
6x	1x	2x	2x	4x
Block	Single Snap Block	Riser	Half Beam	Beam

2



1x	2x	1x	1x	1x
Single Snap Block	Block	Hinge Block	Half Beam	Pulley Block

3

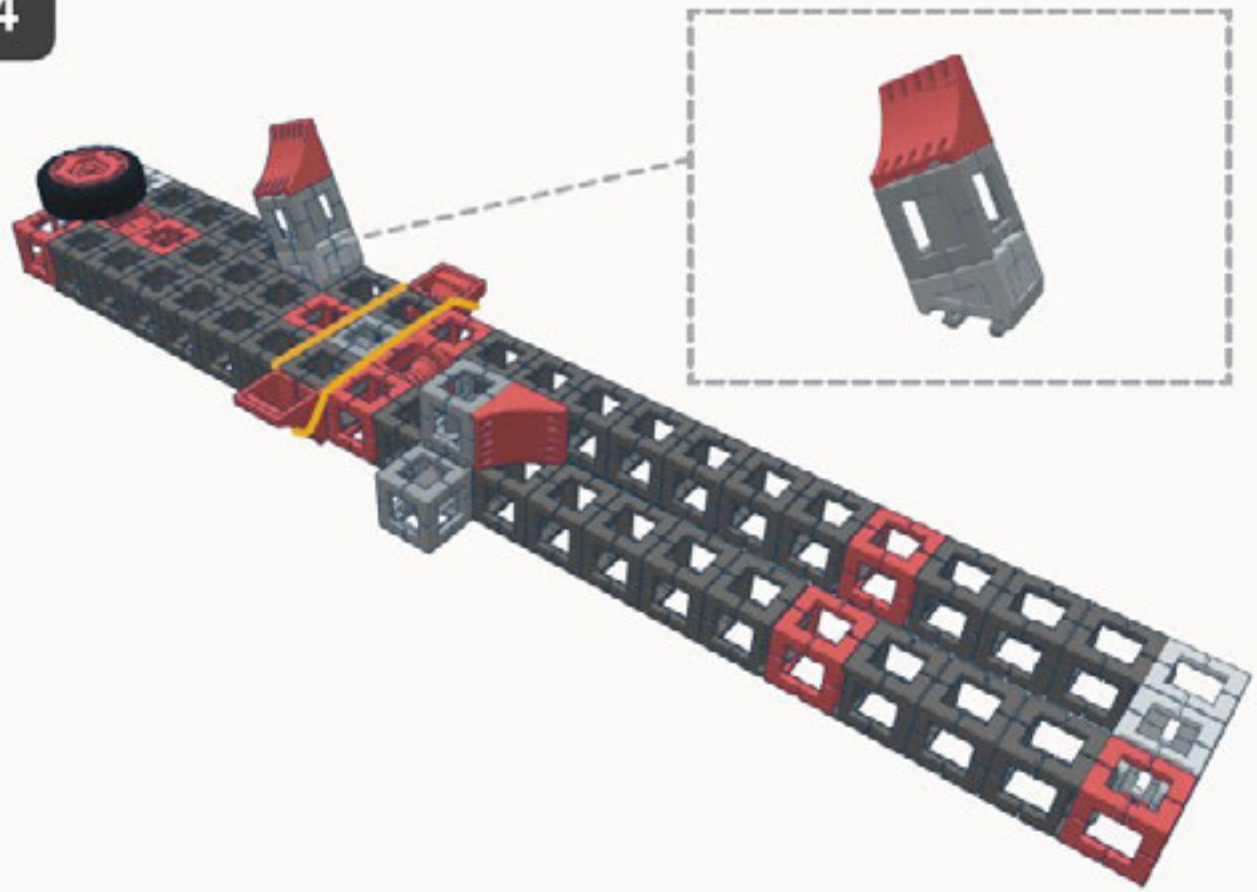


1x
Snap-In Wheel

2x
Corbel

1x
Rubber Band

4

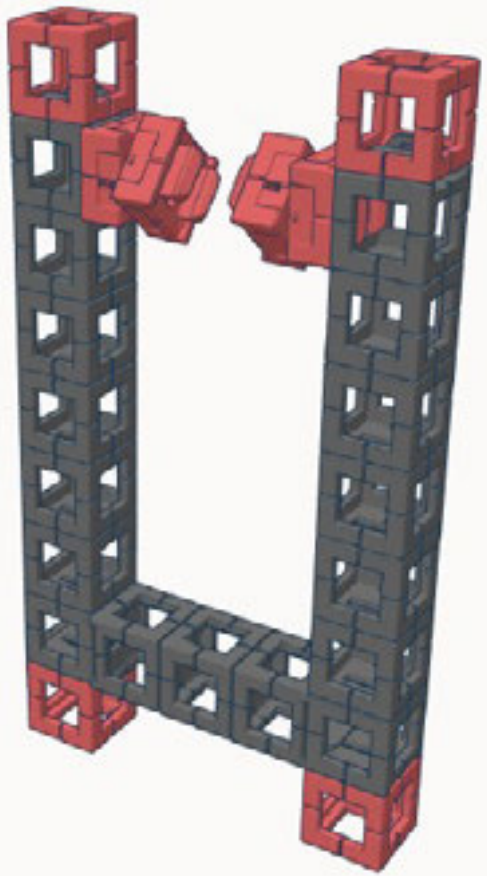


2x
