GCSE

WJEC GCSE
The Sciences (Double Award)

Approved by Qualifications Wales

Sample Assessment Materials

Unit 6: Physics - Waves, Electricity and Energy
Higher Tier

Teaching from 2026
For award from 2028

Version 2 - February 2026

This Qualifications Wales regulated qualification is not available to centres in England.

Made for Wales.
Ready for the world.

WJEC would like to thank the students and teachers of Fitzalan High School, Cardiff and Llanwern High School, Newport for their participation in the creation of these covers.

SUMMARY OF AMENDMENTS

Version	Description	Page number
2	Answer to Q5(a)(i) corrected to show current is from 'B ⟶ A' not 'A ⟶ B'	25

Contents

Surname	Centre number	Candidate number
First name(s)		0

GCSE

3455UF

The Sciences (Double Award) – Unit 6 Physics – Waves, Electricity and Energy

HIGHER TIER
1 hour 15 minutes
SAMPLE ASSESSMENT MATERIALS

Additional materials

A calculator and ruler are permitted.

Instructions to candidates

Use black ink or black ball-point pen. Do **not** use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces provided at the top of this page.

Answer **all** questions.

For examiner's use only		
Question	**Maximum mark**	**Mark awarded**
1.	**16**	
2.	**3**	
3.	**14**	
4.	**12**	
5.	**7**	
6.	**12**	
Total	**64**	

Write your answers in the spaces in this booklet. If you need more space, use the additional page(s) at the back of this booklet. Number the question(s) correctly.

Information for candidates

The number of marks is given in brackets at the end of each question or part-question.

The total number of marks available is **64.**

You should think carefully about how you use your time.

Your responses must be clear, accurate and well presented.

Equations

Speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in speed}}{\text{time}}$	
distance travelled = area under a speed-time graph	
weight = mass × gravitational field strength	W = mg
units used (kWh) = power (kW) × time (hours) cost = units used × cost per unit	
efficiency = $\frac{\text{useful energy transferred}}{\text{input energy}}$ x 100 OR efficiency = $\frac{\text{useful power output}}{\text{input power}}$ x 100	
power = $\frac{\text{energy transfer}}{\text{time}}$	$P = \frac{E}{T}$
V_1 = voltage across the primary coil V_2 = voltage across the secondary coil N_1 = number of turns on the primary coil N_2= number of turns on the secondary coil	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
frequency = $\frac{1}{\text{period}}$	$f = \frac{1}{T}$
wave speed = frequency × wavelength	$v = f\lambda$
change in potential energy = mass × gravitational field strength × change in height	$\Delta PE = mg\Delta h$
kinetic energy = $\frac{\text{mass x velocity}^2}{2}$	$KE = \frac{1}{2}mv^2$
work done = force × distance	W = Fd
power = voltage × current	P = VI
total resistance in a series circuit	$R = R_1 + R_2$
current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
force = mass × acceleration	F = ma

SI multipliers

Prefix	Symbol	Conversion factor	Multiplier
pico	p	divide by 1 000 000 000 000	1×10^{-12}
nano	n	divide by 1 000 000 000	1×10^{-9}
micro	μ	divide by 1 000 000	1×10^{-6}
milli	m	divide by 1000	1×10^{-3}
centi	c	divide by 100	1×10^{-2}

kilo	k	multiply by 1000	1×10^{3}
mega	M	multiply by 1 000 000	1×10^{6}
giga	G	multiply by 1 000 000 000	1×10^{9}
tera	T	multiply by 1 000 000 000 000	1×10^{12}

Answer **all** questions

Examiner only

1. Students in a school in Pembrokeshire investigate background radiation in their area.

They measure the background radiation in the same place in their classroom.

Each time they measure for 2 minutes.
Some of their results are given in the table.

Counts in 2 minutes						
Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Mean
82	78	81	79	21	77	……

(a) (i) One result was recorded incorrectly and is anomalous.

Circle the anomalous result in the table.

