GCSE
PHYSICS
8463/1H

Paper 1 Higher Tier

Mark scheme

June 2024

Version: 1.0 Final

246G8463/1H/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

No student should be disadvantaged on the basis of their gender identity and/or how they refer to the gender identity of others in their exam responses.

A consistent use of 'they/them' as a singular and pronouns beyond 'she/her' or 'he/him' will be credited in exam responses in line with existing mark scheme criteria.

Further copies of this mark scheme are available from aqa.org.uk

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Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make their judgement
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent (for example, a scientifically correct answer that could not reasonably be expected from a student's knowledge of the specification).

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**.
Alternative words in the mark scheme are shown by a solidus eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name **two** magnetic materials.

[2 marks]

Student	Response	Marks awarded
1	iron, steel, tin	1
2	cobalt, nickel, nail*	2

3.2 Use of symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, or uses symbols to denote quantities in a physics equation, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. At any point in a calculation students may omit steps from their working. If a subsequent step is given correctly, the relevant marks may be awarded.

Full marks should be awarded for a correct numerical answer, without any working shown.

Full marks are **not** awarded for a correct final answer from incorrect working.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

An error can be carried forward from one question part to the next and is shown by the abbreviation 'ecf'.

Within an individual question part, an incorrect value in one step of a calculation does not prevent all of the subsequent marks being awarded.

3.6 Phonetic spelling

Marks should be awarded if spelling is not correct but the intention is clear, **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

3.11 Numbered answer lines

Numbered lines on the question paper are intended to support the student to give the correct number of responses. The answer should still be marked as a whole.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and, if necessary, annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level.

The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	thermal / internal (energy) **or** kinetic (energy of the water particles)	ignore heat allow E_k	1	AO1 4.1.1.1 4.3.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	gravitational potential (energy)	allow E_p / GPE allow kinetic / E_k	1	AO1 4.1.1.1

Question	Answers	Mark	AO / Spec. Ref.
01.3	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	3–4	AO3 4.1.1.1 4.3.2.1 4.1.1.2 4.1.2.2 4.1.3
	Level 1: Relevant features are identified and differences noted.	1–2	
	No relevant content	0	
	Indicative content **Method A:** • heated water needs insulating (to maintain high temperature) • energy stored by heating water is much greater (per 100 kg) • useful energy from heating 100 kg of water = 20 160 (kJ) • energy wasted (per 100 kg) = 13 440 (kJ) • efficiency = 60 % **Method B:** • suitable location needed to pump water uphill • pumping water efficiency is higher • useful energy from pumping 100 kg of water = 367.5 (kJ) • energy wasted (per 100kg) = 122.5 (kJ) • efficiency = 75 % A level 2 answer should use the data in a relevant calculation that compares the two methods.		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	**Transport examples:** don't use (petrol / diesel) cars (for transport) **or** don't burn petrol / diesel (for transport)	allow don't use other transport methods e.g. (diesel) buses allow fossil fuels for petrol / diesel	1	AO3 4.1.3
	(instead) use electric cars **or** (instead) use hydrogen-fuelled cars **or** (instead) use a bicycle **or** (instead) use public transport **or** (instead) walk		1	
	Generating Electricity examples: don't use coal / oil / gas (to generate electricity)	allow fossil fuels for coal / oil / gas	1	
	(instead) use renewable methods **or** (instead) use nuclear power	allow specific examples of renewable energy resources	1	
	OR			
	don't use (electrical) appliances when not needed	allow specific examples e.g. lights		
	to reduce the demand for electricity (generated) using coal / oil / gas	allow fossil fuels for coal / oil / gas		
		accept other reasonable changes with valid alternative for 2 marks each		

Total Question 1	**10**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	nuclei neutrons gamma (rays)	this order only	1 1 1	AO1 4.4.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	energy = power × time **or** $E = P \times t$		1	AO1 4.2.4.2 4.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	P = 500 000 000 (W) E = 500 000 000 × 3600 E = 1 800 000 000 000 (J) **or** $E = 1.8 \times 10^{12}$ (J)	 allow a correct substitution of an incorrectly / not converted value of P allow an answer consistent with an incorrectly / not converted value of P	1 1 1	AO2 4.2.4.2 4.1.1.4

