AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.2.2.8

Metals as conductors

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**12**
Available paper years	**2007–2024**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.2.2.8 Metals as conductors

Answer 01 · Mark scheme

March 2007 | CHY1A | Original Q5 | Legacy

Five	**A**	aluminium	**4**
	B	calcium	**2**
	C	sodium	**1**
	D	zinc	**3**

4.2.2.8 Metals as conductors

Answer 02 · Mark scheme

June 2008 | CHY2H | Original Q7 | Legacy

question	answers	extra information	mark
7(a)	2.8.3 on diagram as Xs / dots **or** e	accept paired **or** unpaired	1
7(b)	any **two** from: • electrons in highest energy level **or** electrons in outer shell • electrons are delocalised **or** sea of electrons • electrons are free **or** electrons move around / flow • electrons carry charge / current	 ignore carry electricity	2
Total			**3**

4.2.2.8 Metals as conductors

Answer 02 · Mark scheme June 2008 | CHY2H | Original Q7 | Legacy

COMPONENT NUMBER: CHY2H

COMPONENT NAME: Additional Science / Chemistry

STATUS: Final

DATE: June 2008

Answer 03 · Mark scheme June 2009 | CHY1AP | Original Q4 | Legacy

Four	**3**	**3**	**4**	**1**

4.2.2.8 Metals as conductors

Answer 04 · Mark scheme

January 2010 | CHY2H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)	any **four** from:	max **3** marks if any reference made to covalent / ionic bonding / molecules **or** intermolecular forces **or** graphite / diamond **or** forces of attraction between electrons and then ignore throughout	4
	• giant structure / lattice	ignore layers	
	• positive ions		
	• sea of electrons **or** delocalised / free electrons	ignore electrons can move	
	• awareness of outer shell / highest energy level electrons are involved		
	• (electrostatic) attractions / bonds between electrons and positive ions		
	• bonds / attractions (between atoms/ ions) are strong	allow hard to break for strong ignore forces unqualified	
	• a lot of energy / heat is needed to break these bonds / attractions	ignore high temperature	

Question 4 continues on next page

CHY2H

Question 4 continued

question	answers	extra information	mark
4(b)(i)	that they are <u>very</u> small **or** 1–100 nanometres **or** a few (hundred) atoms	accept tiny / really small / a <u>lot</u> smaller / any indication of very small eg microscopic, smaller than the eye can see ignore incorrect numerical values if very small is given	1
4(b)(ii)	any **2** from: • one (non-bonded) electron from each atom • delocalised / free electrons • electron carry / form / pass current / charge	 allow sea of electrons ignore electrons can move ignore carry electricity	2
Total			**7**

4.2.2.8 Metals as conductors

Answer 04 · Mark scheme January 2010 | CHY2H | Original Q4 | Legacy

CHY2H

Answer 05 · Mark scheme June 2011 | CHY1AP | Original Q3 | Legacy

Three	**3**	**2**	**4**	**1**

4.2.2.8 Metals as conductors

Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(a)		first 3 marks can be obtained from a suitably labelled diagram incorrect structure or bonding or particle = max 3		AO1 2.1.h,i 2.2.4a
	giant structure / lattice / layers / close packed		1	
	made up of atoms / positive ions		1	
	with delocalized / free electrons		1	
	so electrons can move / flow through the metal	accept so electrons can carry charge through the metal accept so electrons can form a current	1	
3(b)		accept converse for pure metal throughout both marks can be obtained from suitable diagrams		AO1 2,2,4c
	an alloy (is a metal which) has different types / sizes of atoms	allow made of different metals allow mixture of metals / atoms / elements ignore particles ignore properties do **not** accept compound	1	
	alloy has distorted layers	allow layers are unable to slide	1	
3(c)(i)	can return to its original shape	accept shape memory alloy accept smart alloy ignore other properties	1	AO1 2.2.4d