Single Snap Block

1x
30° Block

2x
Corbel

5



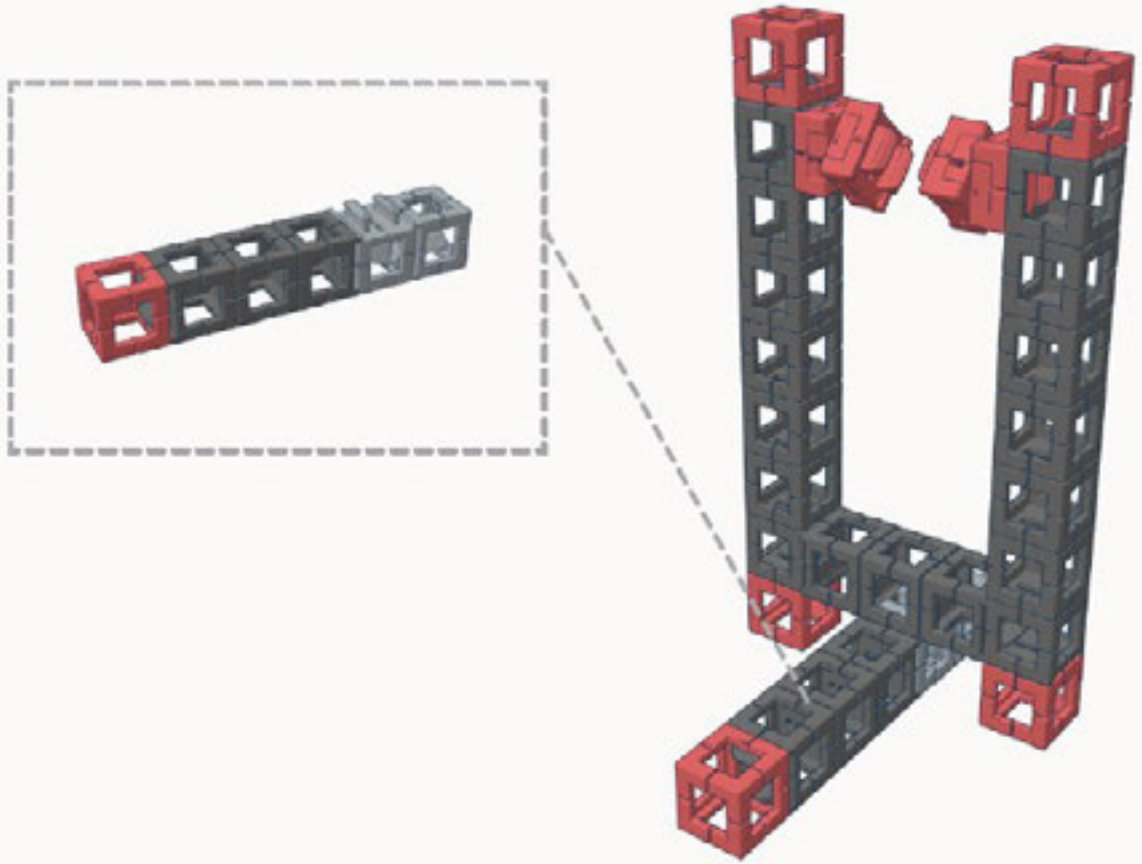
4x
Block

2x
Axle Block

1x
Half Beam

2x
Beam

6

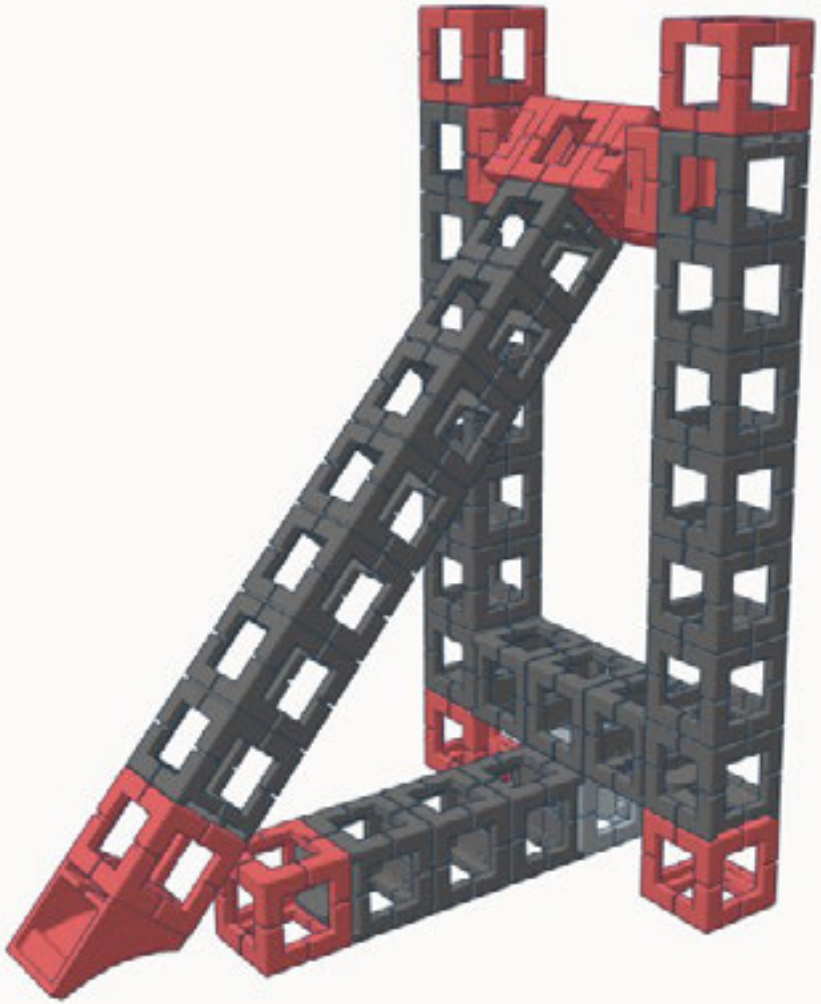


2x
Single Snap Block

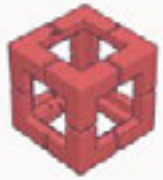
1x
Block

1x
Half Beam

7



