# GCSE
# COMBINED SCIENCE: SYNERGY
# 8465/3H

Higher Tier Paper 3 Physical Sciences

**Mark scheme**

June 2021

Version: 1.0 Final Mark Scheme

2 1 6 G 8 4 6 5 / 3 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.

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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.

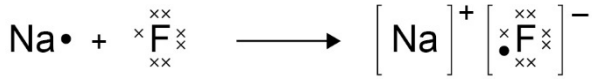
Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

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

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

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

| Question | Answers | Extra information | Mark | AO/ Spec. Ref. |
|---|---|---|---|---|
| **01.4** | high melting point | | 1 | AO1<br>4.6.2.2<br>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<br>4.7.2.2<br>RPA16 |

| Question | Answers | Extra information | Mark | AO/ Spec. Ref. |
|---|---|---|---|---|
| **02.2** | temperature of the wire | | 1 | AO1<br>4.7.2.2<br>RPA16 |

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

| Question | Answers | Extra information | Mark | AO/ Spec. Ref. |
|---|---|---|---|---|
| **02.4** | 1.68 = 0.70 × R<br><br>$R = \frac{1.68}{0.70}$<br><br>R = 2.4 (Ω) | | 1<br><br>1<br><br>1 | AO2<br>4.7.2.2<br>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**<br>• length measured with a ruler<br>• length varied by moving crocodile clips<br>• current measured with an ammeter<br>• potential difference measured with a voltmeter<br>• calculate resistance for each length<br>• record current and potential difference for a large number of different lengths<br>• repeat readings of current and potential difference for each length<br>• repeat readings and anomalies removed<br>• ensure values of current are low to minimise heating of wire<br>• ensure circuit is disconnected between readings<br><br>**Level 3:**<br>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<br><br>allow 8 electrons in the outer / second energy level<br>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<br>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<br><br>all five points plotted correctly | <br><br>allow a tolerance of ± ½ a small square<br>allow **1** mark for four points plotted correctly | 1<br><br>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<br><br>allow going down Group 1 the melting point decreases<br><br>ignore negative correlation | 1 | AO3<br>4.5.1.4 |

| | | |
|---|---|---|
| **Total Question 3** | | **7** |

**Question 4**

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

| Question | Answers | Extra information | Mark | AO/ Spec. Ref. |
|---|---|---|---|---|
| **04.2** | reduction<br><br>electrons are gained (by the $H^+$) | | 1<br><br>1 | AO2<br>4.7.3.1<br>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:<br>• (so) less dust<br>• (so) less waste<br>• (so) less noise pollution<br>• (so) less visual pollution<br>• (so) less transport<br>• (so) less carbon dioxide emitted | allow (so) conserves high grade ores<br><br>ignore mining unqualified<br>ignore cost unqualified | 1 | AO3<br>4.8.2.3 |
| | **alternative approach:**<br>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<br>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<br>4.7.5.3<br>RPA21 |

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

| Question | Answers | Extra information | Mark | AO/ Spec. Ref. |
|---|---|---|---|---|
| **05.5** | displacement (using scrap iron) | allow redox | 1 | AO1<br>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)<br><br>(so) less energy is needed | <br><br>allow (so) less electricity is needed | 1<br><br>1 | AO1<br>4.8.2.2 |

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

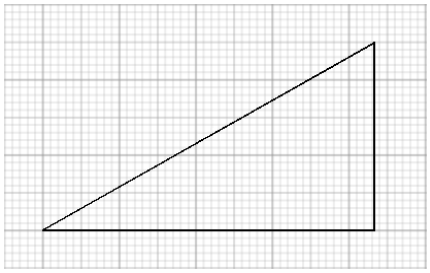
| **Total Question 5** | | **14** |
|---|---|---|

**Question 6**

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

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

| Question | Answers | Extra information | Mark | AO/ Spec. Ref. |
|---|---|---|---|---|
| **06.3** | zero / 0 | | 1 | AO1<br>4.6.1.2<br>4.7.1.5 |

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

| Question | Answers | Extra information | Mark | AO/ Spec. Ref. |
|---|---|---|---|---|
| **06.5** | the horizontal component of the force / 4330 (N)<br><br>must be multiplied by the horizontal distance / displacement / 1000 m | allow ecf from question **06.4**<br><br>this mark is dependent on scoring the first mark | 1<br><br>1 | AO1<br>4.6.1.3<br>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:<br>• catalytic (cracking)<br>• 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)<br>**or**<br>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:<br>• hollow shapes<br>• based on hexagonal rings (of carbon atoms)<br>• (may also contain) rings with five or seven atoms<br>• each atom bonds with three other atoms | | 2 | AO1<br>4.8.1.1 |

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

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

| | | |
|---|---|---|
| **Total Question 7** | | **13** |

**Question 8**

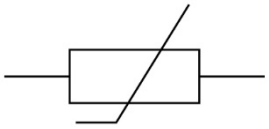
| Question | Answers | Extra information | Mark | AO/ Spec. Ref. |
|---|---|---|---|---|
| **08.1** | a scalar quantity has magnitude only<br><br>a vector quantity has both magnitude and direction | | 1<br><br>1 | AO1<br>4.6.1.1<br>4.7.1.1 |

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

| Question | Answers | Extra information | Mark | AO/ Spec. Ref. |
|---|---|---|---|---|
| **08.3** | (1250 × 5.0) =<br>(1250 × 0.5) + (3000 × *v*)<br><br>6250 = 625 + 3000*v*<br><br>5625 = 3000*v*<br>**or**<br>$v = \frac{5625}{3000}$<br><br>*v* = 1.9 (m/s) | allow initial momentum of car = 1250 × 5.0 = 6250 (kgm/s)<br><br>allow final momentum of car = 1250 × 0.5 = 625 (kgm/s)<br><br>allow momentum of van = 6250 – 625 = 5625 (kgm/s)<br><br>allow 1.875 (m/s) | 1<br><br>1<br><br>1<br><br>1 | AO2<br>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<br>4.6.2.1<br>4.6.2.4<br>4.6.2.6 |
| | **Level 1:** Relevant features are identified and differences noted. | 1–2 | |
| | **No relevant content** | 0 | |
| | **Indicative content**<br><br>**Similarities**<br>• strong bonds<br>• bonding is between atoms<br>• bonding involves outer shell electrons<br><br>**Differences**<br>• hydrogen has covalent bonding but copper has metallic bonding<br>• hydrogen atoms share (pairs of) electrons but copper atoms share delocalised electrons<br>• hydrogen has two atoms bonded together (in a small molecule) but copper has many atoms bonded together<br>• copper electrons are free to move through the whole structure<br><br>ignore properties<br><br>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)<br>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** |
|---|---|---|