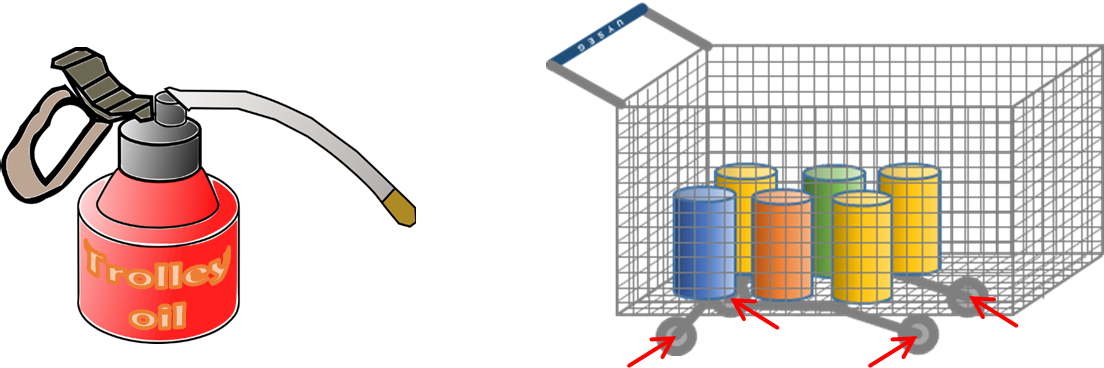
**Trolley racing**

Sophie and Isobel decide to have a race with their shopping trolleys.

Isobel oils the wheels on her trolley to reduce friction.



Some friends are talking about how oiling her wheels will help Isobel in the race.

**Paige:** At top speed she won’t need to push as hard.

**Rebecca:** She will have a higher top speed.

**Tilly:** At the start there will be a bigger resultant force on the trolley.

**Scarlett:** She will be able to push with more force.

**To answer**

1. Who do you think is right about why oiling her wheels will help Isobel?

*Explain your answer.*

* 1. What mistakes do you think the others made?

*What would you say to them to help them to understand?*

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| Cards for  **Trolley racing** |  |
| **Paige:**  At top speed she won’t need to push as hard. | **Rebecca:**  She will have a higher top speed. |
| **Scarlett:**  She will be able to push with more force. | **Tilly:**  At the start there will be a bigger resultant force on the trolley. |

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| Cards for  **Trolley racing** |  |
| **Paige:**  At top speed she won’t need to push as hard. | **Rebecca:**  She will have a higher top speed. |
| **Scarlett:**  She will be able to push with more force. | **Tilly:**  At the start there will be a bigger resultant force on the trolley. |

*Physics > Big idea PFM: Forces and motion > Topic PFM2: Moving by force > Key concept PFM2.3: Changing motion*

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| --- |
| **Response activity** |
| **Trolley racing** |

**Overview**

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| --- | --- |
| Learning focus: | A resultant force on an object can cause it to speed up or slow down, depending on the direction of the force. |
| Observable learning outcome: | Explain why friction and other resistive forces make it necessary to exert a constant force to keep an object moving at a steady speed |
| Activity type: | Talking heads |
| Key words: | Force, weight, friction, drag |

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

* Diagnostic question: Supermarket dash

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

**What does the research say?**

When the speed of an object is being increased, students tend to focus on the applied force that appears to be needed to get it going, and keep it going. They often think that a moving object *has* force that keeps it moving, and which runs out when it comes to rest (Gunstone, R and Watts, 1985; Driver et al., 1994a). Osborne (1985) found that as students get older they *increasingly* hold the view that a force, pushing in the direction of motion, is needed to keep an object moving. In a study of 200 students he found 46% of 13 year olds believed this, increasing to 53% of 14 year olds and 66% of 15 year olds.

Instead of concentrating on the applied force, students need to think about all the forces acting and how they combine to produce the resultant force. They need to identify when it acts, when it changes and when it ceases. This involves understanding friction and the direction it acts in in order to recognise how it contributes to the resultant force (Driver et al., 1994b).

For most students the idea that a bigger force produces a bigger effect is intuitive, but it is important to emphasise that force does not produce speed, but a change in speed (Driver et al., 1994b). In other words: any moving object will continue to accelerate whilst a resultant force is acting on it.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. The statements are also provided as cut-out cards for students to physically organise.

Students should work together to follow the instructions on either the worksheet or the PowerPoint. Giving each group one worksheet to complete between them is helpful for encouraging discussion, but each member should be able to report back to the class. Listening in to the conversations of each group will often give you insights into how your students are thinking.

If there is disagreement when you take feedback, a good way to progress might be 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*

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.

**Expected answers**

1. Rebecca and Tilly are correct.

* Isobel will increase the speed of the trolley until the force of friction is equal in size to the force she is pushing it with. Oiling the wheels increases the speed at which this happens because at any particular speed friction is less.
* Isobel will be able to push with the same force on any trolley and resultant force = force Isobel pushes the trolley with minus the force of friction pushing back on the trolley. For any particular speed oiling the wheels will increase the resultant force.

2. Paige is thinking that the top speed will be the same as before, in which case it would be easier to push the trolley with oiled wheels. Isobel will be pushing the trolley just as hard as before, and her top speed will be bigger.

Scarlett is confusing resultant force with the applied force that Isobel can push with. Isobel is the same person and can push the trolley with the same force as before, but at each particular speed the friction is now smaller.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG); oil can: <https://pixabay.com/en/oil-can-oilcan-oiler-oil-tank-160477/>.

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