**Diving deep**

It is not easy to dive to the bottom of a deep sea.

Divers need training and they use special equipment.



Some students are discussing what it would be like for a diver at the bottom of the sea.

**Max:** It would feel like she is wearing very tight clothes that squeeze her.

**Leo:** It would be hard to walk because of the weight of the water.

**Nathan:** She has a rope because the pressure of the water makes it hard for her to swim up to the surface.

**Kieran:** She needs to wear heavy shoes to hold her down.

**To answer**

1. Who is right about the diver?
   * *Explain your answer*
2. Who is wrong about the diver?
   * *What would you say to help them understand?*

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

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| **Response activity** |
| **Diving deep** |

**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 why pressure in a fluid increases with depth.  Explain why pressure at a particular depth is the same throughout a fluid.  Explain how pressure pushes on an object submerged in a fluid. |
| Activity type: | Talking heads |
| Key words: | Pressure, depth |

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

* Diagnostic question: Underwater beach ball
* Diagnostic question: Squeezing water
* Diagnostic question: Deep water
* Diagnostic question: Underwater cave
* Diagnostic question: Underwater basketball

**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.

The misunderstanding that pressure at a depth in a liquid is equal to the weight of liquid above that point ignores the atmospheric pressure of the air on the surface. For example, the pressure at a one metre depth in water, is about eleven times the water’s weight (Besson, 2004).

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.

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.

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 activity**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*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 the 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.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

Max is correct, the pressure of the water pushes on the diver in all directions.

Kieran is correct because the diver will have an up upward force on her and it will be hard for her to stay on the bottom without extra weights. The upward force is the same as it would be if she were much closer to the surface, because it is caused by the *difference* in pressures between her head and her toes.

Leo is wrong, because pressure in a fluid acts equally in all directions, including up. The diver would not notice any difference between the pressure from above or below. For the same reason Nathan is also wrong.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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