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.

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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 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 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 <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.

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	chemical energy of coal decreases kinetic energy of train increases	 allow **1** mark only for the energy of the coal decreases **and** the energy of the train increases allow 1 mark only for chemical energy (of the coal) is transferred to kinetic energy (of the train)	1 1	AO1 4.7.1.9 4.8.2.4 4.8.2.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.2	$P = \frac{E}{t}$		1	AO1 4.7.2.7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.3	$8000 = \frac{E}{3600}$ $E = 8000 \times 3600$ $E = 28\,800\,000$ (J)		1 1 1	AO2 4.7.2.7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.4	to allow a comparison to be made between steam engines and horses (because) people would know the (typical) power output of a horse (in the 18th century)		1 1	AO3 4.7.2.7

Total Question 1		**8**

Question 2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.1	(test) (bubble through) limewater (result) (limewater) turns cloudy	allow calcium hydroxide solution for limewater MP2 dependent on MP1 being awarded allow (limewater) turns milky	 1 1	AO1 4.7.3.1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.2	(**X** and **Y**) copper nitrate water	in either order allow $Cu(NO_3)_2$ allow H_2O	 1 1	AO2 4.5.2.1 4.7.3.2

Question	Answers	Mark	AO/ Spec. Ref.
02.3	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO3 4.7.4.1
	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 Key steps: • measure a fixed volume of (nitric) acid • measure the temperature of the (nitric) acid • measure a fixed mass of copper carbonate • add the copper carbonate to the (nitric) acid and start timing • measure the volume of gas collected after a set time **or** measure the time taken to collect a fixed volume of gas • repeat for different temperature(s) of the (nitric) acid Other points: • use a measuring cylinder (to measure the volume of (nitric) acid) • add the (nitric) acid to a conical flask • use water bath / ice / kettle / Bunsen burner (to change the temperature of the (nitric) acid) • use a thermometer (to measure the temperature of the (nitric) acid) • use a balance (to measure the mass of copper carbonate) • collect gas in a gas syringe **or** collect gas in a measuring cylinder above water • use a stopclock / stopwatch / timer		

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.4	particles have more energy	allow particles move faster allow more particles have energy greater than the activation energy	1	AO1 4.7.4.3
	(so) more frequent collisions		1	

Total Question 2		**12**

Question 3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.1	independent variable = weight (inside the box) dependent variable = distance (the box slides)		1 1	AO2 4.7.1.6 4.6.1.7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.2	any **one** from: • the surface • the box		1	AO3 4.7.1.6 4.6.1.7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.3	±0.4 cm		1	AO3 4.7.1.6 4.6.1.7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.4	e = 0.10 m $E_e = 0.5 \times 36 \times 0.10^2$ $E_e = 0.18$ (J)	 allow a correct substitution of an incorrectly / not converted value of e allow a correct calculation of an incorrectly / not converted value of e	1 1 1	AO2 4.7.1.6 4.6.1.7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.5	E_k = 0.18 (J)	allow ecf from question **03.4**	1	AO2 4.7.1.6 4.6.1.7

Question	Answers	Mark	AO/ Spec. Ref.
03.6	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	3−4	AO3 4.7.1.6 4.6.1.7
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1−2	
	No relevant content	0	
	Indicative content • use a larger range of weights (allow a specified range) • use a smaller interval (allow a specified interval) • ensure weights are fixed to base of box • ensure ruler is fixed in place • move ruler closer to the surface • use a set square to help measure the distance the box slides • ensure same release point each time ignore take repeat readings and calculate a mean		

Total Question 3		**12**

Question 4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.1	coal / oil / wood / biofuel	allow named biofuel ignore fossil fuel	1	AO1 4.8.2.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.2	any **two** from: • hydrogen is a renewable energy resource • less fuel needed to travel the same distance **or** less frequent refuelling • no carbon dioxide produced **or** only water (vapour) produced	allow burning hydrogen has no negative effects on the environment	2	AO3 4.8.2.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.3	any **three** from: • reduces carbon dioxide emissions • reduces particulates released • conserves natural gas reserves • less global warming		3	AO3 4.8.2.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.4	consumers will have to purchase new appliances **or** appliances may be damaged by burning hydrogen		1	AO3 4.8.2.4
	some appliances may have been bought from outside the UK	allow some appliances may have been bought before 1996	1	

Total Question 4		**8**

Question 5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.1	keep room well ventilated **or** use a fume cupboard	ignore safety goggles ignore don't breathe in the fumes	1	AO3 4.7.4.3 RPA19

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.2	sulfur (is produced) (and sulfur is) a solid (so) the solution turns cloudy (and the cross is no longer visible)	 allow (and sulfur is) an insoluble substance allow (and sulfur forms as) a precipitate	1 1 1	AO1 4.7.4.3 RPA19

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.3	(change) use a light source and light meter (reason) to reduce the error in determining the end point **or** (change) repeat for each concentration **and** calculate a mean (1) (reason) to reduce effect of random errors (1)	MP2 is dependent on corresponding MP1 being awarded allow **1** mark for repeat for each concentration **and** discard anomalous results	 1 1	AO3 4.7.4.3 RPA19