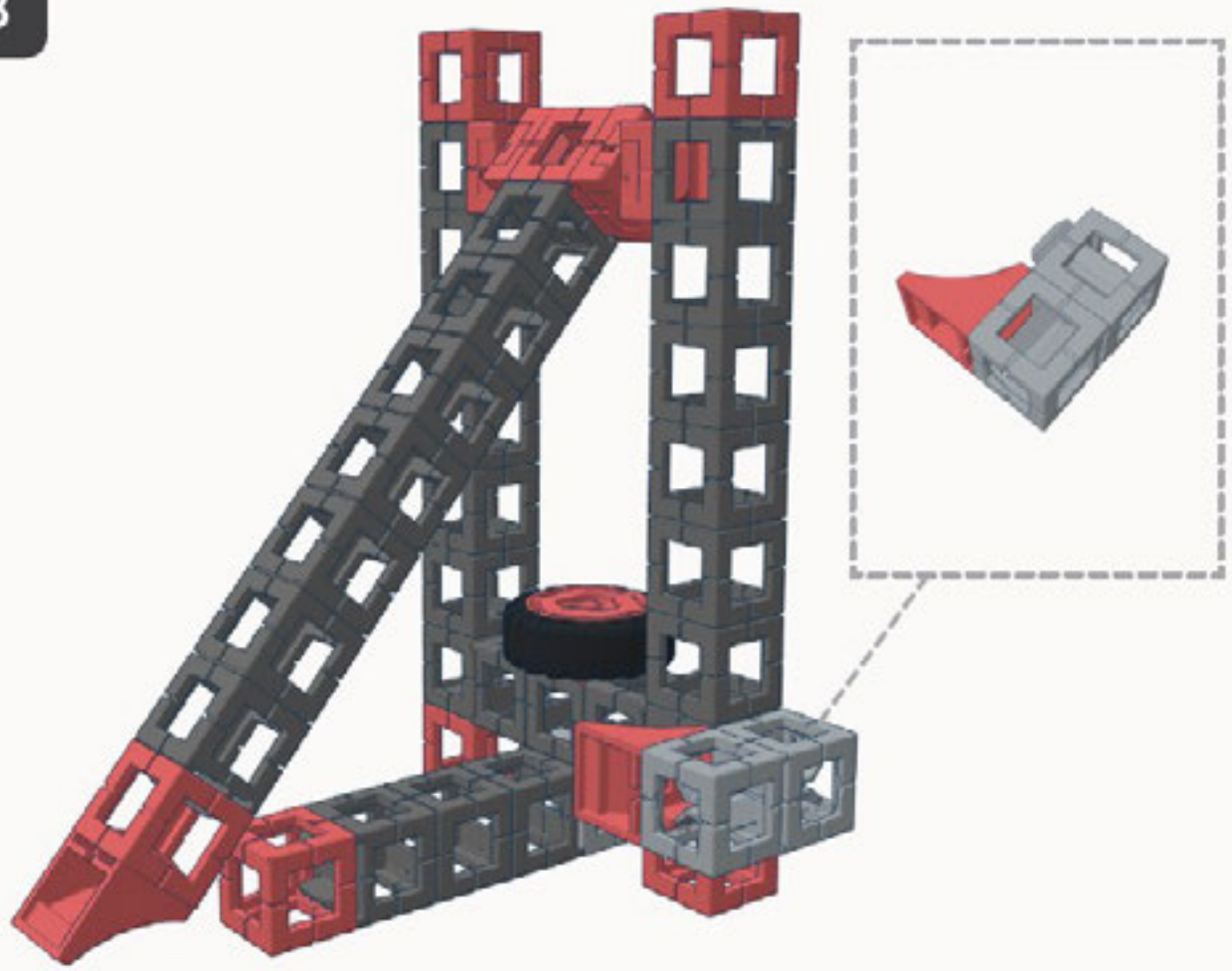
2x
Block



1x
Beam

1x
Corbel

8

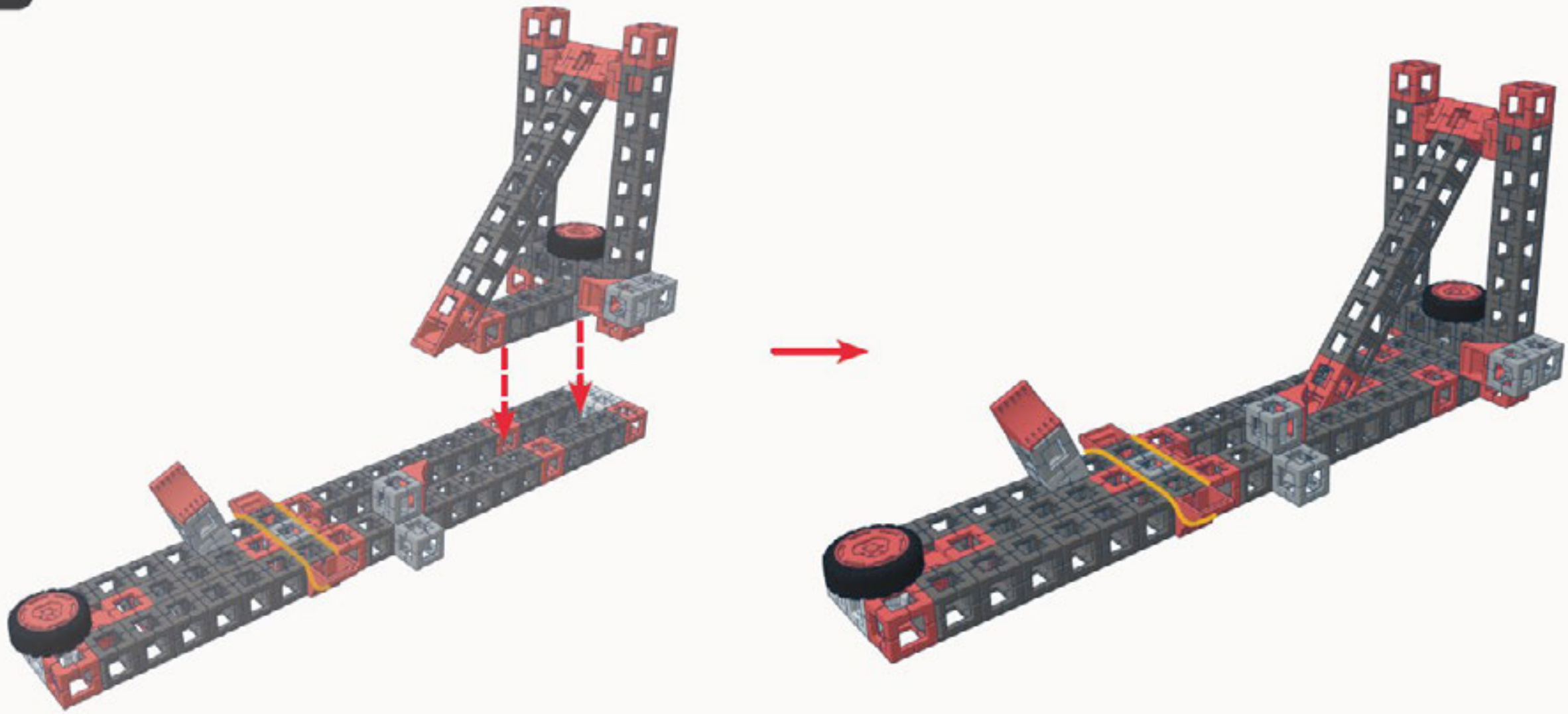


1x
Corbel

1x
Snap-In Wheel

2x
Single Snap Block

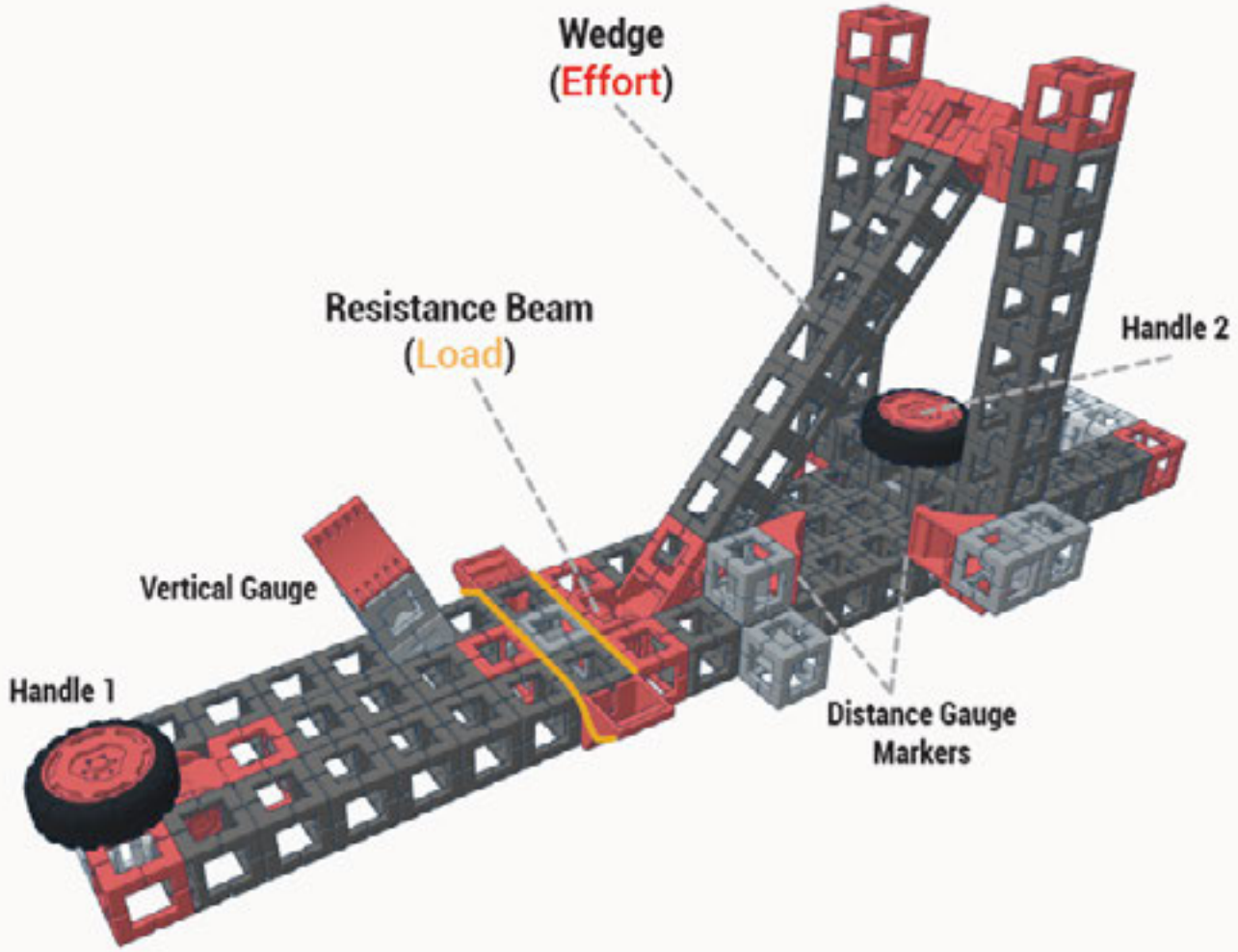
9



Testing the Wedge

Grab handles 1 and 2, then slide the **Wedge (Effort)** towards the tip of the **Resistance Beam (Load)**. After the tips of the wedge and resistance beam are touching, measure the distance between the **Distance Gauge Markers**. Slide the wedge into the resistance beam and observe how it raises to a certain height on the **Vertical Gauge**.

