STEM Simple Machines Set

E96.1 STEM Lessons

This set is covers the subject of Simple Machines in an encompassing and fascinating way. These mechanisms offer a mechanical advantage and are crucial elements of many machines and devices. They are designed to multiply or reduce force, increase or decrease speed and convert one type of motion to another. The set includes enough parts to create 60 working models that cover the subjects of levers, the wedge, the wheel and axle, the screw, the inclined plane, the pulley, as well as the more advanced gears and linkages! You can find easy-to-follow building digital instructions for all models along with detailed explanations of the different scientific principles applied. The methodology suggested combines theory with innovative experimental activities that lead to hands-on learning and engineering creativity.

Including Themes:

- Levers & Linkages
- Wheels, Axles & Inclined Planes
- Pulley Drives
- Gears & Worm Drives
- Cams & Cranks





Engino® EDUCATION

9-12+

Edition: 10/22

Lesson: Seesaw

Discover:

- How does Force generate Moment?
- How can we calculate Moment?

Seesaw

Most children playgrounds contain a seesaw. Did you know that this fun and simple game is a perfect example of how a lever works? You can perform the next experiment and find out how a lightweight child can lift a heavier child on the seesaw using the principle of levers!

Materials Needed:
- Engino STEM & Robotics Mini.

Procedure:

1. Build the **seesaw** model.

2. Remove one wheel from one side of the seesaw and observe what happens.

3. Use your finger, on one side only, to restore the balance again. Then move your finger slowly towards the middle, trying different distances from the centre. Can you feel the difference in effort?

4. Leaving only one wheel on the left side of the seesaw, take the remaining wheels from the package and try to find out how many wheels you need to put on the right side in order for the seesaw to balance . On the right, you can see 4 possible cases to try out (**exercise 1**). Balance the seesaw in each one by stacking on wheels connected with pulleys at the positions indicated. The distances from the center for placing the wheels are: 24, 12, 8 and 6 units.

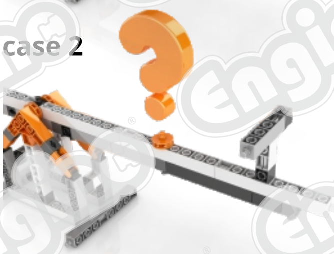
5. Complete **exercises 2, 3 and 4.**

1. Write the number of wheels that are needed to balance the seesaw in each case.

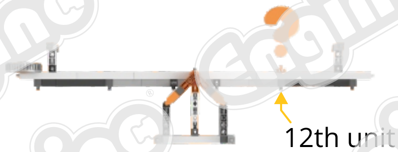
case 1

Wheels needed to balance: ☐

case 2

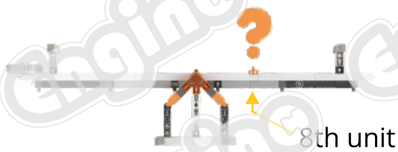


Wheels needed to balance: ☐

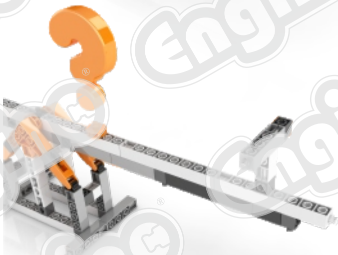


case 3

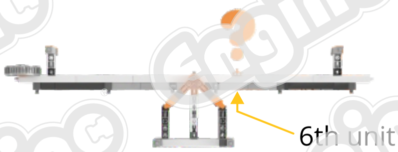
Wheels needed to balance: ☐



case 4



Wheels needed to balance: ☐



2. Let's do some simple math: Multiply the number of wheels with the distance (how many units) from the center, for each side and for each case. What results did you come up with?

case 1	Wheels needed to balance x 24 units =	1 x 24 = 24
case 2	Wheels needed to balance x 12 units =	....
case 3	Wheels needed to balance x 8 units =	....
case 4	Wheels needed to balance x 6 units =	....

3. What conclusion can be extracted from your observations above, about the left and the right side?

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4. With that in mind, how can a lightweight child balance the seesaw when playing with a heavier child?