Explain how you know this result is anomalous. [2]

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(ii) The rest of the results were recorded correctly.
State why the results vary. [1]

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(iii) **Complete the table** by calculating an appropriate mean for the number of counts in 2 minutes. [2]

Space for working.

(iv) Calculate the mean count rate in the classroom in **counts per second**. [2]

Examiner only

count rate = …… cps

(b) The class compare their mean count rate to the typical mean count rate for background radiation in Wales and they find that their result is higher.

(i) Seren suggests that their value is higher because of a systematic error in the apparatus they used.

Suggest what they could do confirm if their findings are correct. [2]

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(ii) She states that the measurement is different because some parts of Pembrokeshire have above average levels of radon gas.

Suggest why some parts of Pembrokeshire have above average levels of radon gas. [1]

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……

Examiner only

(c) (i) Radon, Rn, decays by alpha decay to form Polonium, Po.
Complete the decay equation below for this decay. [2]

$$^{222}_{86}\text{Rn} \longrightarrow \text{.....} \text{ Po} + {}^{4}_{2}\text{He}$$

(ii) Explain why a very high level of radon gas is a health concern. [2]

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(iii) Radon-220 is another isotope of radon.
State what is meant by the term isotope. [2]

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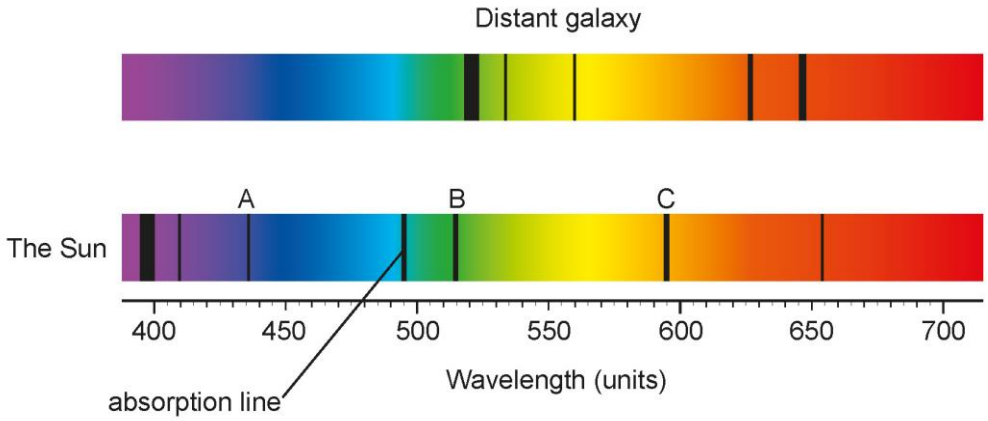
16

Examiner only

2. The diagrams below show absorption lines from a distant galaxy and the Sun.



(a) Explain which absorption line in the Sun's spectra has the smallest frequency. Refer to an equation from page 2 in your answer. [2]

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(b) State what the absorption lines reveal about the Universe. [1]

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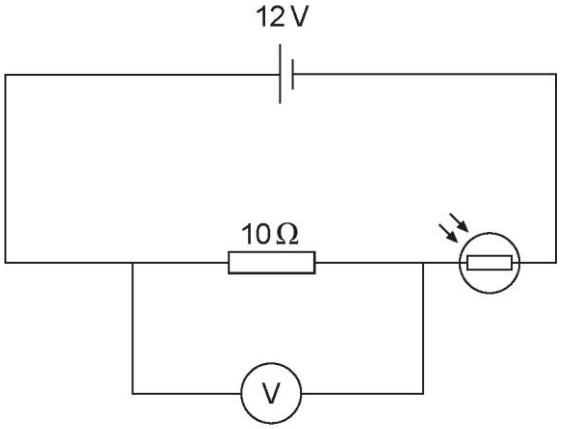
3

Examiner only

3. Students investigate the resistance of a light dependent resistor (LDR).

(a) For their first attempt, they set up the following circuit.



(i) The voltmeter reads 8.0 V.

