*Chemistry > Big idea CPS: Particles and structure > Topic CPS6: Periodic Table*

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| **Key concept (age 11-14)** |
| **CPS6.1: Atomic model** |

**What’s the big idea?**

A big idea in chemistry is that all matter is made up of atoms. The collective, structural arrangement and behaviour of the atoms explains the properties of different substances.

**How does this key concept develop understanding of the big idea?**

This key concept helps to develop the big idea by introducing subatomic structure as described by a basic atomic model.

****The conceptual progression starts by checking understanding of the difference in scale between an atom and a cell. It then supports the development of understanding of a basic atomic model in order to enable a comparison of the particle and atomic models.

**Using the progression toolkit to support student learning**

Use diagnostic questions to identify quickly where your students are in their conceptual progression. Then decide how to best focus and sequence your teaching. Use further diagnostic questions and response activities to move student understanding forwards.

**Progression toolkit: Atomic model**

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| **Learning focus** | The structure of an atom may be represented by an atomic model. | | | | |
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| **As students’ conceptual understanding progresses they can:** | **C o n c e p t u a l p r o g r e s s I o n** | | | | |
| Recognise that atoms are not visible under any type of microscope and that scientists have never ‘seen’ the structure of an atom.  **P** | Distinguish the nucleus of an atom from the nucleus of a cell. | Identify the force of attraction between electrons and the nucleus as being due to electric charge. | Recognise that a typical diagram of atomic structure is not drawn to scale. | Compare the particle and atomic models.  **B** |
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| **Diagnostic questions** | Seeing atoms | Nucleus | Attractive forces | Relative size | Comparing models |
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| **Response**  **activities** | Size sequence | Type of nucleus | Forces of attraction | Sports field | Model explanations |

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| Key: | | | |
| **P** | Prior understanding from earlier stages of learning | **B** | Bridge to later stages of learning |

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| **Seeing atoms** | **Nucleus** | **Attractive forces** | **Relative size** | **Comparing models** |
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| Confidence grid | Talking heads | Simple multiple choice | Simple multiple choice | Talking heads |
| **Size sequence** | **Type of nucleus** | **Forces of attraction** | **Sports field** | **Model explanations** |
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| Sequencing | Focused cloze | Focused cloze | Application and practice | Critiquing a representation |

**What’s the science story?**

An individual atom is itself made up of even smaller particles. The atomic model describes an atom as consisting of a central nucleus (made up of protons and neutrons) surrounded by electrons.

**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 student understanding that the 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 a small, but significant, numbers of students thought that an atom was alive. This appeared to arise due to a confusion that atoms behaved like cells (possibly due to the presence of a nucleus). Both these misunderstandings are included early in the progression so that they may be clarified early on before they give rise to further misconceptions.

In terms of the forces within an atom, research (Taber, 2013) asked student what type of force attracted electrons towards the nucleus. The most popular response were gravity and magnetism (rather than electrostatic forces).

The majority of students had an image of an atom of an atom that did not take into account spatial dimensions. This is perhaps less surprising given that textbook illustrations of the atomic model are not drawn to scale.

Harrison and Treagust (1996) also reviewed transcripts of their student interviews and classified students according the sophistication with which they interpreted models. The progression therefore ends by exploring student understanding of models.

**Guidance notes**

At this stage the basic atomic model is taken to consist of a central nucleus (positive protons plus neutrons) surrounded by negative electrons. Examples are confined to hydrogen or helium atoms which avoid the need to mention electron shells.

**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.

Taber, K.S. (2013). Upper secondary students' understanding of the basic physical interactions in analogous atomic and solar systems. *Research in Science Education,* 43**,** 1377-1406.