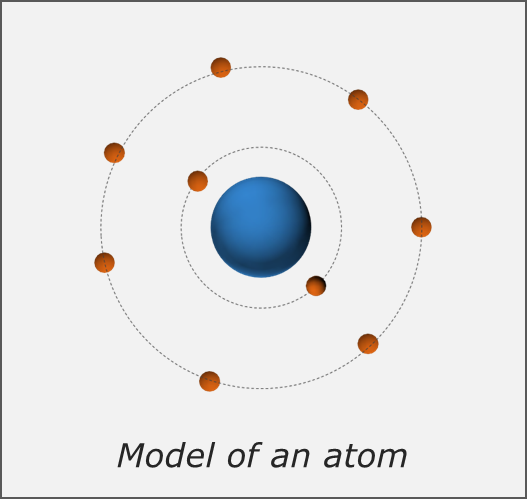
**Building blocks**

A joke that science teachers use a lot goes:

***Q:*** *Why should you never trust an atom?*

***A:*** *Because they make up everything.*

In textbooks, atoms are often drawn like the one in this model:



What is a real atom like?

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** | Only powerful microscopes can see atoms. |  |  |  |  |
| **B** | Atoms have electrons around a nucleus. |  |  |  |  |
| **C** | The nucleus of an atom controls the atom. |  |  |  |  |
| **D** | The nucleus of an atom contains positively charged neutrons. |  |  |  |  |
| **E** | The diameter of an atom is about 10 000 times bigger than the diameter of its nucleus. |  |  |  |  |

*Physics > Big idea PMA: Matter > Topic PMA5: Nuclear physics > Key concept PMA5.1: Atomic nuclei*

|  |
| --- |
| **Diagnostic question** |
| **Building blocks** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | There is a fixed number of positively charged protons in the nucleus of each atom of an element, but the number of neutrons can vary to make isotopes that are either stable or unstable. |
| Observable learning outcome: | Describe the structure and scale of an atom. |
| Question type: | Confidence grid |
| Key words: | Atom, nucleus, electron, proton, neutron, positive charge, negative charge |

|  |  |
| --- | --- |
| **P** | **PRIOR UNDERSTANDING**  This diagnostic question probes understanding of ideas that are usually taught at age 11-14, to aid transition from earlier stages of learning. |

**What does the research say?**

Research into students’ mental models of atoms (Harrison and Treagust, 1996) produced some unexpected responses during student interviews, most notably that the majority of respondents thought that atoms are visible under a powerful microscope. This has implications on students understanding that atomic structure is a model and not a representation of reality. If students believe that scientists have seen atoms then, the researchers suggest, students may be more likely to consider a model to be a realistic representation of the structure of an atom.

Another, much less frequent but surprising response, was that small, but significant, numbers of students thought that an atom was alive. This appeared to arise due to a confusion that atoms behaved like biological cells (possibly due to the presence of something called a nucleus in both).

In Harrison and Treagust’s study (1996), the large majority of students (age 13-16, n=42) pictured electrons much closer to a nucleus than in a real atom. They found students’ ideas of scale were usually similar to the (necessarily) out of scale illustrations of atoms drawn in text books.

This diagnostic question checks for these misunderstandings, which are addressed in the earlier BEST chemistry key concept: CPS6.1: Atomic model.

**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**

Statements B and E are right; and statements A, C and D are wrong.

**How to respond - what next?**

1. Atoms are too small to see with the most powerful optical microscope, and images produced by electron microscopes show computer generated representations of atoms, which typically show atoms as solid balls when they are not.
2. Negative electrons are around the nucleus, but they do not move in orbits around it.
3. In biology students may be taught that the nucleus of a cell controls what goes on in the cell, and sometimes students wrongly apply this understanding to the nucleus of an atom.
4. The nucleus of an atom contains positively charged protons, most nuclei also contain neutrons that have no charge. Some students may think neutrons have a negative charge that attracts protons.
5. The diameter of an atom is about 10 000 times bigger than the diameter of its nucleus.

If students have misunderstandings about the structure or scale of an atom, it can help to use the BEST diagnostic questions and response activities that address each idea separately in the BEST chemistry key concept: CPS6.1: Atomic model.

Students could also rewrite each of the five statements in their own words so that each one is correct. Working in pairs or small groups can help support the construction of a clearer understanding through discussion.

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

* Response activity: Striking gold

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Harrison, A. G. and Treagust, D. F. (1996). Secondary students' mental models of atoms and moelcules: Implications for teaching chemistry. *Science Education,* 80(5)**,** 509-534.