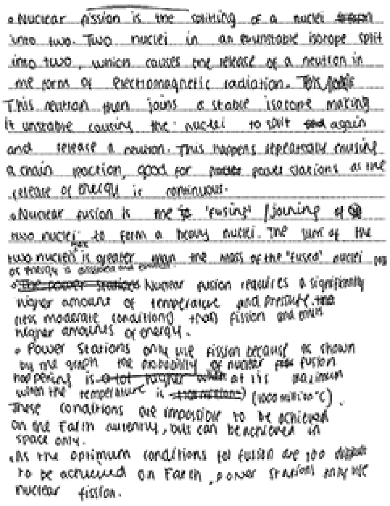
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		**First check the answer on the answer line** **If answer = 7 (%) award 2 marks** (% system margin =) (64.2 − 60.0) ÷ 60.0 × 100 ✓ (% system margin =) 7 (%) ✓	2 (2 x AO 2.1)	
	b	i	**Any two from:** (Idea that) demand may change ✓ (Idea that) supply (capacity) may change ✓ Weather may change / may be warmer or colder than expected ✓	2 (2 x AO 3.2a)	**ALLOW** don't know the exact demand / customers may use more or less electricity/heating (than predicted) **ALLOW** don't know the exact supply (capacity) **ALLOW** wind speed will change **IGNORE** seasons change **Examiner's Comments** A significant number of candidates appeared not to read the question carefully and did not address what was being asked. Answers were also often toovague, e.g. to prepare for worst case scenarios, instead of recognising that both the supply and the demand can change. **Assessment for learning** Candidates should be encouraged to spend more time reading the question carefully, highlighting key words or phrases.
		ii	**First check the answer on the answer line** **If answer = 35 (%) award 2 marks** (% uncertainty =) 0.5 × (6.2− 3.0) ÷ 4.6 × 100 ✓	2 (2 x AO 3.3b)	**ALLOW** answers that round to 35 (%)

			(% uncertainty =) 35 (%) ✓		
	c	i	(Idea that) demand may be greater than supply / possibility of power cuts / may not be able to supply enough electricity(to customers) / **AW** ✓	1 (AO 3.2b)	
		ii	**First check the answer on the answer line** **If answer = 5.68 award 2 marks** 4.5 × 0.04 **OR** 0.18 **OR** 4.5 × 1.04 **OR** 4.68 ✓ 5.68 ✓	2 (2 x AO 2.2)	**ALLOW** 5.7 **<u>Examiner's Comments</u>** The majority of candidates gained full credit, but a significant number of candidates appeared to struggle with percentages, often multiplying by 1.4 instead of 1.04. Another common error was forgetting to add on 1.0 GW to the increased system margin.
			Total	**9**	
2			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**	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

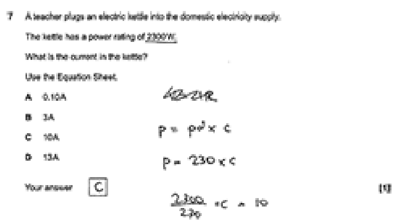
			Detailed explanation of why power stations use nuclear fission *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Basic description of fission **and** fusion **OR** Basic description of fission **AND** basic explanation of why power stations use nuclear fission **OR** 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.*		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 • 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 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 neutron then joins a stable isotope making it unstable causing the nuclei to split again and release a neutron. This happens repeatedly causing a chain reaction, good for power stations as the release of energy is continuous. • Nuclear fusion is the 'fusing' / joining of two nuclei to form a heavy nuclei. The sum of the two nuclei is greater than the mass of the 'fused' nuclei • Nuclear fusion requires a significantly higher amount of temperature and pressure than the less moderate conditions than fission and gives higher amounts of energy. • Power stations only use fission because as shown by the graph the probability of nuclear fusion happening is at its maximum when the temperature is (1000 million °C). These conditions are impossible to be achieved on the Earth currently, but can be achieved 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**	
3	a		**Any four from:** Wrap coil(s) around a (soft iron) rod ✓ Connect a voltmeter across secondary coil / measure p.d. across secondary coil ✓ Connect (a.c. power) supply to primary coil ✓ Change the number of turns in the secondary coil ✓ Keep p.d. of the a.c. supply/primary p.d. constant ✓ Keep number of turns in the primary coil constant ✓	4 (4 × AO 3.3a)	**ALLOW** marks awarded from a clear diagram **ALLOW** coils side by side or on top of one another **ALLOW** dependent variable is p.d. across secondary coil **DO NOT ALLOW** d.c. power supply or cell/battery in diagram **ALLOW** independent variable is number of turns **ALLOW** p.d. of a.c. supply/primary p.d. is a control variable **ALLOW** control variable is number of turns in primary coil **Examiner's Comments** It was evident that most candidates found this question the most challenging on the paper, with usually only the highest achieving candidates gaining more than 1 mark. The question assessed AO3. It required candidates to describe how to use the equipment provided to make a transformer to investigate the relationship between the p.d. across the secondary coil and the number of turns on this coil. Some candidates confused the transformer with an electromagnet and many did not mention primary and secondary coils, this allowed access to the first marking point only. Many drew diagrams where the primary coil and the secondary coil were joined together in a circuit. A few students described bending the iron rod into a square shape like a conventional transformer, and usually these candidates then gained the most marks, because they went on to label

