**Drag force**

Roller coasters push you through the air at a high speed.

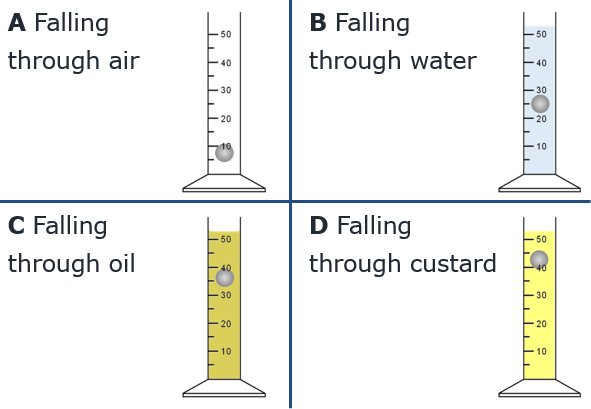
You feel a drag force.

Drag pushes on a falling ball

Each of four balls is dropped at the same time from the same height.

Which ball has the biggest drag force?





*Physics > Big idea PFM: Forces and motion > Topic PFM2: Moving by force > Key concept PFM2.4: Drag*

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| **Diagnostic question** |
| **Drag force** |

**Overview**

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| Learning focus: | The drag force on an object moving through a fluid increases with its speed and can be reduced by making the object more streamlined |
| Observable learning outcome: | Identify in which fluid an object has the biggest drag force |
| Question type: | Simple multiple choice |
| Key words: | Drag |

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| **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?**

The effect of drag on falling objects can be very confusing because although drag (air resistance in air) can significantly affect the motion of an object falling in the real world, students often do not take it into account. In a study, Lee and Kwok (2009) found that when 11- to 12-year-olds (n=204) were asked to label the forces on ball falling through air, 90% were able to label the gravitational force, but none of them included any drag force.

This question investigates students’ understanding of drag in fluids, some of which significantly slow down a falling ball. It can lead on to discussions of drag in air.

**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**

D: falling through custard

**How to respond - what next?**

Drag is a force acting opposite to the relative motion of any object moving with respect to a surrounding fluid. It is the force of the fluid on the moving object. The energy needed to push fluid particles out of its way transfers energy from the kinetic properties of the object to the fluid particles, and correspondingly reduces the speed of the object.

Students may instinctively suggest A: falling through air, because this has the biggest change in position. Some may choose A because they correctly work out the ball is travelling fastest and have (also correctly) linked bigger speed to bigger drag – but have not taken the fluid into account. Some may reason in this way and remember that it is harder to move through water than air and so choose answer B – which shows the ball moving fastest in a liquid.

If students have misunderstandings about how to identify which ball has the largest drag force, it can help to probe and discuss the reasons for the answers they give as suggested in ‘ways to use this question’ above.

The discussion should focus on how drag combines with weight to give a resultant force. In custard the ball speeds up least quickly because the resultant force is smallest.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG); roller coaster: https://pixabay.com/en/fun-roller-coaster-legoland-denmark-937105/; stopwatch: https://pixabay.com/en/stopwatch-dial-timer-minute-watch-34108/.

**References**

Lee, Y. C. and Kwok, P. W. (2009). Can an egg-dropping race enhance students' conceptual understanding of air resistance? *Physics Education,* 44(2)**,** 151-158.