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**GCSE**  
**COMBINED SCIENCE: SYNERGY**  
**8465/4F**

Foundation tier      Paper 4    Physical sciences

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**Mark scheme**

June 2019

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Version: 1.0 Final



1 9 6 G 8 4 6 5 / 4 F / M S

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.

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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 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	weight		1	AO1 4.6.1.4 4.7.1.4
01.2	terminal velocity		1	AO1 4.7.1.4
01.3	$s = 56 \times 40$ $s = 2240 \text{ (m)}$	an answer of 2240 (m) scores <b>2</b> marks	1 1	AO2 4.7.1.2
01.4	$W = 85 \times 9.8$ $W = 833 \text{ (N)}$	an answer of 833 (N) scores <b>2</b> marks	1 1	AO2 4.6.1.4
01.5	air resistance increases		1	AO1 4.7.1.4
<b>Total</b>			<b>7</b>	

## Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	current energy efficiency		1 1 1	AO1 4.7.2.9 4.8.2.5
02.2	50 Hz		1	AO1 4.7.2.5
02.3	23 (%)		1	AO2 4.8.2.4
02.4	(burning gas produces) carbon dioxide  (which) causes global warming  <b>or</b> (which is) a greenhouse gas	allow CO <sub>2</sub> ignore carbon monoxide ignore water (vapour) ignore air pollution  allow greenhouse effect allow climate change allow named effects of climate change do <b>not</b> accept damage to ozone layer	1       1	AO1 4.8.1.3 4.8.2.4





<b>02.8</b>	distance between hairdryer and model wind turbine is fixed <b>or</b> angle / position of hair dryer is the same (each time)	allow distance was a control variable  allow angle / position was a control variable	1	AO3 4.8.2.4
	(so) smaller variation in potential difference measurements <b>or</b> (so) wind speed was constant <b>or</b> (so) wind turbine speed was constant	allow voltage for potential difference  allow (so) force of wind was constant	1	
<b>Total</b>			<b>14</b>	

**Question 3**

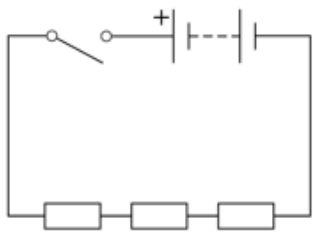
<b>Question</b>	<b>Answers</b>	<b>Extra information</b>	<b>Mark</b>	<b>AO / Spec. Ref.</b>
<b>03.1</b>	(mass in mg =) 800 (mass in g =) 0.8	an answer of 0.8 (g) scores <b>2</b> marks  allow correct unit conversion using incorrectly calculated mass in milligrams	1  1	AO2 4.7.3.1
<b>03.2</b>	carbon dioxide		1	AO1 4.7.3.2 4.7.3.1
<b>03.3</b>	4		1	AO2 4.5.2.1
<b>03.4</b>	add a lid to the top of the glass beaker  use a polystyrene cup instead of the glass beaker		1  1	AO3 4.7.3.3
<b>03.5</b>	continuous variable  independent variable		1  1	AO1 4.7.3.3
<b>Total</b>			<b>8</b>	

## Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	hydroelectricity		1	AO1 4.8.2.4
04.2	plentiful supply of cheap electricity		1	AO3 4.8.2.2 4.8.2.4
04.3	4(Al) 3(O <sub>2</sub> )	an answer of $2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2$ scores <b>2</b> marks	1 1	AO2 4.5.2.1 4.8.2.2
04.4	reduction		1	AO1 4.8.2.1
04.5	(Al <sup>3+</sup> ions are) positive  (so) are attracted (to the negative electrode)	do <b>not</b> accept aluminium atoms are positive, but 2 <sup>nd</sup> marking point can still be scored  allow (so) opposite charges attract	1 1	AO1 4.7.5.2 4.8.2.2
04.6	3 / three		1	AO2 4.7.5.2 4.8.2.2
04.7	carbon dioxide	allow CO <sub>2</sub> allow carbon monoxide <b>or</b> CO ignore carbon oxide	1	AO2 4.5.2.1 4.8.2.2
04.8	electrode / carbon / graphite reacts to produce a gas	allow electrode / carbon / graphite is used up ignore wears away ignore corrodes / rusts	1	AO1 4.5.2.1 4.8.2.2

<b>04.9</b>	(high melting point) (so) will not melt		1	AO3 4.8.2.2
	in the high temperatures (in the electrolytic cell)	ignore the electrolytic cell is very hot	1	
	(unreactive) (so) will not react		1	
	with oxygen <b>or</b> with aluminium oxide	allow (so) electrode doesn't need replacing  ignore with aluminium	1	
<b>Total</b>			<b>14</b>	