Use an equation from page 2 to determine the current through the 10 Ω resistor. [2]

current = …….. A

(ii) Determine the voltage across the LDR. [1]

voltage across LDR = …….. V

(iii) Use your answers to (i) and (ii) and an equation from page 2 to determine the resistance of the LDR. [3]

resistance = …….. Ω

Examiner only

(b) The students amend their circuit so that they can determine the resistance of the LDR more easily.

Suggest how they can amend their circuit. [2]

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(c) The students want to investigate the link between light intensity and the resistance of the LDR.

(i) Suggest how the student could vary the intensity of the light falling on the LDR. [1]

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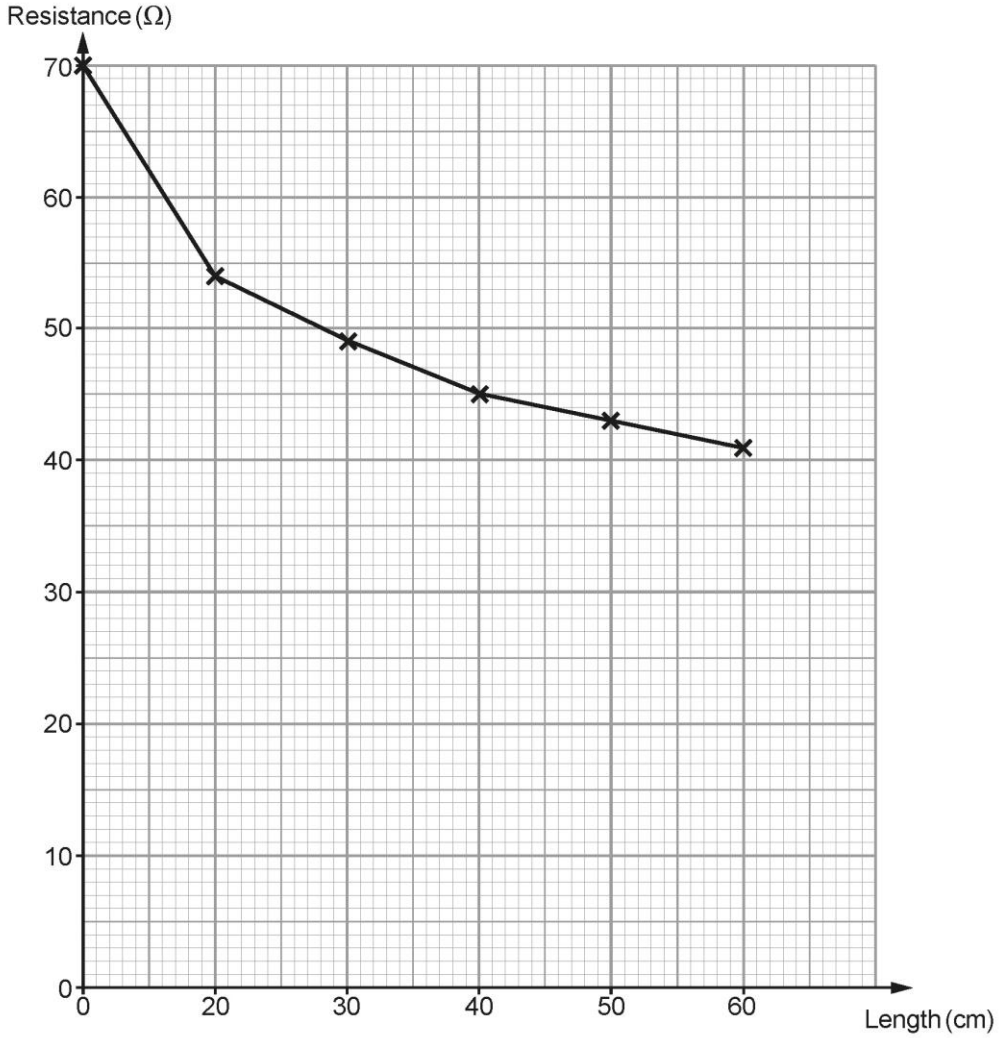
Examiner only

Emily plots the following graph of her group's data.



