**Momentum**

Two tennis balls are thrown at you.

Question 1

* 1. Which tennis ball is the hardest to stop?

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

|  |  |  |
| --- | --- | --- |
| **A** | Harder to stop ball 1 |  |
|  |  |  |
| **B** | Harder to stop ball 2 |  |
|  |  |  |
| **C** | Both the same |  |

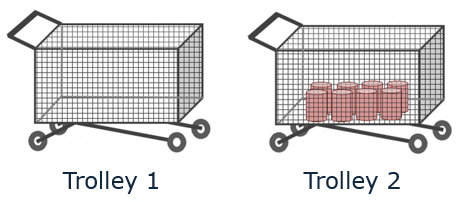
* 1. How would you explain your answer?

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

|  |  |  |
| --- | --- | --- |
| **A** | It is going faster |  |
|  |  |  |
| **B** | It is going slower |  |
|  |  |  |
| **C** | It has more force |  |
|  |  |  |
| **D** | It has less force |  |
|  |  |  |
| **E** | It is the same ball |  |

**Momentum**

You are going to push these shopping trolleys round a corner.



Question 2

1. Which shopping trolley is harder to push round a corner?

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

|  |  |  |
| --- | --- | --- |
| **A** | Harder to turn trolley 1 |  |
|  |  |  |
| **B** | Harder to turn trolley 2 |  |
|  |  |  |
| **C** | Both the same |  |

1. How would you explain your answer?

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

|  |  |  |
| --- | --- | --- |
| **A** | It has more force |  |
|  |  |  |
| **B** | It has less force |  |
|  |  |  |
| **C** | It weighs more |  |
|  |  |  |
| **D** | It weighs less |  |
|  |  |  |
| **E** | The wheels are the same |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Momentum** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | A force makes things change: the speed, direction and/or shape of an object. |
| Observable learning outcome: | * Recognise that the motion of objects that are heavier and/or moving faster are harder to change. |
| Question type: | Diagnostic, two-tier multiple choice |
| Key words: | force, momentum |

|  |  |
| --- | --- |
| **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?**

Forces are often linked to movement and students see force as a property of something that is moving. A property that keeps it moving and which runs out when a moving object comes to rest. In other words students often confuse momentum with force. The idea that force is something within an object that keeps it moving is a widely held view (Driver *et al*, 1994).

**Ways to use this question**

Students can complete the questions individually, before discussing their answers in pairs, small groups or as a class.

You could use an electronic ‘voting system’ or mini white boards to elicit individual answers from a PowerPoint presentation.

Use discussion of the answers as an opportunity to rehearse the vocabulary. Particularly distinguish ‘forces’ as pushed or pulls that *change* the motion (or shape) of an object, and ‘momentum’ that makes the motion of an object harder to change.

*Differentiation*

Read out the questions to the class so that less able readers can think clearly about the science.

**Equipment**

For the class:

* Tennis ball (perhaps useful to illustrate a discussion)

**Expected answers**

1a A, b A 2a B, b C

**How to respond - what next?**

*Question 1:*

Ball 1 is harder to stop because it is going faster and has more ‘momentum’, so a bigger force is needed to stop it. The emphasis should be that a force is what **changes** the motion, and a bigger force is needed here because there is a bigger change necessary.

Some students might choose ‘C, it has more force’, perhaps because they have experienced faster balls hitting their hands harder – but the force of impact is *not* something the ball carries with it and the catcher can change the force by altering how they catch the ball. What the ball has that affects the force of impact is momentum.

Other answers are probably guesses, or for ‘E it is the same ball’ the student is likely to have missed that the balls are travelling at different speeds.

Question 2:

Trolley 2 is harder to turn because it is heavier and has more ‘momentum’, so a bigger force is needed to turn it. The emphasis should again be that a force is what **changes** the motion, and a bigger force is needed here because there is more stuff on the trolley to change the motion of.

For similar reasons to question 1 some students might choose ‘A, it has more force’ because if they are in collision with a heavier trolley it appears to hit them with more force. Again the size of the force of impact is not a fixed thing carried by the trolley and the size of the impact depends on the nature of the collision – and on the momentum of the trolley.

If students have misunderstandings about how the motion of objects that are heavier and/or moving faster are harder to change, it may be helpful to use a demonstration to guide them to a clearer explanation. For example, a tennis ball can be caught differently to change its force of impact; but caught in the same way a faster one will impact with a bigger force. It is important at this stage to distinguish between a force that makes things change, and (extra) momentum that is the property that makes an objects motion harder to change. The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: Force or momentum?

**Acknowledgments**

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Images: UYSEG

**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.