**Squeezing water**

Water is a made of particles.



1. How close together are the particles in liquid water?

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

|  |  |  |
| --- | --- | --- |
| **A** | They are touching each other. |  |
|  |  |  |
| **B** | There are small gaps between them. |  |
|  |  |  |
| **C** | There are big gaps between them, but smaller gaps than between gas particles. |  |

Water at the bottom of the ocean is under a huge pressure.



**2.** Is this pressure large enough to squash water?

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

|  |  |  |
| --- | --- | --- |
| **A** | Water cannot be squashed. |  |
|  |  |  |
| **B** | Water is squashed a tiny bit. |  |
|  |  |  |
| **C** | Water is squashed more than a tiny bit. |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Squeezing 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 in a fluid increases with depth. |
| Question type: | Simple multiple choice |
| Key words: | Pressure, depth, particles |

**What does the research say?**

Even though most students understand that pressure increases with depth in a liquid, many are not sure about *how* pressure can increase with depth. This is because they understand liquids to be incompressible. Just 12% of 14- to 18-year-olds (n= 120) attribute increased pressure in a liquid to a change in the separation of its particles (Besson, 2004). In reality liquids can be compressed by tiny fractions, and compressed more closely together as depth increases.

**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**

1 A – Particles are touching each other in a liquid.

2. B – Water can be squashed a tiny bit, by the huge pressure at the bottom of an ocean.

**How to respond - what next?**

1. Many students think that particles in liquids have gaps between them and that the particle arrangement is intermediate between the arrangements of a solid and a gas. This misunderstanding is reinforced by poor diagrams in many text books.

2. If students think that there are small gaps between particles in a liquid, they may think logically that water can be squashed by pushing these particles together more closely. If this were the case then water would squash by a lot. (For example, if gaps between molecules were the same distance as the diameter of a single water molecule, then more than seven eighths of liquid water would be empty space.)

The particles in water are touching, with repulsive electrostatic forces keeping them apart. Pressure at the bottom of a deep ocean is several hundred times atmospheric pressure and is sufficient to reduce the volume of water by perhaps two or three percent, compared to its volume at the surface.

More importantly, if particles are squashed together against repulsive intermolecular forces, the repulsive intermolecular forces push the particles apart with an equal sized force in the opposite direction. This is the mechanism that causes pressure to increase with depth in a liquid. (In a squashed gas, the dominant mechanism is the increased collision rate between particles, because they are closer together.)

If students have misunderstandings about the separation of particles in a liquid, it may be necessary to review understanding about particle arrangement in solids, liquids and gases. This is covered in detail in the BEST ‘Key concept’: CPS1.1 – Particle model for the solid, liquid and gas states.

If students have misunderstandings about why pressure increases with depth, it may help to review understanding of how solids react, at a particle level, in order to support a heavy mass. This is covered in detail in the BEST ‘Key concept’: PFM3.2 – Hidden forces.

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

* Response activity: Diving deep

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Images: Open water: <https://pixabay.com/photos/sea-ocean-water-turquoise-blue-2277646/>; deep ocean: <https://pixabay.com/photos/jellyfish-underwater-deep-sea-2573867/>.

**References**

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