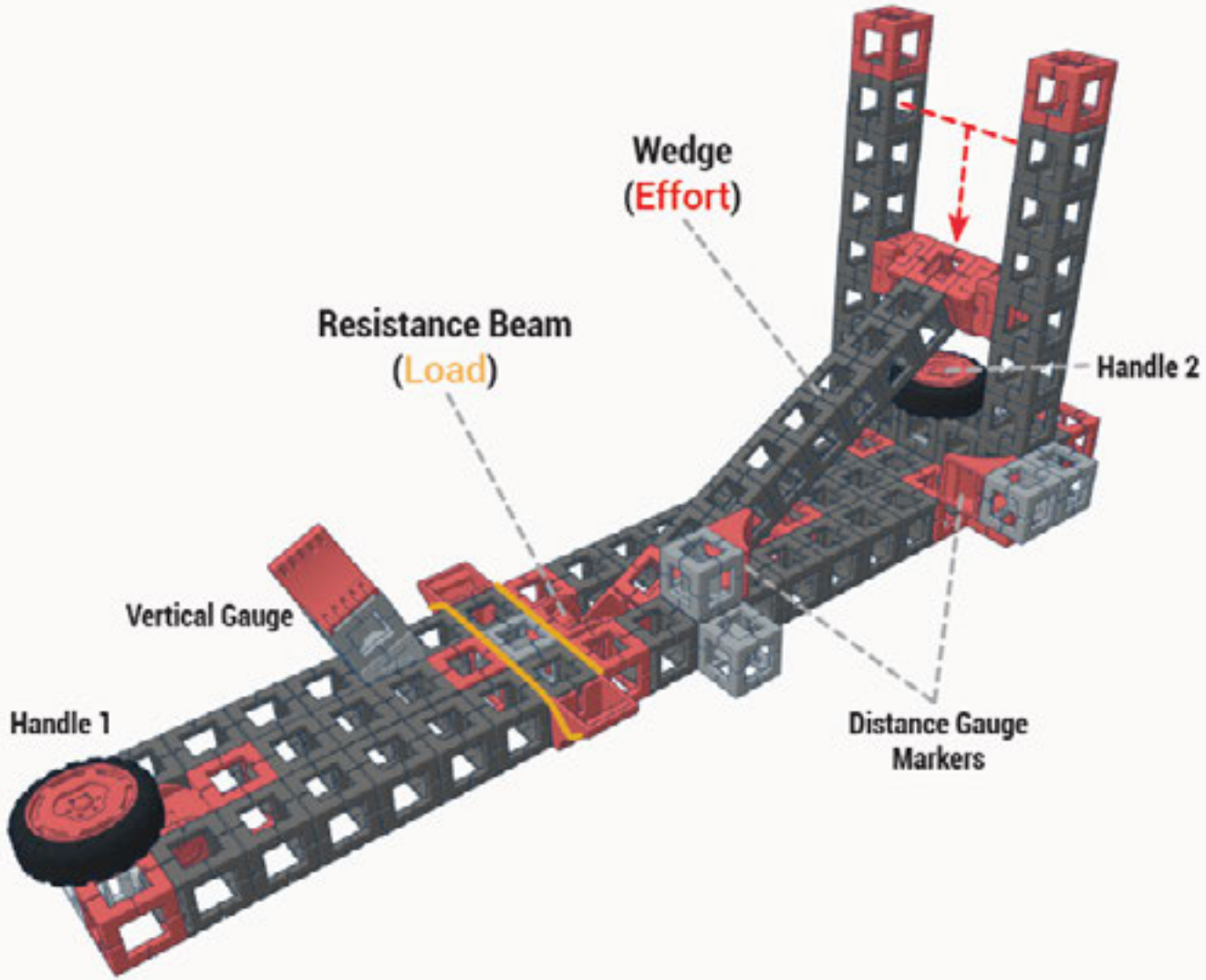
Wedge: Raising Load



Modifying the Wedge

Lower the rise of the wedge by three blocks as shown in the figure to the right. Grab handles 1 and 2, then slide the **Wedge** (**Effort**) towards the tip of the **Resistance Beam** (Load). After the tips of the wedge and resistance beam are touching, measure the distance between the **Distance Gauge Markers**. Slide the wedge into the resistance beam and observe how it raises to a certain height on the **Vertical Gauge**. Notice how much further this wedge has to travel in order to raise the resistance beam to the same height as the previous model. Also, you should be able to notice the amount of effort needed to raise the resistance beam has been reduced.

Wedge: Raising Load



Understanding Mechanical Advantage

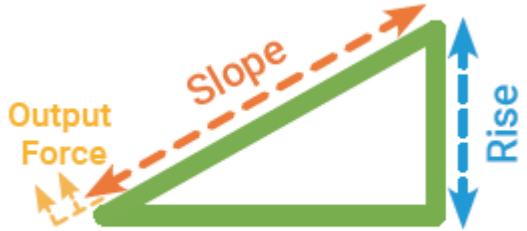
The main purpose of a simple machine is to make work easier. This is done by redirecting motion or creating mechanical advantage. **Mechanical Advantage** exists when the output force of a machine is greater than the input force that was applied to it. To accomplish this, the machine must trade increased time or distance for reduced effort.

Calculating Mechanical Advantage

The wedge reduces the amount of effort needed to separate, raise, or hold an object by creating mechanical advantage. This is done by driving the wedge into an object and using the slope of the wedge to force the object, or a separated portion of the object, in a different direction. The amount of effort needed to drive the wedge is reduced as the length of the slope is increased. To determine how much mechanical advantage exists in a single wedge, divide the length of the slope by the height of the rise.

Formula: Single Wedge

$$\text{Mechanical Advantage} = \frac{\text{Slope}}{\text{Rise}}$$



Single Wedge

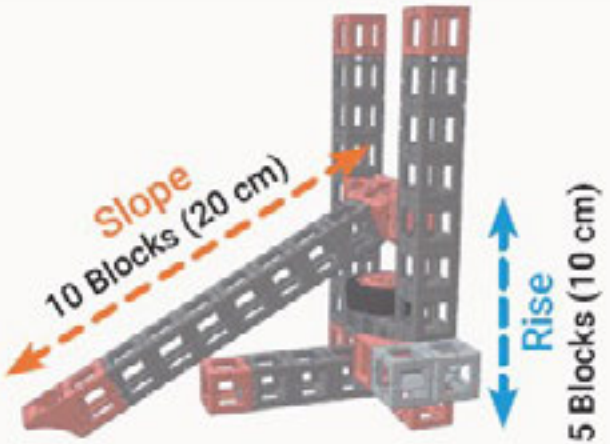
Understanding The Wedge Model

