KESTEVEN AND SLEAFORD HIGH SCHOOL
Physics Scheme of Learning

P7: Radioactivity

Intent – Rationale

Ionising radiation is hazardous but can be very useful. Although radioactivity was discovered over a century ago, it took many nuclear physicists several decades to understand the structure of atoms, nuclear forces and stability. Early researchers suffered from their exposure to ionising radiation. Rules for radiological protection were first introduced in the 1930s and subsequently improved. Today radioactive materials are widely used in medicine, industry, agriculture and electrical power generation.

Sequencing – what prior learning does this topic build upon?	Sequencing – what subsequent learning does this topic feed into?
KS3: Year 8 Atomic structure GCSE: P3 Generating electricity	GCSE: P16 Space A-Level: Topic 10 Radiation and Nuclear Energy
What are the links with other subjects in the curriculum?	**What are the links to SMSC, British Values and Careers?**
GCSE Chemistry: The discovery of the atom	Lesson 6 – GB46 – Uses for radiation in medicine Lesson 7 & 8 – GB46 – Generation of electricity from nuclear energy Lesson 7 & 8 – M3 Environmental effects of nuclear power
What are the opportunities for developing literacy skills and developing learner confidence and enjoyment in reading?	**What are the opportunities for developing mathematical skills?**
FROM THE LIBRARY *Radiation*-539 *Nuclear Energy*-620 *Elements of Nuclear Physics*-539.1 *Introduction to Atomic and Nuclear Physics-539*	• Make calculations using ratios and proportional reasoning to convert units and to compute rates (1c, 3c). • Balance equations representing alpha-, beta- or gamma-radiations in terms of the masses and charges of the atoms involved (1b, 1c, 3c).

	• Calculate the net decline, expressed as a ratio, in a radioactive emission after a given number of half-lives (1c, 3d).

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Intent – Concepts

What knowledge will students gain and what skills will they develop as a consequence of this topic?
Know Name the three types of nuclear radiation the three sub-atomic particles found in an atom (proton, neutron, and electron) and identify some sources of background radiation. Identify the Rutherford (nuclear) model of an atom. Identify the type of decay taking place from a nuclear equation. State that all three types of nuclear radiation are ionising. Define half-life in simple terms such as 'the time it takes for half of the material to decay'. **Apply** Describe some safety precautions used when dealing with radioactive materials. Describe the evidence provided by the Rutherford scattering experiment. Complete decay equations for alpha and beta decay. Describe the process of ionisation. Plot a graph showing the decay of a sample and use it to determine half-life. **Extend** Describe the relative penetrating powers of the three types of nuclear radiation. Explain how Rutherford and Marsden's experiment caused a rejection of the plum pudding model. Explain why particles are ejected from the nucleus during nuclear decay. Evaluate in some detail the risks caused by alpha radiation inside and outside the human body. Compare a physical model of decay with the decay of nuclei, noting the limitations of the model.

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What subject specific language will be used and developed in this topic?	What opportunities are available for assessing the progress of students?
activity the number of unstable atoms that decay per second in a radioactive source **alpha radiation (α)** alpha particles, each composed of two protons and two neutrons, emitted by unstable nuclei **atomic number** the number of protons (which equals the number of electrons) in an atom. It is sometimes called the proton number **beta radiation (β)** beta particles that are high energy electrons created in, and emitted from, unstable nuclei **chain reaction** reactions in which one reaction causes further reactions, which in turn cause further reactions, etc. **count rate** the number of counts per second detected by a Geiger counter **gamma radiation (γ)** electromagnetic radiation emitted from unstable nuclei in radioactive substances **half-life** average time taken for the number of nuclei of the isotope (or mass of the isotope) in a sample to halve **ionisation** any process in which atoms become charged **irradiated** an object that has been exposed to ionising radiation **isotopes** atoms with the same number of protons and different numbers of neutrons **mass number** the number of proton and neutrons in a nucleus **moderator**	P7 L9 End of topic Test Past exam question assessed homework “Atomic Structure”, “Nuclear power hazards”, “Nuclear waste” Teams assignment

substance in a nuclear reactor that slows down fission neutrons **nuclear fission** the process in which certain nuclei (uranium-235 and plutonium-239) split into two fragments, releasing energy and two or three neutrons as a result **nuclear fission reactor** reactors that release energy steadily due to the fission of a suitable isotope, such as uranium-235 **nuclear fusion** the process where small nuclei are forced together to fuse and form a larger nucleus **radioactive contamination** the unwanted presence of materials containing radioactive atoms on other materials **reactor core** the thick steel vessel used to contain fuel rods, control rods and the moderator in a nuclear fission reactor	

Intent – Concepts

Lesson title	Learning challenge	Higher level challenge	Suggested activities and resources
1.Atoms and Radiation	I can describe what radioactivity is I can explain sources of background radiation I can describe the properties of alpha, beta and gamma radiation I can describe the what ionising means	I can explain the similarities and differences between nuclear radiation and visible light. I can describe the relative penetrating powers of the three types of nuclear radiation.	Demo (Radioactive sources, accessories and Geiger counter) Link
2. The Discovery of the Nucleus	I can identify the Rutherford (nuclear) model of an atom. I can identify the locations of protons, neutrons, and electrons in the nuclear model.	I can compare the plum pudding model, Rutherford model, and Bohr model of the atom in terms of the evidence for each model. I can explain how Rutherford and Marsden's experiment caused a	Link

		rejection of the plum pudding model.	
3. Alpha, Beta & Gamma Radiation	I can explain what alpha and beta particles are and what happens to the nucleus when they are emitted	I can explain why particles are ejected from the nucleus during nuclear decay. I can describe the changes in the nucleus that occur during nuclear decay.	Link
4. More about alpha, beta & gamma radiation	I can recognise the penetration power of each type of radiation I can explain the dangers of ionisation	I can describe in detail how the thickness of a material being manufactured can be monitored by using a beta source. I can evaluate in some detail the risks caused by alpha radiation inside and outside the human body.	Demo (Radioactive sources, accessories and Geiger counter) Link
5. Half Life	I can recognise that radioactivity decreases with time I can explain and use the idea of half life	I can compare a physical model of decay with the decay of nuclei, noting the limitations of the model. I can explain how the age of organic material can be determined by using radioactive dating.	Demo (Radioactive dice) Link
6. Medical Imaging and Treatments	I can explain different medical uses for radioactivity including, Medical tracers, - Treating cancer (Radiotherapy, Radioactive implants)	I can describe the use of radioactive implants and the hazards associated with the technique. I can discuss the factors that need to be taken into account when selecting a medical tracer for a diagnostic test. I can explain how a medical tracer is used including the function of a gamma camera.	Link
7. Nuclear Fission	I can explain energy is released from uranium or plutonium by the process of fission	I can explain how a steady-state induced fission reaction can be maintained.	Link

	I can explain fission occurs when a nucleus absorbs a neutron and splits releasing energy	I can explain the differences between naturally occurring isotopes and enriched nuclear fuels.	
8. Nuclear Fusion and Nuclear Waste	I can describe how control of Nuclear Fission in a power station I can explain the process of Nuclear Fusion I can explain the categories and problems associated with radioactive waste	I can discuss the risks and benefits of nuclear power compared to other methods of electricity generation. I can describe and explain the safety precautions that need to take place after a large nuclear accident. I can evaluate in detail a variety of storage or disposal solutions for nuclear waste.	Link
9. End of topic test			