 Module 1: Properties and structure of matter

Year 11 chemistry 2018 10 hours

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Inquiry question

Why are atoms of elements different from one another?

Rationale

Students examine the structure of an atom and explore different models. Students will be introduced to the Bohr and Schrödinger models. Students investigate isotopes and use this understanding to explain radioactivity, demonstrating how isotopes can be stable and unstable.

Outcomes

Working scientifically skills

* CH11-1 Develops and evaluates questions and hypotheses for scientific investigation
* CH11-2 Designs and evaluates investigations in order to obtain primary and secondary data and information
* CH11-3 Conducts investigations to collect valid and reliable primary and secondary data and information
* CH11-4 Selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media
* CH11-5 Analyses and evaluates primary and secondary data and information
* CH11-6 Solves scientific problems using primary and secondary data, critical thinking skills and scientific processes
* CH11-7 Communicates scientific understanding using suitable language and terminology for a specific audience or purpose

Knowledge and understanding

* CH11-8 Explores the properties and trends in the physical, structural and chemical aspects of matter

Depth Study

The following questions can be used as provocations for students to start a depth study.

* How has the model of an atom evolved over time?
* Why have models of the atom changed?
* How has the Bohr model and Schrodinger model informed our current understanding of the atom?

Examples of communicating the above include:

* Poster presentation
* Oral presentation
* Analysis of a documentary
* Collaborative presentations, for example O365 PowerPoint, Apple Keynote, Google Slides, Padlet, Powtoon, mind mapping software, etc.
* Multimedia software
* Infographics
* Podcast
* eBook

If a depth study is included in the unit, the following must be included:

* the two Working Scientifically outcomes of Questioning and Predicting, and Communicating
* a minimum of two additional Working Scientifically outcomes
* further development of at least one Knowledge and Understanding outcome

See [Depth Studies](http://syllabus.nesa.nsw.edu.au/chemistry-stage6/depth-studies/): Year 11 and 12 for more details.

Assessment

* Formative assessment of depth study

Content

The working scientifically skills mentioned in the outcomes should be embedded throughout the teaching and learning experiences

CH11-8 Explores the properties and trends in the physical, structural and chemical aspects of matter

Students:

* investigate the basic structure of stable and unstable isotopes by examining:
	+ their position in the periodic table
	+ the distribution of electrons, protons and neutrons in the atom
	+ representation of the symbol, atomic number and mass number (nucleon number)
* model the atom’s discrete energy levels, including electronic configuration and pdf notation (ACSCH017, ACSCH018, ACSCH020, ACSCH022)
* calculate the relative atomic mass from isotopic composition (ACSCH024)
* investigate energy levels in atoms and ions through:
	+ collecting primary data from a flame test using different ionic solutions of metals (ACSCH019)
	+ examining spectral evidence for the Bohr model and introducing the Schrödinger model
* investigate the properties of unstable isotopes using natural and human-made radioisotopes as examples, including but not limited to:
	+ types of radiation
	+ types of balanced nuclear reactions