Question 3 continues on the next page

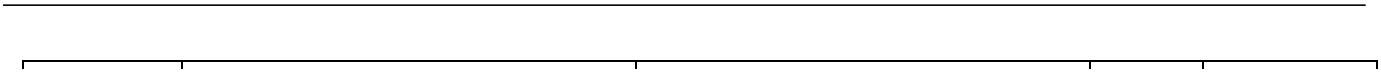
Question 3 continued

3(c)(ii)	(pure copper is too) soft	accept converse accept malleable or bends accept copper is running out ignore references to strength and weakness	1	**AO2** 2.2.4c 2.7.1d
3(c)(iii)	aluminium oxide	accept alumina accept Al_2O_3 ignore bauxite / aluminium ore	1	**AO1** 2.7.1h
3(c)(iv)	any **one** from: • different conditions • different catalyst • different pressure • different temperature	allow different concentration do **not** accept different monomers	1	**AO1** 2.2.5a
3(d)	any **two** from: • accurate • sensitive • rapid • small sample	both needed for 1 mark	1	**AO1** 2.3.2a
Total			**11**	

4.2.2.8 Metals as conductors

Answer 06 · Mark scheme

June 2015 | CH2HP | Original Q3 | Legacy



Answer 07 · Mark scheme

June 2017 | CH2HP | Original Q2 | Legacy

The full source mark scheme begins on page 21. Follow original question 2 in that document.

4.2.2.8 Metals as conductors

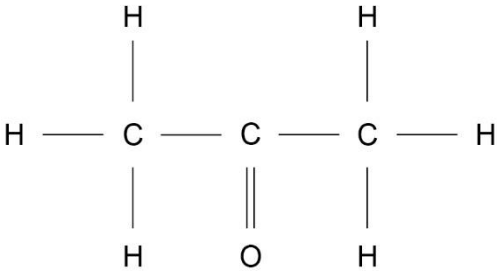
Answer 08 · Mark scheme

November 2021 | 8462/1H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	spherical	allow ball-shaped ignore round / circular	1	AO1 4.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	any **one** from: • drug delivery (round the body) • hydrogen storage • anti-oxidants • reduction of bacterial growth • catalysts • (cylindrical fullerenes for) strengthening materials • (spherical fullerenes for) lubricants		1	AO1 4.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3			1	AO2 4.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	C_3H_6O	allow CH_3COCH_3 allow elements in any order	1	AO2 4.2.1.4

Question 1 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	the intermolecular forces are weak		1	AO1 4.2.2.1 4.2.2.4

Question	Answers	Mark	AO/ Spec. Ref
01.6	**Level 3**: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.2.2.6 4.2.3.2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • bonds are covalent • giant / macromolecular structure • three (covalent) bonds per carbon atom **or** only three electrons per carbon atom used in (covalent) bonds • so one electron per carbon atom (is delocalised) • these delocalised electrons • can move through the structure • carrying (electrical) charge • so graphite conducts electricity • layered structure • of (interlocking) hexagonal rings • with weak (intermolecular) forces between layers **or** no (covalent) bonds between layers • so the layers can slide over each other • so graphite is soft and slippery		

Total			**11**

4.2.2.8 Metals as conductors

Answer 09 · Mark scheme

November 2021 | 8462/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	C		1	AO3 4.2.2.7 4.2.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(in an alloy) the atoms are of different sizes		1	AO1 4.2.2.7
	(so) the layers (of atoms in an alloy) are distorted		1	
	(so in an alloy) the layers slide over each other less easily (than in a pure metal)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	measure temperature change	allow measure the temperature before **and** after the reaction	1	AO1
	when each metal is added to silver nitrate solution		1	AO1
	same concentration / volume of solution **or** same mass / moles of metal	allow same initial temperature (of silver nitrate solution)	1	AO2
	the greater the temperature change the more reactive		1	AO3 4.4.1.2 4.5.1.1 RPA4

Total			8

4.2.2.8 Metals as conductors

Answer 10 · Mark scheme

June 2022 | 8462/1H | Original Q1

Question 1

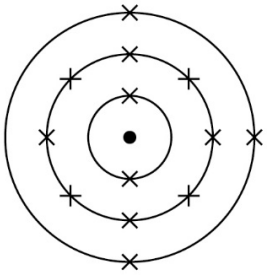
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	D		1	AO3 4.1.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	B		1	AO3 4.1.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	any **two** from: (Group 1 elements) • have lower melting / boiling points • have lower densities • are less strong • are softer	allow converse statements for transition elements allow (Group 1 elements are) more malleable / ductile allow (Group 1 elements) are not useful as catalysts ignore transition elements form coloured compounds ignore transition elements form ions with different charges ignore references to chemical properties	2	AO1 4.1.3.1 4.1.3.2

