SIMPLE MACHINE:

Name: ……………………………………………………………………………………………

Date: ……………..

School: ………………………………………………………………………………………………… Class: …………………

Before the experiments

QUESTIONS BEFORE THE EXPERIMENTS

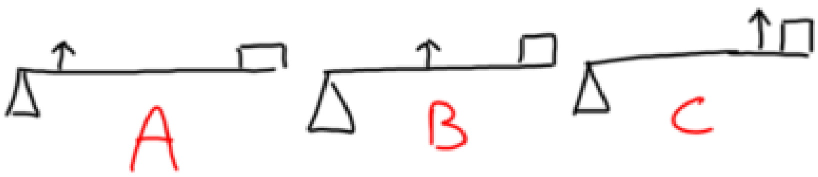
Answer the questions related to the Simple Machine:

1. What is a lever?

2. Levers are all around us. Give examples of where you might see levers working.

3. Explain what is the advantage of using a levers?

4. **a. Which of the levers would be the easiest to lift the load?**



a.

5. **Levers make-work** harder or easier? Explain

Experiment 1

TITLE: Bilateral lever balance condition

FOR THE TEACHER

The aim of the experiment is to determine the equilibrium condition of the bilateral lever.

LAB SHEET

Equipment

What you will need:

1.a school model of a two-sided lever or a bar, a simple stick, a stick, a plastic rod about 30 cm long You can also use a cardboard tube with food foil wrapped around it. It is important that the element is not too smooth and has the same diameter along its entire length

2. three pieces of string or strong thread - they should not be too smooth (slippery);

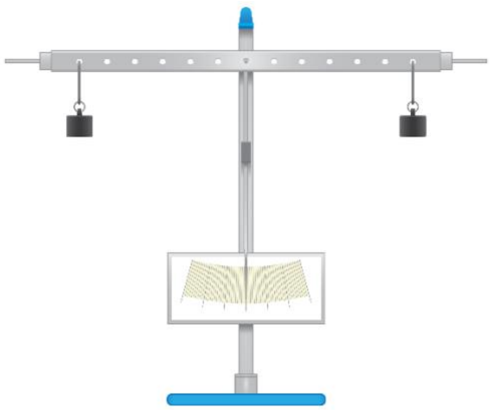
3. ruler;

4. ten equal weights. Instead of them, you can use large candies in wrappers, to which we will tie loops of thread. If we divide the total weight of candies by the number of candies, we determine the weight of a single candy.

Procedure:

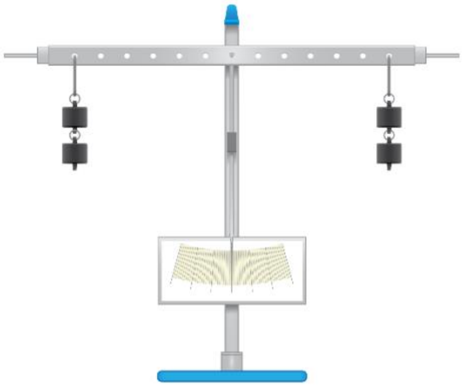
Attach the lever to a tripod.

If you are using a lever that you made yourself - mark its center, then on each side six two-centimeter sections, counting from the center. Tie a string in the middle of the slat and hang it on the stand. A view of a typical school lever is shown in the figure.

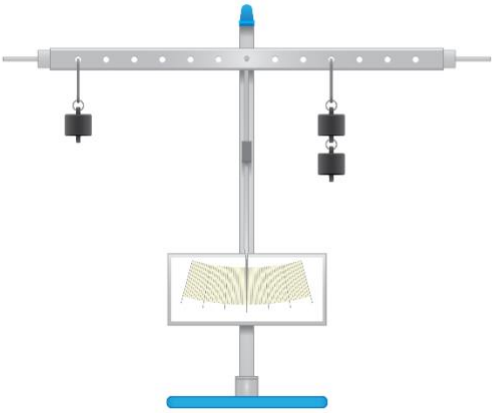


On the left side of the lever on the sixth On the left side of the lever on the sixth marker (counting from the center), hang one weight.

Choose the number of weights that you need to hang on the right side at the same distance from the center so that the lever remains balanced (the bar remains horizontal).



Select the number of weights you need to hang on the right side of the third marker, counting from the center, so that the lever remains balanced (the bar is hanging horizontally).



Select the number of weights that you need to hang on the right side of the second marker, counting from the center, so that the lever remains balanced (the bar hangs horizontally).

On the left side of the lever, hang the four weights on the fifth marker from the center.

