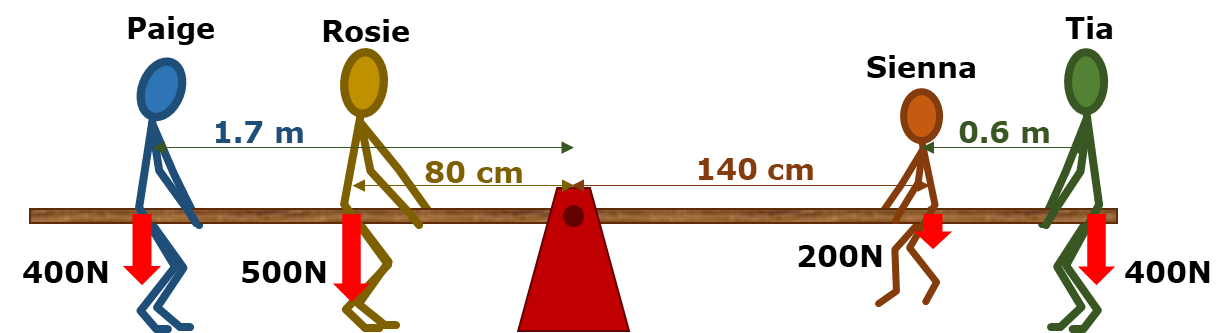
**See-saw calculations**

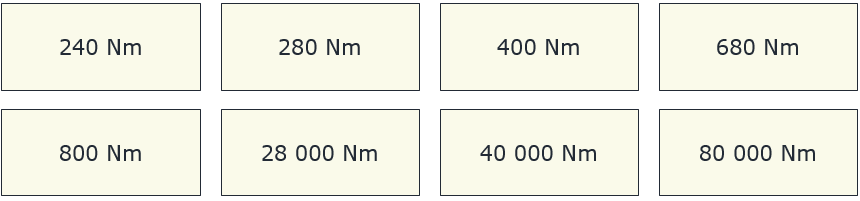
Four children are sitting on a see-saw.

They try to make it balance.



1. Calculate the turning effect of each of the children.

Choose from the answers below.



1. Which way does the see-saw tip?

(Use your answers from question 1 to work this out)

|  |  |  |
| --- | --- | --- |
| **A** | It will tip to the left. |  |
|  |  |  |
| **B** | It will tip to the right. |  |
|  |  |  |
| **C** | It will not tip. |  |

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

|  |
| --- |
| **Diagnostic question** |
| **See-saw calculations** |

**Overview**

|  |  |
| --- | --- |
| 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: | Calculate the size of the turning effect. |
| Question type: | Linking ideas and simple multiple choice |
| Key words: | balance, force, lever, pivot, turning effect |

|  |  |
| --- | --- |
| **B** | **BRIDGING**  This diagnostic question probes understanding of ideas that are usually taught at age 14-16, to build a bridge to later stages of learning. |

**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).

**Ways to use this question**

This activity gives students the opportunity to practise applying their understanding and to clarify their thinking through practising calculations. To support this, students could answer the question in pairs or small groups.

For these questions students are required to convert distances given in centimetres into metres, and to work out a distance to the pivot that is not always given directly. To check whether the see-saw is balanced students need to add the turning forces on each side of the see-saw to see if they are equal.

Listening to individual groups as they work often highlights any difficulties they might have. These can often be overcome, through a whole class clarification or redirection part way through the activity.

Allowing only one student in each pair or small group to write down the answer on behalf of the group encourages discussion of both the science and of the presentation of the answer.

*Differentiation*

If some students are working with a teaching assistant, then a list of prompt questions for the TA could help to make this activity more purposeful.

**Expected answers**

1. Paige: 400 x 1.7 = **680 Nm**

Rosie: distance from pivot = 80 cm = 0.8 m; turning effect is 500 x 0.8 = **400 Nm**

Sienna: distance from pivot = 140 cm = 1.40 m; turning effect is 200 x 1.4 = **280 Nm**

Tia: distance from pivot = 1.4 + 0.6 = 2.0 m; turning effect is 400 x 2.0 = **800 Nm**

2. Anti-clockwise turning effect = 680 Nm + 400 Nm = **1080 Nm**

Clockwise turning effect = 280 Nm + 800 Nm = **1080 Nm**

**C** : It will not tip, because the turning effect is balanced. (BUT: if it is already turning, then it will continue to turn at a steady rate. A resultant turning effort will speed up or slow down the speed of rotation.)

**How to respond - what next?**

The calculations are relatively straight forward for students who are using a calculator and the difficulty is in working out what force and distance to multiply or add in each case.

Some students may not convert cm into m and obtain much larger numbers for the children closer to the pivot. It can help to prompt these students to question whether their answers are reasonable when they think about the real situation. This is a good opportunity to show why using consistent units is important, and for students to always think about whether their answers to calculations make sense, and to use this thinking as a check.

In working out Tia’s turning force two distances that are not given in the same units need to be added. It is likely that some students will multiply the distance given next to Tia instead of the combined distance. Again these students will then get an answer that does not make sense if they consider the actual situation.

The following BEST ‘response activity’ could be used in follow-up to this diagnostic question, in order to make the thinking processes used in these calculations more overt:

* Response activity: Calculating turning effect

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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