4.2.2.8 Metals as conductors

Answer 10 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4		allow any combination of x, •, o, $e^{(-)}$ for electrons	1	AO2 4.1.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	delocalised electrons	allow free electrons	1	AO1 4.2.1.5 4.2.2.8
	(the electrons) carry (electrical) charge	ignore current / electricity for charge	1	
	(the electrons move) through the metal / aluminium / structure	ignore throughout for through	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	ionic		1	AO1 4.2.1.1

4.2.2.8 Metals as conductors

Answer 10 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	magnesium (atom) loses electrons		1	AO2 4.2.1.1 4.2.1.2
	oxygen (atom) gains electrons		1	
	two electrons (are transferred)		1	
	magnesium ions **and** oxide ions are formed	allow Mg^{2+} (ions) **and** O^{2-} (ions) are formed allow magnesium forms positive ions and oxygen forms negative ions allow (both) form a complete outer shell	1	

Total Question 1		13

4.2.2.8 Metals as conductors

Answer 11 · Mark scheme

June 2023 | 8462/1H | Original Q6

Question 6

Question	Answers	Mark	AO/ Spec. Ref
06.1	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	3–4	AO3 4.2.2.7 4.2.2.8 4.4.1.2
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content **relevant points** • silver is the best electrical conductor • aluminium is the least dense • aluminium is the least expensive • copper is a better conductor than aluminium **or** copper is almost as good a conductor as silver • copper is much less expensive than silver • overhead power cables need a low density metal • wiring in homes needs to be affordable • printed circuit boards only require small amounts of material **judgements** • use aluminium for overhead wires because of aluminium's low density and/or lower cost • use copper for domestic wiring because copper is a very good conductor and not too expensive • use silver only for small uses such as circuit boards due to high cost • copper is a good compromise between electrical conductivity and cost		

4.2.2.8 Metals as conductors

Answer 11 · Mark scheme

June 2023 | 8462/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(metals have) delocalised electrons		1	AO1 4.2.1.5 4.2.2.8
	the electrons carry (electrical) charge	ignore current / electricity for charge	1	
	the electrons move through the structure / metal	ignore throughout for through	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	in alloys different sized atoms distort the layers / structure		1	AO3 4.2.2.7 4.2.2.8
	(so) the movement of (delocalised) electrons is restricted		1	

Total Question 6	9

4.2.2.8 Metals as conductors

Answer 12 · Mark scheme

June 2024 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(thermal) energy is transferred by delocalised electrons	allow heat is transferred	1 1	AO1 4.2.1.5 4.2.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2		allow (positive / metal) ions for atoms throughout		AO1 4.2.2.7
	(the alloy / mixture has) different sized atoms		1	
	(so the) layers are distorted		1	
	(so the) layers cannot easily slide	allow (so the) atoms cannot slide over each other	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	$2\,Fe + 3\,Cl_2 \rightarrow 2\,FeCl_3$		1	AO2 4.3.1.1 4.3.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	$1\ Fe^{2+} : 2\ Fe^{3+} : 4\ O^{2-}$		1	AO2 4.4.2.2

4.2.2.8 Metals as conductors

Answer 12 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	(M_r Fe_3O_4 =) 232		1	AO2 4.3.1.2
	(% Fe =) $\frac{3 \times 56}{232} \times 100$	allow $\frac{168}{232} \times 100$ allow correct use of an incorrectly determined M_r using the values of A_r given in the question	1	
	= 72.4 (%)	allow 72.41379 correctly rounded to at least 2 significant figures	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6		a maximum of **4** marks can be awarded for a method which determines and uses the volume of iron oxide as a gas		AO2 4.3.2.1 4.3.2.2
	(40.0 kg =) 40 000 (g)		1	
	(moles Fe_2O_3 = $\frac{40\,000}{160}$ =) 250	allow correct use of an incorrectly converted or unconverted mass	1	
	(moles CO_2 = 250 × $\frac{3}{2}$ =) 375	allow correct use of an incorrectly determined number of moles of Fe_2O_3	1	
	(volume of CO_2 =) 375 × 24	allow correct use of an incorrectly determined number of moles of CO_2	1	
	= 9000 (dm^3)		1	

Total Question 7	15

4.2.2.8 Metals as conductors

GCSE

Additional Science / Chemistry

CH2HP
Final Mark scheme

4408 / 4402
June 2017

Version/Stage: v1.0

4.2.2.8 Metals as conductors

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 Assessment Writer.