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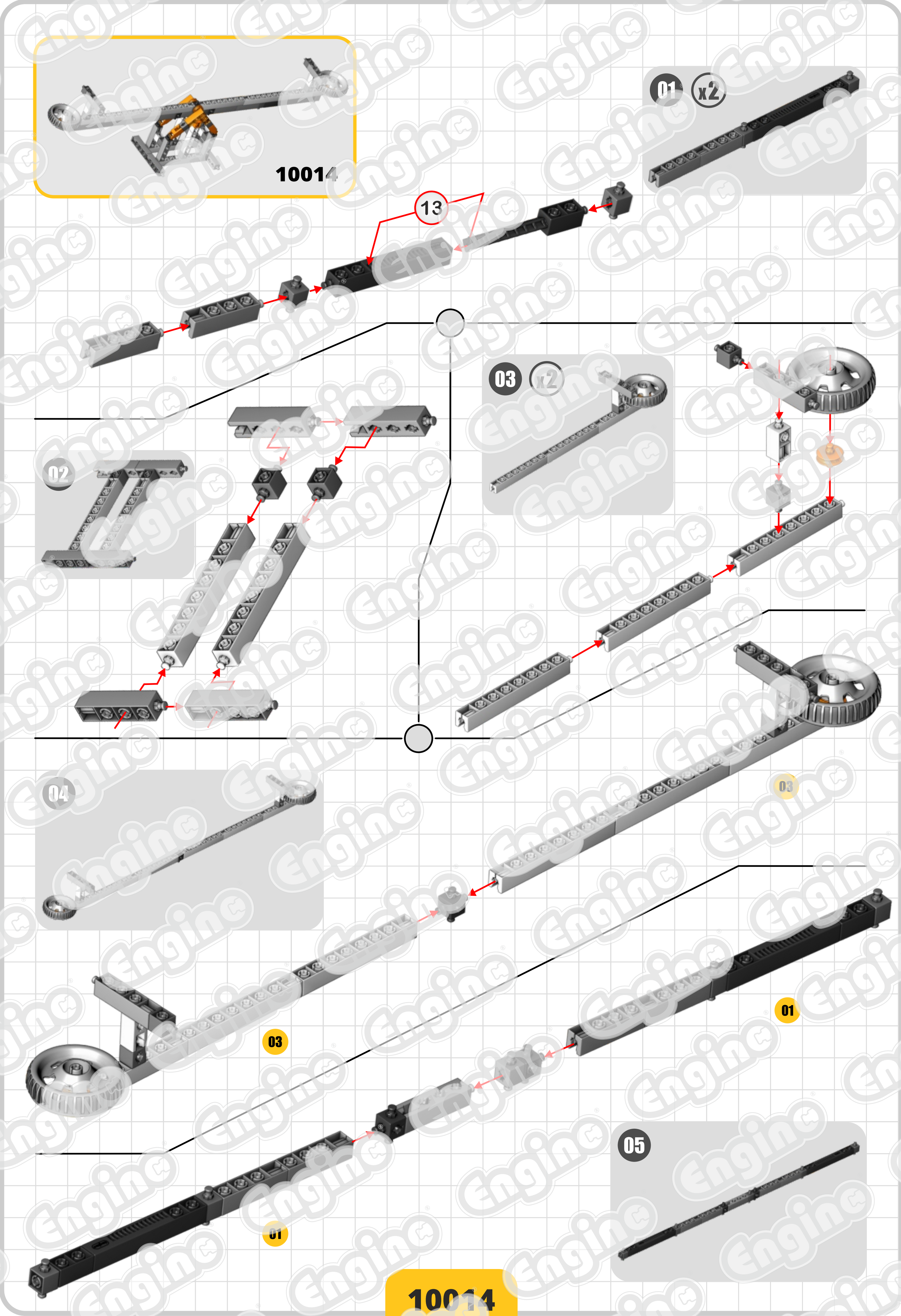
10014
01 x2
13
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03 x2
04
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01
03
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05


06
x2
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09
09
02

Lesson: Parallel scale

Parallel Scale

Many courts have a statue of Lady Justice (or Goddess of Justice) outside their buildings. According to ancient Romans' belief about goddess Justitia and ancient Greek goddess Dike, she is the protector of people that are being judged and responsible for keeping the political and social order. What is special about this Lady is that she holds two objects: a sword, which symbolizes the power of Reason and Justice and a set of scales, for measuring a case's facts.

