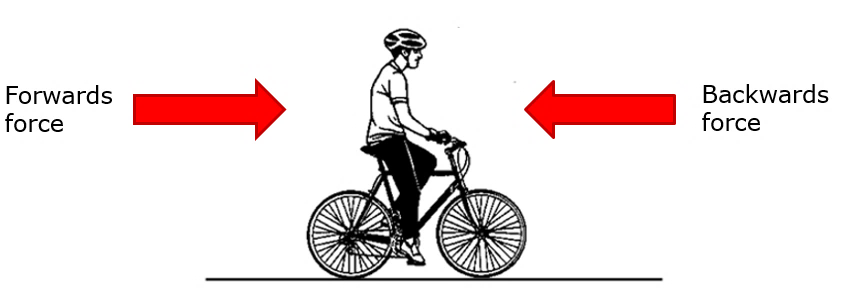
**Cycling forces**

Pedalling makes a force that pushes forwards.

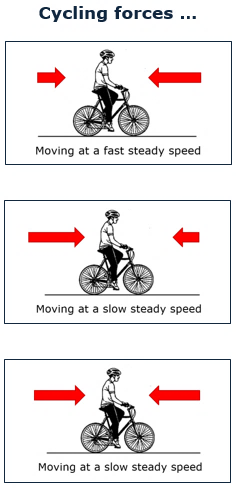
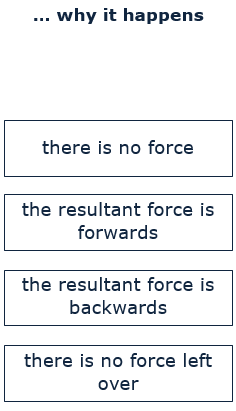
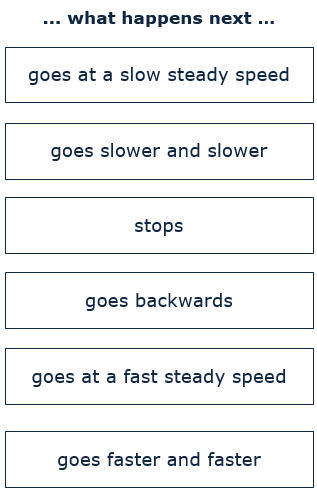
Friction and air resistance make a force that pushes backwards.



**To do**

Join the boxes to explain what happens when the forces change.

Draw one line from the **cycling forces** to **what happens next**. Draw another line to **why it happens**.



*Physics > Big idea PFM: Forces and motion > Topic PFM1: Forces > Key concept PFM1.1: What forces do*

|  |
| --- |
| **Response activity** |
| **Cycling forces** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | A force makes things change: the speed, direction and/or shape of an object. |
| Observable learning outcome: | * Predict correctly the changes caused by forces of different sizes and direction on an object. * Explain changes caused by more than one force acting on an object at the same time. |
| Activity type: | Response, linking ideas |
| Key words: | force, direction, speed, resultant force |

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

* Diagnostic question: Big force, little force
* Diagnostic question: An extra force

**What does the research say?**

Some students find it hard to think of forces in terms of their magnitude and direction (Driver *et al*, 1994). Taking the strength of a force into account is essential to analysing the effect of forces in different situations.

When students see several forces acting together they often perceive them as engaged in a struggle with the strongest one winning (Erickson and Hobbs, 1978).

Students often use the terms speed and acceleration interchangeably. Forces make the speed change and therefore cause acceleration. Common ways that students say this are, for example, ‘going faster’, or ‘increasing speed’. These terms are ambiguous as they do not distinguish between acceleration and a faster steady speed (Driver *et al*, 1994). It is important to be precise with the phrasing of this so that the understanding is clear. Here we have used the phrase ‘getting faster and faster’.

Some students link the idea of no resultant force to no movement. This is the corollary of the commonly held view (Osborne, 1985) that a force, pushing in the direction of motion, is needed to keep an object moving. In a survey of 200 students, Osborne found the latter view was held by the majority of 14 and 15 year olds.

Other students see two equal forces as cancelling each other out when an object is not moving. Some may consider this to be the case also when a moving object is also subject to balanced forces.

**Ways to use this activity**

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

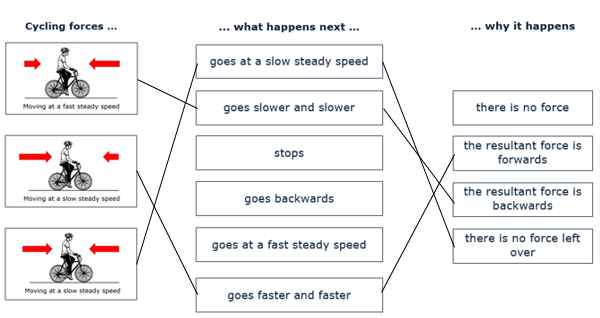
Listening to individual groups as they work often highlights any difficulties they might have. These can often be overcome, through a whole class clarification or redirection part way through the activity.

Asking students to share their answer is a useful check.

*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**

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**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: EPSE

**References**

Driver, R., Squires, A., Rushworth, P. and Wood-Robinson, V. (1994) Making sense of secondary science, research into children’s ideas, Routledge, London, England.

Erickson, G. and Hobbs, E. (1978) ‘The developmental study of student beliefs about force concepts’, Paper presented to the 1978 Annual Convention of the Canadian Society for the Study of Education. 2 June, London, Ontario, Canada.

Osborne, R. (1985) ‘Building on children’s intuitive ideas’, in Osborne, R. and Freyberg, P., *Learning in Science,* Heinemann, Aukland, New Zealand.