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.

Further copies of this mark scheme are available from aqa.org.uk

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MARK SCHEME – GCSE ADDITIONAL SCIENCE / CHEMISTRY – CH2HP – JUNE 2017

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 and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded
- 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.

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

4.2.2.8 Metals as conductors

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, 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

Full marks can be given for a correct numerical answer, without any working shown. However, if the answer is incorrect, mark(s) can be gained by correct substitution/working and this is shown in the 'extra information' column or by each stage of a longer calculation.

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 are 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 Accept/allow

Accept is used to indicate an equivalent answer to that given on the left-hand side of the mark scheme. Allow is used to denote lower-level responses that just gain credit.

3.9 Ignore/Insufficient/Do not allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain a marking point. Any further correct amplification could gain the marking point.
Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

4 Quality of Written Communication and levels marking

In Question 2 students are required to produce extended written material in English, and will be assessed on the quality of their written communication as well as the standard of the scientific response.

Students will be required to:
- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level:

Level 1: Basic

- Knowledge of basic information.
- Simple understanding.
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail.
- The spelling, punctuation and grammar are very weak.

Level 2: Clear

- Knowledge of accurate information.
- Clear understanding.
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given.
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: Detailed

- Knowledge of accurate information appropriately contextualised.
- Detailed understanding, supported by relevant evidence and examples.
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately.
- The answer shows almost faultless spelling, punctuation and grammar.

4.2.2.8 Metals as conductors

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	a smooth curve through or close to all points except (30,12)		1	AO2 2.4
1(a)(ii)	correct reading from the curve in 1(a)(i) (cm^3)	allow a tolerance of +/- 0.5 cm^3	1	AO2 2.4
1(a)(iii)	45-50 (seconds)		1	AO3 2.4
1(a)(iv)	line becomes less steep because gas is produced more slowly	ignore line levels out or plateaus allow examples with figures, eg 12 cm^3 gas from 0 to 20s but 1.5 cm^3 gas in last 20s ignore reaction has stopped or no more gas produced	1 1	AO3 2.4
1(a)(v)	0.6 (cm^3 per second)	allow 0.55 to 0.65	1	AO2 2.4
1(b)(i)	 temperature volume (of hydrogen peroxide)	concentration of hydrogen peroxide = max **1** ignore amount (of hydrogen peroxide)	 1 1	AO3 2.4
1(b)(ii)	 rate increases because more particles (in the same volume) so frequency of collisions increases	incorrect reference to energy = max **2** accept particles closer together allow greater chance of collisions ignore more collisions	 1 1 1	AO1 2.4.1e

4.2.2.8 Metals as conductors

1(c)	(increasing the amount of catalyst) increases rate same final volume of gas	accept steeper graph or graph levels off earlier	1 1	**AO2** 2.4.1g
Total			**13**	

4.2.2.8 Metals as conductors

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>2</td><td></td><td></td><td>6</td><td rowspan="6">AO1
2.1.1h
2.2.4b,c
2.2.5a,b</td></tr>
<tr><td colspan="4">Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a ‘best-fit’ approach to the marking.</td></tr>
<tr><td colspan="4"><table>
<tr><th>0 marks</th><th>Level 1
(1–2 marks)</th><th>Level 2
(3–4 marks)</th><th>Level 3
(5–6 marks)</th></tr>
<tr><td>no relevant information given</td><td>a statement about the structure or a property of a metal
or
a statement about the structure or a property of a polymer</td><td>a statement about the structure or a property of a metal
and
a statement about the structure or a property of a polymer</td><td>a statement about the structure or a property of a metal
and
a statement about the structure or a property of a polymer
and
at least one statement linking structure and property</td></tr>
</table></td></tr>
<tr><td colspan="4">Statements shown as HT only are credited on both FT and HT.
However, HT only means that these statements are not expected in a FT answer.</td></tr>
<tr><td colspan="4">Examples of chemistry points made in response