Discover:

- How parallelism is applied in scales, helping us measure the weight of different objects.

Materials Needed:
- Engino STEM & Robotics Mini.
- Beans, rocks or any other small materials.

Procedure:

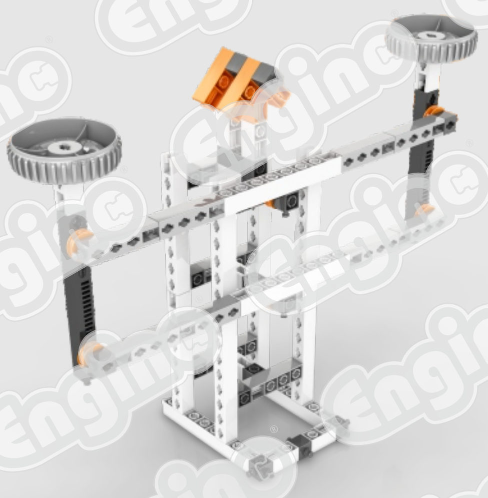
1. Build the **parallel scale** model. If built correctly the model should balance!

2. Play a while with your model, so that you understand how it works. Move the right side with your hand and observe what happens to the other side. Change sides and repeat.

3. Put some small materials like beans or rocks on one of the scalepans and observe what happens. You should notice that the balance of the scale is lost. In order to restore the balance just load the same materials on the other scalepan.

4. Now, remove the part of the model that contains the two scalepans connected together according to **exercise 1**. This part is a linkage! Play a bit with it and try to answer the questions in **exercise 2** and **3** that follow, in order to find out how it works exactly.

5. Complete **exercise 4**.



Engino® "parallel scale" model

1. Indicate the points where the two scalepans are connected in the next picture.

2. What four sided shape is formed when the scale is in balance and the two scalespans are vertical? Find these sides in the picture above and mark them with arrows.

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3. If we push down a scalepan to one side what can you observe about the other scalepan?

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4. If the parallel scale is leaning to one side, are the two scalepans moved in the same length?