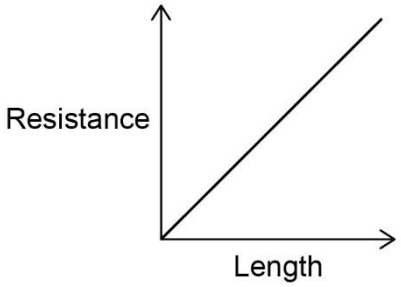
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	any **one** from: • bury the radioactive waste • put the radioactive waste in cooling ponds • transport the radioactive waste in secure vessels • store the radioactive waste in metal containers • cover the radioactive waste in concrete	 allow store it for (at least) one half-life ignore references to high / medium / low level waste ignore label the waste as hazardous	1	AO3 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	number of days = $\frac{92}{100} \times 365$		1	AO2 4.1.3
	number of days = 335.8	allow answers of 335 and 336 days allow an answer of 29.2 (days) for 1 mark	1	

Total Question 2	**10**

Question 3

Question	Answers	Mark	AO / Spec. Ref.
03.1	**Level 3**: The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 4.2.1.3 RPA3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content • measure the length of the wire (between the crocodile clips) using the ruler • length varied by moving crocodile clips • current measured with ammeter • potential difference measured with voltmeter • calculate resistance for each length • use $V = IR$ to calculate resistance • record current and pd for different lengths • repeat readings of current and pd for each length and mean values calculated • remove any anomalous readings • ensure values of current are low to minimise heating of wire • ensure circuit is disconnected between readings **Level 2:** Varying the length of the wire. Measurements / equipment needed for pd and current.		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2			1	AO1 4.2.1.3 4.2.1.4 RPA3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	potential difference is (very) low		1	AO1
	(so) no risk of electric shock **or** (so) no risk of electrocution	allow less risk of electric shock allow so wire won't melt allow so wire won't get hot	1	AO3 4.2.1.3 RPA3

Total Question 3	**9**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	electrons are transferred to the student		1	AO1 4.2.5.1
	(so) her hair is negatively charged	allow each hair has the same (negative) charge	1	
	(and) like charges repel	do not accept student being positively charged for MP1 and MP2	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	the region (around a charged object) where another charged object experiences a force	allow space / area for region allow particle for object	1	AO1 4.2.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	(electric field strength) decreases		1	AO1 4.2.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	$Q = 2 \times 10^{-6}$ (C)		1	AO2 4.2.4.2
	$0.6 = 2 \times 10^{-6} \times V$	allow a correct substitution of an incorrectly / not converted value of Q	1	
	$V = \frac{0.6}{2 \times 10^{-6}}$	allow a correct rearrangement of an incorrectly / not converted value of Q	1	
	$V = 300\,000$ (V)	allow an answer consistent with an incorrectly / not converted value of Q	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	decreased electrical resistance of air		1	AO3 4.2.5.1

