AQA

GCSE
COMBINED SCIENCE: SYNERGY
8465/4H

Higher tier   Paper 4   Physical sciences

Mark scheme

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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.

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

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 his or her judgement
- the Assessment Objectives, level of demand 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.

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**. Different terms in the mark scheme are shown by a / ; 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 error / 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 planets in the solar system.

[2 marks]

Student	**Response**	**Marks awarded**
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, 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. Full marks can, however, be given for a correct numerical answer, without any working shown.

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

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **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 not 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.

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 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.

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	work done = force × distance	allow $W = Fs$	1	AO1 4.6.1.3
01.2		an answer of 245 000 (N) scores **3** marks		AO2 4.6.1.3
	3 430 000 = F × 14		1	
	$F = \frac{3\ 430\ 000}{14}$		1	
	F = 245 000 (N)		1	
01.3	$\text{power} = \frac{\text{work done}}{\text{time}}$	allow $P = \frac{W}{t}$	1	AO1 4.7.2.7
01.4		a numerical answer of 50 scores **3** marks		
	$68\ 600 = \frac{3\ 430\ 000}{t}$		1	AO2
	$t = \frac{3\ 430\ 000}{68\ 600}$		1	AO2
	$t = 50$		1	AO2
	seconds / s		1	AO1 4.7.2.7
Total			**9**	

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	friction in the motor causes energy transfer to the surroundings		1	AO1 4.8.2.5
	the temperature of the motor increases		1	

Question	Answers	Mark	AO / Spec. Ref.
02.2	**Level 2:** The design / plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4	AO3 4.6.1.5
	Level 1: The design / plan 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 mass using a balance / scales, or use masses with known values • measure weight with a newtonmeter **or** use known weights • measure the height using a metre rule (through which the mass is raised) • repeat for different masses • ensure metre rule is vertical when measuring height of bench (using a set square) • account for size of hanger (measuring from floor to base of hanger, or subtracting height of hanger from height of bench) • repeat readings and calculate a mean (after discarding anomalies) • calculate mean to reduce the effect of random errors A Level 2 answer should include named measuring instruments for mass / weight (or using known masses / weights) and height as well as one method of ensuring accurate results		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	efficiency = $\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$		1	AO1 4.8.2.7
02.4		an answer of 8.0 or 8 (J) scores **4** marks an answer of 0.08 (J) scores **3** marks		AO2 4.8.2.7
	15 % = 0.15		1	
	$0.15 = \frac{1.20}{E}$	this mark may be awarded if efficiency is incorrectly / not converted	1	
	$E = \frac{1.20}{0.15}$	this mark may be awarded if efficiency is incorrectly / not converted	1	
	E = 8.0 (J)	this mark may be awarded if efficiency is incorrectly / not converted	1	
Total			**11**	

Question 3

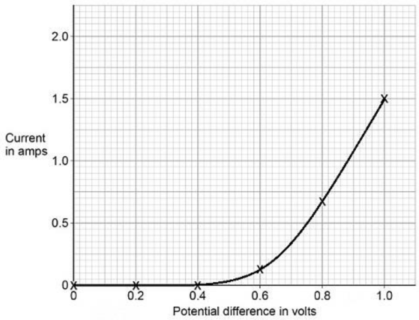
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	to show how it should be recycled	ignore 'so it can be recycled' if unqualified allow to show what type of plastic the bottle is made from	1	AO3 4.8.2.8 4.8.2.9
03.2		an answer of 3.5×10^7 (kg) scores **3** marks an answer of 35 000 000 (kg) scores **2** marks		AO2 4.8.2.9
	(m =) $50\,000\,000 \times \frac{70}{100}$		1	
	(m =) 35 000 000		1	
	(m =) 3.5×10^7 (kg)	allow correct conversion to standard form of an incorrect calculation of mass	1	

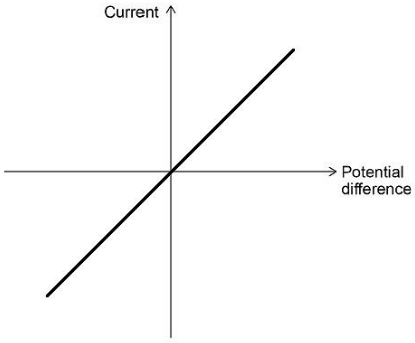
Question	Answers	Mark	AO / Spec. Ref.
03.3	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	AO3 ×2
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	AO3 ×2
	Level 1: Relevant points are made. They are not logically linked.	1–2	1 × AO1 1 ×AO3
	No relevant content	0	4.8.2.8 4.8.2.9