Metal:

Properties
shiny
hardness
(tensile) strength
melting point/boiling point
density
malleable/flexible
ductile
conduct electricity or thermal energy</td></tr>
</table>

4.2.2.8 Metals as conductors

Structure • metals contain atoms /((positive) ions HT only) • (the atoms/(positive) ions/particles are) closely packed / in a regular pattern / in a giant structure/in layers / in a lattice • strong bonds/(electrostatic attractions HT only) • (metal has delocalised electrons HT only) **Polymer:** **Properties** • flexible • melting/boiling point • density • can be shaped/moulded • poor conductor of electricity or thermal energy **Structure** • polymer consists of chains • polymer chains may be tangled • polymer has no cross links. • (polymer has weak intermolecular forces HT only) **Level 3:** **Examples of linked statements:** • metal can be bent and shaped because the layers can slide • some metals are soft because layers can slide • some metals are hard because they have strong bonds and/ or (the atoms/(positive) ions/particles) are closely packed / in a regular pattern / in a giant structure/ in a lattice • metal has high melting/boiling point because they have strong bonds and/ or (the atoms/(positive) ions/particles) are closely packed / in a regular pattern / in a giant structure / in a lattice • metal is strong because of strong bonds • some metals are dense because the atoms are closely packed • (metal can conduct thermal energy and electricity because metal has delocalised electrons HT only) • thermosoftening polymer melts when heated because it has no cross-links (or has weak intermolecular forces HT only) • thermosoftening polymer is flexible because the chains can move over each other	

Total			**6**

4.2.2.8 Metals as conductors

Question	Answers	Extra Information	Mark	AO / Spec. Ref
3(a)(i)	2 bonding pairs 4 unbonded electrons on each atom	accept dots, crosses, e, - or any combination ignore any electrons on any inner shells if no other mark awarded allow **1** mark for 1 bonding pair and 6 unbonded electrons on each atom	1 1	**AO2** 2.1.1g
3(a)(ii)	covalent	allow convalent and covelant ignore single or double ignore shared, shared bond or sharing	1	**AO1** 2.1.1g
3(a)(iii)	weak intermolecular forces require little energy to overcome	reference to weak covalent or weak ionic bonds = **0** accept weak intermolecular bonds MP2 dependent on MP1 if no other mark awarded allow 1 mark for simple/small molecules	1 1	**AO1** **AO2** 2.2.1a,b

4.2.2.8 Metals as conductors

3(b)(i)	**2** Mg + O_2 → **2** MgO	accept multiples	1	**AO2** 2.2.2
3(b)(ii)		reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max **2**		**AO1** **AO2** 2.1.1a,b,c,f
	magnesium loses (electrons) **and** oxygen gains (electrons)		1	
	two (electrons transferred)		1	
	noble gas structure **or** 8 electrons in outer shells **or** (electrostatic) attraction between ions **or** forms ionic bonds	accept full outer shell (of electrons)	1	
3(b)(iii)	particles 1-100 nm in size	accept contain a few hundred atoms/ions accept have a high surface area to volume ratio ignore reference to (very) small particles do **not** accept smaller than an atom/ion	1	**AO1** 2.2.6a

4.2.2.8 Metals as conductors

3(c)	has a high melting point	allow will not melt allow a lot of energy needed to melt ignore boiling point reference to incorrect particles or incorrect bonding or incorrect structure = max **1** from MP2 and MP3	1	**AO1** **AO2** 2.2.3a
	because all atoms linked to other atoms	allow giant structure/lattice ignore many bonds	1	
	by covalent bonds	allow strong bonds allow a lot of energy needed to break bonds accept giant covalent structure for MP2 and MP3	1	
Total			**13**	