(ii) Evaluate Emily's graph and justify the improvements she should make. Assume she has plotted the points correctly. [3]

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(iii) State what conclusions Emily could make from this experiment. [2]

Examiner only

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14

Examiner only

4. Pen y Cymoedd, in South Wales, is the largest onshore wind farm in Wales and England.

It consists of **76** turbines, each of power 3 MW.
It produces electricity at a voltage of 33 kV.

(a) (i) A step-up transformer is used to increase the voltage up to 132 kV.

Use an equation from page 2 to determine the current in the wires of the grid. [4]

current = ……. A

(ii) Explain why step-up transformers are used in the National Grid. [2]

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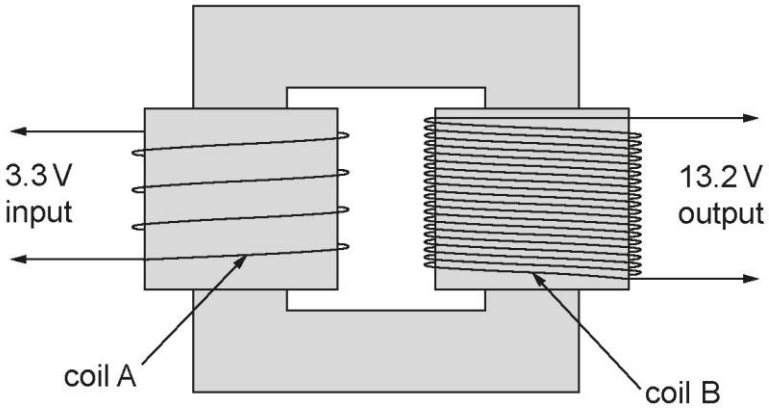
(b) Most wind farms have an efficiency of around 40%.

Each turbine at the wind farm has an output power of 3 MW.
Use an equation from page 2 to determine the input power from the wind to each turbine. [3]

input power = …….. MW

Examiner only

(c) Some students in Neath investigate Pen y Cymoedd.
They want to find out more about transformers.
They build the following transformer.



The input coil has 100 turns.
Use the following equation:

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

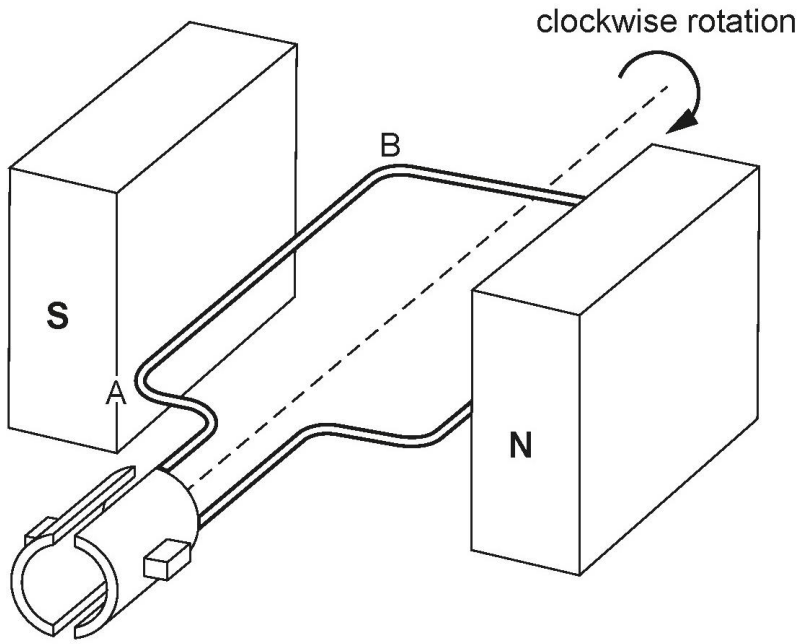
to determine the number of turns needed on the secondary coil. [3]

number of turns, N_2 = ……

12

Examiner only

5. A simplified diagram of an AC generator is shown in the diagram below.



(a) (i) Use Fleming's right-hand rule to explain the direction of the current in the side AB of the coil. [3]

