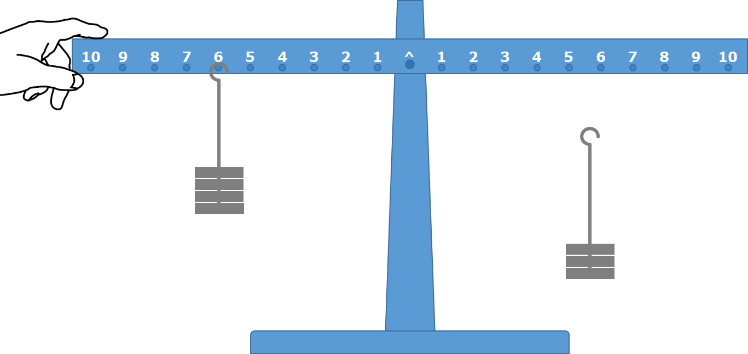
**Balance beam**

Aimee has put four weights onto the balance beam.

She is holding the beam level.

**Predict**

Where should Aimee put a set of three weights to make the beam balance?

**Explain**

Explain why she should put the weights here.

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| **Investigate to see if you are right.** |

**Observe**

Record the number of weights and distances on each side of the beam when it balances.

Do this five times using different weights on each side.

**Explain**

Were your prediction and explanation correct?

Describe a rule that predicts where to put different weights to balance the beam.

*Physics > Big idea PFM: Forces and motion > Topic PFM3: More about force > Key concept PFM3.3: Turning effects*

|  |
| --- |
| **Response activity** |
| **Balance beam** |

**Overview**

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| --- | --- |
| Learning focus: | If a force acts on a pivoted object, the object turns about its pivot: the size of the turning effect depends on the size of the force and on its (perpendicular) distance from the pivot. |
| Observable learning outcome: | Predict the relative size of different turning effects by comparing forces applied and lengths of levers.  Predict where to place different sized weights on either side of a pivoted beam, in order to make it balance. |
| Activity type: | Predict, explain; observe, explain (PEOE) |
| Key words: | balance, force, lever, pivot, turning effect |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: Wire cutters
* Diagnostic question: To tip, or not to tip?

**What does the research say?**

When teaching, it may be helpful not to use the term ‘moment’ to describe turning effects because students often associate the term with ‘time’, or confuse it with ‘movement’. Using ‘turning effect’ can be less problematic (Driver et al., 1994).

When students are able to identify levers and describe what they do with confidence, the next step is to identify and develop an understanding of the measureable forces (effort and load), the distances from the pivot, and the relative distances moved by the load and the effort. Students need to develop understanding of how the distance from the pivot and the applied force combine to produce a turning effect. These are compensating variables because when a force is applied at a greater distance from a pivot it requires less effort for it to achieve the same turning effect as another force applied closer to the pivot (Driver et al., 1994). It is important to make explicit that when a smaller applied force is needed because a longer lever is being used, the applied force has to be moved through a greater distance than a bigger force acting on a shorter lever. This is necessary in order to subvert the misconception that you can get ‘something for nothing’ (Institute of Physics).

Giving students first-hand experience of balancing different sized weights on a pivoted beam can help students move from a qualitative to a quantitative understanding of turning effects.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict *what* they think will happen, and then to explain *why* they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

Students now carry out the practical, or watch a demonstration. You will need to decide whether it is better for each group to carry out the practical and risk some unexpected observations, or to demonstrate the activity so that everyone *observes* the same thing.

After the practical each group should be given the opportunity to change, or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their *explanations* and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Equipment**

For each student/pair/group:

* Balance beam
* Two sets of weights (e.g. sets of ten 100g hanging masses of which each mass has a weight of approximately 1 Newton)

**Technician notes**

Many schools in England are likely to have a set of suitable balances that were purchased for an activity in the CASE (Cognitive Acceleration in Science Education) project.

**Health and safety**

Falling and/or rolling weights can be a hazard.

Hanging masses falling onto a bench can break the joint where the bottom mass fixes to the hanger. It may be appropriate to place offcuts of carpet underneath the hanging masses.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

Aimee should place the weights at a distance of 8 from the pivot.

The general rule is that the force (weight) x distance from the pivot is the same on both sides for the beam to balance.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Hand: <https://pixabay.com/vectors/pointing-finger-hand-show-151637/>, Peter Fairhurst (UYSEG).

**References**

Driver, R., et al. (1994). *Making Sense of Secondary Science: Support Materials for Teachers,* London: Routledge.

Institute of Physics. *Supporting Physics Teaching 11-14: Machines, Levers* [Online]. Available at: <http://supportingphysicsteaching.net/MaHome.html> [Accessed June 2019.