Question	Answers	Extra information	Mark	AO / Specification reference
01.1	temperature change = 20 °C - 4 °C = 16 °C energy transferred = mass × specific heat capacity × change in temperature = 0.5 × 3930 × 16 = 31 440 J/3.1 × 10^4 J		1 1 1	AO2 4.1.1.3
01.2	to keep the inside of the refrigerator cool/at 4 °C by slowing the transfer of thermal energy from the outside to the inside of the refrigerator		1 1	AO2 4.1.2.1
01.3	a low thermal conductivity so that the energy transfers very slowly across the material		1 1	AO3 4.1.2.1
01.4	a refrigerator with a high efficiency rating has insulation material with a low thermal conductivity because less electricity is used so less energy is wasted	accept reverse argument	1	AO3 4.1.2.1 4.1.2.2
02.1	the data are not continuous the names are categoric		1 1	AO2
02.2	one in 1990 three in 2017	accept three times as many in 2017 than in 1990 for 2 marks	1 1	AO2 4.1.3
02.3	total fossil fuels in 1990 = 230 + 20 + 0 = 250 total fossil fuels in 2017 = 20 + 10 + 140 = 170 change = –80 (TWh)		1 1 1	AO2 4.1.3

Question	Answers	Extra information	Mark	AO / Specification reference
02.4	coal plausible reason e.g., coal more expensive/less available/too polluting/causes global warming or greenhouse gases		1 1	AO2 AO3 4.1.3
03.1	the cost of production of solar cells/photovoltaic cells is very high		1	AO1 4.1.3
03.2	the cheapest method is coal which produces the highest mass of CO_2 per unit CO_2 is a greenhouse gas/contributes to climate change/global warming		1 1 1	AO2 AO3 4.1.3
03.3	**two** from: • there are other considerations such as nuclear fuel produces radioactive waste • nuclear accidents cause radioactive material to be released • which could have a significant impact on the environment	one for each correct answer up to a maximum of two marks	2	AO3 4.1.3
03.4	(biomass involves) growing plants plants take in CO_2 from the atmosphere which would lower the concentration of CO_2/reduce the greenhouse effect/effects of climate change/idea of carbon neutral		1 1 1	AO2 AO3 4.1.3

Question	Answers	Extra information	Mark	AO / Specification reference
04.1	points should be plotted at: (0,0), (2,0), (4,0.1), (6, 1.2), (8, 2.4), (10, 3.6), (12, 3.6), (14, 3.6)	one mark for correct variable on the *x*-axis and *y*-axis one mark for appropriate scale on the *x*-axis and *y*-axis one mark for three or four points of data plotted correctly two marks for all data points plotted correctly one mark for drawing a line of best fit	5	AO2 AO3 4.1.3
04.2	for small wind speeds the output is zero as the wind speed increases, the output power increases for a wind speed over 10 m/s, the power output doesn't change/is constant		1 1 1	AO2 4.1.3
04.3	advantage – no greenhouse gases produced while it is in use/renewable resources/can be used in remote places disadvantage – wind speed is variable/wind doesn't always blow/needs a large space/noisy		1 1	AO1 4.1.3
05.1	independent – number of sheets of transparent film dependent – energy per second		1 1	AO2 4.1.3
05.2	**three** from: • the distance of the lamp from the solar cell • the angle of the solar cell • the type/thickness of transparent film • the type/area of solar cell	one mark for each correct answer up to a maximum of three marks	3	AO3 4.1.3

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Specification reference</th></tr>
<tr><td>05.3</td><td>statement one: do not incorporate 2.11 into the calculation of the mean/change mean to 3.65/repeat test
statement two: add units to columns 2/3 and change mean to mean energy per second (J/s)
statement one: change all the measurements to the same number of significant figures/three significant figures.</td><td></td><td>1
1
1</td><td>AO3
4.1.3</td></tr>
<tr><td>05.4</td><td>uncertainty = $\pm \frac{(4.32 - 4.12)}{2}$
$= \pm \frac{0.2}{2}$
= ± 0.1 J/s</td><td></td><td>1
1</td><td>AO2
4.1.3</td></tr>
<tr><td>06.1</td><td>a renewable resource can be replenished as it is used, but a non-renewable resource cannot</td><td></td><td>1</td><td>AO1
4.1.3</td></tr>
<tr><td>06.2</td><td><table><tr><th>Resource</th><th>Used to generate electricity</th><th>Used as a fuel in cars</th><th>Is a renewable resource</th></tr><tr><td>coal</td><td>✓</td><td></td><td></td></tr><tr><td>biomass</td><td>✓</td><td>✓</td><td>✓</td></tr><tr><td>oil</td><td>✓</td><td>✓</td><td></td></tr><tr><td>wind</td><td>✓</td><td></td><td>✓</td></tr></table></td><td>one mark for each correct column</td><td>3</td><td>AO1
AO2
4.1.3</td></tr>
<tr><td>06.3</td><td>non-renewable resources are very reliable/can produce a more/steady supply of electricity</td><td></td><td>1</td><td>AO2
4.1.3</td></tr>
</table>

