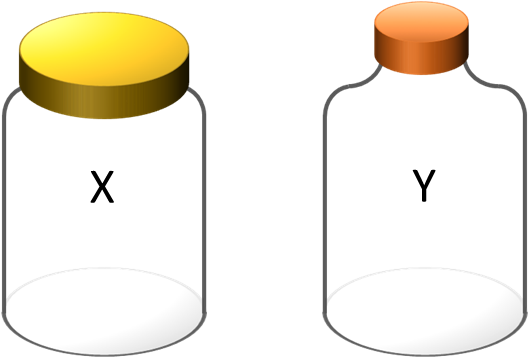
**Lids off**

The lids of these jars twist off.



Which lid needs less force to twist off?

Put a tick (✓) in the box next to the best answer.

|  |  |  |
| --- | --- | --- |
| **A** | The one on jar X. |  |
|  |  |  |
| **B** | The one on jar Y. |  |
|  |  |  |
| **C** | They both need the same force. |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Lids off** |

**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: | Recall that a bigger applied force and/or a longer lever gives a larger turning effect. |
| Question type: | Simple multiple choice |
| Key words: | force, turning effect |

|  |  |
| --- | --- |
| **P** | **PRIOR UNDERSTANDING**  This diagnostic question probes understanding of ideas that are usually taught at age 5-11, to aid transition from earlier stages of learning. |

**What does the research say?**

From an early age students often have an intuitive understanding of turning effects through their everyday interactions with doors, see-saws and other mechanical devices (Inhelder and Piaget, 1958; Driver et al., 1994a; Institute of Physics). In England students investigate levers as force multipliers at age 9-10 (Department for Education, 2013); before progressing they need to be able to put into words their intuitive understanding that an effort further from a pivot leads to a bigger turning effect (Driver et al., 1994b). Driver et al. also point out that building understanding of turning effects from students’ intuition is more effective than limiting teaching to arithmetic manipulation of the formula: moment = force x perpendicular distance from the pivot.

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., 1994b).

**Ways to use this question**

Students should complete the question individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

The answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

**A** The one on jar X.

**How to respond - what next?**

Twisting lids off is a less obvious situation in which force is applied at a distance from a pivot in order to turn an object.

Many students may realise that the jar with the larger lid is easier to open through experience, but this is not especially obvious and it is not likely that many are able to put the reasons for this clearly into their own word.

If students have difficulty in describing that it is easier to open a jar with a bigger lid because force is applied further from the pivot, it can help to investigate what is happening using similar examples. A relatively easy one to try is to turn a door lever (handle) close to the pivot and then further from the pivot, to notice the difference in force needed. This idea can be extended to thinking about door knobs, and perhaps to discussing why door levers are often fitted to doors of the elderly or infirm (because they require less force to turn).

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

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