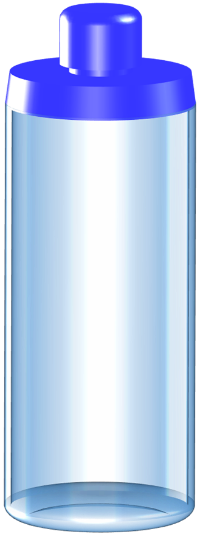
**Gas pressure**

This bottle is filled with a gas.

Explain how gas pressure is caused by the particles of gas.

Pick ***one*** statement in each row to explain how.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | Particles of the gas move quickly in all directions. | | | |
| 2 | They move a few metres every second. | | They move hundreds of metres every second. | |
| 3 | They do not get very far before they collide with another particle or the walls of the bottle. | | | |
| 4 | They are more likely to hit another particle… | | They are more likely to hit the walls of the bottle… | |
| 5 | …because there are so very many particles. | …because there are thousands of particles. | | …because there are just ten or twenty particles. |
| 6 | Gas pressure is caused when particles push each other apart. | | Gas pressure is caused when particles hit the walls of their container. | |
| 7 | The harder and more often the collisions, the higher the pressure. | | | |

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

|  |
| --- |
| **Response activity** |
| **Gas pressure** |

**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.  Explain the effect of temperature change on the pressure of a fixed volume of fluid. |
| Activity type: | Explanation story |
| Key words: | Pressure, particle |

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

* Diagnostic question: Squashing air
* Diagnostic question: More pressure
* Diagnostic question: Hot air
* Diagnostic question: Cold air

**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.

Before using a particle model to explain pressure, it may be necessary to resolve students’ misunderstandings about the motion and distribution of particles in gas.

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It is best done as a pencil and paper exercise.

Students should read the statements and follow the instructions on the worksheet. 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.

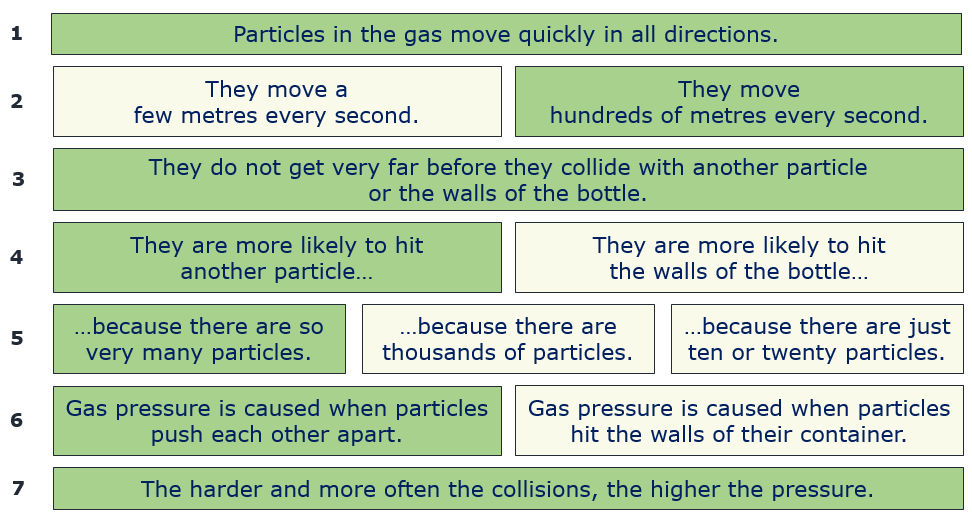
Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*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**

****

N.B. At atmospheric pressure, the average separation of particles in the air is about 0.000 001 mm, and the average distance an air particle travels between collisions with another air particle (mean free path) is 0.000 068 mm.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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

Driver, R., et al. (1994). *Making Sense of Secondary Science: Support Materials for Teachers,* London: Routledge.

Psillos, D. (1999). Teaching fluids: intended knowledge and students' actual conceptual evolution. *International Journal of Science Education,* 21(1)**,** 17-38.

Sere, M. (1986). Childrens' conceptions of the gaseous state, prior to teaching. *European Journal of Science Education,* 8**,** 413-25.