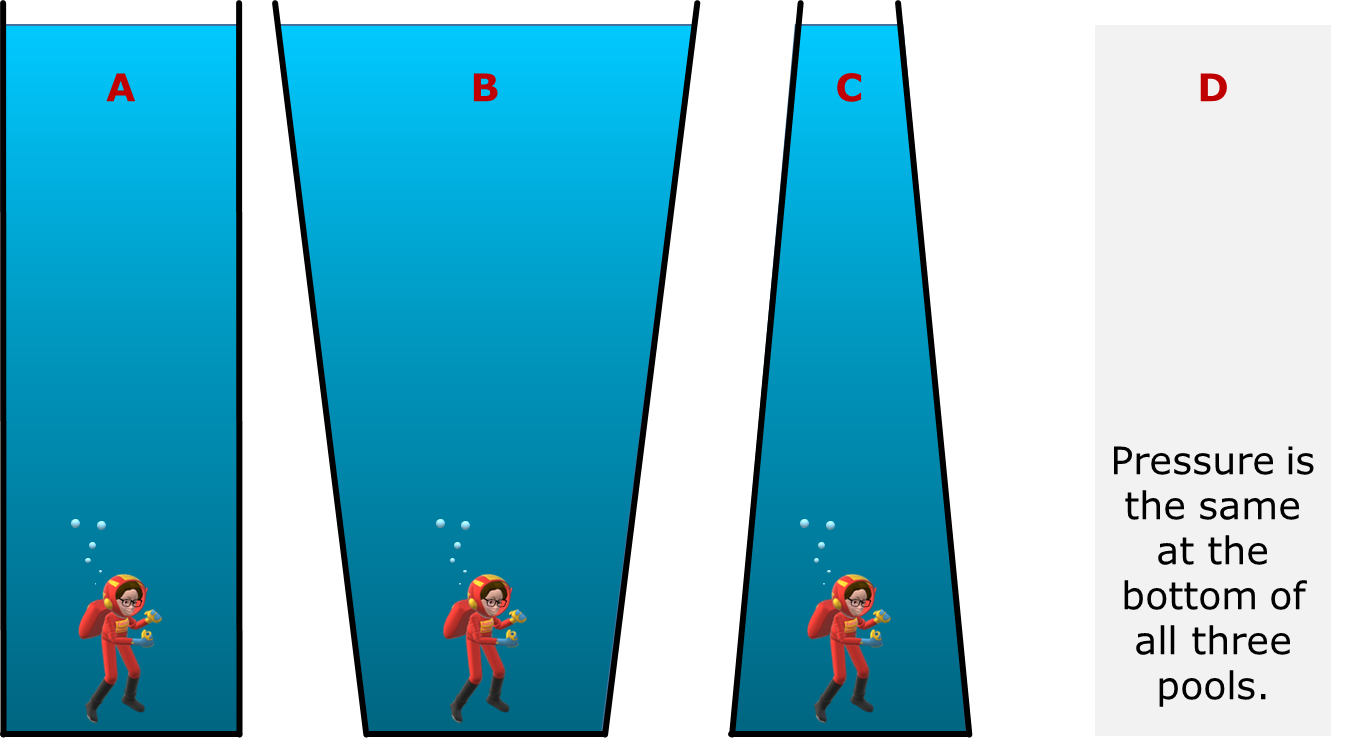
**Deep water**

The pressure is very big at the bottom of the sea.



These three diving pools each have the same depth of water.

At the bottom of which pool is pressure the biggest?



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

|  |
| --- |
| **Diagnostic question** |
| **Deep water** |

**Overview**

|  |  |
| --- | --- |
| 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 why pressure at a particular depth is the same throughout a fluid. |
| Question type: | Simple multiple choice |
| Key words: | Particle, pressure, depth |

**What does the research say?**

Engel Clough and Driver (1985) found that 67% of 12-year-olds, 80% of 14-year-olds and 87% of 16-year-olds (n=84) realised that pressure increases with depth in a liquid. However, only 13% of 12-year-olds, increasing to 34% of 16-year-olds recognised that pressure in the liquid acts in all directions. It is common for students to have the misunderstandings: that pressure *is the weight of the liquid;* and that pressure in a liquid pushes only downwards.

It is common for students to think that pressure is bigger at the bottom of a wider container, than at the same depth in a narrower one, because the total weight of the liquid it contains is greater (Engel Clough and Driver, 1985; Psillos, 1999; Besson, 2004). Besson (2004) found that just 14% of students aged 14-18 (n=141) predicted correctly that pressure depended *only* on depth, in a particular liquid. He found that 60% of students thought pressure was larger in a wider container; and surprisingly that 20% thought pressure was bigger in a narrower one. One common justification for the latter misunderstanding was that a fluid in a smaller space is more tightly packed, and another is that the walls of a container actively press in on a fluid.

**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.

*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 – Pressure is the same at the bottom of all three pools.

**How to respond - what next?**

It is likely that a majority of students will choose answer B, because there is a greater weight of water pressing down from above. At the top of pool B however, there is a much larger surface area than at the top of pool C. This means that the extra water at the top of pool B is supported by a larger area of water underneath. The force pushing down on each particle just below the surface is the same in each pool. This argument can be repeated all the way down to the bottom to show that the pressure at the bottom of each pool is the same.

A significant minority are likely to choose pool C, as the one with the greatest pressure. They may think this is because the water is ‘more compressed’ with particles less free to move around; or they may think that the walls put a pressure onto the water and actively press on the water.

If students don’t think that pressure at a particular depth is the same throughout a fluid, no matter what shape of container it is in, it is probably necessary to demonstrate that this is true, before attempting to explain why it is true.

**Demonstrating that pressure of water at a particular depth is the same, no matter what shape the container is.**

* Two or more plastic bottles of different shapes are needed, each with a tight fitting screw top. They should all be quite tall.
* Make an identical hole in the side of each bottle 1 cm above the bottom.
* Mark a horizontal line on each bottle at the same level – about three-quarters of the way up the shortest bottle.
* Cover the hole with a finger and fill each bottle with water to a few centimetres above the horizontal line. Screw each lid on tightly. This will keep the water in without a finger over the hole.
* Place each bottle in turn on a raised platform next to a sink. A large upturned *Gratnell tray* works well.
* The idea is to unscrew the top of each bottle in turn and to measure how far the water shoots out horizontally when the water level in the bottle falls to the marked line.
* Measurement strategies will depend on the set up and resources available. Placing a ruler behind the water stream and using a smart-phone to film the investigation works well. The film clips can be played back in slow motion, in order for measurements to be taken. Alternatively, with practice, it may be possible to time for the water in two different shaped bottles to fall to the line at the same time.

**NB** Starting at the line doesn’t work very well, because it takes a few moments for a steady stream of water to develop.

Each stream of water should reach the same distance, so long as the holes are identical. Care needs to be taken getting this right.

If students are happy that pressure is the same at the same depth of water in different shaped containers, it may be helpful for them to discuss in pairs or small groups the reasons for this observation. If there is a range of answers, you may choose to respond through structured class discussion. Ask one group to explain their reasons; ask a second group 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.

Careful questioning can guide students to the scientific understanding. Asking students to write down their own explanations helps to both check and to consolidate individual understanding.

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

* Response activity: Diving deep

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG), from an idea by Besson (2004).

Images: Peter Fairhurst (UYSEG).

**References**

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