LEARNING ABOUT: Levers

What is a first-class lever?
I bet all of you have been to the doctor for a general check-up! Do you remember getting on a weird device with movable beams and some strange numbers written on them? What do you think is that device and how does it work exactly? You are about to find out by carrying out the following experiment.

Objectives:

- What is a first-class lever? What is a Moment?

Level of difficulty ★★★★★

Materials needed:
1. Engino **building instructions booklet: LEVERS,** pages **3-4.**
2. Engino SIMPLE MACHINES (M10) or LEVERS (M01).
3. Beans, rocks or any other small materials.

Procedure:

1. Build the **movable weight scale** model.

2. Try to balance the model with the help of the movable part (that is the part that contains a wheel) and count the distance from the fulcrum in squares, starting from the blue piece near the fulcrum. How many squares is that distance and what is that distance called?

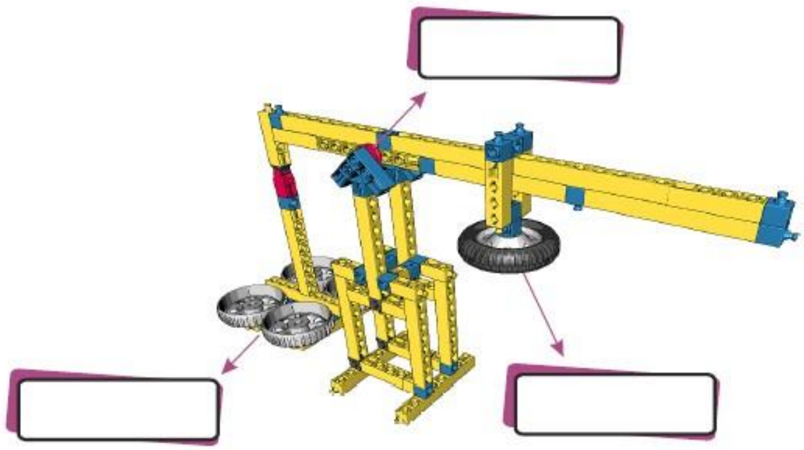
3. Now, we will need some small materials to put as weights on the scalepan (or weighing pan). These could be: rocks, beans, erasers or even other Engino parts that are included in your set. Put 3 or 4 of these materials on the scale and see what happens.

4. You will probably see that the balance is lost and the scale is leaning on the scalepan's side. Restore the balance again by moving the movable weight. Is the distance of the movable weight bigger than before?

5. Place some more materials on the loading base until it's fully loaded and try to balance the beam again. Is it possible? Why does this happen?

Engino "movable weight scale" model

1) Look at your Engino "movable weight scale" and fill-in the boxes with these words: **load, effort, fulcrum**.



2) Which one of the three elements (load, fulcrum, effort) of the lever above is placed between the other two?

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3) How does a balance beam scale work?

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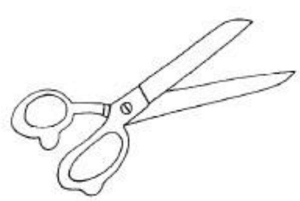
4) In the following images you can see some examples of first-class levers. Take a look at the pictures and try to identify where the load, the effort and the fulcrum are applied in each case.

Claw hammer



Scissors

Pliers

LEARNING ABOUT: Linkages

Pantograph

I'm sure you have seen beautiful pictures and sketches made by artists in magazines, or even by your friends in their sketch books. Wouldn't it be nice if there was a way of creating larger copies of the images you like that would still have the sense of a freehand design and not the look of a photocopy? Try the model of the pantograph in the next experiment and you will be amazed at what you will be capable of!

Objectives:

- What is the pantograph?
- How can you copy and enlarge shapes?

Level of difficulty ★★★★★

Materials needed:

1. Engino **building instructions booklet: LINKAGES,** page **9.**
2. Engino SIMPLE MACHINES (M10) or LINKAGES (M02).
3. A pencil, pieces of paper and sticky tape.