	Indicative content **Raw materials** • crude oil non-renewable so will run out **or** limited supply • aluminium ore non-renewable so will run out **or** limited supply • aluminium requires more energy to be processed from raw material • aluminium extraction (more energy intensive) so costs higher • energy may be supplied from non-renewable sources (for aluminium and / or PET) • difference in energy used to process raw material for 1 kg $2.1 \times 10^8 - 8.4 \times 10^7 = 1.26 \times 10^8$ (J) • 1 kg aluminium needs $2.1 \times 10^8 \div 8.4 \times 10^7 = 2.5$ times more energy to process raw material than 1 kg PET **Manufacturing** • energy may be supplied from non-renewable sources (for can and / or bottle) • volume / mass / weight of can and bottle is the same • more energy needed to manufacture one PET bottle from processed materials • difference in energy used to manufacture 1 kg of cans / bottles = $9.8 \times 10^6 - 2.6 \times 10^6 = 7.2 \times 10^6$ (J) • 1 kg PET bottles needs $9.8 \times 10^6 \div 2.6 \times 10^6 = 3.8$ times more energy to manufacture than 1 kg aluminium cans **Use and operation during lifetime** • cost of transport is likely to be similar because same mass / volume • cans are disposed of after one use • PET bottles can be reused / refilled after use **Disposal / recycling** • higher percentage of aluminium from cans is recycled compared to PET from bottles • higher percentage of PET from bottles goes to landfill • aluminium cans can be recycled to produce more cans / aluminium • PET can be recycled to produce carpets and clothing • PET can be recycled to produce more bottles • difference in % recycled is 70 – 24 = 46% • ratio of Al recycled to PET recycled is 70 ÷ 24 = 2.9 **additional calculations** • difference in total energy needed per kg = $2.126 \times 10^8 - 9.38 \times 10^7 = 1.188 \times 10^8$ (J) • 1 kg aluminium cans needs $2.126 \times 10^8 \div 9.38 \times 10^7 = 2.3$ times more total energy than 1 kg PET bottles • justified conclusion A Level 3 answer should refer to both types of container, consider at least three of the four stages of an LCA, include a calculation and a judgement.		

Total			**10**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	add a variable resistor to the circuit (in series) **or** use a different number of cells in the battery	allow use a variable power supply	1	AO1 4.7.2.2
04.2	to keep the temperature constant	allow to stop the components heating up references to overheating alone are insufficient ignore references to variation in output from the battery	1	AO1 4.7.2.2
	(as) temperature may affect the current / resistance / potential difference	allow temperature may affect the readings	1	
04.3	0.01 A		1	AO2 4.7.2.2
04.4	all points plotted correctly	allow ± ½ a small square allow **1** mark for 4 or 5 points plotted correctly	2	AO2 4.7.2.2
	line of best fit drawn through points		1	
04.5	diode		1	AO3 4.7.2.2

04.6	straight line from the origin in positive quadrant continued into negative quadrant with constant gradient		1 1	AO1 4.7.2.2
Total			**10**	

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	to alter / improve the taste of the tablet	allow to relax the muscles of the intestine allow to aid digestion	1	AO3 4.7.3.2
05.2		an answer of 0.000762 **or** 7.62×10^{-4} (moles) scores **3** marks an answer of 0.762 **or** 0.00076190476 (moles) scores **2** marks an answer of 0.76190476 (moles) scores **1** mark		AO2 4.5.2.4
	(conversion 64.0 mg to) 0.0640 g		1	
	(moles =) $\frac{0.0640}{84}$	allow 0.00076190476 allow correct expression using an unconverted or incorrectly converted value for mass	1	
	= 0.000762 (moles) **or** = 7.62×10^{-4} (moles)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation using the masses in the question	1	

05.3		an answer of $MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$ scores **3** marks		
	(reactants) $MgCO_3$ **and** HCl (products) CO_2 **and** H_2O		1	AO1
	(product) $MgCl_2$		1	AO2
	correct balancing of correct formulae	allow correct multiples	1	AO2 4.5.2.1 4.7.3.1 4.7.3.2

05.4	temperature change / increase	allow the highest temperature of the mixture ignore temperature unqualified	1	AO1 4.7.3.3

05.5	any **two** changes with corresponding reasons: (change) use a lid (reason) to reduce energy transfer (change) repeat (steps 1–4 for each mass) **and** calculate a mean (reason) to reduce effect of random errors (change) use a digital thermometer **or** use a temperature sensor **and** data logger (reason) to reduce instrument reading error (change) use a smaller interval for mass (reason) to produce a better line of best fit	ignore to prevent energy transfer allow for **1** mark repeat (steps 1–4 for each mass) **and** discard anomalous results allow for **1** mark use a thermometer with a higher resolution	4	AO3 4.7.3.3
05.6	line graph mass is a continuous variable	dependent on scoring 1st marking point allow both variables are continuous allow data is continuous allow independent variable is continuous	1 1	AO3 AO1 4.7.3.3
Total			**14**	

