GCSE
COMBINED SCIENCE: SYNERGY
8465/3H

Higher Tier Paper 3 Physical Sciences

Mark scheme

June 2021

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216G8465/3H/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.

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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	(element) nitrogen (reason) any **one** from: • has an atomic number of 7 • has 7 electrons • has 7 protons	allow N MP2 dependent on MP1 being awarded allow has an electronic structure of 2,5	 1 1	AO2 4.5.1.1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.2	• 8 electrons on F **and** none on Na • Na^+ **and** F^- an answer of: can be awarded **2** marks	allow any combination of dots, crosses, circles or $e^{(-)}$ for electrons	1 1	AO2 4.6.2.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.3	(strong) electrostatic forces of attraction (between) oppositely charged ions		1 1 1	AO1 4.6.2.2 4.6.2.3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.4	high melting point		1	AO1 4.6.2.2 4.6.2.3

Total Question 1		**8**

Question 2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.1	0.05 (A)		1	AO3 4.7.2.2 RPA16

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.2	temperature of the wire		1	AO1 4.7.2.2 RPA16

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.3	potential difference = current × resistance **or** $V = IR$		1	AO1 4.7.2.2 RPA16

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.4	1.68 = 0.70 × R $R = \frac{1.68}{0.70}$ R = 2.4 (Ω)		1 1 1	AO2 4.7.2.2 RPA16

Question	Answers	Mark	AO/ Spec. Ref.
02.5	**Level 3**: The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 4.7.2.2 RPA16
	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 • length measured with a ruler • length varied by moving crocodile clips • current measured with an ammeter • potential difference measured with a voltmeter • calculate resistance for each length • record current and potential difference for a large number of different lengths • repeat readings of current and potential difference for each length • repeat readings and anomalies removed • ensure values of current are low to minimise heating of wire • ensure circuit is disconnected between readings **Level 3:** Measured quantities and equipment, including varying the length and a strategy to minimise errors.		

Total Question 2	**12**

Question 3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.1	noble gases		1	AO1 4.5.1.3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.2	(both have) complete outer energy levels	allow shell for energy level allow 8 electrons in the outer / second energy level allow 2 electrons in the innermost energy level	1	AO1 4.5.1.3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.3	(different) number of energy levels / shells	allow different (total) number of electrons allow neon is 2,8 **and** argon is 2,8,8	1	AO2 4.5.1.3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.4	(*y*-axis) melting point in ˚C **and** (*x*-axis) relative atomic mass all five points plotted correctly	 allow a tolerance of ± ½ a small square allow **1** mark for four points plotted correctly	1 2	AO2 4.5.1.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.5	the higher the relative atomic mass, the lower the melting point	allow converse allow going down Group 1 the melting point decreases ignore negative correlation	1	AO3 4.5.1.4

Total Question 3		**7**

Question 4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.1	(test) burning splint (result) (burns rapidly with) a pop sound		1 1	AO1 4.7.3.1 4.7.5.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.2	reduction electrons are gained (by the H^+)		1 1	AO2 4.7.3.1 4.7.5.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.3	(moles of $MgCl_2$ = moles of Mg = $\frac{0.72}{24}$ =) 0.03		1	AO2 4.5.2.3 4.5.2.4 4.5.2.5
	(M_r of $MgCl_2$ = 24 + (2 × 35.5) =) 95		1	
	(mass of $MgCl_2$ =) 0.03 × 95	allow correct use of incorrectly calculated value(s) of M_r of $MgCl_2$ and/or moles of $MgCl_2$	1	
	= 2.85 (g)		1	
	alternative approach:			
	(M_r of $MgCl_2$ = 24 + (2 × 35.5) =) 95 (1)			
	24 (g of Mg) gives 95 (g of $MgCl_2$) (1)	allow correct use of incorrectly calculated M_r of $MgCl_2$		
	(0.72 g of Mg gives) $\frac{0.72}{24}$ × 95 (g of $MgCl_2$) (1)			
	= 2.85 (g) (1)			

Total Question 4		**8**

Question 5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.1	phytomining does not involve digging / removal / disposal of rocks	allow converse	1	AO1
	any **one** from: • (so) less dust • (so) less waste • (so) less noise pollution • (so) less visual pollution • (so) less transport • (so) less carbon dioxide emitted	allow (so) conserves high grade ores ignore mining unqualified ignore cost unqualified	1	AO3 4.8.2.3
	alternative approach: high grade ores are scarce (so) they are conserved (2)			

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.2	grow plants to absorb copper compounds (from ground)		1	AO1 4.8.2.3
	(harvest and) burn the plants		1	
	the ash contains copper compounds		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.3	graphite is inert / unreactive		1	AO1 4.7.5.3 RPA21

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.4	copper chloride (the test is for) chlorine (gas)		1 1	AO3 4.7.5.3 4.7.5.4 RPA21

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.5	displacement (using scrap iron)	allow redox	1	AO1 4.8.2.3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.6	the mixture has a lower melting point (than pure aluminium oxide) (so) less energy is needed	 allow (so) less electricity is needed	1 1	AO1 4.8.2.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.7	oxygen is produced at the positive electrodes (so) oxygen reacts with the carbon / electrodes (so) carbon dioxide is produced (as a gas)		1 1 1	AO1 4.7.5.2 4.8.2.2

