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| Year 11 Chemistry |
| Depth study guide |
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| We recommend that an ANSTO excursion becomes the starting point for a nuclear science depth study. ANSTO’s Year 11 Chemistry excursion, together with the *ANSTO* *Year 11 Chemistry Excursion Workbook*, helps students cover a number of outcomes in Module 1, Properties and structure of matter, and in Working Scientifically.  Our *ANSTO* *Year 11 Chemistry Depth Study Guide* provides students and teachers with ideas and resources for depth study activities after their excursion.  **NESA requirements for Depth Studies**   * A minimum of 15 hours of in-class time is allocated in both Year 11 and Year 12 * At least one depth study must be included in both Year 11 and Year 12 * The two Working Scientifically outcomes of Questioning and Predicting, and Communicating must be addressed in both Year 11 and Year 12 * A minimum of two additional Working Scientifically skills outcomes, and further development of at least one Knowledge and Understanding outcome, are to be addressed in all depth studies. |

## Topic 1: Radiation in our everyday life

### Suggested activities

* Construct a table to compare radiation dose from different sources, and estimate your total yearly radiation dose.
* Make a cloud chamber at school to observe background radiation and radiation from a small radiation source.
* Compare and contrast different radiation detection instruments, including cloud chambers, scintillation counters, Geiger-Muller counters, dosimeters and radiation badges. Explain how each device is used to monitor levels of radiation exposure to workers and the environment.
* Compare and contrast the following units of measurement for radiation (Sv, Bq, rad, Gy, Ci, Rem, dps).
* Design and perform an experiment to demonstrate how time, distance and shielding can be used to minimise dose to radiation workers.

### Suggested resources

* ANSTO. (2017). Nuclear science inquiry skills (videoconference). [https://www.ansto.gov.au/education/secondary/videoconferences](http://www.ansto.gov.au/elearning).
* ANSTO. (2016). How radioactive am I (Infographic). [https://www.ansto.gov.au/education/apps](http://www.ansto.gov.au/games).
* ANSTO. (2016). Understanding radiation: ANSTO cloud chamber. ([https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos)).
* United Nations Environment Programme. (2016). Radiation: Effects and sources. <http://www.unscear.org/unscear/en/publications/booklet.html>.
* ANSTO. (2015). Cloud chamber experiment: Teachers guide. <https://www.ansto.gov.au/education/secondary/workbooks-and-datasets>.
* ANSTO. (2013). What is radiation? (brochure). [https://www.ansto.gov.au/corporate-publications](http://www.ansto.gov.au/resources/publications/booksandleaflets)
* ANSTO. (2008). Radioisotope use and production in Australia (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos)

## Topic 2: Medical radioisotopes

### Suggested activities

* Create a detailed flow chart (with chemical equations) to explain the production, use and disposal of a selected medical radioisotope (e.g. Molybdenum-99/Technetium-99m, Fluorine-18, Iodine-131).
* Interview a nuclear medicine expert via videoconference. Use primary and secondary sources to summarise their research.
* Compare and contrast the production of nuclear medicines in a nuclear reactor and in a cyclotron.
* Compare and contrast the use of technetium-99m in a SPECT scan with the use of fluorine-18 in a PET scan.
* Create a table of all the nuclear medicines produced in the OPAL reactor (isotope name, ABZ notation, half-life, decay equation and description of its use)
* Explain how medicine of your choice is produced in a nuclear reactor and compare this with the production of a nuclear medicine from a cyclotron
* The production of nuclear medicine generates low and intermediate-level radioactive waste. Justify the production and use of nuclear medicines in the format of a comment article in the Sydney Morning Herald.
* Compare the radiation dose received by patients during different nuclear medicine procedures and compare this with doses received from other sources of radiation in everyday life.
* Research the history and development of a selected nuclear medicine and present this information as a timeline. Explain how the effectiveness of its use as a radiopharmaceutical has improved over time.
* Interview a nuclear medicine expert. Use primary and secondary sources to summarise their role, research and career path in the format of a LinkedIn profile.

