**Where is the force?**

Chloe picks up her bag.

An arrow shows the force she used.

1. Which arrow shows the force Chloe uses to pick up her bag?

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **A** |  |  |  | **D** |  |
|  |  |  |  |  |  |
| **B** |  |  |  | **E** |  |
|  |  |  |  |  |  |
| **C** |  |  |  |  |  |

1. How would you explain your answer?

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

|  |  |  |
| --- | --- | --- |
| **A** | The weight is here |  |
|  |  |  |
| **B** | Her muscles are here |  |
|  |  |  |
| **C** | She touches the bag here |  |
|  |  |  |
| **D** | The bag moves like this |  |

*Physics > Big idea PFM: Forces and motion > Topic PFM1 Forces > Key concept PFM1.2: Describing forces*

|  |
| --- |
| **Diagnostic question** |
| **Where is the force?** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Forces arise when two objects interact; the force on one object is always equal in size, and opposite in direction to the force on the other object; force arrows indicate the size, direction and location of each force. |
| Observable learning outcome: | Correctly position a force arrow to show how a particular force acts. |
| Question type: | Two-tier multiple choice |
| Key words: | Force, force arrow |

**What does the research say?**

An arrow is a useful way to indicate on a diagram the direction of any force that is acting on an object. The arrowhead shows the direction in which the force acts on the object. The tip or the tail of the arrow shows the point on the object at which the force acts (it does not matter which is used; the meaning is the same).

Terry *et al* (1985) found that many 11-14 year old students were quite ad hoc in their use of force arrows: they did not effectively start them from the point of action, use them to indicate the direction of force or change their length to indicate the size of the force. This may contribute, as Driver *et al* (1994) noted, to the difficulty that some students have in thinking of forces in terms of their magnitude and direction.

Understanding the reasons for positioning of force-arrows accurately helps students develop the ability to interpret force diagrams that show the effect of multiple forces acting on an object, so an early consolidation of this is important.

**Ways to use this question**

Students should complete the questions 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 follow on question will give you insights into how they are thinking and highlight specific misunderstandings that some may hold.

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**

**a.** B, **b.** C

**How to respond - what next?**

The force acts at the point where two object interact, which is where Chloe’s hand touches the handle. (In the whole situation: Chloe’s hand pulls up on the bag and the bag pulls down on Chloe’s hand; (Earth’s gravity pulls down on the bag (from its centre of mass) and the bag’s gravity pulls up on the Earth).

**Answers of A to part b** show students may be thinking that the force is directly linked to properties of the bag. This is not true as Chloe could for example, apply more force than the bag’s weight to throw the bag in the air, or less force and not get it off the ground.

**Answer a) A, b) B** suggests students are thinking there needs to be an active cause to a force – like the engine in a car giving it force. This is linked to the idea that force is a substance inside an object that gets used up.

**Answer D to part b** links force to the motion of an object and shows a confusion of force with momentum.

If students have misunderstandings about where to place the force arrow, a suitable response might be to give them the opportunity to practise drawing force arrows onto diagrams of further examples. Doing this in pairs or small groups will encourage social construction of new ideas through dialogue. The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: Measuring forces

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Images: UYSEG

**References**

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Terry, C., Jones, G. and Hurford, W. (1985) ‘Children’s conceptual understanding for force and equilibrium’, Physics Education 20(4): 162-5.