**Question 5**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1			1	AO1 4.7.2.2 4.7.2.3 4.7.2.4
05.2	ammeter voltmeter		1 1	AO1 4.7.2.2
05.3	so the temperature of the resistors would remain constant		1	AO3 4.7.2.2
05.4	4 points correctly plotted  straight line of best fit	allow tolerance of $\pm\frac{1}{2}$ a small square  allow 1 mark for 3 points correctly plotted	2  1	AO2 4.7.2.2
05.5	line of best fit is straight	allow resistance increases by $2.2 \Omega$ each time  allow resistance increases by same amount each time	1	AO3 4.7.2.2
05.6	lower		1	AO1 4.7.2.2 4.7.2.3
<b>Total</b>			<b>9</b>	

## Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$\rightleftharpoons$	allow description of the reversible sign	1	AO1 4.7.4.8
06.2	(X) 0.81 (g)  (Y) 0.45 (g)	allow correct subtraction using an incorrect value for X	1  1	AO2 4.7.4.8
06.3	to make sure all the water was removed		1	AO3 4.7.4.8
06.4	a reaction that gives out energy to the surroundings		1	AO1 4.7.3.3
06.5	18 (°C)		1	AO2 4.7.3.3
06.6	increases		1	AO2 4.7.3.3
<b>Total</b>			<b>7</b>	

**Question 7**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	metre rule	allow tape measure	1	AO3 4.7.1.4
07.2	increase the extension of the elastic band	allow pull the elastic band back further / more allow increase the tension in the elastic band	1	AO3 4.7.1.4 4.6.1.6
07.3	any <b>one</b> from: <ul style="list-style-type: none"> <li>• height of bench</li> <li>• size / mass / weight of ball</li> <li>• length / elasticity / type of elastic band</li> </ul>	allow the ball allow the elastic band	1	AO3 4.7.1.4 4.6.1.6
07.4	(Hazard): elastic band snapping <b>or</b> elastic band hitting a student <b>or</b> the ball may hit a student  (Precaution): wear safety glasses <b>or</b> wear goggles <b>or</b> ensure the area is clear <b>or</b> don't extend the elastic band too far	for <b>2</b> marks the precaution must match the hazard	1	AO3 4.7.1.4 4.6.1.6
		matches both hazards		
		matches both hazards		
matches first hazard only	1			
07.5	(from) 0.5 (m/s to) 2(.0) (m/s)	allow (from) 2(.0) (m/s to) 0.5 (m/s)	1	AO2 4.7.1.4
07.6	90 (cm)	allow answers in the range 88 to 92 (cm) inclusive	1	AO3 4.7.1.4



<b>07.7</b>	kinetic energy = $0.5 \times \text{mass} \times (\text{speed})^2$	allow $E_k = \frac{1}{2} mv^2$	1	AO1 4.7.1.9
<b>07.8</b>	$E_k = 0.5 \times 0.0044 \times 1.6^2$  0.005632 (J)  0.0056 (J) <b>or</b> $5.6 \times 10^{-3}$ (J)	an answer of 0.0056 (J) scores <b>3</b> marks  an answer that rounds to 0.0056 (J) scores <b>2</b> marks   allow an answer correctly rounded to 2 significant figures from an incorrect calculation using the values in the question	1  1  1	AO2 4.7.1.9
<b>Total</b>			<b>11</b>	

**Question 8**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	work done = force × distance	allow $W = Fs$	1	AO1 4.6.1.3
08.2	$3\,430\,000 = F \times 14$  $F = \frac{3\,430\,000}{14}$  $F = 245\,000 \text{ (N)}$	an answer of 245 000 (N) scores <b>3</b> marks	1  1  1	AO2 4.6.1.3
08.3	power = $\frac{\text{work done}}{\text{time}}$	allow $P = \frac{W}{t}$	1	AO1 4.7.2.7
08.4	$68\,600 = \frac{3\,430\,000}{t}$  $t = \frac{3\,430\,000}{68\,600}$  $t = 50$  seconds / s	a numerical answer of 50 scores <b>3</b> marks	1  1  1  1	AO2  AO2  AO2  AO1 4.7.2.7
<b>Total</b>			<b>9</b>	