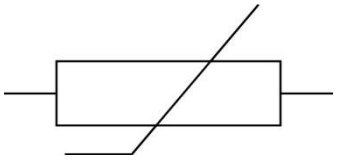
Total Question 4	**10**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	<u>50</u> (Hz) <u>230</u> (V)	this order only	1 1	AO1 4.2.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	340 mW = 0.34 W		1	AO2 4.2.4.1
	$0.34 = 0.75^2 \times R$	allow a correct substitution of an incorrectly / not converted value of *P*	1	
	$R = \frac{0.34}{0.75^2}$	allow a correct rearrangement of an incorrectly / not converted value of *P*	1	
	$R = 0.60$ (Ω)	allow an answer consistent with an incorrectly / not converted value of *P* allow a correct answer given to more than 2 sf	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	the dirt changes the (measured) resistance of the coin **or** the (measured) resistance is different from the expected resistance (of the coin)	 allow the measured resistance does not match the resistance of a known coin allow dirt stops charge flow (through the coin) allow dirt stops the current (in the coin)	1	AO3 4.2.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4			1	AO1 4.2.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	R_{Total} = 400 + 80 (= 480 Ω)		1	AO2 4.2.1.3 4.2.2
	12 = I × 480 **or** $I = \frac{12}{480}$	allow a correct substitution / rearrangement with R_{Total} in range 470 - 490 Ω	1	
	I = 0.025 (A)	allow a correct calculation using R_{Total} in range 470 - 490 Ω	1	
	V = 0.025 × 80	allow a correct substitution using their calculated value of I (using $V = IR$) and R_{Th} in range 70 - 90 Ω	1	
	V = 2.0 (V)	allow a correct calculation using their calculated value of I (using $V = IR$) and R_{Th} in range 70 - 90 Ω	1	
	OR			
	total R = 400 + 80 (= 480) (1)			
	ratio (Th:R) = 80:480 (1)	allow a range of R_{Th} between 70 and 90 Ω		
	ratio = 1:6 (1)	allow a correct ratio using a value of R_{Th} between 70 and 90 Ω		
	$V = \frac{1}{6} \times 12$ (1)	allow a correct substitution using a value of R_{Th} between 70 and 90 Ω		
	V = 2.0 (V) (1)	allow an answer in the range 1.8 (V) to 2.2 (V)		

Total Question 5	**13**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	elastic potential (energy)	*allow E_e / EPE*	1	AO1 4.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	$E_e = 0.5 \times 735 \times 8.0^2$	allow a correct substitution using k = 1470 (N/m) and e = 8 (m) **or** k = 1470 (N/m) and e = 16 (m) **or** k = 735 (N/m) and e = 16 (m)	1	AO2 4.1.1.2
	$E_e = 23\,520$ (J)	this answer only	1	
	total $E_e = 47\,040$ (J)	this answer only	1	
	$47\,040 = 240 \times 9.8 \times h$	allow a correct substitution of their calculated value of E_e (using $E_e = 0.5ke^2$)	1	
	$h = \frac{47\,040}{(240 \times 9.8)}$	allow a correct rearrangement using their calculated value of E_e (using $E_e = 0.5ke^2$)	1	
	$h = 20$ (m)	allow an answer consistent with their value of E_e (using $E_e = 0.5ke^2$)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	air resistance (opposes the motion of the pod upwards)		1	AO3
	(so) not all of the elastic potential energy will be transferred to gravitational potential energy	allow the energy transfer is not 100% efficient allow some energy is transferred to the surroundings allow some energy is dissipated ignore energy is wasted ignore reference to mass of person in pod	1	AO1 4.1.2.1 4.1.2.2

Total Question 6	**9**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	random error		1	AO3 4.3.1.1 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	thin string would affect the volume measurement less (than thick string)	allow thin string would displace less water (than thick string) ignore absorption of water by string	1	AO3 4.3.1.1 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	the measuring cylinder could not be used to measure to 2 dp **or** the resolution of the measuring cylinder is 0.2 cm^3	allow the resolution is 0.1 cm^3 ignore the resolution is too low	1	AO3 4.3.1.1 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	subtract 0.02 g from the measured value	ignore zero the balance	1	AO3 4.3.1.1 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	$0.44\ cm^3 = 4.4 \times 10^{-7}\ m^3$		1	AO2 4.3.1.1 RPA5
	$21\ 500 = \frac{m}{4.4 \times 10^{-7}}$	allow a correct substitution of an incorrectly / not converted value of *V*	1	
	$m = 21\ 500 \times 4.4 \times 10^{-7}$	allow a correct rearrangement of an incorrectly / not converted value of *V*	1	
	$m = 0.00946$ (kg) **or** $m = 9.46 \times 10^{-3}$ (kg)	allow an answer consistent with an incorrectly / not converted value of *V*	1	

