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

Higher Tier Paper 4 Physical Sciences

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**Mark scheme**

June 2024

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Version: 1.0 Final



2 4 6 G 8 4 6 5 / 4 H / 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.

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](http://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 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 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.

### 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	bar magnet		1	AO1 4.6.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	the rods become magnetised	allow the rods become (induced) magnets ignore the rods are magnetic	1	AO3 4.6.3.1 4.6.3.4
	(and) the ends of the rods have the same (magnetic) poles (so repel each other)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	copper is not a magnetic material		1	AO1 4.6.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	(pole A) north <b>and</b> (pole B) south		1	AO3 4.6.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	the weight of the iron disc is 2.0 N		1	AO3 4.6.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>01.6</b>	(the magnetic field surrounding) the electromagnet attracts the iron	allow magnetism is a non-contact force	1	AO2 4.6.3.4 4.6.1.1
	(increasing the current) increases the strength of the magnetic field	allow the magnetic flux density increases	1	
	(which) increases the (magnetic) force on the iron disc		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>01.7</b>	line curving upwards above original line	a line which becomes vertical scores no marks	1	AO3 4.6.3.4
	line starts at 2.0 N	MP2 dependent on MP1	1	

<b>Total Question 1</b>	<b>11</b>
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**Question 2**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	any <b>two</b> from: <ul style="list-style-type: none"> <li>• volume of (sulfuric) acid</li> <li>• concentration of (sulfuric) acid</li> <li>• temperature (of sulfuric acid)</li> <li>• mass of metal</li> <li>• surface area of metal</li> </ul>	ignore amount of (sulfuric) acid allow pH (of sulfuric acid) ignore room temperature ignore amount of metal allow size of metal	2	AO3 4.7.3.1 4.7.4.2 4.7.4.3 4.7.5.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	(least reactive) copper iron zinc (most reactive) magnesium	allow Cu allow Fe allow Zn allow Mg	1	AO3 4.7.5.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	(test) burning splint		1	AO1 4.7.3.1 4.7.5.4
	(result) (hydrogen) burns with a pop sound	MP2 dependent on MP1	1	

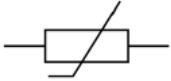
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	stopper (tightly fitted) <b>and</b> delivery tube (under measuring cylinder)		1	AO3 4.7.4.1 4.7.5.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	volume of hydrogen / gas (collected)	if no other mark awarded allow 1 mark for volume <b>and</b> time	1	AO3 4.7.4.1 4.7.5.1
	time taken to collect the hydrogen / gas		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	cm <sup>3</sup> /s		1	AO1 4.7.4.1 4.7.5.1

<b>Total Question 2</b>	<b>9</b>
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## Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1			1	AO1 4.7.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	the room temperature is 20 °C	allow no ice available	1	AO3 4.7.2.2

Question	Answers	Mark	AO / Spec. Ref.
03.3	<b>Level 3:</b> The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3 4.7.2.2
	<b>Level 2:</b> The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	<b>Level 1:</b> The method 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>• vary the temperature of the thermistor</li> <li>• measure temperature (with a thermometer)</li>   <li>• measure the current (from the ammeter)</li> <li>• measure potential difference (from the voltmeter)</li> <li>• use measurements to calculate resistance (using <math>V = I R</math>)</li>   <li>• description of a suitable circuit</li> <li>• use a water bath to vary temperature</li> <li>• use an interval of 10 °C</li> <li>• use a range of 20 °C to 70 °C</li> </ul>		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	potential difference = current × resistance or $V = I R$		1	AO1 4.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	$R = 750 (\Omega)$		1	AO2 4.7.2.2
	$6.0 = I \times 750$	allow a correct substitution using a value of $R$ in the range 740( $\Omega$ ) to 760 ( $\Omega$ )	1	
	$I = \frac{6.0}{750}$	allow a correct rearrangement using a value of $R$ in the range 740 ( $\Omega$ ) to 760 ( $\Omega$ )	1	
	$I = 0.0080 (A)$	allow an answer consistent with a value of $R$ in the range 740( $\Omega$ ) to 760 ( $\Omega$ )	1	

