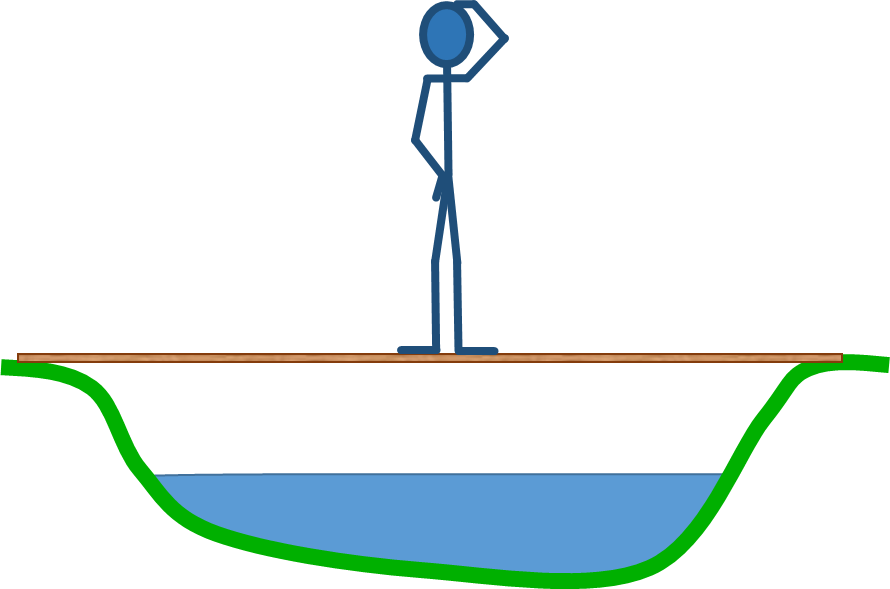
**John’s plank**

John has made a bridge using a plank of wood.

He stands on the bridge to test it out.



How does the plank support people who weigh different amounts?

Pick ***one*** statement in each row to explain how.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | John is standing on a bridge he made using a plank of wood. | | | |
| 2 | John’s weight pushes on the plank and makes it bend a little bit. | | The plank supports John’s weight without bending at all. | |
| 3 | The upwards force on John is the biggest force. | The downwards force on John is the biggest force. | | The forces on John are balanced. |
| 4 | The plank pushes up on John with a force equal to his weight. | The plank pushes up on John with a force bigger than his weight. | | The plank pushes up on John with a force smaller than his weight. |
| 5 | John’s friend joins him on the bridge and the plank goes down in the middle. | | | |
| 6 | The plank pushes up with the same size force as before. | The plank pushes up with a bigger force than before. | | The plank pushes up with less force than before. |

*Physics > Big idea PFM: Forces and motion > Topic PFM3: More about force > Key concept PFM3.2: Hidden forces*

|  |
| --- |
| **Response activity** |
| **John’s plank** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | An object resting on the floor squashes it a little and, because at a microscopic level the floor is springy, it pushes back on the object with an equal sized force in the opposite direction to the object’s weight. |
| Observable learning outcome: | Explain how a ruler, made into a bridge, changes to support weights of different sizes. |
| Activity type: | Explanation story |
| Key words: | balanced, force, weight |

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

* Diagnostic question: Ruler bridge

**What does the research say?**

Research by Terry *et al (1985)* has shown that expressing Newton’s third law in the form: “for every action (force) there is an equal and opposite reaction” is confusing for students aged 11-16. It is far clearer to describe in full: the force of object A on object B is equal in size, and opposite in direction to the force of object B pushing on object A.

When thinking about one object resting on a surface, students typically apply a concept of force that is different to the one they use for objects in motion. In a study of 1000 Norwegian upper secondary students, Sjoberg and Lie (1981) found that just 50% of the young people recognised ‘passive’ forces acting when there was no movement.