Total Question 7	**8**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	(air) particles are closer together	ignore reference to kinetic energy of particles ignore reference to concentration of air particles	1	AO1 4.3.3.2
	(so) frequency of collision between air particles and syringe walls increased	do not credit MP2 if linked to an increase in kinetic energy	1	
	larger (total) force on a smaller (surface) area	allow larger force per unit area	1	
		if no other marks score allow 1 mark for pressure increases because volume decreases and pV = constant		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	the mean kinetic energy of the particles increases		1	AO1 4.3.3.1

Question	Answers	Extra information	Mark	AO / Spec.
08.3	c = 1010 (J/kg °C)	allow full credit for a correct method using E = 0.0000130 (kJ)	1	AO2 4.1.1.3 4.3.2.2
	$0.0130 = 2.60\times10^{-8} \times 1010 \times \Delta\theta$	allow a correct substitution of an incorrectly / not converted value of c	1	
	$\Delta\theta = \dfrac{0.0130}{(2.60 \times 10^{-8} \times 1010)}$	allow a correct rearrangement of an incorrectly / not converted value of c	1	
	$\Delta\theta$ = 495 (°C)	allow an answer consistent with an incorrectly / not converted value of c allow a correct answer given to more than 3 sig figs	1	

Total Question 8	**8**

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	radiation (from source **A**) travels (approximately) 3 cm (in air)		1	AO1 4.4.2.1 4.4.3.1
	(after which) count rate decreases to background radiation		1	
	(because) alpha radiation has a short range (in air)	allow alpha radiation has (very) low penetrating ability allow beta <u>and</u> gamma radiation have a (much) longer range in air	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	use an aluminium sheet	allow other materials that beta would be stopped by e.g. brick, sheets of iron / lead, etc. ignore sheet(s) of metal foil unless thickness is given	1	AO1 4.4.2.1
	(which) beta radiation will not penetrate but gamma will **or** (which) only gamma will penetrate	MP2 dependent on scoring MP1	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	any **one** from: • increase distance between source and teacher • limit exposure time • use tongs / forceps • wear a lead apron • keep source in box unless in use • stand behind safety screen • point source away from teacher	allow any reasonable precaution that increases distance between the source and the teacher, or limits exposure time ignore wear PPE unqualified ignore examples of additional clothing	1	AO1 4.4.2.4

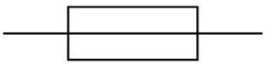
Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	wear gloves / apron **or** wear a lab coat **or** handle source with tongs / forceps	allow no eating / drinking (while radioactive source is in the lab) allow do not touch the source (with bare hands) ignore wear a mask ignore wear safety glasses ignore protective clothing unqualified ignore wear a hazmat suit ignore wear PPE unqualified	1	AO1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	tangent drawn on line at 300 s	do not allow a line drawn that crosses the graph line	1	AO2
	attempt to calculate gradient of the tangent	allow missing power for Δy	1	AO2
	activity = 7.1×10^{20}	allow a value between 6.5 and 7.6×10^{20}	1	AO1
	becquerel / Bq	ignore decays/second	1	4.4.2.1

Total Question 9	**11**

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	brown		1	AO1 4.2.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2			1	AO1 4.2.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.3	t = 0.400 (s)		1	AO2 4.2.1.2
	$2.0 = I \times 0.400$	allow a correct substitution of an incorrectly / not converted value of *t*	1	
	$I = \frac{2.0}{0.400}$	allow a correct rearrangement using an incorrectly / not converted value of *t*	1	
	$I = 5.0$ (A)	allow an answer consistent with an incorrectly / not converted value of *t*	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.4	L = 60 000 (J/kg)	allow full credit for a correct method using E = 0.00102 (kJ)	1	AO2 4.3.2.3
	1.02 = m × 60 000	allow a correct substitution of an incorrectly / not converted value of L	1	
	$m = \frac{1.02}{60\,000}$	allow a correct rearrangement using an incorrectly / not converted value of L	1	
	$m = 1.7 \times 10^{-5}$ (kg)	allow an answer consistent with an incorrectly / not converted value of L	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.5	time taken would increase		1	AO3
	more energy would need to be transferred (in total)	MP2 dependent on scoring MP1	1	AO1 4.1.2.1 4.3.2.3

Total Question 10	**12**