The Rokenbok model that was built demonstrates how a wedge can be used to reduce the amount of effort needed to raise or separate an object. In the first wedge that was built (Example 1), the **slope** of the wedge was 10 blocks (20 cm), and the **rise** was 8 blocks (16 cm). Divide 20/16 and this will give a mechanical advantage of 1.25:1. This means the resistance beam will **rise** 1 unit of measurement for every 1.25 units of measurement it travels up the **slope** of the wedge. As the wedge is driven into the resistance beam, it forces the resistance beam up the **slope**. Since the **slope** is a longer distance than the **rise**, the amount of effort that needs to be applied to the wedge is reduced.

In the modified wedge (Example 2), the **slope** remained 10 blocks (20 cm), but the **rise** was lowered to 5 blocks (10 cm). Divide 20/10 and this will give a mechanical advantage of 2:1. This means the resistance beam will **rise** 1 unit of measurement for every 2 units of measurement it travels up the **slope** of the wedge. This modification requires the resistance beam to travel a further distance, but the amount of effort that needs to be applied to the wedge has been reduced.

Example 1: Wedge

Example 2: Modified Wedge

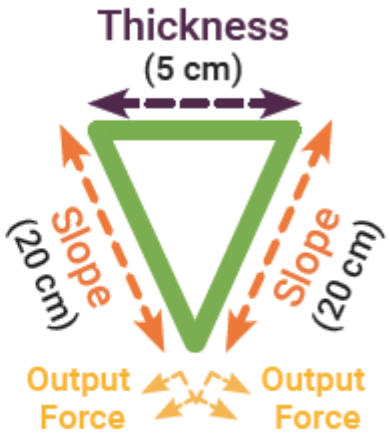


The Double Wedge

A double wedge includes two slopes. As the double wedge is driven into an object, it separates the object, and forces both sides of the object up the slopes of the wedge. This means that half of the input force goes to each side of the wedge. To calculate how much mechanical advantage exists in a double wedge, divide the length of the longest **slope** by the maximum **thickness** of the wedge. In the double wedge pictured to the right, both **slopes** of the wedge are 20 cm, while the **thickness** is 5 cm. Divide 20/5 and this will give a mechanical advantage of 4. This means as the wedge is driven into an object, the object will separate 1 unit of measurement for every 4 units of measurement each side is forced up the slopes of the wedge.