| Teaching and learning | Evidence of learning |
| --- | --- |
| * Investigate the structure of the atom including charge and relative mass:
	+ protons (positive, 1)
	+ neutrons (neutral,1)
	+ electrons (negative, 0)
* Define the atomic number as equals to the number of protons.
* Define the mass number as equal to the number of protons and neutrons (nucleon number).
* Identify elements using the periodic table using:
	+ symbol
	+ atomic number
	+ mass number (nucleon number).
* Define an isotope as an atom of the same element with different number of neutrons.
	+ Compare isotopes of the same element to determine similarities and differences.
	+ Example - Hydrogen: protium (A = 1), deuterium (A = 2), and tritium (A = 3).
	+ Use models to compare different isotopes.
	+ Solve problems to identify isotopes based on secondary source information.
* Define stable isotopes as an atom with a proton to neutron ratio of 1:1 (first 20 elements) and 1:1.5 (for elements after 20).
	+ Use Zone of Stability Graph to determine if an isotope is stable or unstable.
	+ Use Graph and watch video: [Band of Stability](http://ch302.cm.utexas.edu/nuclear/radioactivity/selector.php?name=band-stability)
 | * Identify the charge and mass of the subatomic particles.
* Define the terms atomic number and mass number.
* Model the distribution of electrons, protons and neutrons in the atom.
* Use symbols to represent elements, atomic number and mass number (nucleon number).
* Define the term isotope.
* Solve problems to identify isotopes based on secondary source information.
 |
| * Define relative atomic mass.
* Watch: [What is Relative Atomic Mass?](https://www.youtube.com/watch?v=aqfQKzbTCVo)
* Calculate the relative atomic mass of elements using the equation:
* Relative atomic mass = (% of isotope 1 × mass of isotope 1) + (% of isotope 2 × mass of isotope 2) ÷ 100
 | * Define relative atomic mass.
* Calculate relative atomic mass of elements using secondary source information.
 |
| * Define an unstable isotope as a radioisotope.
* Define radioisotope as an unstable isotope that emits radioactive decay to turn into different elements.
* Identify types of radiation.
* Create a summary table of types of radiation.
* Example table: [Types of Radiation](http://misswise.weebly.com/types-of-radiation.html)
* Solve problems to balance nuclear decay equations.
* Identify a natural and human-made radioisotope.
* Examples include:
	+ uranium-238 (natural)
	+ iodine-123 (human-made)
* For each named natural and human-made radioisotope identify the type of radiation emitted.
* For each named natural and human-made radioisotope construct balanced nuclear reactions (for both alpha and beta).
	+ Construct or use a decay series graph for Uranium-235 to write balanced nuclear reactions.
	+ Example [Radioactive Decay Series Graph](https://saylordotorg.github.io/text_general-chemistry-principles-patterns-and-applications-v1.0/s24-nuclear-chemistry.html)
 | * Define the term radioisotope.
* Identify types of radiation and particle emitted.
* Balance nuclear equations.
* Identify a natural and human-made radioisotope, including radiation emitted and balanced equation.
 |
| * Identify energy levels (shells) and electron capacity. These energy levels may be identified as k, l, m, n.
* [Example diagram](https://www.electronicspoint.com/tutorialimages/Semi/03391.png)
* Model atoms using energy levels (k,l,m,n) to model electronic configuration.
	+ Model atoms using lollies or craft materials to represent energy levels (shells), protons, neutrons and electrons.
	+ Identify how many electrons can be found in a specific energy level (shell).
 | * Identify energy levels and construct atoms demonstrating their correct number of electrons in each energy level (shell).
 |
| * Predict electronic configurations of different atoms using models and information from the periodic table.
* [NESA periodic table](http://www.boardofstudies.nsw.edu.au/syllabus_hsc/pdf_doc/chemistry-data-sheet-2017-02.pdf)
	+ Understand the link between period number the energy level.
	+ Understands the link between the group number and the number of electrons in the valence shell.
 | * Predict electronic configurations of different atoms using models and information from the periodic table.
 |
| * Define the term orbitals and give examples (spdf).
* Watch: [Khan Academy – Orbitals](https://www.khanacademy.org/science/biology/chemistry--of-life/electron-shells-and-orbitals/v/orbitals)
* [Dummies guide to electron configuration notation](http://www.dummies.com/education/science/chemistry/how-to-depict-electrons-in-electron-configuration-notation/)
* Describes how an electron’s probability of any given point may be located within an orbital.
* Create a model of orbital shells. Cut out each orbital shape (side on view) and overlap them to create orbitals of an element.
* Use the diagonal or Aufbau rule to determine the electron configuration of elements (possible [worksheet 1](http://misterguch.brinkster.net/PRA014.pdf) [worksheet 2](https://www.hasdk12.org/cms/lib/PA01001366/Centricity/Domain/1149/Configurations.doc))
* Possible free apps that can be used in class.
	+ [Electron orbitals](https://play.google.com/store/apps/details?id=com.gputreats.orbitalexplorer&hl=en) (Android – free)
	+ [Virtual orbitals 3D chemistry](https://play.google.com/store/apps/details?id=com.AnuragAnandHazaribag.VirtualOrbitals3D&hl=en) (Android – free) Paid apps are available on the Apple App Store.
 | * Define the term orbital.
* Describes how an electron’s probability of any given point may be located within an orbital (s, p, d, f).
 |
| * Determine and predict spdf notations of different atoms using the periodic table and/or other forms of data such as spdf tables and graphs.
	+ Example website with resources: [Electronic Configuration Info](https://chem.libretexts.org/Core/Physical_and_Theoretical_Chemistry/Electronic_Structure_of_Atoms_and_Molecules/Electronic_Configurations/Electronic_Configurations_Intro)
	+ Watch: Khan Academy - [More on Orbitals and Electron Configuration](https://www.khanacademy.org/science/biology/chemistry--of-life/electron-shells-and-orbitals/v/more-on-orbitals-and-electron-configuration)
	+ Create a visual representation of order of subshell filling to help predict spdf notations.
	+ Watch: [How to draw orbital diagrams](https://www.youtube.com/watch?v=bgAuj4EEmw4)
 | * Determine and predict spdf notations of different atoms.
 |
| * Collect and use primary data from a flame test using different ionic solutions of metals to investigate energy levels in atoms and ions.
* [Flame test instructions](http://www.chemguide.co.uk/inorganic/group1/flametests.html)
* Examine spectral evidence for the Bohr model the Schrödinger model to investigate energy levels in atoms and ions.
* Read and discuss, [“The breakdown of the Bohr atomic model” in Young Scientists Journal.](https://ysjournal.com/archive/ysj-issue-2/the-breakdown-of-the-bohr-atomic-model/) Compare and contrast the atomic models of Bohr and Schrödinger.
 | * Conduct a flame test and relate the results to the energy levels in atoms and ions.
* Use data to investigate energy levels in atoms and ions.
* Define the Bohr and Schrödinger models of the atom.
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Reflection and evaluation: