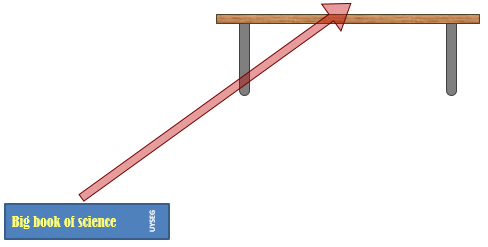
**Sankey diagrams**

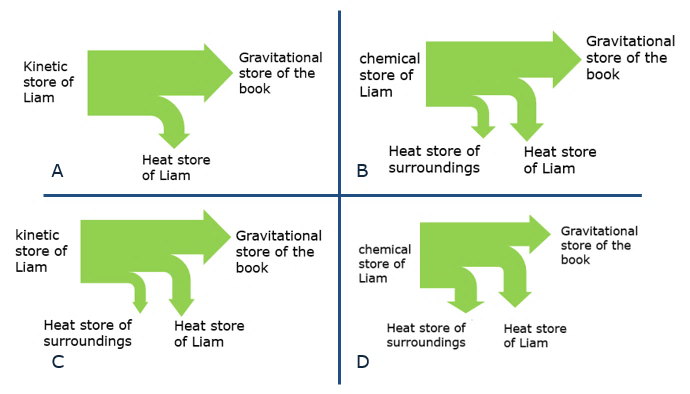
A Sankey diagram shows the energy stores. And it shows *how much* energy is moved to each store.

1. What happens when Liam lifts the book onto a high shelf?



Which Sankey diagram best shows what happens?

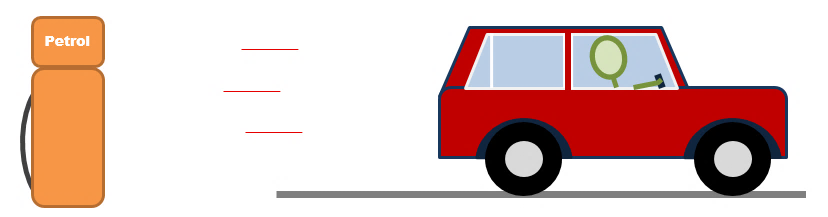
Put a tick (✓) next to the correct answer.



**Sankey diagrams**

A Sankey diagram shows the energy stores. And it shows *how much* energy is moved to each store.

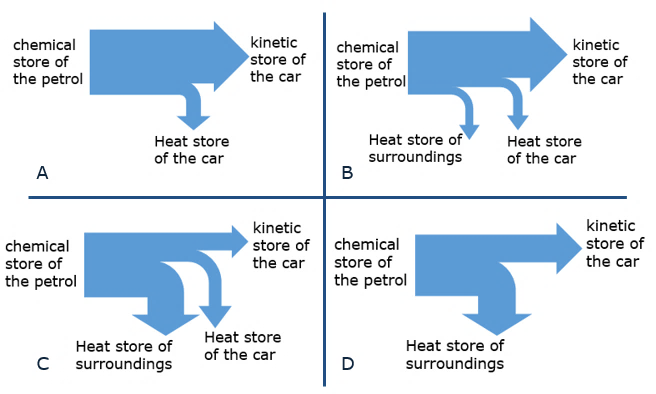
1. What happens when this car sets off and speeds up to 30 mph?



Cars are about 20% efficient

Which Sankey diagram best shows what happens?

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



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

|  |
| --- |
| **Diagnostic question** |
| **Sankey diagrams** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | An energy store of some kind is necessary for something to happen, and something happens when energy transfers between energy stores. |
| Observable learning outcome: | * Represent energy transfers in events using Sankey diagrams |
| Question type: | Diagnostic, simple multiple choice |
| Key words: | Energy store, energy transfer, chemical, heat, gravitational, kinetic |

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

**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).

Energy transfers can be represented with box and arrow diagrams that clearly show the different energy stores *and* the ways in which the energy is transferred (these energy diagrams are used in the response activity: *Energy stores circus* and in the second progression toolkit for this key concept). Sankey diagrams do not show the ways that energy is transferred, but they do show the relative amounts of energy transferred in different ways. (Millar, 2011) also notes that Sankey diagrams imply conservation of energy.

In a study of students aged 12-14 (Duit, 1981) found that, even after teaching, very few students use ideas of the conservation of energy to explain their predictions about unfamiliar events. This question requires students to consider the dissipation of energy into heat stores and the conservation of energy to analyse events.

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 question 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.

The answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

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**

1. B 2. C

**How to respond - what next?**

In question 1:

Answers A and C begin with Liam’s motion and indicate that students may be linking energy to forces and motion. B and D both show the correct energy stores, and students need to consider relative amounts of energy transferred to different stores. At this stage they are unlikely to have any idea of what these proportions are.

D shows equal proportions of energy transferred to each energy store, diagram B is a more realistic representation. Students may select D if they do not understand that the width of the arrows is proportional to the amount of energy transferred (although this thinking will mean that answer B is also picked half of the time).

In question 2:

Answers A and D do not show one of the heat stores. Answer B does show the correct energy stores, but too big a proportion going to the kinetic store. Students choosing this answer may not have noticed the 20% efficiency label, or they may not understand what this means. Alternatively, selecting this answer may indicate that students are simply not using the understanding that the width of the arrow is in proportion to the amount of energy.

If students have misunderstandings about selecting the Sankey diagram with the correct energy stores, it can be helpful to talk through a few examples in which, through class discussion, all the energy stores are identified. Students can then practise more examples, working in pairs or small groups, to help consolidate understanding through dialogue.

If students have misunderstandings about relating the width of the arrow to the relative amount of energy that is transferred, then giving them examples to draw can be helpful. For most students at this stage, drawing Sankey diagrams to scale is challenging and uses maths skills that are more advanced than they may have been taught in their maths lessons. It will probably be appropriate to use phrases such as ‘most of the energy’ or ‘a tiny bit of the energy’.

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

* Response activity: Energy stores circus

**Acknowledgments**

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Images: UYSEG

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