4.2.2.8 Metals as conductors

Question	Answers	Extra Information	Mark	AO / Spec. Ref
4(a)	add copper oxide and (sulfuric) acid		1	**AO1** **AO2** 2.6.1b,c
	excess (copper oxide)		1	
	filter (to remove excess)	ignore impurities	1	
	heat /boil / evaporate / leave (to crystallise)	do **not** accept to dryness	1	
4(b)	(M_r CuO =) 79.5		1	**AO2** 2.3.3c
	24.95/249.5 **or** 0.1 **OR** 79.5/249.5 **or** 0.3186…	allow ecf for M_r CuO from step 1 allow correct rounding to min 2SF	1	
	(24.95/249.5 x 79.5=) 7.95	allow ecf for M_r CuO from step 1 allow ecf from step 2 of incorrect calculation/ rounding of correct ratio allow correct rounding to min 2SF correct answer with or without working gains 3 marks	1	
4(c)(i)	as wealth decreases, ethene production decreases (with the exception of country C or D)	accept converse	1	**AO2** **AO3** 2.6
	sulfuric acid production is not linked to wealth		1	

4.2.2.8 Metals as conductors

4(c)(ii)	use of products of ethene has increased	allow use of polymers / plastics / ethanol / poly(ethene) has increased ignore use of ethene as a (bio)fuel ignore cost	1	**AO3** 2.2.5
Total			**10**	

4.2.2.8 Metals as conductors

Question	Answers	Extra Information	Mark	AO / Spec. Ref
5(a)(i)	draw line on paper put (dots of) inks on line place (bottom of) paper in solvent / water any **one** from: line drawn in pencil allow dots of ink to dry line above solvent lid		1 1 1 1	**AO1** 2.3.2b
5(a)(ii)	any **two** from: • A has 3 colours **and** B has 4 colours • 2 colours are the same • **A** has 1 colour not in **B and B** has 2 colours not in **A**	accept 3 colours are different if no other mark awarded allow **one** more colour in ink **B** than in ink **A** (or converse)	2	**AO3** 2.3.2b
5(b)(i)	substances carried by gas through column / tube / coil (packed with solid) (different substances move through the column) at different speeds	 accept (different) substances come out at different times or have different retention times	1 1 1	**AO1** 2.3.2c
5(b)(ii)	(relative) molecular mass	allow (relative) formula mass allow RFM, RMM, M_r	1	**AO1** 2.3.2c
Total			**10**	

4.2.2.8 Metals as conductors

Question	Answers	Extra Information	Mark	AO / Spec. Ref
6(a)(i)	tick (✓) by: the initial temperature reading was too low		1	**AO3** 2.5
6(a)(ii)	the reaction is exothermic	allow energy is given out	1	**AO3** 2.5.1b
6(b)(i)	(positive/hydrogen) ions gain electrons hydrogen is below sodium in the reactivity series so hydrogen / H_2 is produced	accept (positive/hydrogen) ions are reduced accept reference to high reactivity of sodium If no other mark awarded allow hydrogen (and sodium) ions **or** positive ions are attracted to negative electrode for **1** mark	1 1 1	**AO1** **AO2** 2.7.1c,f,i
6(b)(ii)	**2** (Cl^-) → **Cl_2 + 2e^-**	must be completely correct allow multiples	1	**AO1** 2.7.1g
6(b)(iii)	solution is alkaline because sodium hydroxide / NaOH is produced **or** sodium hydroxide / NaOH is left over	accept hydroxide (ions) / OH^- is produced **or** hydroxide (ions) / OH^- is left over	1 1	**AO1** **AO2** 2.7.1i; 2.6.2d
Total			**8**	

4.2.2.8 Metals as conductors

Answer 08 · Examiner comments

November 2021 | 8462/1H | Original Q1

Question 1 (standard demand)

01.1 There were many good answers but some focused on the hexagonal arrangement of bonds rather than the molecule as a whole. Others did not appear to realise the shape is three dimensional and described the molecule as a circle.

01.2 Many students knew the uses as catalysts, for drug delivery round the body, as lubricants' and for strengthening other materials. There were, however, some vague answers such as 'in medicine'.

01.3 This was well done. A few students drew double bonds between all the atoms. Some students did not appear to realise that all they had to do was copy the positions of the atoms and replace each shared pair of electrons with a line.

