UNIT 1: ELECTRICITY, ENERGY AND WAVES
HIGHER TIER

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (apart from the questions where a level of response mark scheme is applied).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statements.

Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)		Less fossil fuels used to generate electricity (1) so less CO_2 produced (1)		2		2		
		(ii)		Reduction in gas used to generate electrical energy (1) The other energy sources remain similar (1)		2		2		
		(iii)		National Grid [connects users to power stations via a network of cables] (1) Electrical energy can be transferred from other parts of UK (1)	2			2		
		(iv)		28 000 + 23 000 = 51 000 [GWh] (1) 51 000 – 45 000 = 6 000 [GWh] (1)		2		2	2	
	(b)	(i)		Solar PV	1			1		
		(ii)		Wind shows a significant increase in 2011 / whereas the other renewable sources are pretty constant between 2004 to 2011 (1) due to more wind farms constructed / windier weather (1)			2	2		
	(c)			Bar will be taller / longer (1) as more electricity generated by renewable sources (1) Wind may continue to follow upward trend but solar PV would increase (1)			3	3	1	
				Question 1 total	**3**	**6**	**5**	**14**	**3**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)		Current Z to Y = second finger (1) B field N to S first finger (1) Thumb up for upward force (1)		3		3		3
		(ii)		Reverse battery / swap magnetic poles		1		1		1
	(b)			**Any 2 × (1) from:** Stronger magnets More coils Larger current Iron core added	2			2		2
				Question 2 total	**2**	**4**	**0**	**6**	**0**	**6**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)		Selection of: $I = \frac{V}{R}$ (1) Substitution of: $\frac{230}{40}$ (1) Current = 5.75 [A] (1)	1 1	1		3	3	
		(ii)		Selection of: $P = V \times I$ (1) Substitution of: 230 (1) × 5.75 (**ecf**) Power = 1 322.5 [W] (1) **Alternative solution:** Selection of: $P = I^2 \times R$ (1) Substitution of: 5.75^2 (**ecf**) × 40 (1) Power = 1 322.5 [W] (1)	1 1	1		3	3	
	(b)			S1 closed introduces a resistor in parallel that reduces the total resistance (1) [in the circuit / more current flows]. The resistors in parallel are identical so the total resistance will ½ (1) [whilst the current doubles] Their claim is correct as the power doubles because P α I when V = constant (1) **Alternative response:** S1 closed introduces a resistor in parallel that reduces the total resistance (1) [in the circuit / more current flows]. The resistors in parallel are identical so the total resistance will ½ (1) [whilst the current doubles]. Their claim is correct as the power doubles because P α I^2 and P α R (1) when V constant. **Alternative response:** Both in parallel (1) Voltage the same across both, same current as original resistor (1) So double the power as two resistors (1)			3	3		
				Question 3 total	**4**	**2**	**3**	**9**	**6**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			**Indicative content:** Using microwaves for the geostationary satellite means a longer distance to travel but they do travel faster than the infra-red in the shorter optical fibre. The microwaves used travel $\frac{36\,000 \times 2}{9\,000}$ = 8 times the distance compared to the infra-red signal. However, the infra-red signal travels at half the speed. This means that the optical fibre takes a ¼ of the time to transfer information compared to the satellite method. Alternatively it may be said that the satellite has a time delay that is 4 times greater than the optical fibre, which would be a disadvantage. Other advantages of optical fibres include more security and a very low error rate compared to the microwaves used in the satellite transmission. Optical fibres also provide greater data transfer rates (10 Gb/s) compared to satellites (50 Mb/s). **5 – 6 marks** Detailed description of advantages / disadvantages, along with the correct reasoning for time delay. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.* **3 – 4 marks** A brief description of some qualitative advantages / disadvantages, with an attempt to compare time delay. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.* **1-2 marks** A basic description of any qualitative advantages / disadvantages. *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure. The candidate uses limited scientific terminology and inaccuracies in spelling,*	4	2		6	2	0