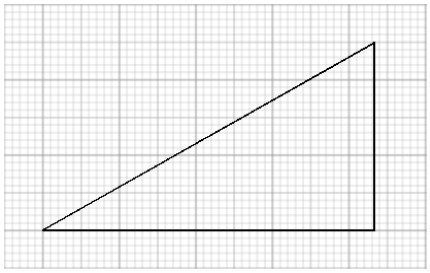
Total Question 5		**14**

Question 6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.1	weight = mass × gravitational field strength **or** *W* = *mg*		1	AO1 4.6.1.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.2	735 = m × 9.8 $m = \frac{735}{9.8}$ m = 75 (kg)		1 1 1	AO2 4.6.1.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.3	zero / 0		1	AO1 4.6.1.2 4.7.1.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.4	 vertical component = 2500 (N) horizontal component = 4330 (N)	tolerances to be set at pre-pre	1 1 1	AO1 AO2 AO2 4.6.1.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.5	the horizontal component of the force / 4330 (N) must be multiplied by the horizontal distance / displacement / 1000 m	allow ecf from question **06.4** this mark is dependent on scoring the first mark	1 1	AO1 4.6.1.3 4.6.1.2

Total Question 6		**10**

Question 7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.1	C_8H_{18}		1	AO2 4.8.1.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.2	any **one** from: • catalytic (cracking) • steam (cracking)		1	AO1 4.8.1.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.3	(cracking alkanes) produces small(er) alkanes	allow hydrocarbons / molecules for alkanes	1	AO1 4.8.1.4
	(and) small(er) alkanes are more useful as fuels	allow converse	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.4	(2 × 12) : (4 × 1) **or** 24 : 4		1	AO2 4.5.2.3
	= 6 : 1		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.5	diamond		1	AO1 4.8.1.1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.6	any **two** from: • hollow shapes • based on hexagonal rings (of carbon atoms) • (may also contain) rings with five or seven atoms • each atom bonds with three other atoms		2	AO1 4.8.1.1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.7	6 900 000 × 14 = 9.66 × 10^7 (nm) **or** 96 600 000 (nm)	 allow 9.7 × 10^7 (nm)	1 1	AO2 4.8.1.1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.8	contain delocalised electrons (and the electrons) move through the structure / nanotube	allow contain free electrons allow (so) electrons can carry charge through the structure / nanotube ignore throughout for through ignore current / electricity for charge	1 1	AO1 4.8.1.1

Total Question 7		**13**

Question 8

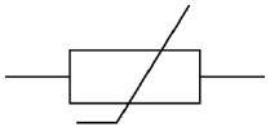
Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.1	a scalar quantity has magnitude only a vector quantity has both magnitude and direction		1 1	AO1 4.6.1.1 4.7.1.1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.2	displacement = 52 (km) direction = ~135˚ (°)		1 1	AO2 4.6.1.1 4.7.1.1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.3	(1250 × 5.0) = (1250 × 0.5) + (3000 × *v*) 6250 = 625 + 3000*v* 5625 = 3000*v* **or** $v = \frac{5625}{3000}$ *v* = 1.9 (m/s)	allow initial momentum of car = 1250 × 5.0 = 6250 (kgm/s) allow final momentum of car = 1250 × 0.5 = 625 (kgm/s) allow momentum of van = 6250 – 625 = 5625 (kgm/s) allow 1.875 (m/s)	1 1 1 1	AO2 4.7.1.8

Total Question 8		8

Question 9

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
09.1			1	AO1 4.7.2.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
09.2	between 50 and 100°C		1	AO3 4.7.2.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
09.3	t = 1200 (s)		1	AO2 4.7.2.8
	Q = 0.015 × 1200	this mark may score if t is not / incorrectly converted	1	4.7.2.1
	Q = 18 (C)	this mark may score if t is not / incorrectly converted	1	
	E = 18 × 15	this mark may score if t is not / incorrectly converted	1	
	E = 270 (J)	allow an answer consistent with their value of t	1	
	or			
	P = 0.015 × 15 (1)			
	P = 0.225 (W) (1)			
	t = 1200 (s) (1)			
	E = 0.225 × 1200 (1)			
	E = 270 (J) (1)			

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
09.4	P = 720 (W)		1	AO2 4.7.2.7
	$720 = 12^2 \times R$	this mark may score if P is not / incorrectly converted	1	
	$R = \frac{720}{12^2}$	this mark may score if P is not / incorrectly converted	1	
	R = 5.0 (Ω)	allow an answer consistent with their value of P	1	

Total Question 9		**11**

Question 10

Question	Answers	Mark	AO/ Spec. Ref.
10.1	**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	AO1 4.6.2.1 4.6.2.4 4.6.2.6
	Level 1: Relevant features are identified and differences noted.	1–2	
	No relevant content	0	
	Indicative content **Similarities** • strong bonds • bonding is between atoms • bonding involves outer shell electrons **Differences** • hydrogen has covalent bonding but copper has metallic bonding • hydrogen atoms share (pairs of) electrons but copper atoms share delocalised electrons • hydrogen has two atoms bonded together (in a small molecule) but copper has many atoms bonded together • copper electrons are free to move through the whole structure ignore properties to access **level 2** there must be a comparison of the bonding of both hydrogen and copper		

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
10.2	(energy needed to break bonds =) 2**Y** + 498	allow H–H for **Y**	1	AO2 4.7.4.5
	(energy released in forming bonds = 4 × 464 =) 1856		1	
	(bonds broken – bonds formed = energy released) 2**Y** + 498 –1856 = – 486	allow correct use of incorrectly calculated values from step 1 and/or step 2	1	
	(2**Y** =) 872		1	
	(**Y** =) 436 (kJ/mol)	allow correct use of incorrectly calculated value from step 4	1	

Total Question 10		**9**