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| Year 12 Physics |
| Tour outline and syllabus outcomes |
| ANSTO is a leader in applied physics research, operating Australia’s only nuclear reactor, the Australian Synchrotron, cyclotrons and linear accelerators.ANSTO conducts Year 12 Physics excursions, which cover specific Knowledge and Understanding content from Module 8: From the Universe to the Atom - Properties of the Nucleusand Working Scientifically skills from the NSW NESA Stage 6 Physics syllabus. These excursions consist of:* A 120 minute tour of ANSTO’s research facilities, including the OPAL research reactor, ANSTO Nuclear Medicine production facility, Australian Centre for Neutron Scattering, and the Centre for Accelerator Science
* A 20 minute break for students
* 70 minutes of educator-led activities and a presentation in our Discovery Centre theatrette and display area

Students will complete the excursion workbook during the excursion. |
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| **Excursion content** | **Syllabus links** |
| Pre-work in excursion workbook:* Process information to identify properties of alpha, beta and gamma radiation
* Predict the decay mode for radioisotopes
* Determine the isotopes formed in nuclear decays and transmutations
* Determine the activity or amount of a radioactive sample remaining using its half-life
 | **Module 8: From the Universe to the Atom**Properties of the Nucleus* analyse the spontaneous decay of unstable nuclei, and the properties of the alpha, beta and gamma radiation emitted.
* examine the model of half-life in radioactive decay and make quantitative predictions about the activity or amount of a radioactive sample using the following relationships:

 Nt = N0e-λt λ = (ln2)/(t1/2) where Nt = number of particles at time t, N0 = number of particles present at t = 0, λ = decay constant, t1/2 = time for half the radioactive amount to decay.* analyse relationships that represent conservation of mass-energy in spontaneous and artificial nuclear transmutations, including alpha decay, beta decay, nuclear fission and nuclear fusion.
* account for the release of energy in the process of nuclear fusion.
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| Tour (120 min)* Students visit the OPAL research reactor, ANSTO Nuclear Medicine production facility, Australian Centre for Neutron Scattering, and the Centre for Accelerator Science. We discuss how:
	+ controlled fission reaction inside OPAL is used to produce nuclear medicines, irradiate silicon and produce neutrons for research
	+ neutrons are used in diffraction experiments to investigate crystal structures of materials
	+ linear particle accelerators are used to conduct environmental research
	+ nuclear medicines are designed, produced and used to diagnose and treat disease
	+ nuclear waste is managed
 | **Module 8: From the Universe to the Atom**Properties of the nucleus* analyse the spontaneous decay of unstable nuclei, and the properties of the alpha, beta and gamma radiation emitted
* model and explain the process of nuclear fission, including the concepts of controlled and uncontrolled chain reactions, and account for the release of energy in the process

 Deep Inside the Atom* investigate the operation and role of particle accelerators in obtaining evidence that tests and/or validates aspects of theories, including the Standard Model of matter
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| **Excursion content** | **Syllabus links** |
| In the Discovery Centre (70 min):* Participate in a demonstration of the properties of alpha, beta and gamma radiation
* Observe the change in radiation count with distance from a source
* Observe the change in radiation count with the interposition of shielding
* investigate how half-life of a radioisotope is determined experimentally
* explore an analogy of binding energy
* evaluate a model of the process of nuclear fission
* explore ANSTO’s science work, future directions of nuclear technology and nuclear waste management.
 | **Module 8: From the Universe to the Atom**Properties of the nucleus* analyse the spontaneous decay of unstable nuclei, and the properties of the alpha, beta and gamma radiation emitted
* examine the model of half-life in radioactive decay and make quantitative predictions about the activity or amount of a radioactive sample using the following relationships:

 Nt = N0e-λt λ = (ln2)/(t1/2) where Nt = number of particles at time t, N0 = number of particles present at t = 0, λ = decay constant, t1/2 = time for half the radioactive amount to decay.* model and explain the process of nuclear fission, including the concepts of controlled and uncontrolled chain reactions, and account for the release of energy in the process

**Working scientifically*** Questioning and predicting
* Processing data and information
* Analysing data and information
* Conducting investigations
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| Post-work in excursion workbook:* Use authentic radioactive decay data to determine the half-life of Technetium-99m and discuss the accuracy of the values determined
* Perform calculations to predict the energy released in nuclear decays and transmutations
 | **Module 8: From the Universe to the Atom**Properties of the nucleus* examine the model of half-life in radioactive decay and make quantitative predictions about the activity or amount of a radioactive sample using the following relationships:

 Nt = N0e-λt λ = (ln2)/(t1/2) where Nt = number of particles at time t, N0 = number of particles present at t = 0, λ = decay constant, t1/2 = time for half the radioactive amount to decay.* predict quantitatively the energy released in nuclear decays or transmutations, including nuclear fission and nuclear fusion, by applying:

– the law of conservation of energy– mass defect– binding energy– Einstein’s mass–energy equivalence relationship  𝐸 = 𝑚𝑐2 |