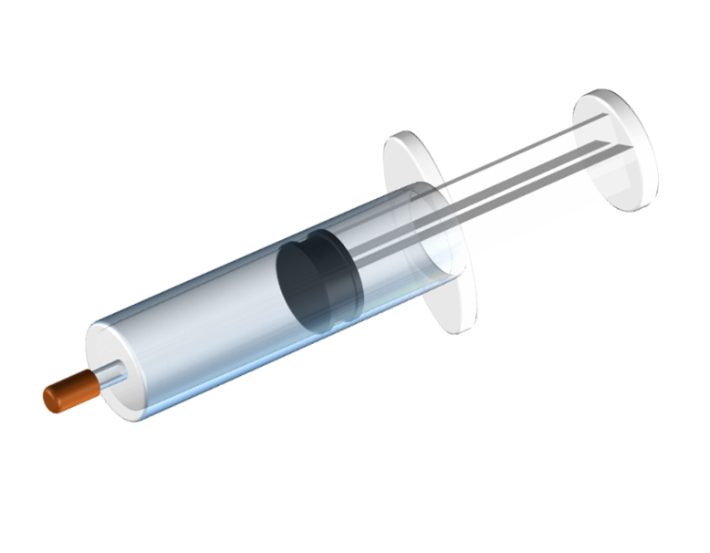
**Squashing air**

Air is squashed in a sealed syringe.

The more the air is squashed; the bigger the pressure the air has.



These statements are about what happens when air is squashed in the syringe.

*For each statement, tick (✓)* ***one*** *column to show what you think.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | Particles of air are pushed closer together along the length of the syringe. |  |  |  |  |
| **B** | Particles of air are pushed closer together across the width of the syringe. |  |  |  |  |
| **C** | Particles of air in the syringe bounce off each equally hard in all directions. |  |  |  |  |

*Physics > Big idea PMA: Matter > Topic PMA4: Particle explanations > Key concept PMA4.2: Pressure*

|  |
| --- |
| **Diagnostic question** |
| **Squashing air** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The pressure of a fluid is a measure of how hard its particles are pushing each other apart, and it is proportional to the size of the force exerted by the fluid on a surface. |
| Observable learning outcome: | Explain why the pressure of a fluid is a scalar quantity that is equal in all directions. |
| Question type: | Confidence grid |
| Key words: | Pressure, particle |

**What does the research say?**

Psillos (1999) examined how textbooks develop an understanding of pressure and found that they nearly always introduce pressure as a measure of how concentrated a force is and use the equation ‘P=F/A’ to define it. Usually, examples of solids pushing down onto a surface are used to consolidate understanding and in these examples surface pressure is a vector quantity acting in one direction. From such an introduction, students can interpret pressure wrongly as a ‘pressing force’ and may (as some textbooks do) describe a fluid ‘exerting a pressure’.

In contrast to pressure between solid surfaces, pressure in a fluid is a scalar quantity, yet few students think of pressure acting in all directions in air or water (Driver et al., 1994).

Following large scale studies of students’ conceptions about gases (n=600, age 11-13) and fluids (n=944, age 14-20) by Séré (1986) and Besson (2004) respectively, both researchers conclude that there is a need for students to systematically reason how the motion of particles cause pressure effects, as a preliminary step in the study of pressure. Ideas about the movement of particles in a fluid can then be used to explain why the force on a surface, F = P x A.

This question explores how students apply an understanding of the particle model to a gas that is squashed in one direction.

**Ways to use this question**

Students should complete the confidence grid 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.

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**

All three statements are right.

**How to respond - what next?**

Particles in a gas are in constant motion and frequently bounce off each other in random directions to spread evenly throughout a container. If a gas is squashed in one direction, its particles quickly scatter off each other to spread out evenly again, in all directions.

Pressure in a gas can be thought of as a measure of how hard its particles are pushing each other apart. If pressure in one part of a gas is increased, scattering of particles quickly evens out pressure throughout the gas.

Students who think about pressure as a pressing force may think statement B is wrong. They may hold a mental model of the particles being squashed together as the turns of a spring would be, but this model does not work for a fluid in which particles are free to move in all directions.

Students who understand that gas particles are free to move in all directions are likely to think statement B is correct. However if they think that pressure, like a force, is directional, they are still unlikely to say that statement C is correct.

If students have misunderstandings about why the pressure of a fluid is a scalar quantity that is equal in all directions, it can help to revise understanding of the particle model of liquids and gases. Careful questioning can elicit understanding of how squeezing a liquid or gas in one direction causes the movement of particles in all directions through the fluid, until they are evenly spaced out and pressure is equal throughout the fluid. The simple demonstration of pressing down on a partially inflated balloon shows this clearly.

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

* Response activity: Gas pressure
* Response activity: Bottled gas

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Image: Peter Fairhurst (UYSEG).

**References**

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