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Examiner only

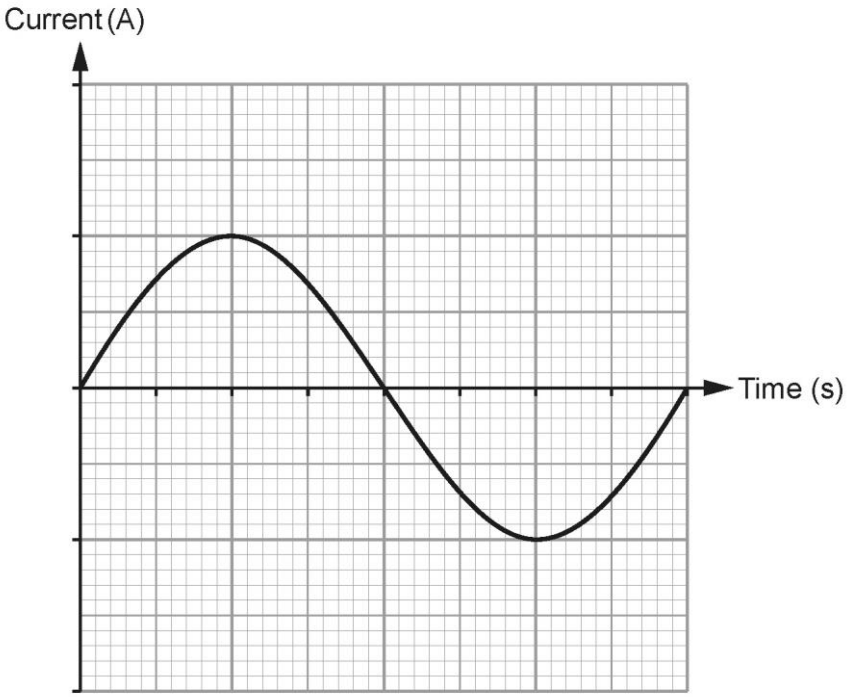
(ii) Increasing the speed of rotation increases the induced current.

State **two** other ways in which the size of the induced current in the coil could be increased. [2]

1. ……

2. ……..……..

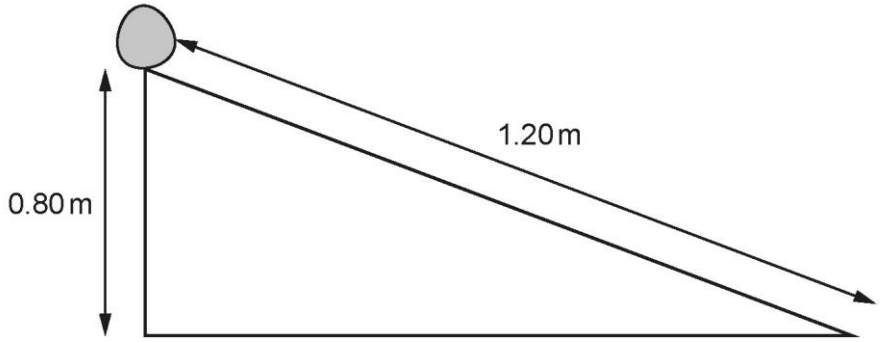
(b) The current in the coil is shown on the graph below.
On the same graph draw the current for a coil rotating twice as fast. [2]



7

Examiner only

6. Some students investigate energy transfer using a bean bag, of mass 150 g, sliding down a slope.



(a) (i) State the principle of conservation of energy. [1]

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……

(ii) The bean bag slides, from rest, from the top to the bottom of the ramp. Use an equation from page 2 to calculate the change in the energy stored gravitationally. [2]

Gravitational field strength, g, = 10 N/kg.

change in energy stored gravitationally = …… J

Examiner only

(b) (i) The teacher asks the students to calculate the maximum possible speed of the bean bag at the bottom of the ramp.