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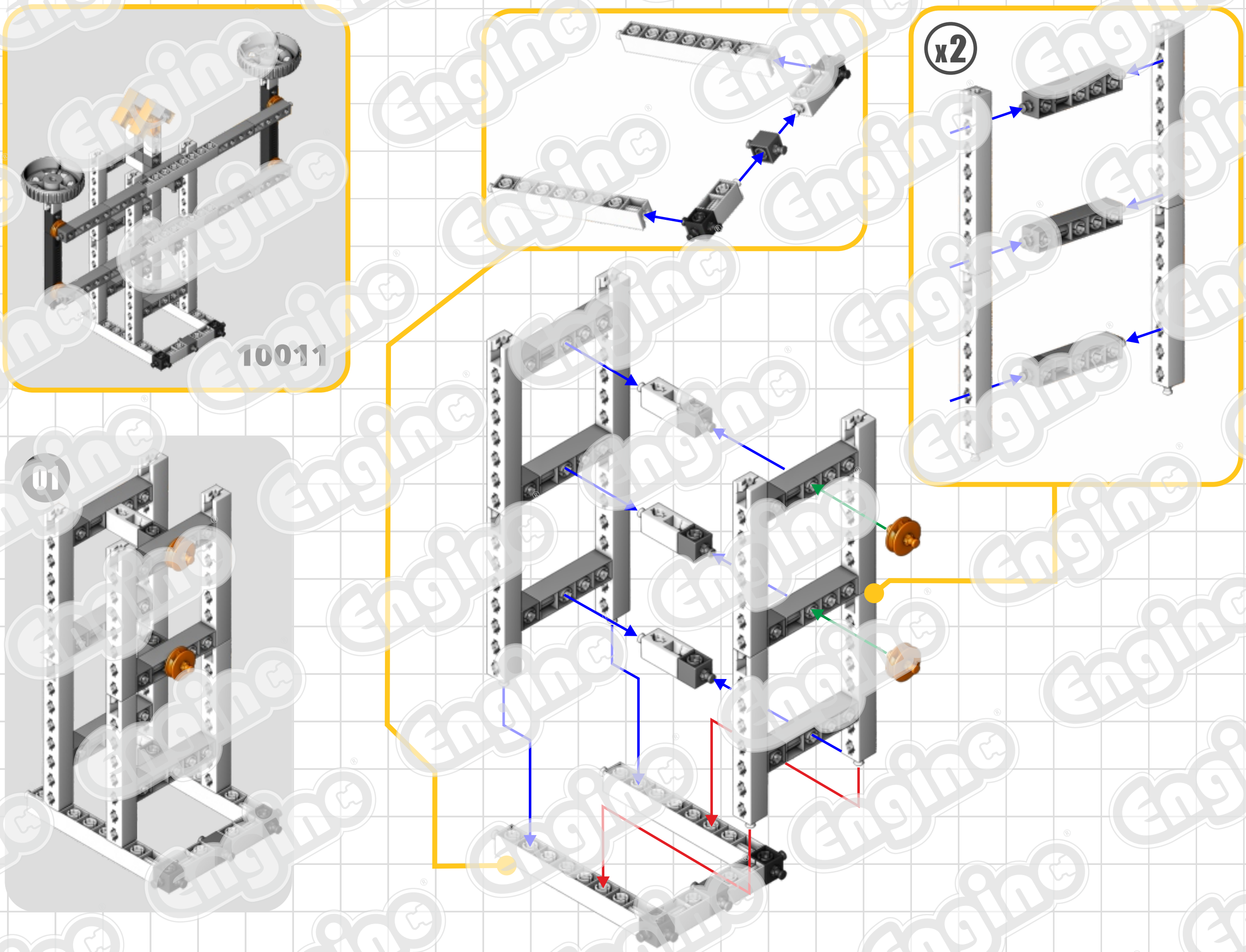
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