				punctuation and grammar. **0 marks** *No attempt made or no response worthy of credit.*						
	(b)			Orbit above equator (1) [of Earth] Orbit period of 24 hour (1) Orbits in the same direction as Earth spins (1)	3			3		
				Question 4 total	**7**	**2**	**0**	**9**	**2**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)		18 not 17.5	1			1	1	1
		(ii)		7 sheets **or** 25 **and** 19	1			1	1	1
		(iii)		$\frac{50 - 46}{2}$ = 2 [mA]	1			1	1	1
		(iv)		To see if data are reproducible (1) so that there is more confidence in the data/findings/conclusion (1)	2			2		2
	(b)	(i)		All 7 points plotted correctly within ±½ small square division (1) Suitable scales (i.e. intervals of 10 mA on the y-axis and intervals of 1 on the x-axis) (1) Smooth curve of best fit within ± ½ small square division of all points (1) Don't accept thick, double, whispy lines		3		3	3	3
		(ii)		As the sheets of tracing paper increases the current decreases (1) However, doubling the number of sheets of tracing paper on the graph doesn't ½ the current (1) or alternative method so it is not true to say it is inversely proportional (1)			3	3		3
	(c)			Cloud cover varies each day (1) So the amount of energy produced will be variable (1)	2			2		
				Question 5 total	**7**	**3**	**3**	**13**	**6**	**11**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			Molecules gain KE (1) [as temperature increases] so there are more collisions per second on the wall of the can [which means higher pressure] / force increasing for fixed area (1)	2			2		
	(b)			Selection of: $\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ (1) Realisation that: $V_1 = V_2$ or by implication (1) $\frac{280 \times 10^3 \cancel{V_1}}{(273+27)} = \frac{p_2 \cancel{V_2}}{(273+227)}$ (1 - for conversion to Kelvin) $p_2 = 5 \times 10^5$ [Pa] so can doesn't explode (1)	1 1	1 1		4	3	
				Question 6 total	**4**	**2**	**0**	**6**	**3**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		880 J to heat 1 kg (1) By 1 °C (1)	2			2		
		(ii)		$Q = m \times c \times \Delta\theta$ = 0.75 × 880 × 60 (1) Q = 39 600 [J] (1)	1	1		2	2	
	(b)			Aluminium temp change = (80 – 30.5) (1) [= 49.5 °C] Al: 0.75 × 880 × 49.5 **ecf** (1) Water: 0.50 × 4 200 × (30.5 – T_{water}) (1) $\frac{32\,670}{2\,100}$ = 15.6 = (30.5 - T_{water}) (1 - manipulation) T_{water} = 14.9 [°C] (1)	1 1	1 1 1		5	5	
	(c)			Reach same temperature in engine (1) Water has a higher specific heat capacity (1) So absorbs more heat [per given mass] (1)			3	3		
				Question 7 total	**5**	**4**	**3**	**12**	**7**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			Mass (single bottle) = density × volume (1 - manipulation) = 0.95 × 50 = 47.5 [g] (1) Bottles in bale = $\frac{190 \times 10^3}{47.5}$ (1 - conversion) = 4 000 (1) (**ecf**) Number recycled per week = $\frac{45}{100} \times 7.25 \times 10^5 \times 7 = 2.28 \times 10^6$ (1) $\frac{2.28 \times 10^6}{4\,000}$ = 570.9 = 570 bales (1) accept 571 bales **Alternative solution:** $7.25 \times 10^5 \times 0.45$ = number of bottles per day (1) $7.25 \times 10^5 \times 0.45 \times 7$ = number of bottles per week (1) Total volume = $7.25 \times 10^5 \times 0.45 \times 7 \times 50$ (1) Total mass (g) = $7.25 \times 10^5 \times 0.45 \times 7 \times 50 \times 0.95 = 108.48 \times 10^6$ g (1) Number of bales = $\frac{108.48 \times 10^6}{190\,000}$ (1 – conversion kg→ g) Answer = 570.9 = 570 bales (1) accept 571 bales		6		6	6	
	(b)			$\frac{F_X}{A_X} = \frac{F_Y}{A_Y} = p$ (1) $A_Y = 15\ A_X$ (1) $F_Y = 15 \times F_X = 15 \times 500 = 7\,500$ [N] (1)		3		3	3	
	(c)			Air / gas can be compressed (1) so larger force will be needed at X to exert same 7 500 N at Y (1)			2	2		
				Question 8 total	**0**	**9**	**2**	**11**	**9**	**0**

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SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	3	6	5	14	3	0
2	2	4	0	6	0	6
3	4	2	3	9	6	0
4	7	2	0	9	2	0
5	7	3	3	13	6	11
6	4	2	0	6	3	0
7	5	4	3	12	7	0
8	0	9	2	11	9	0
TOTAL	32	32	16	80	36	17