Choose the number of weights that you need to hang on the right side of the fourth marker from the center so that the lever remains balanced (the bar is hanging horizontally).

Measurement table for experience									
Left side					**Right-hand side**				
Number of weights	**Weight of weights** m[kg]m[kg]	**Force of gravity** F[N]F[N]	**Distance from the axis of rotation** r[cm]r[cm]	**The product** F·rF-r [N·cm][N-cm]	**Number of weights**	**Weight of weights** m[kg]m[kg]	**Force of gravity** F[N]F[N]	**Distance from the axis of rotation** r[cm]r[cm]	**The product** F·rF-r [N·cm][N-cm]

Measurement table for experience									
Left side					**Right-hand side**				
Number of weights	**Weight of weights** m[kg]m[kg]	**Force of gravity** F[N]F[N]	**Distance from the axis of rotation** r[cm]r[cm]	**The product** F·rF-r [N·cm][N-cm]	**Number of weights**	**Weight of weights** m[kg]m[kg]	**Force of gravity** F[N]F[N]	**Distance from the axis of rotation** r[cm]r[cm]	**The product** F·rF-r [N·cm][N-cm]

1. Complete the table by calculating:
    1. weight (mm = weight of one weight x number of weights), remember to express it in kilograms;
    2. gravity of the weights, using the formula F=m·gF=m-g;
    3. the product of the gravity and the distance of the suspension point of the weights from the axis of rotation of the lever.

FIX CONCEPTS AND REFLECTIONS

Summary

The observations show that the lever remains in equilibrium even when the forces applied on both sides of the axis of rotation are not the same.

The lever remains in equilibrium when the forces applied on both sides of the axis of rotation have the same direction and sense (action of one of them tries to turn the lever clockwise and the other - counterclockwise) and the product of the values of the forces and arms of these forces is the same both sides of the axis of rotation. We can write this conclusion by the formula: FL· rL = FP· rP. This condition is true for forces perpendicular to the lever, but this is what we were dealing with when the lever was in equilibrium.

Remember!

The double-sided lever remains in equilibrium if the product of the force and the force arm has the same value on both sides of the lever support point, that is:

F1· r1 = F2· r2

and the forces on both sides of the axis of rotation have the same sense and are perpendicular to the lever.

Experiment 2

TITLE: Determination of body weight with a two-sided lever.

LAB SHEET

Introduction

This experiment aim to determinate body weight with a two-sided lever, another body of known weight and a ruler.

Equipment

What you will need:

1. a school model of a two-sided lever or a simple stick, a stick, a plastic rod about 30 cm long. You can also use a cardboard tube on which food foil was wound - it is important that the element is not too smooth and has the same diameter along the entire length;

2. three pieces of string or strong thread (they should not be too smooth or slippery);

3. two small, identical foil bags;

4. ruler;

5. a weight or other object of known weight - it can be a bag of pudding or a chocolate bar, the weight of which is indicated on the packaging (we will also call this item a weight);

6. item to be weighed - for example, a pencil case.

Procedure:

In the middle of the stick, tie a piece of string tightly enough so that the stick does not slide out by itself, but loosely enough to move it around.

Grab the string, pick up the stick, check that it is hanging horizontally, and if not, move the string a little and check the balance - keep doing this until it is perfectly level. Mark the position of the string where the stick hangs horizontally.

Tie a piece of string with a loop at the end of each plastic bag. The loops must be large enough to be easily slipped over the ends of the stick. These are our scale dishes.

Erasmus+
KA2 - Strategic Partenrship in the field of education, training and youth
2018-1-IT02-KA201-048443
01.09.2018 > 31.08.2021
OpenCom
eurodesk

Put the weight in one pan and the weighing object in the other, hang the weighing pan at the ends of the stick and carefully start lifting the balance by the middle string.

If the balance tilts to one side, move the weighing pan on that side closer to the center. Try to keep the weighing pan containing the lighter object hanging almost to the end of the stick. Check that the weight you lifted is in balance. If not, repeat the movement of the heavier object until it is balanced.

When the dishes are in such a place that the stick hanging on the middle string is balanced - mark the positions of the dishes.

Use a ruler to measure the distance from the center to the pan containing the weight and write down:

r1 = ... cm

Use a ruler to measure the distance from the center to the pan containing the weighing body and write down:

r2 = ... cm

Record the mass of the weight:

m1 = ... g

FIX CONCEPTS AND REFLECTIONS

Now we proceed to calculate the unknown weight of the weighed body. Let us denote it mx.