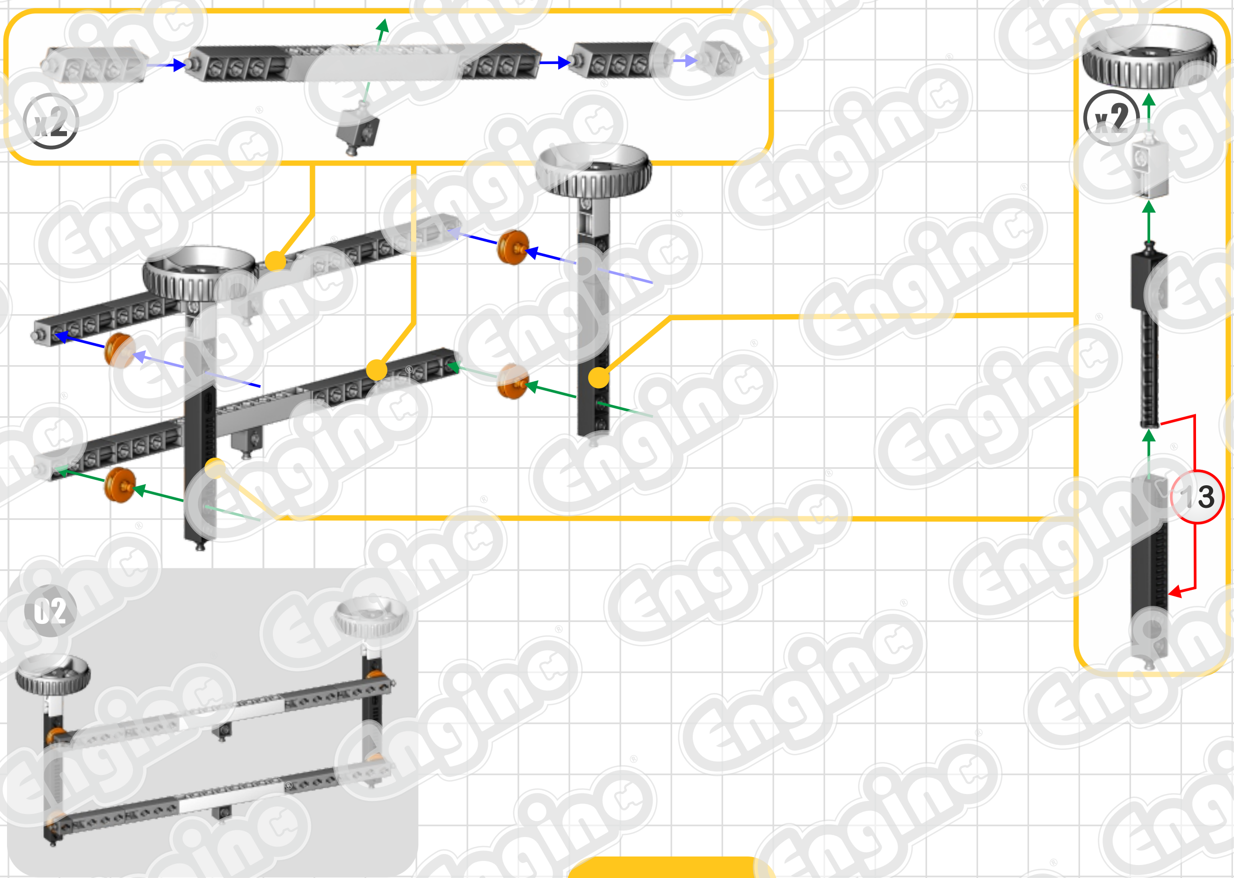
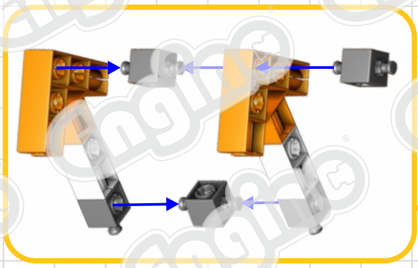
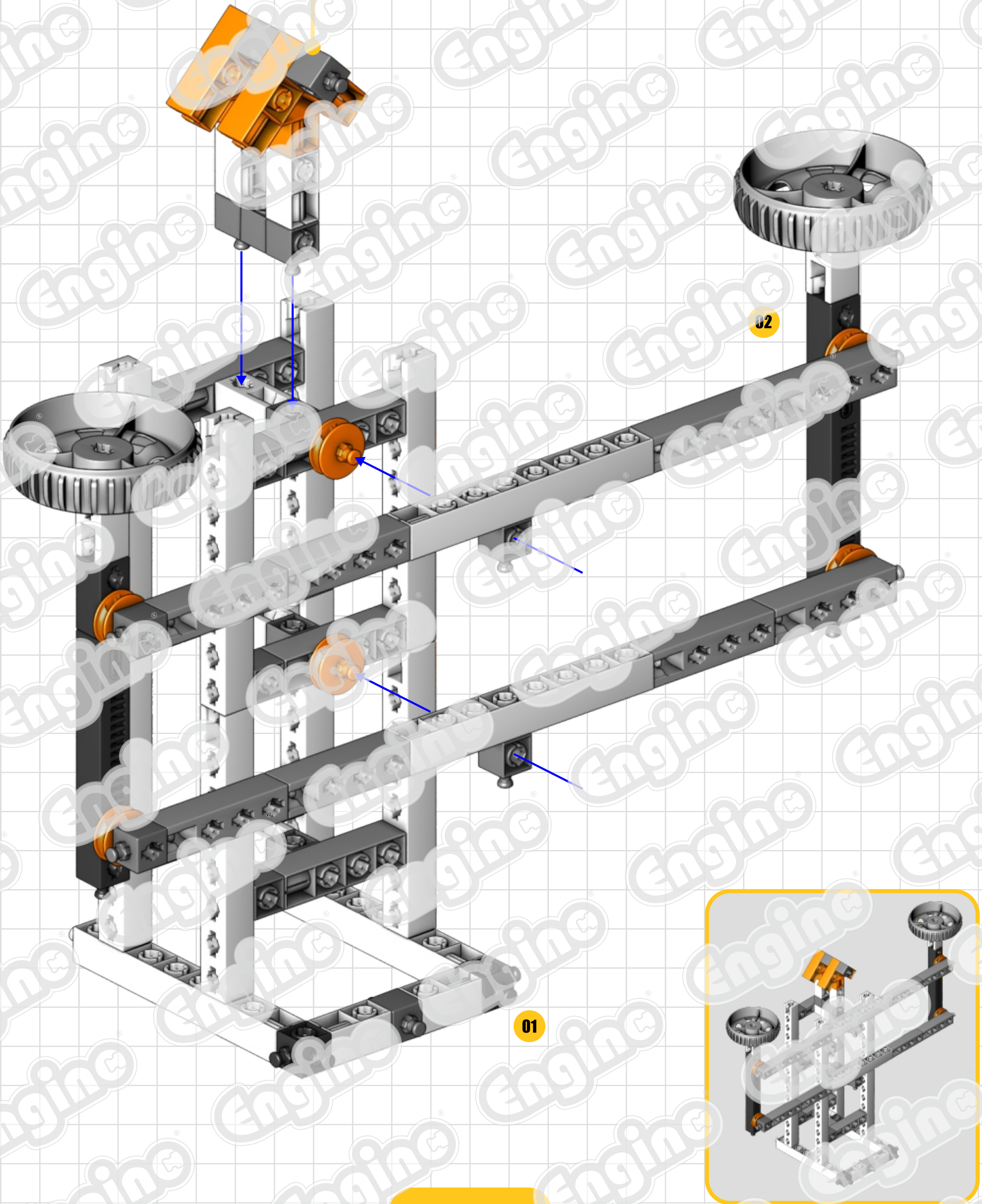
01
x2