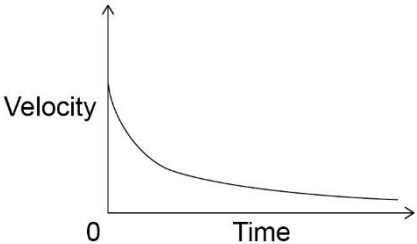
<b>Total Question 3</b>	<b>13</b>
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**Question 4**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>04.1</b>	gradient = $\frac{200}{4}$		1	AO2 4.7.1.2
	speed = 50 (m/s)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>04.2</b>	the skydiver accelerates	allow the speed increases	1	AO1 4.7.1.4
	and then reaches terminal / constant / maximum velocity (after 8 seconds)	allow speed for velocity	1	
		allow the acceleration decreases to zero (after 8 seconds)		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>04.3</b>	the skydiver's weight is constant		1	
	(but) air resistance increases as speed increases		1	
	(until) weight = air resistance		1	
	(when) resultant force is zero	allow until the skydiver reaches terminal velocity	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>04.4</b>			1	AO3 4.7.1.2 4.7.1.4

**Total Question 4**
**9**

**Question 5**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	(so) the ions are free to move	allow (so) the ions can move (freely)	1	AO1 4.7.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	(so the electrodes) do not react		1	AO1 4.7.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(test) damp (blue / red) litmus paper	ignore paper turns red	1	AO1 4.7.5.2 4.7.5.4
	(result) (litmus paper) is bleached or (litmus paper) turns white		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	$K^+ + e^- \rightarrow K$		1	AO2 4.7.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	reduction		1	AO1 4.7.5.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>05.6</b>	water molecules break down to produce hydrogen ions (and hydroxide ions)		1	AO3
	(and) hydrogen is less reactive than potassium		1	AO1
	(so) hydrogen ions gain electrons	allow (so) hydrogen ions are reduced	1	AO1
	to form a hydrogen molecule		1	AO1 4.7.5.2 4.7.5.3 RPA 21

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.7	(mass of KCl = $0.030 \times 74.5 =$ $2.235$ (g)  (50 cm <sup>3</sup> =) 0.050 (dm <sup>3</sup> )  (concentration =) $\frac{2.235}{0.050}$  $= 44.7$ (g/dm <sup>3</sup> )  <b>OR</b> (50 cm <sup>3</sup> =) 0.050 dm <sup>3</sup> (1)  (concentration = $\frac{0.030}{0.050} =$ ) $0.6$ (mol/dm <sup>3</sup> ) (1)  (concentration =) $0.6 \times 74.5$ (1)  $= 44.7$ (g/dm <sup>3</sup> ) (1)	allow correct use of an incorrectly determined value for mass allow correct use of incorrect / no conversion of volume  allow an answer consistent with an incorrectly determined value for mass allow an answer consistent with the use of incorrect / no conversion of volume   allow correct use of incorrect / no conversion of volume  allow correct use of an incorrectly determined value for concentration in mol/dm <sup>3</sup>  allow an answer consistent with the use of an incorrectly determined value for concentration in mol/dm <sup>3</sup>	1  1  1  1   1	AO2 4.5.2.6
<b>Total Question 5</b>			<b>14</b>	



## Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$P = 240$ (W)		1	AO2 4.7.2.7
	$240 = I \times 16$	allow a correct substitution using an incorrectly / not converted value of $P$	1	
	$I = \frac{240}{16}$	allow a correct rearrangement using an incorrectly / not converted value of $P$	1	
	$I = 15$ (A)	allow an answer consistent with an incorrectly / not converted value of $P$	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	$t = 21\,600$ (s)		1	AO2 4.7.2.8 4.7.2.7 4.7.2.1
	<b>or</b>			
	$t = 6 \times 60 \times 60$			
	$E = 18 \times 21\,600$	allow a correct substitution using an incorrectly / not converted value of $t$	1	
	$E = 388\,800$ (J)	allow an answer consistent with an incorrectly / not converted value of $t$	1	
	$388\,800 = Q \times 24$	allow a correct substitution using their calculated value of $E$ (using $E = Pt$ )	1	
	$Q = \frac{388\,800}{24}$	allow a correct rearrangement using their calculated value of $E$ (using $E = Pt$ )	1	
	$Q = 16\,200$ (C)	allow an answer consistent with their calculated value of $E$ (using $E = Pt$ )	1	
	<b>OR</b>			
	$18 = I \times 24$ (1)			
	$I = \frac{18}{24}$ (1)			
	$I = 0.75$ (A) (1)			
	$t = 21\,600$ (s) (1)			
$Q = 0.75 \times 21\,600$ (1)	allow a correct substitution using an incorrectly / not converted value of $t$			
$Q = 16\,200$ (C) (1)	allow an answer consistent with an incorrectly / not converted value of $t$			