We know that our stick with the scales suspended on the central string was a two-sided lever, which means that at the moment of achieving balance, the following condition was met:

$F1 \cdot r1 = F2 \cdot r2$.

The forces F1 and F2 are the weights of items placed in the dishes, that is:

$F1 = m1 \cdot g$, $F2 = mx \cdot g$.

After substituting these forces in the equilibrium condition of the levers, we obtain the equation:

$m1 \cdot g \cdot r1 = mx \cdot g \cdot r2$ /: g, $m1 \cdot r1 = mx \cdot r2$ /: r2,

$mx = m1 \cdot r1r2$.

We substitute the data recorded during the measurements and calculate the mass of the object.

Experiment 3

TITLE: Plank as a one-sided lever

FOR THE TEACHER

The teacher must always mentally estimate the force needed to raise the board to do not expose the student to overload. For example, with a two-meter board on which three pupils (45 kg each) are standing at a distance of 20 cm from the end of the board, lifting force will be equivalent to 135 kg / 10 = 13.5 kg. You have to take care of the aggravating group it was moved as close as possible to the end of the board.

If we are not carrying out this experiment in the field, it is worth going to the corridor or to a room with enough free space. If we don't have one possibilities, at least let's move the benches and chairs away. Students watching the measurements let's set it up so that in the event of loss of balance by people standing on the board, they fall in the arms of the observers and did not hit the furniture.

LAB SHEET

Equipment

•pine board with a thickness of min. 25 mm, width approx. 25 cm and longer be equal to 2 m (preferably approx. 3 m); does not need to be planed;

• any work gloves, they can be "vampires" (if the board is not planed);

• a wooden bar, approx. 20 mm thick, approx. 20 mm wide and 25 cm long or a similar support (it can be a strip of hard polystyrene);

• workshop tape measure, 3–5 m long, or a 2 meter long ruler

m. For didactic reasons, it is advisable that the ruler should be longer than the board (no then you have to measure the boards in sections; see notes).

Procedure:

1. Students put the plank on the floor. They put a stand under one of its ends (such so that you can slip your fingers under the board).

2. The teacher places 2-3 students on the plank, as close as possible to the end of the leaning on the floor.

3. One student grabs the other end of the board (the supported one) and lifts it up without much effort up. Together with the students, the teacher indicates the axis of rotation and the arms of the resulting rotation single-sided lever way.

Erasmus+
KA2 - Strategic Partenrship in the field of education, training and youth
2018-1-IT02-KA201-048443
01.09.2018 > 31.08.2021
OpenCom
eurodesk

4. The students measure the length of both lever arms with a tape measure. They assume that the weight of the group pupil weighters are placed in the center of the area occupied by their feet (the student-observer marks this place on the board with a marker pen).

5. Students who stood on the board say how much they weigh. Everyone calculates together by what force the fourth student raised the board (the simplest version does not take into account the weight of the board).

6. The teacher draws the students' attention to the fact that the length of the arms is always measured from the axis turnover, and that the student-sinkers lifted only slightly, while in the meantime it's over the planks were raised much higher.

The students measure the height of the end of the board with a ruler (this can already be measured on the board unloaded) and the rise of the mid-point around which the incriminating students stood the lever.

8. Using the formula for the work of both forces, everyone recalculates the value of the student's strength carrying a board. The result should be similar to the previous one.

The experiment can be repeated by moving the incriminating students a little closer to the center the board (not too close - the force at the end of the board must not endanger the health of the lifting student) or by changing the number of students loading the board at the axis of rotation

FIX CONCEPTS AND REFLECTIONS

It should be emphasized that the length of the arms of each lever is always measured from the axis of rotation. With a one-sided lever, students struggle with this: they often measure distances from the axis to the point of application of the first force and then incorrectly from there to the point of application of the second force. To preserve the correct image of the measurements in memory students should measure the length of the board "at a time", so the ruler must be long enough. You can also use a more advanced variant of the calculations, including the weight of the board itself. It is not necessary to add up all the moments of strength. Just estimate the force needed to lift one end of the board as half the weight of the board (see: pickaxe and stone block experience) and add this fix. We calculate the weight of the board, assuming that the density of dry pine wood is approx. 500 kg / m^3 (1 l has a mass of 0.5 kg, and 1 cm^3 weighs 0.5 g). The volume of the board is calculated from the formula for the volume of the cuboid after taking appropriate measurements. By picking up the plank from the floor, the teacher can draw students' attention in the correct way lifting, without endangering the lower spine (which, by the way, also works like lever) to excessive load. We lift by using the thigh muscles while maintaining straight back, not bending down and straightening.