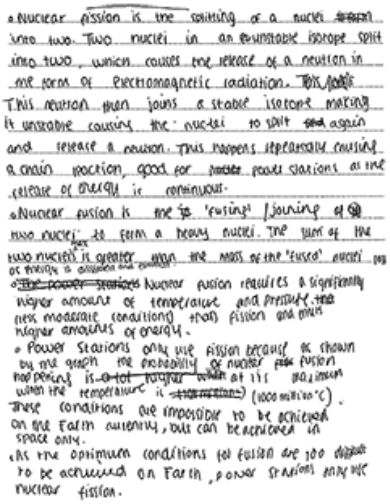
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Detailed descriptions of fission **and** fusion **AND** Detailed explanation of why power stations use nuclear fission *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Detailed description of fission **or** fusion **AND** Clear explanation of why power stations use nuclear fission **OR** Clear description of fission **and** fusion **AND** Clear explanation of why power stations use nuclear fission **OR** Clear description of fission **or** fusion **AND** Detailed explanation of why power stations use nuclear fission *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Basic description of fission **and** fusion **OR** Basic description of fission **AND** basic explanation of why power stations use nuclear fission **OR**	6 (4 × AO 1.1) (2 × AO 3.2a)	**AO1.1 – Demonstrates knowledge and understanding of nuclear fission and fusion reactions.** • fusion involves joining two lighter/smaller nuclei together into a heavier nucleus to release large amounts of energy • fission involves splitting a heavier/larger nucleus, when hit by a neutron, into two lighter/smaller nuclei to release large amounts of energy • fission releases (2 or 3) neutrons • fusion releases more much energy than fission • fission produces dangerous waste / fusion would not • fission can lead to an uncontrolled chain reaction **AO3.2a – Analyses information and ideas to make judgements about nuclear fusion power stations.** • there is a range of temperatures over which fusion can occur • the probability of fusion happening is very low at low temperatures / temperatures less than 10 million °C • fusion requires very high temperatures/pressures to occur / **ORA** for fission • the highest probability of fusion happening is at approximately 1000 million °C • difficult to contain gases/plasma at very high temperatures for fusion • hard to achieve the high temperatures/pressures needed for fusion on the Earth

			Basic description of fusion **AND** basic explanation of why power stations use nuclear fission *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant*. **0 mark** *No response or no response worthy of credit.*		• more energy is required to make fusion work than is produced at present • more expensive to make fusion work • fusion reactors would be safer **Examiner's Comments** This was the Level of Response question, targeted up to Grade 9, and assessing AO1 and AO3. There was a wide range of marks achieved, with some responses of an excellent standard, and the question discriminated very well. Very few candidates did not achieve any credit. The majority of candidates were able to give a basic description of fission or fusion, or they explained why power stations only use nuclear fission at present, although the values they read from the graph were not always correct. Many candidates achieving Level 1 had answers which lacked detail or did not answer every part of the question. More detailed responses required for Level 2 and 3 included using correct scientific terminology and a detailed analysis of the graph. Poor quality of communication, including incorrect scientific terminology, or the same facts repeated a number of times, prevented some candidates from achieving a higher mark. **Misconception** Some common misconceptions and errors seen in responses included: • using the term 'atom' instead of 'nucleus' when describing fission and fusion

					• stating that an electron (rather than a neutron) is used to bombard a uranium nucleus • stating that the largest probability of fusion happening was at 1000 °C, because the unit of the axis was not read carefully enough • confusing ideas about fission and fusion • fusion reactors are more dangerous than fission reactors. Exemplar 3  • Nuclear fission is the splitting of a nuclei [illegible] into two. Two nuclei in an unstable isotope split into two, which causes the release of a neutron in the form of electromagnetic radiation. This [illegible] This neutron then joins a stable isotope making it unstable causing the nuclei to split and again and release a neutron. This happens repeatedly causing a chain reaction, good for [illegible] power stations as the release of energy is continuous. • Nuclear fusion is the 'fusing' [joining of the two nuclei] to form a heavy nuclei. The sum of the two nuclei is greater than the mass of the 'fused' nuclei [illegible] of energy is released and emitted. • The power stations Nuclear fusion requires a significantly higher amount of temperature and pressure, the most accurate conditions) than fission and uses higher amounts of energy. • Power stations only use fission because as shown by the graph the probability of nuclear fusion reactions is [illegible] when the temperature is [illegible] (1000 million °C). These conditions are impossible to be achieved on the Earth currently, this can be replicated in space only. • As the optimum conditions for fusion are too difficult to be achieved on Earth, power stations only use nuclear fission. This response achieved Level 3, 6 marks. The description of both fission and fusion is very detailed, using correct terminology about nuclei. The candidate has also given a full explanation about why power stations only use nuclear fission at present.
			Total	**6**	
2			**A**	1 (AO 1.1)	**Examiner's Comments** Under half of candidates answered this question correctly. The most common incorrect answer was B – the teacher is only contaminated, and not irradiated, when they spill the radioactive element on their hands.

			Total	**1**	
3			D ✓	1 (AO2.2)	**Examiner's Comments** This question assessed candidates' knowledge of nuclear fission. Most candidates correctly chose option D. **Exam Hint** Many candidates drew simple sketches of step 2 and step 3 to help them visualise what was happening in the model.
			Total	**1**	