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| Senior Physics Videoconference |
| 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 Senior Physics videoconferences, which cover specific Science Understanding content from the Australian Curriculum **Unit 1: Thermal, nuclear and electrical physics**, specifically the section Ionising radiation and nuclear reactions Science Inquiry Skills and Science as a Human Endeavour content descriptions are also addressed. ANSTO videoconference outlineThe videoconference outlined on the following pages is for an **80 minute lesson**, however, it can be adjusted to suit shorter or longer lesson times. The content can also be modified to suit individual teacher requirements.A **videoconference workbook**, that complements what is presented, has been developed for students to complete during the videoconference. The workbook also includes post- videoconference activities. Answers for the activities in the workbook are available on request.During the videoconference, students will: * Investigate the properties of the three main types of radiation (alpha, beta and gamma)
* Collect data during a demonstration of a radiation experiment, using low level radioactive sources and radiation detection equipment.
* Observe background radiation in our cloud chamber
* Understand how half-life of a radioisotope is determined experimentally
* Understand the operation and uses of OPAL (Open Pool Australian Lightwater) Research Reactor
* Explore a model of the process of nuclear fission
* Examine the interconnectedness of the concepts of the law of conservation of energy, mass defect, binding energy and Einstein’s mass–energy equivalence relationship 𝐸 = 𝑚𝑐2, and the application of these concepts to nuclear fission and nuclear fusion
* Understand the operation of ANSTO’s tandem particle accelerators and their uses
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**Links to Senior Physics Australian Curriculum**

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| **Videoconference content** | **Curriculum links** |
| **Radiation Investigation*** Demonstration of the properties of alpha, beta and gamma (penetration through paper, aluminium, lead) using alpha, beta and gamma radioactive sources and scintillation counter.
* Demonstration of penetration of ionising radiation using radioactive objects and scintillation counter
* Observe the change in radiation count with distance from the source and interposition of shielding
* Why some atoms radioactive – discussion of neutron to proton graph and radioactive decay equations

**Cloud Chamber*** How a cloud chamber detects radiation
* Students draw traces left by alpha particles, beta particles and muons in the cloud chamber
 | **Science Understanding**Some nuclides are unstable and spontaneously decay, emitting alpha, beta and/or gamma radiation over time until they become stable nuclides (ACSPH028)Alpha, beta and gamma radiation have sufficient energy to ionise atoms (ACSPH030)**Science Inquiry Skills**Identify, research, construct and refine questions for investigation; propose hypotheses; and predict possible outcomes (ACSPH001)Represent data in meaningful and useful ways, including using appropriate Système Internationale (SI) units and symbols; organise and analyse data to identify trends, patterns and relationships; identify sources of random and systematic error and estimate their effect on measurement results; identify anomalous data and calculate the measurement discrepancy between experimental results and a currently accepted value, expressed as a percentage; and select, synthesise and use evidence to make and justify conclusions (ACSPH004)Select, construct and use appropriate representations, including text and graphic representations of empirical and theoretical relationships, flow diagrams, nuclear equations and circuit diagrams, to communicate conceptual understanding, solve problems and make predictions (ACSPH006) |
| **Half life*** view a short video on how half life is determined experimentally
* Predict the half life of a sample using a decay curve
 | **Science Understanding**Each species of radionuclide has a specific half-life (ACSPH029)$N=N\_{0}\left(\frac{1}{2}\right)$ *n*(for whole numbers of half-lives only)*N*= number of nuclides remaining in a sample, *n*= number of whole half-lives.**Science Inquiry Skills**Select, use and interpret appropriate mathematical representations, including linear and non-linear graphs and algebraic relationships representing physical systems, to solve problems and make predictions (ACSPH007) |

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| **Videoconference content** | **Curriculum links** |
| **OPAL*** Virtual tour of the OPAL research reactor to discuss:
	+ The reactor components and their function
	+ operation and safety of the reactor
	+ The purpose of the controlled fission reaction inside OPAL to produce nuclear medicines, irradiate silicon and produce neutrons for research

**Energy from the atomic nucleus*** The process of nuclear fission and nuclear fusion in terms of mass defect, accounting for release of energy in each process
* Binding Energy analogy and its relationship to nuclear fission and nuclear fusion
* The ITER project
 | **Science Understanding**Neutron-induced nuclear fission is a reaction in which a heavy nuclide captures a neutron and then splits into two smaller radioactive nuclides, with the release of neutrons and energy (ACSPH033)A fission chain reaction is a self-sustaining process that may be controlled to produce thermal energy, or uncontrolled to release energy explosively (ACSPH034)Einstein’s mass/energy relationship, which applies to all energy changes, enables the energy released in nuclear reactions to be determined from the mass change in the reaction (ACSPH031)Nuclear stability is the result of the strong nuclear force, which operates between nucleons over a very short distance and opposes the electrostatic repulsion between protons in the nucleus (ACSPH027)Alpha and beta decay are examples of spontaneous transmutation reactions, while artificial transmutation is a managed process that changes one nuclide into another (ACSPH032)Nuclear fusion is a reaction in which light nuclides combine to form a heavier nuclide, with the release of energy (ACSPH035)More energy is released per nucleon in nuclear fusion than in nuclear fission because a greater percentage of the mass is transformed into energy (ACSPH036) |
| **Particle accelerators*** operation and role of ANSTO particle accelerators
* Linear particle accelerators are used to conduct environmental research
 | **Science as a Human Endeavour**Scientific knowledge can enable scientists to offer valid explanations and make reliable predictions (ACSPH014)Scientific knowledge can be used to develop and evaluate projected economic, social and environmental impacts and to design action for sustainability (ACSPH015) |