HIGHER TIER

	Question			Marking details	Marks
1.	(a)	(i)		Any 2 x (1) from: • produces a lot of energy <u>for a small mass</u> of fuel or is a concentrated energy source (accept amount for mass) • it is reliable or it can generate all of the time • produces no pollutant <u>gases</u> / doesn't contribute to global warming (accept named gas or greenhouse gases) (do not accept no pollution) • produces only a small volume of (solid) waste (accept amount for volume) • less dependence on fossil fuels / conserves fossil fuels • provides energy security	2
		(ii)		Any (1) from: • [radioactive waste] may <u>leak</u> [into the ground / environment] (don't accept radiation leaking) • geological changes (accept earthquakes etc.) • radioactive material may get into the food chain • [over time if location not correctly recorded] it may be excavated Do **not** accept answers in terms of property prices or damages the environment or cost or terrorism.	1
	(b)			Does not add to / cause global warming or greenhouse effect (1) because carbon dioxide released during burning = carbon dioxide used during growing / overall add no carbon dioxide to the environment (1) (Accept they are carbon neutral <u>or</u> they <u>just</u> release CO_2 <u>back</u> into the air) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
	(c)	(i)		Grass (1) low<u>est</u> crop yield (accept <u>only</u> 5 tonnes .... (1) low<u>est</u> energy content (accept <u>only</u> 16 ......) (1)	3
		(ii)	(I)	$\dfrac{50000}{10} = 5\,000\,[\text{km}^2]$ Mark for the answer	1
			(II)	50 000 x 20 = 1 000 000 [units] Mark for the answer	1
		(iii)		Less land / space used (1) so less destruction of habitats / so more land available for food production (1) (Don't credit references to CO_2 or SO_2.) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
				Question total	**[12]**

Question			Marking details	Marks
2.	(a)		$\rho = \dfrac{104}{80}$ (1) = 1.3 (1) kg/m^3 (1) **Alternative:** $\rho = \dfrac{104000}{80000000}$ (1) = 0.0013 (1) g/cm^3 (1)	3
	(b)	(i)	A	1
		(ii)	A	1
		(iii)	Because <u>hot</u> air rises / expands (don't accept heat rises or least dense)	1
	(c)		**Indicative content** The silver sheet reflects infra-red radiation back into the radiator and reflects heat back into the room. The ridged panels / bubble wrap trap insulating pockets of air between the radiator and the wall, reducing heat lost through the wall by conduction. Plastic is also an insulator. The outside air temperature of the wall will be reduced by both factors above, so convection will be reduced. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
			Question total	**[12]**

Question				Marking details	Marks
3.	(a)			1.3 [seconds]	1
	(b)	(i)		Scales on both axes more than ½ of the grid used (1). All Points correct (no tolerance allowed) (1) best fit curved line drawn passing through (0,0) (1) allow **ecf.** Don't accept double lines / whispy / disjointed / wobbly lines.	3
		(ii)		Wave speed increases (1) at a decreasing rate (don't accept non-linearly) (1) allow **ecf** from graph	2
		(iii)		65 $\pm$ 1 [cm/s] allow **ecf** from graph	1
	(c)			Any row of data used. E.g. Distance = 30 x 3.0 = 90 [cm] (1) Tray length = $\dfrac{90}{4}$ (1) for dividing by 4, allow **ecf** for 90 = 22.5 [cm] (1) $\pm$ 0.1cm (allow **ecf** if depth 3.0 cm data used) For 90 [cm] on answer line award 1 mark.	3
				Question total	**[10]**
4.		(i)		total power input = 44 000 MW (1) useful power output = 0.9 x 44 000 **(ecf)** MW (1) = 39 600 [MW] (1) Award 2 marks for 37 582 [MW]	3
		(ii)		<u>step-up transformer</u> / <u>high voltage</u> (1) so <u>decrease / lower / less</u> current **or** <u>less</u> power / heat / energy loss [in cables] (1) (treat small current as neutral) **Either mark can be awarded on its own but only award 2 marks if they are linked.**	2
		(iii)		Correct power of 996 MW used (1) Division of power by voltage with matching units (1) A division by 8 appearing anywhere (1) Award 2 marks for $\dfrac{996}{0.27} = 3\,689$ [A] Award 1 mark for $\dfrac{996}{270} = 3.689$ [A]	3
				Question total	**[8]**

Question				Marking details	Marks
5.				X is iodine – 131 (1) Reasoning: count rate only reduced by lead / so must be gamma emitter (1) Y is silver – 110 (1) Reasoning: count rate reduced by aluminium and lead / so must be beta and gamma emitter (1) Z is radium – 226 (1) Reasoning: count rate reduced by paper and lead / so must be alpha and gamma emitter (1) **AWARD A MAXIMUM OF 5 MARKS ONLY**	5
				Question total	**[5]**
6.	(a)	(i)		X-rays & ultraviolet 1 mark each – correctly positioned	2
		(ii)		<table><tr><td>Region of em spectrum</td><td>Wavelength range (m)</td></tr><tr><td>Gamma rays</td><td>$<1 \times 10^{-11}$</td></tr><tr><td>X rays</td><td>1×10^{-11} to 1×10^{-9}</td></tr><tr><td>Ultraviolet</td><td>1×10^{-9} to 4×10^{-7}</td></tr><tr><td>Visible light</td><td>4×10^{-7} to 7×10^{-7}</td></tr></table> shortest wavelength inserted alongside gamma rays (1) correct sequence for the remaining 3 (1)	2
	(b)			Use of 1×10^{-9} (1) subs & manip (1) ans 3×10^{17} [Hz] (1) If answer of 7.5×10^{14} [Hz] award 2 marks	3
				Question total	**[7]**

Question				Marking details	Marks
7.				**Indicative content:** They are spectra of light crossed by dark lines. They can tell us the composition of the star/galaxy gas cloud because different elements will absorb light at different wavelengths to produce each dark line. They can also tell us how far away the galaxy is from us, and the further away from us the faster the galaxy moves because the further the dark lines are red shifted. **5 – 6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3 – 4 marks** The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1 – 2 marks** The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
				Question total	**[6]**
				HIGHER TIER PAPER TOTAL	**[60]**