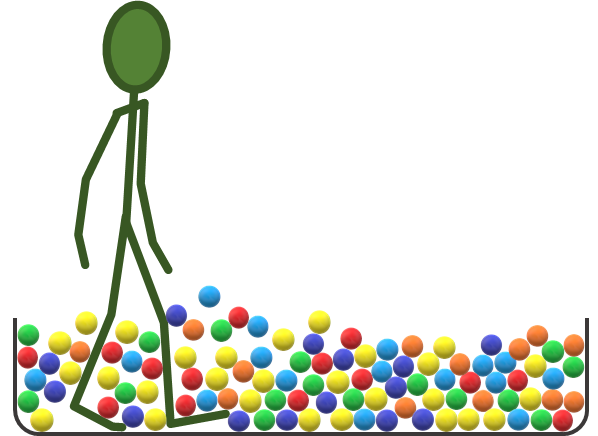
**Ball pool drag**

Some students are using a ball pool to think about drag.

They are thinking about walking through water.

They want to explain why drag gets bigger when you walk faster.



**To answer**

* 1. What do the coloured balls represent?
  2. What does a person do to the balls as they walk along?
  3. What do the balls do to the person who is walking?
  4. If the person walks faster, the drag on them increases.

How can you use this model to explain what happens?

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

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| **Response activity** |
| **Ball pool drag** |

**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: | Describe how streamlining reduces drag force  Explain why the drag force on an object increases with the object’s speed  Describe the forces acting on an object when it is moving at a constant speed through a fluid |
| Activity type: | Critiquing a representation |
| Key words: | Drag, resultant force, speed, streamlining |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: Drag on helmets
* Diagnostic question: Speed is a drag
* Diagnostic question: Top speed

**What does the research say?**

Drag (often called air resistance in air) is a force acting opposite to the relative motion of any object moving with respect to a surrounding fluid. Drag 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 potential speed of the object.

When the speed of an object is being increased, students tend to focus on the applied force that appears to be needed to get it going, and keep it going. They often think that a moving object *has* force that keeps it moving, and which runs out when it comes to rest (Gunstone, R and Watts, 1985; Driver et al., 1994a). Osborne (1985) found that as students get older they *increasingly* hold the view that a force, pushing in the direction of motion, is needed to keep an object moving. In a study of 200 students he found 46% of 13 year olds believed this, increasing to 53% of 14 year olds and 66% of 15 year olds.

Instead of concentrating on the applied force students need to think about all the forces acting and how they combine to produce the resultant force. They need to identify when the resultant force acts, when it changes and when it ceases. This involves understanding drag and the direction it acts in in order to recognise how it contributes to the resultant force (Driver et al., 1994b).

This activity engages students in thinking about how particles in a fluid interact with an object moving through it, in order to develop understanding of drag in terms of the object pushing on the fluid particles and the fluid particles pushing back on the object with an equal sized force in the opposite direction.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

Philosophically science can be said to be a description of the ‘best model’ we have for the world. In this activity students should identify ways in which this particular model is a good representation of the real world, and ways in which it is not.

Students should work together to answer the questions on either the worksheet or the PowerPoint. Giving each group one worksheet to complete between them is helpful for encouraging discussion, but each member should be able to report back to the class. Listening in to the conversations of each group will often give you insights into how your students are thinking.

Ending with the students completing the worksheet or questions from the PowerPoint individually, might help them to consolidate their learning.

*Differentiation*

You may choose to use simplified worksheets for some students, for example with gaps to fill in so they can focus on the science. In some situations it may be more appropriate for a teaching assistant to read and/or scribe for one or two students.

**Expected answers**

1. The coloured balls represent the water particles.
2. The person pushes on the balls with a force that moves them mainly in the direction the person is walking in.
3. The balls push back on the person with an equal sized force in the opposite direction.
4. As the person walks faster they:
   * push more balls out of the way each second (or in any fixed amount of time);
   * and push each ball with more force than before\*.

This means each ball pushes back on the person with a greater sized force, and more particles push on the person each second. Both factors contribute to increasing the total size of the force (drag) pushing back on the person.

\*For the teacher: in a collision between a moving object and a particle in a fluid, the size of the force on the particle is equal to the rate of change of momentum of the particle. A faster moving object causes bigger changes of momentum of the particle, which is why the force on the particle is bigger.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

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