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.4	all five points plotted correctly line of best fit	allow a tolerance of ± ½ a small square allow **1** mark for four points plotted correctly	2 1	AO2 4.7.4.3 RPA19

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.5	value obtained from extension of line of best fit	allow ecf from question **05.4** if no line drawn allow a value in the range 14 to 19 (s)	1	AO3 4.7.4.3 RPA19

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.6	as the concentration (of sodium thiosulfate solution) increases, the rate of reaction increases	ignore as the concentration increases the time taken decreases	1	AO3 4.7.4.3 RPA19

Total Question 5		**11**

Question 6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.1	air resistance increases until it equals the forward force (so) the resultant force is zero		1 1	AO1 4.6.1.2 4.7.1.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.2	$5.0^2 - 1.0^2 = 2 \times 1.6 \times s$ $24 = 3.2 \times s$ **or** $s = \frac{24}{3.2}$ s = 7.5 (m)		1 1 1	AO2 4.7.1.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.3	s = 296 × 1000 = 296 000 (m) t = 3600 (s) v = 82 (m/s)	 allow $v = \frac{296\ 000}{3600}$ for **2** marks allow 82.$\dot{2}$ (m/s)	1 1 1	AO2 4.7.1.2

Total Question 6		8

Question 7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.1	the polarity (of the supply) continuously changes	allow p.d. for potential difference allow a potential difference that changes direction	1	AO1 4.7.2.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.2	the output of one 40 m turbine is greater than two 20 m turbines **or** the output of one 40 m turbine is more than twice as great as two 20 m turbines (but) a 40 m turbine is unlikely to cost twice as much (as two 20 m turbines)		1 1	AO3 4.8.2.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.3	15 000 kW		1	AO3 4.8.2.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.4	73.9 MJ = 73 900 000 J 73 900 000 = $0.5 \times 236\,000 \times v^2$ $v^2 = \frac{73\,900\,000}{0.5 \times 236\,000}$ **or** $v^2 = 626$ v = 25.0 (m/s)		1 1 1 1	AO2 4.7.1.9

Total Question 7		**8**

Question 8

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.1	base		1	AO1 4.7.3.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.2	(gently) heat the filtrate / solution	allow evaporate water	1	AO1 4.7.3.2 RPA17
	until crystals start to form	allow until half of the filtrate / solution remains	1	
	leave (remaining filtrate / solution) to cool / crystallise		1	
	dry the crystals with (filter) paper	allow dry the crystals in a warm oven allow until the crystals are dry	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.3	record the mass of copper oxide added		1	AO3 4.7.3.2 RPA17
	wash the residue	allow wash the excess copper oxide	1	
	dry the residue	allow dry the excess copper oxide	1	
	measure the final mass of dry copper oxide		1	
	subtract the mass of dry copper oxide from the mass of copper oxide added		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.4	(M_r of CuO = 63.5 + 16 =) 79.5		1	AO2 4.5.2.4
	(moles of CuO =) $\frac{2.4}{79.5}$	allow correct use of incorrectly calculated value of M_r of CuO	1	
	= 0.0302 (mol)		1	
	(moles of ions = 0.0302 × 2 =) 0.0604 (mol)	allow correct use of incorrectly calculated value of moles of CuO	1	
	(number of ions =) $0.0604 \times 6.02 \times 10^{23}$	allow correct use of incorrectly calculated value of moles of ions	1	
	= 3.64×10^{22}	allow 3.63608×10^{22}	1	

Total Question 8		**16**

Question 9

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
09.1	$198 = 5.5 \times a$ $a = \frac{198}{5.5}$ $a = 36\ (m/s^2)$ $36 = \frac{\Delta v}{0.25}$ $v = 9.0\ (m/s)$		1 1 1 1 1	AO2 4.7.1.6 4.7.1.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
09.2	the total momentum (of the ball and pins) before the collision is the same as the total momentum (of the ball and pins) after the collision (because) this is a closed system **or** (because) there are no external forces acting		1 1	AO1 4.7.1.8

Total Question 9		**7**

Question 10

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
10.1	l = 0.850 (m)		1	AO2
	0.102 = B × 6.00 × 0.850	allow a correct substitution of an incorrectly / not converted value of l	1	AO2
				AO2
	$B = \frac{0.102}{6.00 \times 0.850}$	allow a correct rearrangement using an incorrectly / not converted value of l	1	AO2
				AO1
	B = 0.0200	allow an answer consistent with their value of l	1	4.6.3.5
	Tesla / T		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
10.2	the direction of the force depends on the direction of the current		1	AO1 4.6.3.6
	the commutator reverses the direction of current through the coil		1	
	so the direction of the force reverses every half turn		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
10.3	current would only be in one direction	allow current no longer reverses	1	AO1 4.6.3.6
	so coil / motor would only rotate a quarter of a rotation **or** so coil / motor would only rotate 90°	allow for **1** mark only wires would become tangled	1	

Total Question 10		**10**