Formula: Double Wedge

$$\text{Mechanical Advantage} = \frac{\text{Slope}}{\text{Thickness}}$$



Double Wedge

Extension Activity

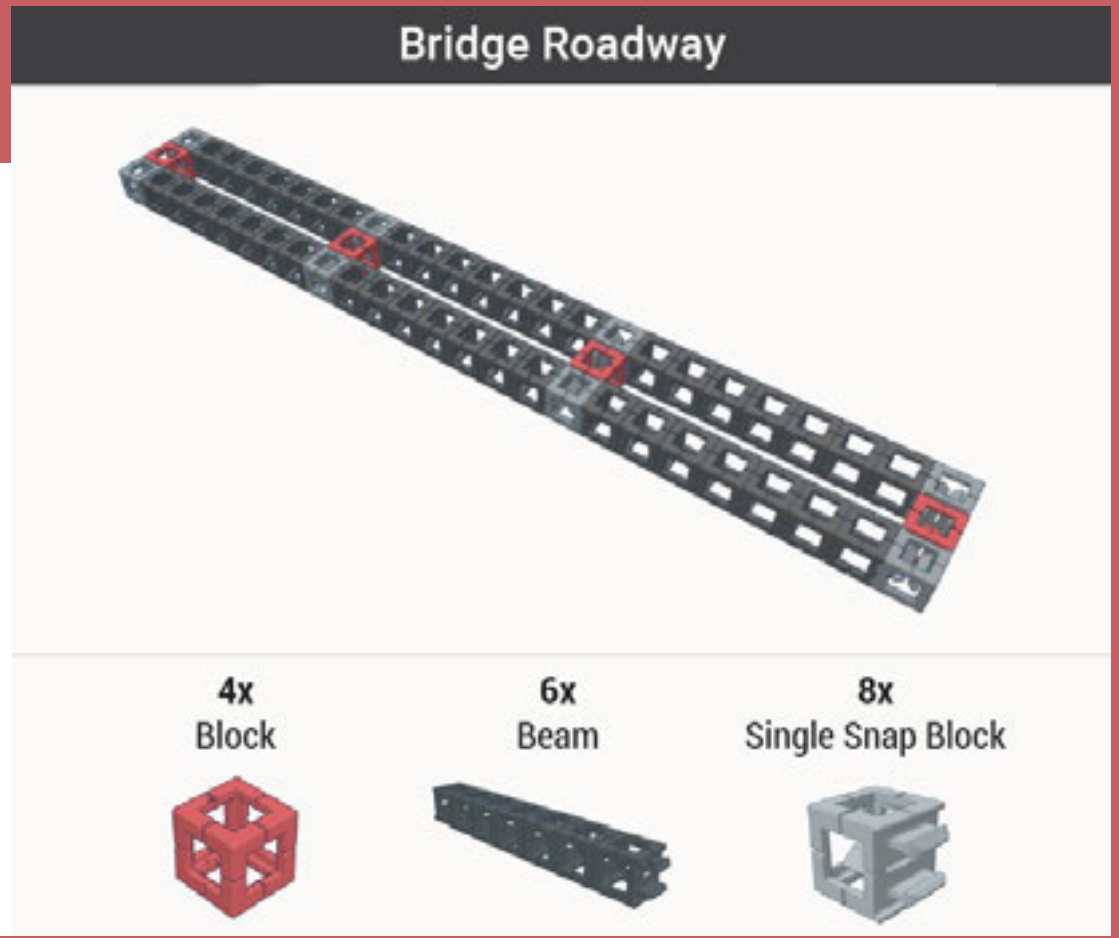
Design Brief: Scenario

There is an old bridge on ROK Road that needs to be replaced. It was built long ago and is too low for sailboats to safely pass underneath. Due to the increasing number of sailboats in the area, the city is looking to build a new bridge that can be raised and lowered when necessary.

Design & Engineering Challenge

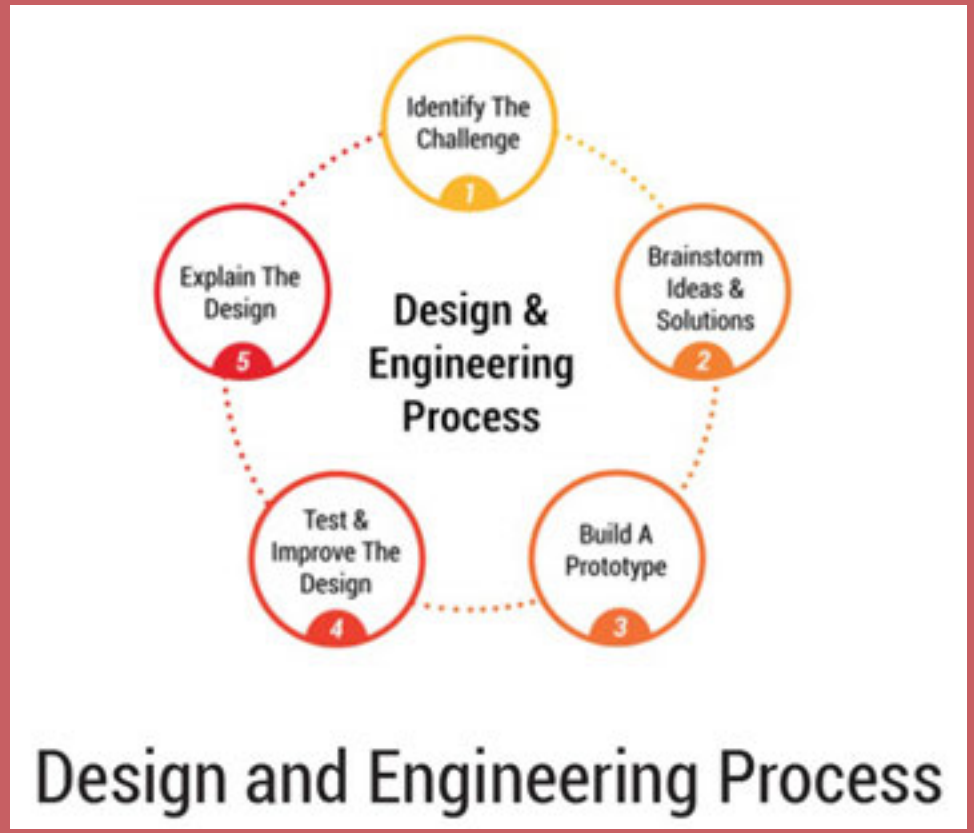
Your challenge is to design and engineer a custom lift featuring the wedge that can raise and lower a bridge roadway, to allow sailboats to safely pass underneath