					the two coils and connected the power supply and voltmeter in the correct places. Most candidates were not specific about which coil they were referring to when writing about the power supply, voltmeter and changing the number of turns.
	b	i	**First check the answer on answer line** **If answer = 19.5 (V) award 3 marks** Rearrangement: (V_s =) V_p × (N_s ÷ N_p) ✓ (V_s =) 230 × (300 ÷ 3540) ✓ (V_s =) 19.5 (V) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** 19 (V) or 19.49 (V) **ALLOW** 1 mark for correct substitution into unrearranged equation, e.g., 230 / V_s = 3540 / 300
		ii	**First check the answer on answer line** **If answer = 0.39 (A) award 3 marks** Rearrangement: (I_p =) (I_s × V_s)÷ V_p ✓ (I_p =) 4.62 × 19.5 ÷ 230 ✓ (I_p =) 0.39 (A) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** ECF from **(c)(i)** **ALLOW** (I_p =) (I_s × N_s)÷ N_p **ALLOW** (I_p =) 4.62 × 300 ÷ 3540 **ALLOW** 1 mark for correct substitution into unrearranged equation, e.g., 230 × I_p = 4.62 × 19.5 **OR** 3540 × I_p = 4.62 × 300 **<u>Examiner's Comments</u>** The calculations in Questions 21 (b) (i) and (b) (ii) were generally answered well, with a significant number of candidates gaining full credit. Other candidates struggled with rearranging the equations, but still gained marks for substituting the given information into an unrearranged equation. **Assessment for learning** Candidates could benefit from short activities where they practise

					rearranging the transformer equations with four terms.
	c	i	Candidate states turns ratios from 2 different points on the graph ✓ Candidate concludes that as turns ratio doubles then power loss is not half / power loss decreases by a factor of 4 / × ¼ / quarters ✓	2 (AO 3.1a) (AO 3.1a)	e.g., at a ratio of 5, power loss = 0.08 (W) but at a ratio of 10, power loss = 0.02 (W) **ALLOW** tolerance of +/− ½ small square **ALLOW** e.g., power loss at a ratio of 10 should be 0.04 (W) **<u>Examiner's Comments</u>** This question was answered well, with correct values read from the graph and the calculation completed, along with the correct conclusion. Some candidates misread the graph, so could score a maximum of 1 mark, for example, a power loss of 0.8 W was stated instead of 0.08 W for a turns ratio of 5, or a power loss of 0.5 W for a turns ratio of 2.5.
		ii	**Any two from:** Transformers increase voltage/p.d. (before national grid) / AW ✓ Transformers decrease current ✓ Transformers decrease power/energy losses ✓	2 (2 × AO 1.2)	**ALLOW** energy losses are proportional to the current squared / less heat lost to the surroundings / high current causes large energy losses / more efficient energy transfer **DO NOT ALLOW** stops power/energy losses **<u>Examiner's Comments</u>** This question has often been asked in past GCSE Physics papers, and candidates performed slightly better, but still more than one in five candidates did not gain credit. Many gained one mark for the idea of less energy lost (as heat), but only the higher achieving candidates were able to link this to higher voltages resulting in a lower current.

					Assessment for learning Candidates should be aware that the idea of **no** energy losses will not gain credit.
			Total	**14**	
4			**C**	1 (AO 2.1)	**<u>Examiner's Comments</u>** This question assessed candidates' recall of the voltage of the mains supply in the UK and rearrangement of the relevant equation from the Equation Sheet. The vast majority of candidates did this successfully. There was evidence that some candidates who chose the incorrect option had tried to use an incorrect equation such as $P = I^2R$. Exemplar 1  7 A teacher plugs an electric kettle into the domestic electricity supply. The kettle has a power rating of 2300W. What is the current in the kettle? Use the Equation Sheet. A 0.10A B 3A C 10A D 13A Your answer C [1] This response shows how the candidate identifies the correct equation from the equation sheet, recalls the voltage of the mains supply in the UK and rearranges the equation to calculate the current in the kettle.
			Total	**1**	
5	a	i	**1** Not enough wind/force/energy/speed to turn the turbine ✓ **2** (Speed too high so) could damage the turbine / turbine is shut down to stop damage/for safety reasons ✓	2 (2 × AO3.2a)	**ALLOW** turbine does not turn **ALLOW** idea of (the turbine/it) being damaged/broken
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4.3 (MJ) award 5 marks**	5 (AO2.2) (AO1.2) (2 ×	**ALLOW** equation in any form **ALLOW** 4.2857 … × 10^6 or 4.3 × 10^6 for 4 marks