01.4 This was answered well, although a number of students had two oxygen atoms in their formula. A few appeared to misunderstand the question and gave the relative formula mass.

01.6 Some students gave full, detailed accounts of both properties. The reasons for the slipperiness of graphite were better understood than its electrical conductivity, though many did not refer to the weakness of the forces between the layers. There was some poor use of language in the description of the structure, with atoms, molecules and ions being used interchangeably. A fairly common misconception is that there are gaps between the layers, allowing 'electricity' to somehow slip through. Many students did not seem to appreciate that the electric current is delocalised electrons themselves flowing through the structure.

4.2.2.8 Metals as conductors

Answer 09 · Examiner comments — November 2021 | 8462/1H | Original Q6

Question 6 (standard and standard / high demand)

06.2 This was poorly answered, with many instances of incorrect use of scientific terms. Some referred to molecules instead of atoms, different shapes instead of different sizes, and rows instead of layers. Many did not refer to the layers in a metal at all, merely referring to atoms, or a vague 'they' not being able to slide. Even those who did refer to layers rarely said those layers were distorted. There were many incorrect answers in terms of an incorrect type of bonding, and many thought that alloys are compounds.

06.3 Students were expected to do a simple comparison of the temperature change when each metal was added separately to silver nitrate solution. A control variable was needed for full marks to be awarded, as well as how the results would show which metal was the more reactive. Some students did not appear to know how to progress, with some trying to measure a temperature change while heating with a Bunsen burner, and some appearing to confuse reactivity with melting or boiling point. Of those students who did realise what was required, many spoiled their control variable by referring to the same 'amount' of a substance instead of volume, or concentration, or mass, as appropriate to the substance. Many students referred to temperature rather than temperature change. A few students tried to get round the fact that no other chemicals were available by making zinc nitrate and then seeing if Q would react with it. This approach could have worked but only if they had taken steps to ensure that all the silver nitrate had reacted before adding Q.

Answer 10 · Examiner comments — June 2022 | 8462/1H | Original Q1

Question 1 (Standard demand)

01.1 Students found this question challenging. It was expected that the lack of electrical conductivity and the low melting point would have suggested a non-metal and therefore section **D**. However, fewer than half of students gave this response, with distractors **A** and **C** both proving very attractive to students.

01.2 Nearly two thirds of students recognised element **R** as a transition metal and therefore in area **B**.

01.3 Fewer than 20% of students scored two marks, although more than half scored at least one mark. Students were asked to compare physical properties of Group 1 elements with transition elements. Many students gave chemical properties such as reactivity instead of physical properties. Others referred to atomic structure. Some students described a property of either a Group 1 element or a transition element without reference to the other.

01.4 Nearly all students could draw the electronic structure correctly.

01.5 The great majority of students referred to delocalised electrons in their answer. Many also referred to the electrons carrying charge. However, few articulated the idea that the electrons themselves move through the metal in a particular direction. Many implied that the movement was random by the use of words such as 'throughout' rather than 'through'. Some students incorrectly referred to electrons bumping into other atoms or electrons.

01.6 The great majority of students correctly identified the type of bonding.

4.2.2.8 Metals as conductors

Answer 10 · Examiner comments June 2022 | 8462/1H | Original Q1

01.7 The majority of students gave excellent descriptions of the transfer of two electrons from a magnesium atom to an oxygen atom to produce magnesium ions and oxide ions,with more than 80% scoring at least three marks. A few students showed a lack of understanding by subsequently referring to electrons being shared.

Answer 11 · Examiner comments June 2023 | 8462/1H | Original Q6

Question 6 (standard, standard/high and high demand)

06.1 Nearly a half of students gave Level 3 answers, nearly all of the others giving Level 1 responses. However, fewer than one in six students reached the top of Level 3.