Question	Answers	Extra information	Mark	AO / Specification reference
07.1	wind/wave/hydroelectric/geothermal/solar/biofuel		1	AO1 4.1.3
07.2	in 1990, the total kWh for these resources was 225 million kWh, out of a total of 250 million kWh so percentage = $\frac{225 \times 100}{250}$ = 90% in 2015 there were 190 million kWh out of 225 million kWh so percentage = $\frac{190 \times 100}{225}$ = 84.4% The percentage has decreased/so has the overall energy use	accept 230 million kWh, giving 92%	1 1 1 1 1	AO2 AO3 4.1.3
07.3	change in energy use in 5 years = 230 million kWh - 250 million kWh = -20 million kWh rate of decrease = $\frac{20 \text{ million kWh}}{5 \text{ years}}$ = 4 million kWh/year current use = 230 million kWh hours, half of this is 115 million kWh number of years = $\frac{115 \text{ million kWh}}{4 \text{ kWh per year}}$ = 28.8 years	accept 4 with no working for one calculation mark accept 29 with no working for one calculation mark	1 1 1 1	AO3 4.1.3
07.4	<u>sensible suggestions:</u> • the energy use might halve in this time because people use more energy efficient devices/want to save money • the energy use might not halve in this time because this is an estimate based on past data/you cannot be sure that the downward trend will continue / world population is increasing		1 1	AO3 4.1.3

Question	Answers	Extra information	Mark	AO / Specification reference
08.1	annual energy required by the village = 7000×10^{6} × 60 min × 60 sec = 2.52×10^{13} J (2.5×10^{13} to two significant figures)		1 1	AO2 4.1.3
08.2	energy generated by one turbine per year = 33 000 W × 60 sec × 60 min × 24 h × 365 days = 1.04×10^{12} J so you would need $\frac{2.52\times10^{18}}{1.04\times10^{12}}$ = (24.2) 25 wind turbines		1 1 1 1	AO2 4.1.3
08.3	25 × 1 million = £25 million 7000 MWh = 7 000 000 kWh total cost = 7 000 000 × £0.50 = £3.5 million biofuel is cheaper		1 1 1 1	AO3 4.1.3
08.4	**Level 3:** Both resources evaluated, with at least one advantage **and** disadvantage of both given.		5-6	AO3 4.1.3
	Level 2: Both resources evaluated, but an advantage or disadvantage missing for one resource.		3-4	
	Level 1: Only one resource evaluated, or only advantages **or** disadvantages given.		1-2	
	No relevant comment.		0	

Question	Answers	Extra information	Mark	AO / Specification reference
	Indicative content: • both resources are renewable • biofuels are reliable • biofuels could be carbon neutral/carbon dioxide released by burning fuel (theoretically should) equal the carbon dioxide absorbed from the atmosphere by the living matter • however, carbon dioxide also produced during the process to make and transport biofuels • biofuel would contribute to climate change by producing CO_2. • wind turbines can be noisy • wind turbines are not reliable, as only produce electricity when it is windy • wind power does not contribute to climate change/ no pollutant gases			
09.1	**two** from: • oil • coal • gas	one mark for each correct answer up to a maximum of two marks	2	AO1 4.1.3
09.2	suitable resource e.g., hydroelectric, tidal power correct description e.g., water in a lake moves down a hill/mountain through a generator that produces electricity		1 1 1	AO1 AO2 4.1.3

Question	Answers	Extra information	Mark	AO / Specification reference
09.3	**two** comments e.g., tides happen regularly/twice a day water can be released from a lake on demand **or** the height of tides varies rainfall to fill the lake is variable	one mark for each correct comment up to a maximum of two marks	2	AO3 4.1.3
09.4	carbon dioxide is a greenhouse gas it contributes to climate change/causes global warming		1 1	AO1 4.1.3
09.5	power station affects habitats of wildlife	accept any suitable comment	1	AO2 4.1.3
10.1	gravitational potential energy = mass × gravitational field strength × height		1	AO1 4.1.1.2
10.2	60 × 9.8 × 10 = 5880 J		1 1	AO2 4.1.1.2
10.3	(extension =) 10 - 3.2 = 6.8 5880 J = 0.5 × k × 6.8^2 (spring constant =) $\frac{5880}{(0.5 \times 6.8^2)}$ = 254.33 = 254 N/m		1 1 1 1 1	AO1 AO2 4.1.1.2