**Total Question 6**
**10**

**Question 7**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(to the) right	allow from the left (to the right)	1	AO3 4.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	upthrust	allow buoyancy ignore thrust	1	AO1 4.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	$W = 3430 \text{ (N)}$	allow a correct substitution of an incorrectly / not converted value of $W$  allow a correct rearrangement of an incorrectly / not converted value of $W$  allow an answer consistent with their incorrectly / not converted value of $W$	1	AO2 4.6.1.4
	$3430 = m \times 9.8$		1	
	$m = \frac{3430}{9.8}$		1	
	$m = 350 \text{ (kg)}$		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	the single force that has the same effect as all of the original forces acting together	allow (vector) sum of all the forces acting on the object	1	AO1 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>07.5</b>	horizontal and vertical components drawn on <b>Figure 12</b>		1	AO2 4.6.1.2
	length of horizontal component = 3 (cm) <b>and</b> length of vertical component = 4 (cm)		1	
	horizontal component = 150 (N) <b>and</b> vertical component = 200 (N)		1	
<b>Total Question 7</b>			<b>10</b>	

**Question 8**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>08.1</b>	a strong acid is completely ionised in (aqueous) solution		1	AO1 4.5.2.6 4.7.3.5
	(but) is dilute if there is (only) a small number of hydrogen ions per unit volume (of solution)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>08.2</b>	decreases by a factor of 10		1	AO1 4.7.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>08.3</b>	measure the mass of calcium carbonate added		1	AO3 4.7.3.2 RPA 17
	wash the residue	allow wash the excess calcium carbonate	1	
	dry the residue	allow dry the excess calcium carbonate	1	
	measure the final mass of (dry) calcium carbonate		1	
	subtract the final mass from the mass of calcium carbonate added		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>08.4</b>	$\frac{3 \times 16}{63} \times 100$		1	AO2 4.5.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	$\text{Ca}(\text{NO}_3)_2$		1	AO2 4.6.2.2 4.7.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.6	$(M_r \text{MgCl}_2 = 24 + 2 \times 35.5 =) 95$		1	AO2 4.5.2.4 4.5.2.5
	$(\text{moles MgCl}_2) = \frac{47.5}{95}$	allow correct use of an incorrectly determined $M_r$ of $\text{MgCl}_2$	1	
	$= 0.5$		1	
	$(\text{mole ratio MgCl}_2 : \text{Mg}^{2+} = 1:1)$ $= 0.5:0.5$	allow correct use of an incorrectly determined number of moles of $\text{MgCl}_2$	1	
	$(\text{number of Mg}^{2+} \text{ ions})$ $= 0.5 \times 6.02 \times 10^{23}$	allow correct use of an incorrectly determined number of moles of $\text{Mg}^{2+}$	1	
	$= 3.01 \times 10^{23}$	allow an answer consistent with an incorrectly determined number of moles of $\text{Mg}^{2+}$	1	

<b>Total Question 8</b>	<b>16</b>
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**Question 9**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>09.1</b>	voltmeter reading: stays the same	MP2 dependent on MP1	1	AO1 4.7.2.2 4.7.2.3
	(because) the battery pd is constant / 12 (V)		1	
	ammeter reading: decreases	MP4 dependent on MP3	1	
	(because) the (total) resistance of the circuit increases		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>09.2</b>	the total pd must be equal to the pd across the battery	allow maximum resistance for 15 $\Omega$  allow minimum resistance for 0 $\Omega$	1	AO3 4.7.2.2 4.7.2.3 RPA16
	(so when) the resistance of the variable resistor is 15 $\Omega$ , the pd across the fixed resistor is 6 V		1	
	(so when) the resistance of the variable resistor is 0 $\Omega$ , the pd across the fixed resistor is 12 V		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<b>09.3</b>	any <b>one</b> from: <ul style="list-style-type: none"> <li>• use fewer cells in the battery</li> <li>• use a variable resistor with a larger range</li> <li>• add another resistor in series in the circuit</li> </ul>	allow decrease the potential difference across the power supply	1	AO3 4.7.2.2 4.7.2.3 RPA16

<b>Total Question 9</b>	<b>8</b>
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