**Pressure can**

A little bit of water is added to a drinks can and heated.

When the water boils steam comes out of the top of the can.

Particles of air and water leave the can.

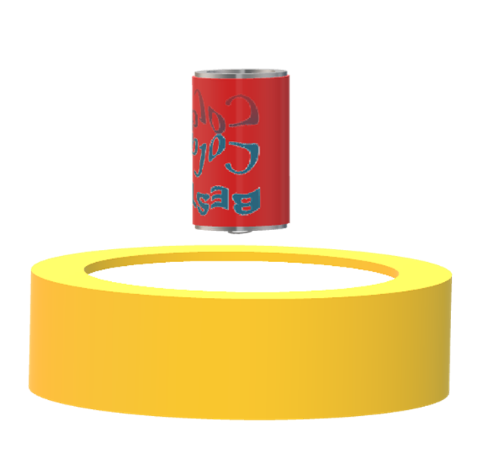
**Predict**

The can is turned upside-down and put into cold water.

What do you think happens?

**Explain**

Explain why you think this will happen.

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| **Watch a demonstration of the can being put into cold water.** |

**Observe**

Describe what you see.

Describe how quickly this happens.

**Explain**

Were your prediction and explanation correct?

Try to improve your first explanation to explain what happens more clearly.

*Physics > Big idea PMA: Matter > Topic PMA2: Floating and sinking > Key concept PMA2.2: Pressure in fluids*

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| **Response activity** |
| **Pressure can** |

**Overview**

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| Learning focus: | Pressure increases with depth in a fluid, so the force exerted by a fluid is larger on the lower surface of an immersed object than on the upper surface. This results in an upward force on the object. |
| Observable learning outcome: | Explain phenomena that are caused by differences in fluid pressure, on either side of a boundary. |
| Activity type: | Predict, explain; observe, explain (PEOE) |
| Key words: | Particles, pressure, atmospheric pressure |

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

* Diagnostic question: Magic glass

**What does the research say?**

Both Séré, in her study (n=600) of what 11- to 13-year-olds thought about gases ( Séré, 1986), and Besson, in his study (n=944) of upper secondary and university students’ conceptions and reasoning about fluids (Besson, 2004), argue that there is a need for students to systematically reason how the motion of particles cause pressure effects, as a preliminary to the study of pressure, in order to avoid several common misunderstandings.

For students to develop a robust understanding of pressure in fluids, Psillos (1999) suggests that they first observe and describe phenomena caused by fluid pressure, before using ideas about the movement of particles to explain the cause of each one.

Students generally understand increases in pressure, such as when a tyre is inflated, and make links between the amount of a gas squashed into a container and its pressure ( Séré, 1985; Besson, 2004). Some however, consider that there is a *normal amount* of air that if exceeded, causes pressure; and if it is not exceeded, there is *no* pressure ( Séré, 1985). Students find explanations involving reduced pressure or equilibria more challenging. For example, in a study by Engel Clough and Driver (1985), about half of students aged 11-13 (n=84) described vacuums as actively sucking.

Students often think that fluids can only exert a pressure when they are moving, and assume that the pressure is in the direction of motion ( Séré, 1986; Driver et al., 1994).

**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.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict *what* they think will happen, and then to explain *why* they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

**Students now watch a demonstration of the collapsing can:**

* Use a Bunsen burner to heat about a 1 cm depth of water in the bottom of a used aluminium drinks can, until there is a lot of steam coming out of the top.
* Place a safety screen in front of the demonstration and wear protective eyewear.
* Turn off the heat and place a large bowl of cold water next to the can.
* Gently tighten a clamp from a retort-stand onto the can so that it is held securely.
* Smoothly and reasonably quickly turn the can upside-down and dip it into the cold water so that the opening is sealed by the water.
* The can *should* be crushed immediately by the pressure of the air in the room.
* A second can could be crushed mechanically, to show just how much force the air exerted on the can – and how much more completely the air crushed it than is achieved by, for example, stamping on it.

After the practical each group should be given the opportunity to change, or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their *explanations* and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Equipment**

For the class:

* Clear safety screen
* Large bowl of cold water
* Several empty drinks cans (x2 minimum)
* Clamp from a retort-stand
* Bunsen burner, tripod, gauze, heat-resistant mat

**Technician notes**

The clamp from a retort-stand is clamped to the can to avoid it slipping as it is turned over. The grip from a pair of tongs is much less secure.

**Health and safety**

Steam and hot water can burn. The can needs to be inverted and there is a risk of splashing or spilling boiling water.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

The can is immediately and completely crushed by the air pressure.

The steam pushes air out of the can. In contact with the cold water, the steam condenses to leave a vacuum in the can – with very few particles of gas.

Air particles on the outside of the can bash into the outside surface. There are no (many fewer) particles bashing onto the inside surface of the can. The particles press so hard on the outside of the can that they crush it.

The can crushes immediately because the particles in the air are moving about very, very quickly.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

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