Myfanwy suggests a value of 4.0 m/s.
Shakul suggests a value of 16.0 m/s.
Identify who is correct. Explain why. [4]

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(ii) Explain why the bean bag will not reach the predicted speed. [2]

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(iii) The students use light gates to determine the actual speed of the bean bag at the bottom of the slope.

State why light gates improve the accuracy of the results in this experiment. [1]

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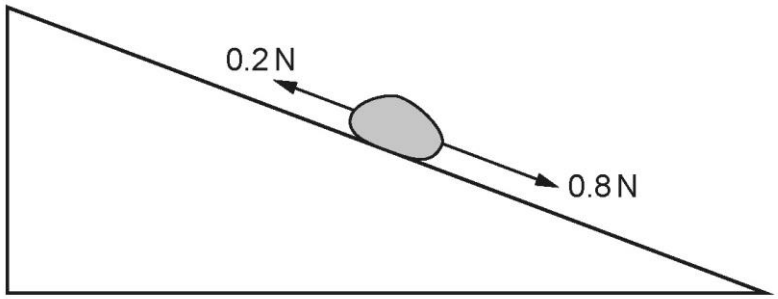
Examiner only

(c) The diagram shows the forces acting on the bean bag, explain why it speeds up.

Refer to Newton's laws in your answer. [2]



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12

END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.
	…… ……

Examiner only

GCSE THE SCIENCES (DOUBLE AWARD)
UNIT 6

Physics: Waves, Electricity and Energy

Higher Tier

MARK SCHEME

Guidance for examiners

Generic marking principles

- Marks awarded are always whole marks (not half marks, or other fractions).
- Answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.
- Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
- Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Positive marking

It should be remembered that candidates are writing under examination conditions and credit should be given for what the candidate writes, rather than adopting the approach of penalising candidates for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Marks should not be deducted for a less than perfect answer if it satisfies the criteria of the mark scheme.

For questions that are objective or points-based, the mark scheme should be applied precisely. Marks should be awarded as indicated and no further subdivision made.

Mark schemes often list points which may be included in candidates' answers. The list is not exhaustive. The inclusion of *'Credit any other valid response.*' (or similar instruction) within mark schemes allows for the possible variation in candidates' responses. Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme. Credit should be given according to the accuracy and relevance of candidates' answers.

Appropriate terminology is reflected in exemplar responses in mark schemes. However, unless there is a specific requirement within a question, candidates may be awarded marks where the answer is accurate but expressed in their own words.

Marking abbreviations

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

ecf = error carried forward
bod = benefit of doubt

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
1.	(a)	(i)	Trial 5, 21, circled (1) It doesn't follow the pattern / is very different to the other values (1)			2	2		2	
		(ii)	Because decay is random	1			1		1	
		(iii)	82 + 78 + 81 + 79 + 77 = 397 (1) $\frac{397}{5}$ = 79.4 (1)		2		2	2	2	
		(iv)	$\frac{79.4 \text{ ecf}}{120}$ = 0.662 [cps] (1)		2		2	2	2	
	(b)	(i)	Repeat with a different detector (1) Take readings over a longer period (1)			2	2		2	
		(ii)	Due to different types of rock / more granite	1			1			
	(c)	(i)	218 (1) 84 (1)		2		2			
		(ii)	Radon can be breathed in / enters lungs (1) and the alpha [it emits] is very ionising (1)		2		2			
		(iii)	An atom of the same element with the same number of protons but a different number of neutrons.	2			2			
			Question 1 total	**4**	**8**	**4**	**16**	**4**	**9**	**0**

Question		Marking details	Marks available						
			AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
2.	(a)	Line C because it has the longest wavelength (1) But the same speed and wave speed = frequency × wavelength (1)		2		2			2
	(b)	The Universe is expanding	1			1			
		Question 2 total	**1**	**2**	**0**	**3**	**0**	**0**	**2**