			(Useful output energy transfer per second =) 1.5 (MJ) ✓ Efficiency = Useful output energy transfer ÷ Input energy transfer ✓ (Input energy transfer =) 1.5 ÷ 0.35 ✓ (Input energy transfer =) 4.2857… ✓ (Input energy transfer =) 4.3 (MJ) ✓	AO2.1) (AO1.2)	**ALLOW** an incorrect answer rounded to 2 sig. fig. for this mark **<u>Examiner's Comments</u>** This question required candidates to identify the correct equation from the Data Sheet, which made the question more accessible. They then had to rearrange the equation, substitute in the correct value for output energy transferred per second for a speed of 10 m/s from the graph and give their answer to two significant figures. Nearly all candidates scored full marks. The main error was using the value for the wind speed (10 m/s) as the output energy in the equation. As candidates usually showed their calculations, they were still able to gain compensatory marks.
	b	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 7.7×10^{17} (J) award 2 marks** 215 (TWh) from graph ✓ ($215 \times 3.6 \times 10^{15}$ =) 7.7×10^{17}(J) ✓	2 (2 × AO1.2)	**ALLOW** 210 – 220 (TWh) from graph **ALLOW** 1 mark for any correct conversion into J e.g. $210 \times 3.6 \times 10^{15} = 7.6 \times 10^{17}$(J) $220 \times 3.6 \times 10^{15} = 7.9 \times 10^{17}$(J) **IGNORE** answer not in standard form
		ii	**Any two from:** More wind turbines have been built ✓ Modern turbines have a better design / are more efficient ✓ (wind turbines) do not produce air pollution/harmful gases/carbon dioxide/greenhouse gases / do not contribute to global warming/greenhouse effect/climate change ✓ (idea that wind turbines) conserve/reduce use of fossil fuels ✓ (Idea of) renewable energy ✓ (wind turbines) have low fuel/running costs once set up ✓	2 (2 × AO1.1)	**IGNORE** increased demand **ALLOW** better technology **IGNORE** no pollution / better for the environment unless qualified **IGNORE** sustainable **ALLOW** reduce use of finite resources / fossil fuels are running out **ALLOW** high cost of fossil fuels **<u>Examiner's Comments</u>** Most candidates gained at least 1 mark, usually for the idea of renewable energy. Answers such as 'no pollution', 'environmentally friendly', or just 'global warming' were not given any marks.

	c	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 70 (A) award 2 marks** Rearrangement: Current in secondary coil = current in primary coil × potential difference across primary coil ÷ potential difference across secondary coil **OR** 2800 × 900 ÷ 36000 ✓ (Current in secondary coil =) 70 (A) ✓	2 (2 × AO2.1)	**ALLOW** rearranged equation in symbols or numbers **<u>Examiner's Comments</u>** This question required candidates to identify the correct equation from the Data Sheet, which made the question more accessible.
		ii	**Any three from:** It is a <u>step-up</u> transformer / to increase p.d. ✓ Decrease current (in power lines) ✓ less energy wasted/lost / less heat in power lines / less thermal transfer ✓ (idea that) power loss depends on current^2 ✓	3 (3 × AO1.1)	**ALLOW** voltage **ALLOW ORA** for high current **IGNORE** just ideas about efficiency **DO NOT ALLOW** so no power wasted / no energy wasted (as heat in power lines) / no thermal transfer **IGNORE** less power loss **<u>Examiner's Comments</u>** Many candidates gained 1 mark for the idea of less energy lost (as heat) but only the more successful responses were able to link this to higher voltages resulting in a lower current.
		iii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.25 (Ω) award 3 marks** Rearrangement: resistance = power ÷ (current)^2 ✓ (Resistance =) 864 900 ÷ 1860^2 or 864 900 ÷ 3 459 600 ✓ (Resistance =) 0.25 (Ω) ✓	3 (1 × AO1.2) (2 × AO2.1)	**Allow** ¼ (Ω)
			Total	**19**	