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	release ball from a particular release height measured using a metre rule	allow tape measure for metre rule	1	AO3 4.7.1.4
	measure horizontal distance reached by ball using a metre rule	allow tape measure for metre rule	1	
	repeat and calculate a mean (excluding anomalies)		1	
	repeat for a range of different release heights		1	
	suggestion of how to reliably tell where the ball hits the ground	eg tray of sand, carbon paper, video	1	
	release ball rather than pushing down the ramp **or** mark position on ramp so ball is released from same position each time		1	
06.2	random errors in the results	allow reference to specific difficulties in obtaining repeatable results ignore reference to anomalies / outliers ignore human error unqualified	1	AO3 4.7.1.4
06.3		allow **2** marks for two correct pairs of values that show that doubling one quantity does not cause the other quantity to double		AO3 4.7.1.4
	the line of best fit is not straight	allow gradient is not constant	1	
	and doesn't pass through the origin		1	
Total			**9**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	vectors have magnitude and direction (but) scalars have magnitude only	allow size for magnitude ignore reference to named quantities if no other marks scored allow **1** mark for vector quantities have direction but scalar quantities do not	1 1	AO1 4.6.1.1
07.2	in a closed system (total) momentum before an event is equal to (total) momentum after	allow if no external forces act allow collision for event	1 1	AO1 4.7.1.8
07.3	initial momentum of **A** = 60 × 5.5 initial momentum of **A** = 330 (kg m/s) 330 + (2 × m) = 4 × (60 + m) 330 + (2 × m) = 240 + (4 × m) **or** 330 – 240 = (4 × m) – (2 × m) **or** 90 = 2 × m m = 45 (kg)	an answer of 45 (kg) scores **5** marks	1 1 1 1 1	AO2 4.7.1.8
Total			**9**	

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	hydroelectric(ity)	allow HEP	1	AO1 4.8.2.4
08.2	plentiful supply of electricity **or** plentiful supply of renewable energy		1	AO3 4.8.2.2 4.8.2.4

08.3		an answer of 529 (kg) scores **4** marks		AO2 4.5.2.5
	(M_r Al_2O_3) 102		1	
	(moles Al_2O_3 = $\frac{1\,000\,000}{102}$)	allow correct calculation using incorrectly calculated value for M_r of Al_2O_3		
	= 9 804		1	
	(moles Al = 9 804 × 2 =) 19 608	allow correct calculation using incorrectly calculated value of moles of Al_2O_3	1	
	(mass Al = $\frac{19\,608}{1\,000}$ × 27)	allow correct answer using incorrectly calculated value of moles of Al		
	= 529 (kg)	allow 529.4117647 (kg) correctly rounded to at least 2 significant figures	1	
	alternative approach (M_r of Al_2O_3 =) 102 **or** (2 × M_r of Al_2O_3 =) 204 (1) (proportion by mass of Al in Al_2O_3 =) $\frac{54}{102}$ **or** $\frac{108}{204}$ **or** 0.529 (1) (mass of Al =)1 000 × $\frac{54}{102}$ **or** 1 000 x 0.529 (1) = 529 (kg) (1)			

08.4	$Al^{3+} + 3e^{-} \rightarrow Al$		1	AO2 4.7.5.2 4.8.2.2
08.5	(mixture) has a lower melting point (than aluminium oxide)	allow cryolite lowers the melting point (of aluminium oxide) ignore boiling point do not accept cryolite is a catalyst	1	AO1 4.8.2.2
	(so) less energy is required (to melt the mixture)	ignore cost	1	
08.6		allow anode for positive electrode		AO1 4.8.2.2
	positive electrode is made out of carbon / graphite	allow both electrodes are made of carbon / graphite	1	
	oxygen is produced at positive electrode (during electrolysis)		1	
	(so) carbon and oxygen react (to produce carbon dioxide)	allow $C + O_2 \rightarrow CO_2$	1	
08.7	(property)			AO3 4.8.2.2
	high melting point	ignore boiling point	1	
	(reason)			
	(so) would not melt in the high temperatures (in the electrolytic cell)		1	
	(property)			
	inert / unreactive	ignore low reactivity	1	
	(reason)			
	(so) does not react with oxygen		1	
	or			
	(so) does not react with aluminium oxide	ignore (so) does not react with aluminium		
Total			**16**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	the height from which the skydiver jumped		1	AO1 4.7.1.4
09.2		allow speed for velocity throughout		AO1 4.7.1.4 4.7.1.5
	at **A**: there is a resultant force downwards	allow weight is the only force on the skydiver allow weight is greater than air resistance	1	
	between **A** / **B** and **C**: velocity increases	allow skydiver accelerates	1	
	resultant force decreases **or** air resistance increases		1	
	(so) acceleration decreases **or** (so) velocity increases at a decreasing rate	allow (so) rate of change of velocity decreases	1	
	at **C**: resultant force is zero	allow forces are balanced allow air resistance = weight	1	
	velocity is constant **or** terminal velocity is reached		1	

09.3		an answer of 3 400 000 (J) **or** 3 380 000 (J) **or** 3 379 000 (J) scores **5** marks		AO2 4.7.1.4 4.7.1.9 4.8.2.5
	$E_k = 0.5 \times 80 \times 55^2$		1	
	E_k = 121 000 J		1	
	3.50 MJ = 3 500 000 J	allow 121 000 J = 0.121 MJ	1	
	(energy transferred to surroundings) 3 500 000 – 121 000	allow 3.5 – 0.121 allow 3 500 000 **or** 3.5 – their calculated E_k	1	
	= 3 400 000 (J)	allow 3.4 MJ / megajoules allow an answer consistent with their calculated E_k	1	

Total			**12**