**Slower football**

After Dylan kicks the football it slows down.



1. Why does the football slow down?

For each statement, tick (✓) **one** column to show what you think.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Places** | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | Its kinetic store of energy gets used up |  |  |  |  |
| **B** | It bashes into air particles making them move faster |  |  |  |  |
| **C** | It bashes into blades of grass making them move |  |  |  |  |
| **D** | The force pushing it gets used up |  |  |  |  |

*Physics > Big idea PFM: Forces and motion > Topic PFM1: Forces > Key concept PFM1.5: Energy stores and transfers*

|  |
| --- |
| **Diagnostic question** |
| **Slower football** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | When a force makes things change it mechanically transfers energy between different energy stores.  Friction transfers energy mechanically into a heat store of energy. |
| Observable learning outcome: | * Describe how energy can be transferred in different ways |
| Question type: | Diagnostic, confidence grid |
| Key words: | Energy store, energy transfer, drag, friction, heat |

**What does the research say?**

In teaching energy the BEST resources have adopted a framework based on ‘energy stores’ and ‘energy pathways’ which is advocated by, amongst others, (Boohan, 2014), (Millar, 2014) and (Tracy, 2014). As Millar (2014) says, this approach “is not perfect - but it is adequate and significantly better than [approaches] based on lists of ‘forms of energy’.” A clear guide to this approach can be found on the Institute of Physics’ website (Institute of Physics).

This question focuses on describing how energy dissipates by heating. Friction and drag are forces generated by an interaction between two objects or materials that move against each other. Work is done to move particles more quickly, which increases the temperature.

Describing how friction and drag cause heating introduces students to the dissipation of energy. Millar (2005) suggests that to make sense of the *law of conservation of energy*, students need to know that in almost every event there is some heating, whether desired or not, and a consequential increase in the heat store of the surroundings.

A summary of the BEST approach to teaching energy can be found on the Best Evidence Science Teaching home page which is on the STEM Learning website (Fairhurst, 2018).

**Ways to use this question**

Students should complete the confidence grid 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.

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**

B and C are correct. A and D are wrong.

**How to respond - what next?**

Both B and C describe how other objects or materials have energy transferred to them. Students may be able to add extra steps and detail to describe how this happens.

Answer A describes the energy as being ‘used up’, when in fact it is transferred to another place. Students may have the right understanding, but be using the language inaccurately. Asking where the energy has gone can clarify this.

Answer D suggests students are thinking that an applied force is necessary to keep an object moving, and that it can be used up like a fuel. These ideas are covered more fully in the BEST topic: *PFM2 Moving by force.*

If students have misunderstandings about why the ball slows down, it can be helpful to discuss the processes and mechanisms of the different ways energy is transferred from the kinetic store of the football to energy stores of the surroundings. Giving students further examples to discuss in pairs or in small groups can encourage social construction of new ideas about energy dissipation through dialogue.

The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: Transferring energy

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: UYSEG

**References**

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Millar, R. (2014). Teaching about energy: from everyday to scientific understandings. *School Science Review,* 96(354)**,** 6.

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