x2
x2
13
02




02
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Lesson: Wedge

Wedge

Phidias was a great Greek sculptor, painter and architect. One of the "seven wonders of the ancient world", the statue of Zeus at Olympia, was his creation. For this he used a special form of a wedge, a sculptor's chisel! Carry out the following experiment and discover what happens with the forces acting on the wedge.

Discover:

- What is a wedge?
- How does a wedge multiplies a force?
- What is the Mechanical advantage and how can you calculate it?

Materials Needed:
– Engino STEM & Robotics Mini.

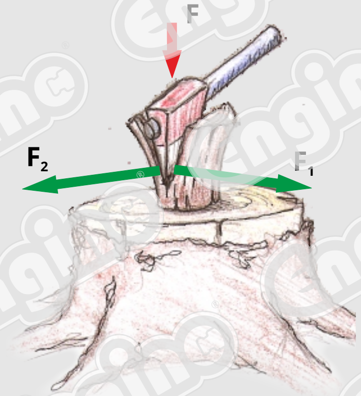
Procedure:

1. Build the wedge model.

2. Consider the base with the extending rods as a "tree log" that is going to be split, similar to the real axe and log shown in the last image below. The wedge is the other object looking like a "T" shape. This will be the "axe".

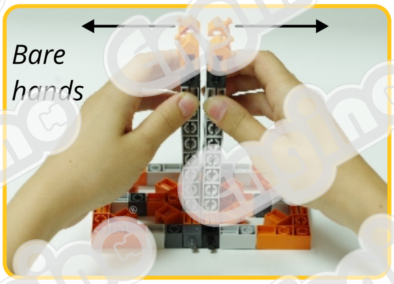
Engino® "splitting wedge" model

3. First, try to split the "log" using your bare hands, pulling from its sides, feeling the amount of effort you need to apply. Then use the wedge to split the "log" by placing it on the top and pushing downwards in a gentle manner, like in the picture in the right table. Try to feel the amount of effort you apply.

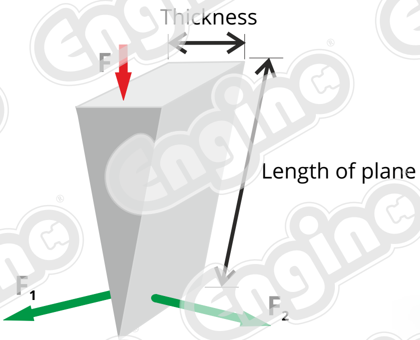


Forces acting on a log when using an axe

1. Complete the following pictures according to your observations from the experiment. Write the words **easy** or **difficult**, comparing the amount of effort you applied when conducting the two tests.



2. Can you draw the forces applied on the Engino® splitting wedge model based on the drawing of the wedge next to it?



3. The **Mechanical advantage** (M.A.) of the wedge, like all simple machines, is defined as the amount by which the input force is multiplied. For the wedges it can be calculated as the length of the inclined plane divided by its thickness. Can you use your ruler to measure these distances in the figure above and calculate the **Mechanical advantage?** How about the Engino wedge?

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