4.2.2.8 Metals as conductors

Answer 11 · Examiner comments June 2023 | 8462/1H | Original Q6

In order to reach Level 3, at least one judgement was necessary. Many students misinterpreted the question and thought that just one metal should be used for all three uses, instead of selecting the best metal for each individual use. These students usually chose copper on the basis of its high electrical conductivity and low cost; these students were able to score 3 marks. The best answers gave reasoned judgements for all three uses, based on a consideration of cost and/or density for overhead cables, conductivity and cost for wiring in homes, and tiny amounts of material required for printed circuit boards. Many students did not realise the significance of the density in the selection of a metal for overhead power cables, and its lack of importance for the other uses. Some incorrectly related density to strength, malleability or other properties. Others stated that because 'the government' pays for overhead cabling, cost is not an issue.

Many students wasted time and space quoting actual figures from the table, which is unnecessary. 'Copper is nearly as conductive as silver but far cheaper' conveys the essential points without any actual figures. Examiners expect the students to analyse the figures and add value to the data given in a table.

06.2 Nearly a quarter of students gave fully correct answers, with most able to score at least one mark. The majority of students knew that electrical conductivity is due to delocalised electrons, and most referred to electrons as charge carriers. However, many merely referred to the movement of electrons as being 'throughout' the structure, meaning everywhere within it, rather than 'through' the structure, meaning a unidirectional movement (when a pd is applied) rather than random movement. Some students referred to electrons transferring charge from one to another; this is not correct.

06.3 Nearly a third of students scored at least one mark on this high demand question, which required the linking of two different areas of the specification. Students needed to link what they knew about alloys (distorted layers due to different sized atoms) to electrical conductivity, to suggest that the distorted layers would impede the flow of electrons. Some students seem to think that the atoms in an alloy have different shapes.

4.2.2.8 Metals as conductors

Answer 12 · Examiner comments — June 2024 | 8462/1H | Original Q7

Question 7 (standard, standard/high and high demand)

07.1 Only a quarter of students gained both marks, and a third did not score. Many students described how solids in general conduct thermal energy, rather than answering the question which is specifically about conduction in a metal. Many students realised that the process has something to do with delocalised electrons. However, many described how electricity is conducted, rather than thermal energy. The idea of the delocalised electrons transferring thermal energy through the metal was not at all well known. As the question asked how thermal energy is conducted, repetition of the word 'conduct' did not help to explain the meaning of that word.

07.2 This question discriminated well, with over a half of students scoring 2 or 3 marks. There were many well-expressed, complete answers. Common errors often involved an attempt to describe some sort of stronger bonding (sometimes covalent or ionic) in the alloy. Some lost credit because of poor use of language; it is not 'metals' which are different sizes, but their atoms (or positive ions). A common error was to refer to different shapes of atoms. 'Particles' is also insufficient as it could refer to other types of particle than atoms. 'Intermolecular forces' were often referred to, although they are not present in either a pure metal or an alloy.

07.3 Just over a half of students identified the correct equation, spotting that the mole ratio of Fe:Cl_2 was 2:3. The most popular distractor was Fe + Cl_2 → $FeCl_2$, where the student had ignored the information provided about the reacting number of moles.

07.4 Only two fifths of students identified the correct response by working out the total charge of the various combinations and choosing the one with a net zero charge. $3Fe^{2+}$:$4O^{2-}$ was a very popular distractor, with $3Fe^{3+}$:$4O^{2-}$ not far behind.

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Answer 12 · Examiner comments — June 2024 | 8462/1H | Original Q7

07.5 Over three quarters of students obtained full marks on this question. For those who did not, it was sometimes difficult to award any credit because the M_r had not been evaluated. Common errors were $56/M_r$ x 100 or $64/M_r$ x 100. Some students attempted to bring in the 0.12 and 0.18 from question **07.3**, which was about a different compound.

07.6 Those students who understand moles had little difficulty with this question; almost a half scored at least 4 marks. The most common error was a failure to convert the mass of Fe_2O_3 to grams. Some students attempted to calculate a volume of Fe_2O_3, not appreciating that it is a solid as shown by the state symbols in the equation. Some students unnecessarily calculated the mass of carbon dioxide before converting this to a volume. The mole ratio was sometimes applied incorrectly to the mass of Fe_2O_3. Despite being given the M_r of Fe_2O_3 as 160, many students used 320 instead. Whilst this sometimes led mathematically to the 'correct' answer, it is incorrect chemistry and full credit was therefore not awarded.