Teachers' guide

Objectives of the lesson

Cognitive objectives

- Students know which variables affect the balance of the scale and connect them
- Students can describe why the scale balances in each case
- Students can explain the results of their inquiries

Emotional objectives:

- Students are encouraged to make measurements and wonder about their results
- Students are willing to check their assumptions
- Students are willing to make the measurements properly

Psychomotor objectives:

- Students collaborate with each other to achieve the objectives of the activity
- Students can communicate effectively with their groups and in the plenary discussion, develop their critical thinking skills and be creative when they are asked to solve a problem
- Students develop fine motor skills

Introduction to the activity

The occasion for the introductory discussion are the old scales, found in various shops, and the ancient Goddess Themis, who holds the scales of justice. You can discuss about how the balance works and modern applications of it.

Building

The construction is big, but not time consuming.

Be careful! If the weights are equal and on equal distances, the balance will balance in any point you let it, because the total torque is equal to zero, so it will not necessarily balance horizontally. Also, if you change the weights or the distances, it will again balance at a point where the total torque is equal to zero. So, you have to let the balance from a horizontal point (point zero) and then see where it tilts. This means you have to create an indicator.

Answers to the worksheet

Build until step 9B. Then, for the following steps, see the worksheet.

1. The weights balance on the horizontal level, because the weights are equal and their distance from the axle of the balance is equal. Explain to your students that the important variables are two: the distance and the weight. If we want to have balance, we have to achieve the right combination of them. You can explain that in the balances we saw in the presentation the distance is fixed, and we only change the weight. You can also add these in the introductory presentation, if you consider it more suitable.

Notice that the scale balances again.

2. Notice that the balance balances on the horizontal level, because the weight is doubled and the distance is the half.

Using a weight, and starting from the horizontal level, the balance tilts to the left. This happens because the weights are equal, but the distance of the left weight is greater.

3. The balance tilts to the right, because the weight is tripled and the distance is the half. So, to greater weight "wins".

4. Open inquiry for the students. If you see that they don't take initiative, you can organize the inquiry for them.

5. Use an 8M axle and 4 medium wheels to achieve balance with the unknown weight in the 5th hole from the left and the four weights on the 15th hole from the right. All holes are measured from the axle of the balance.

It is around: $w_{unknown} \times 5 = 2 \times 4 \times 15 \rightarrow w_{unknown} = 24\ gr$

*Most probably you will not do the math, since students of that age cannot understand them. You can just ask them to find the point the scale will balance qualitatively.

6. Open building for the students. You can see a suggested solution in the following photograph.