Procedure:

1. Build the **pantograph** model. If you are left-handed create a mirror copy of the model.

2. If we open the pantograph, we observe that there are two straight lines, **AB** and **BC**, as well as a **parallelogram shape OBRD** inside (see picture). Count the length (in Engino squares) of line **AB** (starting from the square of point **A** up to and including the last "red joint" piece, point **B**). How many squares is that distance? Do the same for line BC (starting from point **B** down to point **C**). How many squares is that distance? Is it the same length as that of line **AB**?

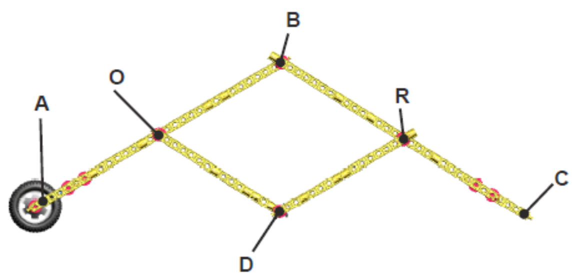
3. Count the distance **AO** (from point A to the point where line **AB** is connected with the parallelogram, point **O**). Also, count the distance **BR** (from point **B** to the point where line BC is connected to the parallelogram, point **R**). Are these two distances the same in length?

4. Place a pencil on the last hole of your pantograph and try to track the next images of a **rectangle** and a **triangle** with the black piece (point **D**). This would be **Test 1**. Draw your copies on a piece of paper, that should be fixed on your desk with sticky tape, and measure the **length** and **width** of each. If you are facing any problems, read the pantograph tips.

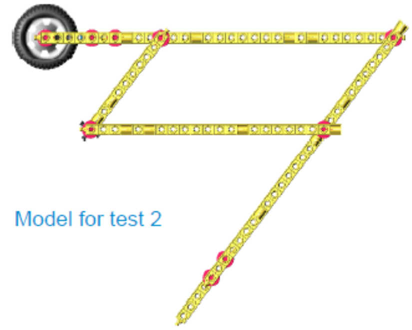
6. For **Test 2,** you need to remove the parallelogram of the pantograph and create another one, by replacing the red joint pieces at a distance of 10 Engino squares from point **A** and 10 Engino squares from point **B**. Use the appropriate Engino parts to complete the parallelogram (see picture) and track the images as before, in order to complete the table.

1) Complete the following table according to your observations. Some measurements are already in place to help you. Compare the dimensions of the original rectangle and triangle with the copies you made for each test. What can you observe? How is it related to the distance ratio?

Test	Total distance (squares)	Connection distance (squares)	Distance ratio (total/ connection)	Rectancle's original size (cm)		Triangles' original size (cm)		Copy rectancle size (cm)		Copy triangle size (cm)	
				length	width	length	width	length	width	length	width
1	30	15	30/15 = 2	2	5	4	3				
2	30	10									
3	30	20									



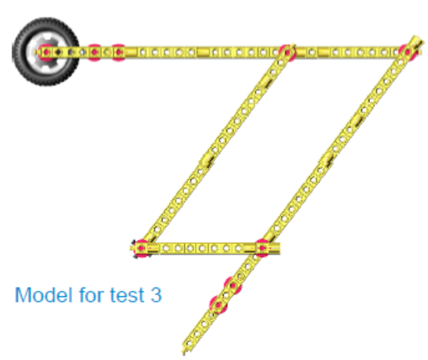
Pantograph's points for counting the necessary distances



Model for test 2

7. For **Test 3** you need to do similar changes, but this time the distance from point **A** should be 20 Engino squares and the distance from point **L** should also be 20 Engino squares (see picture on the right). Complete the table again.

8. Finally, you can try making a smaller copy of a picture by changing the functions of points **D** and **C**. Thus, remove the pencil from the end and attach it on the black piece (you can use tape to attach it on the part). Track an image using point C this time.



Model for test 3