### Suggested resources

* ANSTO. (2017). Meet an expert (videoconference). [https://www.ansto.gov.au/education/secondary/videoconferences](http://www.ansto.gov.au/elearning).
* Currie, G. (2017). Nuclear medicine explainer (video). <https://www.youtube.com/watch?v=98zuh9S2L7o>.
* Currie, G. (2016). Nuclear medicine comes from nuclear reactors. Sydney Morning Herald (25/2/16). <http://www.smh.com.au/comment/nuclear-medicine-comes-from-nuclear-reactors-20160225-gn3dlg.html>.
* United Nations Environment Programme. (2016). Radiation: Effects and sources. <http://www.unscear.org/unscear/en/publications/booklet.html>.
* ABC News. (2015). Four million nuclear medicine doses produced (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2014). Half-life hero (online game). [https://www.ansto.gov.au/education/apps](http://www.ansto.gov.au/games).
* ANSTO. (2015). Cyclotrons and PET scans (fact sheet). [https://www.ansto.gov.au/education/secondary/workbooks-and-datasets](http://www.ansto.gov.au/workbooks).
* ANSTO. (2015). Discover ANSTO (e-magazine). [https://www.ansto.gov.au/education/apps](http://www.ansto.gov.au/games).
* ANSTO. (2015). Molybdenum/Technetium supply chain (fact sheet). [https://www.ansto.gov.au/education/secondary/workbooks-and-datasets](http://www.ansto.gov.au/workbooks).
* ANSTO. (2015). PET scan animation (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2014). OPAL research reactor (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* Psjrbrown. (2013). Cyclotron principle (video). <https://www.youtube.com/watch?v=xnCCX8Qm7wQ>.
* Channel 7. (2012). The scientists behind life-saving cancer treatments (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2012). Nuclear medicine: Answering your questions (brochure). [http://https://www.ansto.gov.au/corporate-publications](http://www.ansto.gov.au/Resources/Publications/BooksandLeaflets).
* ANSTO. (2011). Year 11 and 12 nuclear chemical equations sheet. [https://www.ansto.gov.au/education/secondary/workbooks-and-datasets](http://www.ansto.gov.au/workbooks).
* The Open University. (2008). SPECT imaging technique – Imaging in medicine (11/13) (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* The Open University. (2008). Iodine therapy – Radiotherapy and its physics (4/15) (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).

## Topic 3: Radioisotopes for the environment

### Suggested activities

* Create a table of different isotopes used for dating (isotope name, half-life, range of ages able to be dated, example uses).
* Interview an expert in isotopic environmental science. Use primary and secondary sources to summarise their role, research and career path in the format of a LinkedIn profile.
* Process and analyse data about carbon dioxide concentrations and its effect on speleothem growth in Jenolan Caves.
* Process and analyse data about air pollution in North-Western Sydney.
* Process and analyse data about historical greenhouse gas concentrations in Antarctica.
* Create an infographic to explain what groundwater is, why it needs to be sustainably managed, and how ANSTO scientists calculate the age of different groundwater sources.

### Suggested resources

* ANSTO. (2017). Meet an expert (videoconference). [https://www.ansto.gov.au/education/secondary/videoconferences](http://www.ansto.gov.au/elearning).
* ANSTO. (2017). Raw data sources for analysis ([https://www.ansto.gov.au/education/secondary/workbooks-and-datasets](http://www.ansto.gov.au/datasets)).
* ANSTO. (2016). Feather Map citizen science project. <feathermap.ansto.gov.au>.
* ANSTO. (2016). Sirius tandem accelerator (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2016). Using nuclear science to benefit Indigenous Australia (brochure). <https://www.ansto.gov.au/corporate-publications>.
* ANSTO. (2015). Discover ANSTO (e-magazine). [https://www.ansto.gov.au/education/apps](http://www.ansto.gov.au/games).
* ANSTO. (2015). Radiocarbon dating on ANSTO’s VEGA accelerator (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2015). Understanding past climates (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2015). Water science: Aquatic ecosystems (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2015). Water science: Groundwater resources (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2014). Mapping groundwater in Mozambique (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2014). Revealing the sources of Sydney’s air pollution (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2014). Water research (brochure). [http://https://www.ansto.gov.au/corporate-publications](http://www.ansto.gov.au/Resources/Publications/BooksandLeaflets).
* ANSTO. (2011). Greenhouse gas concentrations from Law Dome (Antarctica) ice cores and Cape Grim (Tasmania) measurements. <https://www.ansto.gov.au/education/resources/posters>.

## Topic 4: The nuclear fuel cycle and managing nuclear waste

### Suggested activities

* Write a double-sided page of frequently asked questions (FAQs) and answers that community members might ask about nuclear waste.
* Evaluate the safety of storing nuclear waste at ANSTO.
* Draw an annotated flow chart to illustrate how uranium is mined and refined, used as fuel in nuclear reactors, and then processed and stored as nuclear waste.

