Year 11 Chemistry

Depth study guide

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.
- ANSTO. (2016). How radioactive am I (Infographic). https://www.ansto.gov.au/education/apps.
- ANSTO. (2016). Understanding radiation: ANSTO cloud chamber. (https://www.youtube.com/user/ANSTOVideos).
- 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
- ANSTO. (2008). Radioisotope use and production in Australia (video). https://www.youtube.com/user/ANSTOVideos

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.
- 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.
- ANSTO. (2014). Half-life hero (online game). https://www.ansto.gov.au/education/apps.
- ANSTO. (2015). Cyclotrons and PET scans (fact sheet). https://www.ansto.gov.au/education/secondary/workbooks-and-datasets.
- ANSTO. (2015). Discover ANSTO (e-magazine). https://www.ansto.gov.au/education/apps.
- ANSTO. (2015). Molybdenum/Technetium supply chain (fact sheet). https://www.ansto.gov.au/education/secondary/workbooks-and-datasets.
- ANSTO. (2015). PET scan animation (video). https://www.youtube.com/user/ANSTOVideos.
- ANSTO. (2014). OPAL research reactor (video). https://www.youtube.com/user/ANSTOVideos.
- 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.
- ANSTO. (2012). Nuclear medicine: Answering your questions (brochure). http://https://www.ansto.gov.au/corporate-publications.
- ANSTO. (2011). Year 11 and 12 nuclear chemical equations sheet. https://www.ansto.gov.au/education/secondary/workbooks-and-datasets.
- The Open University. (2008). SPECT imaging technique – Imaging in medicine (11/13) (video). https://www.youtube.com/user/ANSTOVideos.
- The Open University. (2008). Iodine therapy – Radiotherapy and its physics (4/15) (video). https://www.youtube.com/user/ANSTOVideos.

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.
- ANSTO. (2017). Raw data sources for analysis (https://www.ansto.gov.au/education/secondary/workbooks-and-datasets).
- ANSTO. (2016). Feather Map citizen science project. feathermap.ansto.gov.au.
- ANSTO. (2016). Sirius tandem accelerator (video). https://www.youtube.com/user/ANSTOVideos.
- 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.
- ANSTO. (2015). Radiocarbon dating on ANSTO's VEGA accelerator (video). https://www.youtube.com/user/ANSTOVideos.
- ANSTO. (2015). Understanding past climates (video). https://www.youtube.com/user/ANSTOVideos.
- ANSTO. (2015). Water science: Aquatic ecosystems (video). https://www.youtube.com/user/ANSTOVideos.
- ANSTO. (2015). Water science: Groundwater resources (video). https://www.youtube.com/user/ANSTOVideos.
- ANSTO. (2014). Mapping groundwater in Mozambique (video). https://www.youtube.com/user/ANSTOVideos.
- ANSTO. (2014). Revealing the sources of Sydney's air pollution (video). https://www.youtube.com/user/ANSTOVideos.
- ANSTO. (2014). Water research (brochure). http://https://www.ansto.gov.au/corporate-publications.
- 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.
- ANSTO. (2015). Safely managing Australia's radioactive waste (video). https://www.youtube.com/user/ANSTOVideos.
- ANSTO. (2013). How does Synroc work (video). https://www.youtube.com/user/ANSTOVideos.

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.
- ANSTO. (2017). Synchrotron science: Discoveries with light. https://www.ansto.gov.au/education/secondary/workbooks-and-datasets.
- 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.
- ANSTO. (2014). Echidna: High-resolution powder diffractometer (video). https://www.youtube.com/user/ANSTOVideos.
- 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.
- 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.

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