When Minstrell (1982) asked two US high school physics classes (aged 14+) about forces on an object resting on a table, most of the students understood that gravity was exerting a downwards force on the object, but only about half described the table exerting an upwards force. Students who did not identify an upwards force mostly described the table as ‘getting in the way’ (Driver et al., 1994). Typically those who recognised an upwards force from the table described the downwards force as bigger. In a further study, Montanero et al. (2002) found that only a very small minority of 11- to 16-year-olds (n=240) consistently applied the correct scientific understanding that the upwards force of a surface is the same size (and in the opposite direction) to the weight of an object that it supports.

Bridging analogies gradually take learners through a series of easily understood ‘base analogies’, in order to lead them to an understanding of a challenging ‘target concept’, which is outside the realm of their usual experience or understanding. Squashing a spring or seeing a ruler flex more as extra weight is added seems to make it plausible to them that a table surface flexes in a similar way in order for an upward force to be created (Bryce and MacMillan, 2005).

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It is best done as a pencil and paper exercise.

Students should read the statements and follow the instructions on the worksheet. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

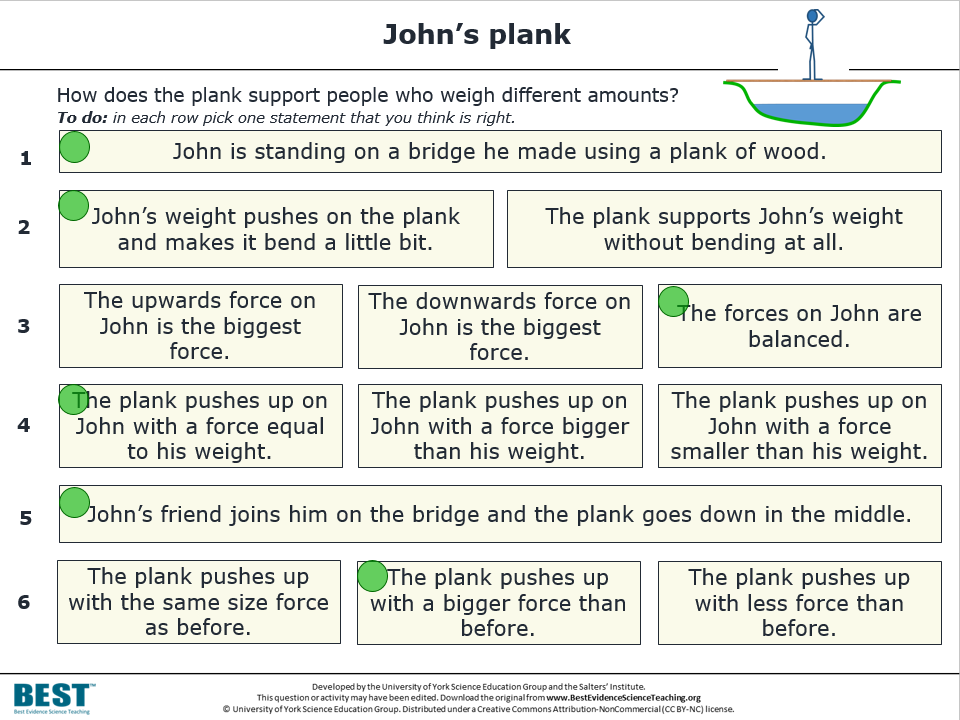
Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*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 the 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.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

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**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Bryce, T. and MacMillan, K. (2005). Encouraging conceptual change: the use of bridging analogies in the teaching of action-reaction forces and the 'at rest' condition in physics. *International Journal of Science Education,* 27(6)**,** 737-763.

Driver, R., et al. (1994). *Making Sense of Secondary Science: Research into Children's Ideas,* London, UK: Routledge.

Minstrell, J. (1982). Explaining the "aqt rest" condition of an object. *The Physics Teacher,* 20**,** 10-14.

Montanero, M., et al. (2002). Implicit theories of static interactions between two bodies. *Physics Education,* 37 (4)**,** 318-323.

Sjoberg, S. and Lie, S. (1981). Ideas about force and movement among Norwegian pupils and students. *Institute of Physics Report Series: Report 81-11.* University of Oslo.

Terry, C., Jones, G. and Hurford, W. (1985). Children's conceptual understanding for force and equilibrium. *Physics Education,* 20(4)**,** 162-165.