***Instructions to build bridge roadway are pictured in the image to the right.**



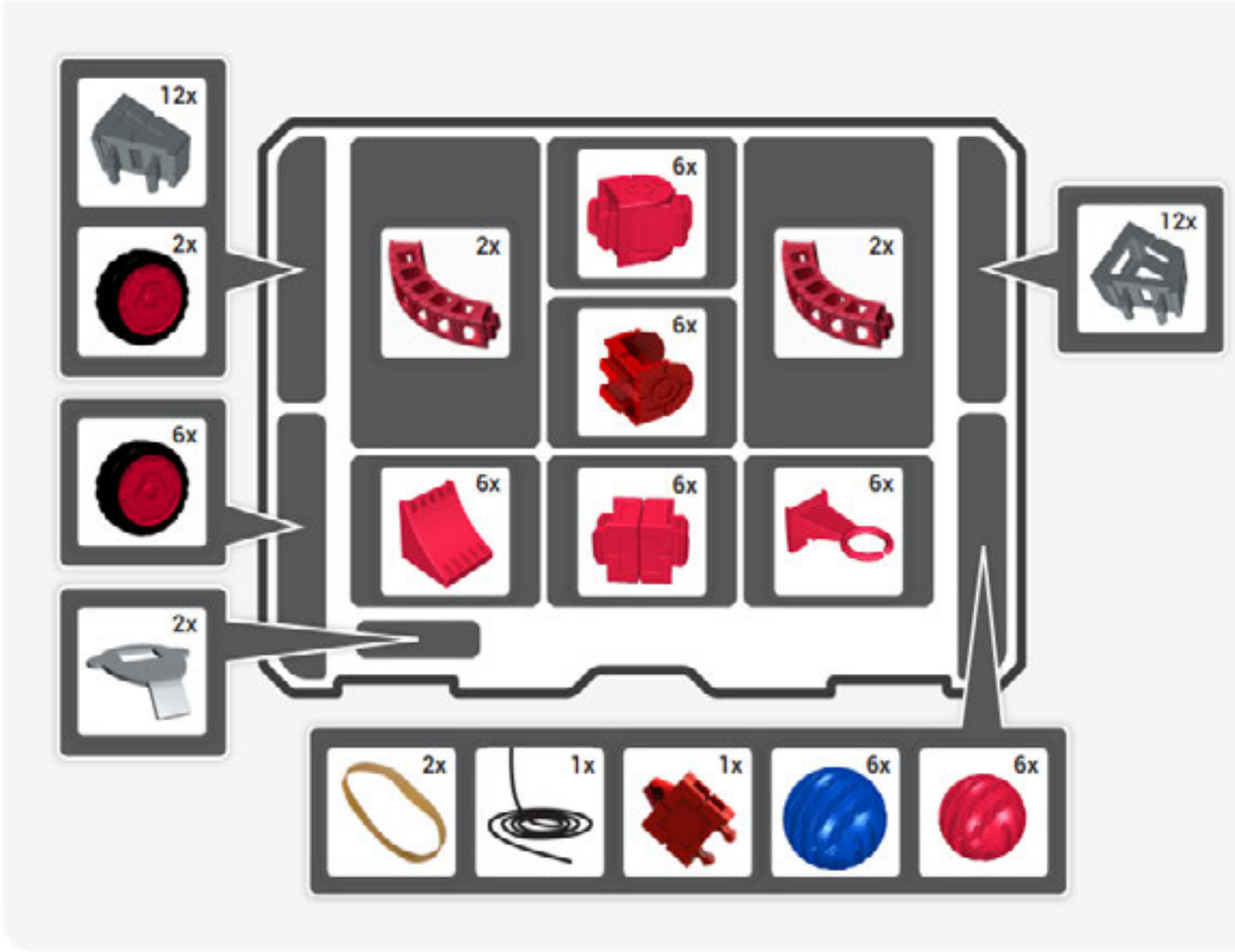
Specifications

- 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 bridge roadway do not count towards the budget.



Clean Up

BOTTOM OF MODULE



REMOVABLE BINS