**Question 9**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	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.
09.2	<b>Level 2:</b> 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
	<b>Level 1:</b> The design / plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	<b>No relevant content</b>	0	
	<b>Indicative content</b> <ul style="list-style-type: none"> <li>• measure mass using a balance / scales, or use masses with known values</li> <li>• measure weight with a newtonmeter <b>or</b> use known weights</li> <li>• measure the height using a metre rule (through which the mass is raised)</li> <li>• repeat for different masses</li>   <li>• ensure metre rule is vertical when measuring height of bench (using a set square)</li> <li>• account for size of hanger (measuring from floor to base of hanger, or subtracting height of hanger from height of bench)</li> <li>• repeat readings and calculate a mean (after discarding anomalies)</li> <li>• calculate mean to reduce the effect of random errors</li> </ul> <p>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.</p>		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	$\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$		1	AO1 4.8.2.7
09.4	$15\% = 0.15$ $0.15 = \frac{1.20}{E}$ $E = \frac{1.20}{0.15}$ $E = 8.0 \text{ (J)}$	an answer of 8.0 or 8 (J) scores <b>4</b> marks  an answer of 0.08 (J) scores <b>3</b> marks  this mark may be awarded if efficiency is incorrectly / not converted  this mark may be awarded if efficiency is incorrectly / not converted  this mark may be awarded if efficiency is incorrectly / not converted	1  1  1  1	AO2 4.8.2.7
<b>Total</b>			<b>11</b>	

**Question 10**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	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
10.2	(m =) $50\,000\,000 \times \frac{70}{100}$  (m =) 35 000 000  (m =) $3.5 \times 10^7$ (kg)	an answer of $3.5 \times 10^7$ (kg) scores <b>3</b> marks  an answer of 35 000 000 (kg) scores <b>2</b> marks         allow correct conversion to standard form of an incorrect calculation of mass	1         1         1	AO2 4.8.2.9

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

	<p><b>Indicative content</b></p> <p><b>Raw materials</b></p> <ul style="list-style-type: none"> <li>• crude oil non-renewable so will run out <b>or</b> limited supply</li> <li>• aluminium ore non-renewable so will run out <b>or</b> limited supply</li> <li>• aluminium requires more energy to be processed from raw material</li> <li>• aluminium extraction (more energy intensive) so costs higher</li> <li>• energy may be supplied from non-renewable sources (for aluminium and / or PET)</li> <li>• difference in energy used to process raw material for 1 kg  <math>2.1 \times 10^8 - 8.4 \times 10^7 = 1.26 \times 10^8</math> (J)</li> <li>• 1 kg aluminium needs <math>2.1 \times 10^8 \div 8.4 \times 10^7 = 2.5</math> times more energy to process raw material than 1 kg PET</li> </ul> <p><b>Manufacturing</b></p> <ul style="list-style-type: none"> <li>• energy may be supplied from non-renewable sources (for can and / or bottle)</li> <li>• volume / mass / weight of can and bottle is the same</li> <li>• more energy needed to manufacture one PET bottle from processed materials</li> <li>• difference in energy used to manufacture 1 kg of cans / bottles =  <math>9.8 \times 10^6 - 2.6 \times 10^6 = 7.2 \times 10^6</math> (J)</li> <li>• 1 kg PET bottles needs <math>9.8 \times 10^6 \div 2.6 \times 10^6 = 3.8</math> times more energy to manufacture than 1 kg aluminium cans</li> </ul> <p><b>Use and operation during lifetime</b></p> <ul style="list-style-type: none"> <li>• cost of transport is likely to be similar because same mass / volume</li> <li>• cans are disposed of after one use</li> <li>• PET bottles can be reused / refilled after use</li> </ul> <p><b>Disposal / recycling</b></p> <ul style="list-style-type: none"> <li>• higher percentage of aluminium from cans is recycled compared to PET from bottles</li> <li>• higher percentage of PET from bottles goes to landfill</li> <li>• aluminium cans can be recycled to produce more cans / aluminium</li> <li>• PET can be recycled to produce carpets and clothing</li> <li>• PET can be recycled to produce more bottles</li> <li>• difference in % recycled is <math>70 - 24 = 46\%</math></li> <li>• ratio of Al recycled to PET recycled is <math>70 \div 24 = 2.9</math></li> </ul> <p><b>additional calculations</b></p> <ul style="list-style-type: none"> <li>• difference in total energy needed per kg = <math>2.126 \times 10^8 - 9.38 \times 10^7 = 1.188 \times 10^8</math> (J)</li> <li>• 1 kg aluminium cans needs <math>2.126 \times 10^8 \div 9.38 \times 10^7 = 2.3</math> times more total energy than 1 kg PET bottles</li> <li>• justified conclusion</li> </ul> <p>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.</p>		
<b>Total</b>			<b>10</b>