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| Year 12 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 Year 12 Physics videoconferences, which cover specific Knowledge and Understanding content from NSW NESA Stage 6 Physics syllabus **Module 8: From the Universe to the Atom**, specifically the section Properties of the Nucleus, Inquiry question: How can the energy of the atomic nucleus be harnessed? Working Scientifically skills from the NSW NESA Stage 6 Physics syllabus 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 NSW NESA Stage 6 Physics syllabus**

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| **Videoconference content** | **Syllabus 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
 | * analyse the spontaneous decay of unstable nuclei, and the properties of the alpha, beta and gamma radiation emitted.

**Working scientifically*** Questioning and predicting
* Processing data and information
* Analysing data and information
* Conducting investigations
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| **Half life*** view a short video on how half life is determined experimentally
* Predict the half life of a sample using a decay curve
 | * 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-λtλ = (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. |

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| **Videoconference content** | **Syllabus 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
 | * 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
* 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.
* 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 |
| **Particle accelerators*** operation and role of ANSTO particle accelerators
* Linear particle accelerators are used to conduct environmental research
 | * 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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