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
3.	(a)	(i)	Substitution: current = $\frac{8.0}{10}$ (1) Current = 0.8 [A] (1)	1	1		2	2	2	
		(ii)	12 – 8.0 = 4.0 [V]		1		1		1	
		(iii)	Substitution: $0.8 = \frac{4.0\ \textbf{ecf}}{\text{resistance}}$ (1) Rearrangement: resistance = $\frac{4.0\ \textbf{ecf}}{0.8}$ (1) Resistance = 5.0 [Ω] (1)	1	1 1		3	3	3	
	(b)		Add an ammeter (1) Move the voltmeter so it is in parallel with the LDR (1)			2	2		2	
	(c)	(i)	Have a <u>lamp</u> next to the LDR connected to a variable power supply / use a ruler to change the distance between the lamp and the LDR			1	1		1	
		(ii)	The x-axis scale is non-linear and should have included 10 cm (1) The y-scale is not appropriate, truncation should have been included so that the data covers more than half of the graph paper (1) A point-to-point graph is not appropriate for continuous data (1)			3	3	1	3	
		(iii)	As {light intensity / distance} increases resistance decreases (1) At a decreasing rate (1)			2	2		2	
			Question 3 total	**2**	**4**	**8**	**14**	**6**	**14**	**0**

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
4.	(a)	(i)	Total power = [76 × 3 × 10^6] = 228 MW (1) Substitution and conversions i.e. 228 × 10^6 = 132 × 10^3 × current (1) Rearrangement: current = $\frac{228 \times 10^6}{132 \times 10^3}$ (1) Current = 1727 [A] (1)		4		4	4		
		(ii)	[They increase the voltage] to reduce the current (1) To reduce heat loss / heating in the wires / increase efficiency of transfer (1)	2			2	2		
	(b)		Substitution: $40 = \frac{3 \times 100}{\text{input power}}$ (1) Rearrangement: Input power = $\frac{3 \times 100}{40}$ (1) Input power = 7.5 [MW] (1)	1	1 1		3	3		3
	(c)		Substitution: $\frac{3.3}{13.2} = \frac{100}{N_2}$ (1) Rearrangement: $N_2 = \frac{100}{0.25}$ (1 N_2 = 400 (1)	1	1 1		3	3		
			Question 4 total	**4**	**8**	**0**	**12**	**12**	**0**	**3**

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
5.	(a)	(i)	First finger points in direction of field (1) and thumb in direction of motion (1) So current is from B ⟶ A (1)		3		3			
		(ii)	Stronger magnet (1) More turns on the coil (1)	2			2			
	(b)		Amplitude is doubled (1) Period is halved (1)		2		2	2		
			Question 5 total	**2**	**5**	**0**	**7**	**2**	**0**	**0**

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
6.	(a)	(i)	Energy cannot be created or destroyed; it is transferred from one store to another	1			1			1
		(ii)	PE = 0.15 (1) $\times$10 $\times$ 0.80 (1) substitution – accept sub of 150g PE = 1.2 [J]	1	1		2	2	2	
	(b)	(i)	[All PE converted to KE / no friction / no energy transfer to thermal store] so KE = 1.2 J (1) 1.2 = 0.5 $\times$ 0.15 $\times$ v^2 (1) $v^2 = \frac{1.2}{0.075}$ (1) v = 4.0 [m/s] (1)			4	4	3	4	
		(ii)	[Friction acts on the bean bag] so energy is transferred to the thermal store (1) so, less energy is in the kinetic store (1)		2		2		2	
		(iii)	reduces human reaction time errors / reduces random error	1			1		1	
	(c)		Force down the slope is bigger / there is a resultant force down the slope / the forces are unbalanced (1) Speeds up according to Newton's second law, $F = ma$ (1)		2		2			2
			Question 6 total	**3**	**5**	**4**	**12**	**5**	**9**	**3**

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	Enquiry Skills	Connections Relationships
1	4	8	4	16	4	9	0
2	1	2	0	3	0	0	2
3	2	4	8	14	6	14	0
4	4	8	0	12	12	0	3
5	2	5	0	7	2	0	0
6	3	5	4	12	5	9	3
TOTAL	**16**	**32**	**16**	**64**	**29**	**32**	**8**