### Suggested resources

* ANSTO. (2017). Managing waste at ANSTO (webpage). <https://www.ansto.gov.au/education/nuclear-facts/managing-waste>.
* Currie, G. (2017). Nuclear medicine explainer (video). <https://www.youtube.com/watch?v=98zuh9S2L7o>.
* Department of Industry, Innovation and Science. (2017). National Radioactive Waste Management Facility (webpage). <radioactivewaste.gov.au>.
* Currie, G. (2016). Nuclear medicine comes from nuclear reactors. Sydney Morning Herald (25/2/16). <http://www.smh.com.au/comment/nuclear-medicine-comes-from-nuclear-reactors-20160225-gn3dlg.html>.
* ANSTO. (2015). Safely managing Australia’s radioactive waste (brochure). [https://www.ansto.gov.au/corporate-publications](http://www.ansto.gov.au/resources/publications).
* ANSTO. (2015). Safely managing Australia’s radioactive waste (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* ANSTO. (2013). How does Synroc work (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).

## Topic 5: Neutron diffraction and synchrotron science in chemistry

### Suggested activities

* Interview an expert in neutron diffraction research. Use primary and secondary sources to summarise their role, research and career path in the format of a LinkedIn profile.
* Write a news article for the Daily Telegraph about a recent research discovery made using a neutron diffraction instrument or the Australian Synchrotron.

### Suggested resources

**Neutron diffraction and Synchrotron research**

* ANSTO. (2017). Meet an expert (videoconference). [https://www.ansto.gov.au/education/secondary/videoconferences](http://www.ansto.gov.au/elearning).
* ANSTO. (2017). Synchrotron science: Discoveries with light. [https://www.ansto.gov.au/education/secondary/workbooks-and-datasets](http://www.ansto.gov.au/workbooks).
* Maynard-Casely, H. (2017). Helen-Maynard-Casely (profile). Cosmos Online. <https://cosmosmagazine.com/contributors/helen-maynard-casely>.
* ANSTO. (2014). Crystallography curiosity files. [https://www.ansto.gov.au/education/secondary/workbooks-and-datasets](http://www.ansto.gov.au/workbooks).
* ANSTO. (2014). Echidna: High-resolution powder diffractometer (video). [https://www.youtube.com/user/ANSTOVideos](http://www.ansto.gov.au/educationvideos).
* Australian Synchrotron. (2012). Research at the Australian Synchrotron (video). <https://www.youtube.com/watch?v=74n8L5X2YSI>.

**Interplanetary chemistry**

* ANSTO. (2017). Meet an expert (videoconference). [https://www.ansto.gov.au/education/secondary/videoconferences](http://www.ansto.gov.au/elearning).
* ANSTO. (2016). Planetary science recreating Titan’s conditions on earth (video). <https://www.youtube.com/user/ANSTOVideos>
* ANSTO. (2016). Synchrotron used to find structure of a new material that could be found on the surface of Saturn’s moon Titan (30/3/16). <https://www.ansto.gov.au/news>
* Maynard-Casely, H. (2016). Discovering the bath scum on Titan. The Conversation. <https://theconversation.com/discovering-the-bath-scum-on-titan-55759>

**The Feather Map of Australia Project**

* ANSTO. (2017). Feather Map (website). <feathermap.ansto.gov.au>.
* ANSTO. (2017). Meet an expert (videoconference). [https://www.ansto.gov.au/education/secondary/videoconferences](http://www.ansto.gov.au/elearning).

**Other research examples**

* ANSTO. (2017). Bringing fossils to life with neutrons and 3D printing. <https://www.ansto.gov.au/news>
* ANSTO. (2017). Dingo sees through heavy corrosion to help identify an historic firearm. <https://www.ansto.gov.au/news>
* ANSTO. (2017). Promising new cathode material for low-temperature solid-oxide fuel. <https://www.ansto.gov.au/news>
* ANSTO. (2016). Seeing inside an ancient Australian Indigenous artefact non-invasively. <https://www.ansto.gov.au/news>
* Australian Synchrotron. (2016). Cosmic dust reveals Earth’s ancient atmosphere. <https://www.ansto.gov.au/news>
* Australian Synchrotron. (2016). Pioneering Australian partnership of art and science reveals hidden masterpiece. <https://www.ansto.gov.au/news>