**Underwater cave**

Sometimes there are caves under the sea.



**a.** What do you think about the pressure in the cave?

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

|  |  |  |
| --- | --- | --- |
| **A** | Pressure at **X** is the same as pressure at **Y**. |  |
|  |  |  |
| **B** | Pressure is bigger at **X** in the open sea. |  |
|  |  |  |
| **C** | Pressure is bigger at **Y** in the cave. |  |

**b.** What is the best reason for your last answer?

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

|  |  |  |
| --- | --- | --- |
| **A** | Pressure depends on how much water is above that point. |  |
|  |  |  |
| **B** | Pressure depends on depth. |  |
|  |  |  |
| **C** | Water is more concentrated here. |  |
|  |  |  |
| **D** | Water has more freedom to move here. |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Underwater cave** |

**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: | Two-tier 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.

Besson (2004) asked students to predict how pressure in an underwater cave compared to pressure at the same depth in open water. He found that 8% of 14- to 15-year-olds (n=96) thought the pressure would be the same in each case; 56% thought pressure would be greater in the cave; and 36% that pressure would be greater in open water. In follow up to this question, he asked students how they thought their predicted differences in pressure would affect the flow of water into or out of the cave. This prompted many of them to reassess their thinking towards a more scientific understanding.

**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 misconceptions 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. A – Pressure is the same in the cave as it is at the same depth in open sea.

b. B – Pressure depends on depth (and on the type of liquid or gas).

**How to respond - what next?**

It is very likely that students will get *part a* wrong. The pressure of the water in the cave must be the same as the pressure of water at the same depth in the sea, because there is a connection of water between these locations. If water is under pressure at one end of the connection, it pushes water towards the other end unless the other end pushes back with an equal sized force in the opposite direction. It does this only when the pressure of water at each end is the same. The cave is not filling up (it is already full) nor emptying, so there is no flow of water and the pressures must be the same.

Students who think pressure is bigger in the open sea (answer B) may do so because there is more water in the open sea, than in the cave. They may reason that the extra water pushes down to cause a bigger pressure; or they perhaps hold the misunderstanding that it is only the depth of water *directly above* a point that determines the pressure. In the cave, there is a much shorter column of water above each point.

Significant numbers of students may say pressure is greater in the cave because they think water is more ‘concentrated’ in the cave, or because they think that when water is restricted in the cave it is harder for water particles to move around.

If students have misunderstandings about why pressure at a particular depth is the same throughout a fluid, it can help to ask them to explain how the water will flow if the pressures inside and outside the cave were different. Careful questioning can help students to realise that water will flow from a higher pressure to a lower pressure, and that a steady flow of water is not possible between the cave and the open sea.

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**

Besson, U. (2004). Students' conceptions of fluids. *International Journal of Science Education,* 26:14**,** 1683-1714.

Engel Clough, E. and Driver, R. (1985). What do children understand about pressure in fluids? *Research in Science and Technology Education,* 3(2)**,** 133-134.