AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.5.2.2

Fuel cells

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**7**
Available paper years	**2009–2025**

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.

4.5.2.2 Fuel cells

Answer 01 · Mark scheme

June 2009 | CHY2F | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)(i)	gives out a large amount of energy only water produced / product is non polluting (owtte)	 allow it does not harm the environment	1 1
6(a)(ii)	does not explode / burst into flames owtte	ignore will not react	1
6(a)(iii)	hydrogen absorbed and released much faster	allow more efficient allow can store a larger amount	1
6(b)(i)	B		1
6(b)(ii)	a lithium atom loses an electron		1
6(b)(iii)	C		1
6(c)	reversible		1
6(d)(i)	much smaller		1
6(d)(ii)	surface area		1
Total			**10**

4.5.2.2 Fuel cells

Answer 01 · Mark scheme

June 2009 | CHY2F | Original Q6 | Legacy

CHY2F

4.5.2.2 Fuel cells

Answer 02 · Mark scheme June 2014 | CH3FP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
5(a)	electrical		1	1 / 3.3.1i	A
5(b)(i) **view with graph**	900	accept any answer between *840* and *960*	1	2 / 3.3	G
5(b)(ii)	any **one** from: • little demand • few hydrogen cars • *changeover from petrol to hydrogen will take time*	*allow answers in terms of petrol*	1	3 / 3.3	E
5(c)	X on rising section of *line*		1	2 / 3.3.1d	E
Total			**4**		

4.5.2.2 Fuel cells

Answer 02 · Mark scheme

June 2014 | CH3FP | Original Q5 | Legacy



Answer 03 · Mark scheme

June 2018 | 8462/1F | Original Q10

The full source mark scheme begins on page 13. Follow original question 10 in that document.

4.5.2.2 Fuel cells

Answer 04 · Mark scheme

June 2019 | 8462/1F | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	concentration (of solution / electrolyte) temperature (of solution / electrolyte)	 ignore room temperature allow volume (of solution / electrolyte) allow size of electrodes allow distance between electrodes do **not** accept electrode **X** unqualified do **not** accept (measured) voltage	1 1	AO3 4.5.2.1
04.2	(most reactive) magnesium zinc (least reactive) cobalt	allow Mg allow Zn allow Co	1	AO3 4.4.1.2 4.5.2.1
04.3	0 (volts) two different metals are needed to produce a voltage	 dependent on voltage being given as 0 volts allow the two electrodes are the same metal allow there is no difference in reactivity (between the electrodes)	1 1	AO3 4.5.2.1
04.4	connect cells (in series) use $\left(\frac{12}{1.5} =\right)$ 8 cells	ignore putting cells together	1 1	AO1 AO2 4.5.2.1
04.5	electric toy		1	AO3 4.5.2.1 4.5.2.2

4.5.2.2 Fuel cells

Question 4 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(advantage) any **one** from: • faster to refuel (than recharging) • can travel further (before refuelling) • hydrogen can be renewable • produces a constant voltage • no toxic chemicals released after disposal	allow lasts longer allow hydrogen is renewable allow the only product is water ignore no emissions	1	AO3 4.5.2.1 4.5.2.2
	(disadvantage) any **one** from: • hydrogen is made from fossil fuels • hydrogen is made from non-renewable resources • hydrogen is difficult to store • hydrogen is flammable / explosive • costs more to refuel (than recharging) • costs more to manufacture • not many hydrogen filling stations	ignore expensive unqualified	1	
Total			**10**	

4.5.2.2 Fuel cells

Answer 05 · Mark scheme

November 2020 | 8462/1F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	water	allow H_2O do **not** accept energy	1	AO1 4.1.1.1 4.5.2.2
03.2	W = energy X = activation energy Y = overall energy change Z = progress of reaction		1 1 1 1	AO1 4.5.1.2
03.3	to produce a potential difference		1	AO1 4.5.2.2
03.4	magnesium **and** copper (the metals) have the largest difference in reactivity		1 1	AO2 4.4.1.2 4.5.2.1
Total			**8**	

4.5.2.2 Fuel cells

Answer 06 · Mark scheme

November 2021 | 8462/1F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(zinc-carbon) cheap(est) (alkaline) long(est) lasting (nickel-metal hydride) rechargeable	 allow do not have to be thrown away	1 1 1	AO3 4.5.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	any **one** from: • (metal / alkaline waste) can be toxic / harmful / corrosive • (metal / alkaline waste) could cause pollution in landfill sites • recycling would save resources	allow (batteries) can ignite / explode ignore dangerous	1	AO3 4.5.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	copper and iron		1	AO2 4.5.2.1

Question 2 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	any **one** from: • temperature (of electrolyte / solution) • concentration (of electrolyte / solution)	ignore type of electrode / electrolyte allow size / mass / length of electrode allow surface area of electrode allow distance between electrodes allow volume of solution / electrolyte	1	AO3 4.5.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	hydrogen oxygen	allow H_2 allow O_2	1 1	AO2 4.5.2.2

Total			8

4.5.2.2 Fuel cells

Answer 07 · Mark scheme

June 2025 | 8462/1F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	sodium chloride solution		1	AO2 4.4.3.1 4.5.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(metal) **B** (reason) the two metals must be different (to produce a voltage)	 allow the voltage is 0.0 V MP2 is dependent upon the award of MP1	1 1	AO3 4.5.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(most reactive) **D** **A** **C** (least reactive) **B**		1	AO3 4.5.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(number of cells =) $\frac{14.4}{3.6}$ = 4		1 1	AO2 4.5.2.1

4.5.2.2 Fuel cells

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	water		1	AO1 4.5.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	reversed	ignore faster	1	AO1 4.5.2.1

Total Question 3	8

4.5.2.2 Fuel cells

AQA

GCSE
CHEMISTRY

8462/1F - PAPER 1 FOUNDATION TIER

Mark scheme

8462

June 2018

Version/Stage: 1.0 Final

4.5.2.2 Fuel cells

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 CHEMISTRY – 8462/1F – JUNE 2018

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 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

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 not accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

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.

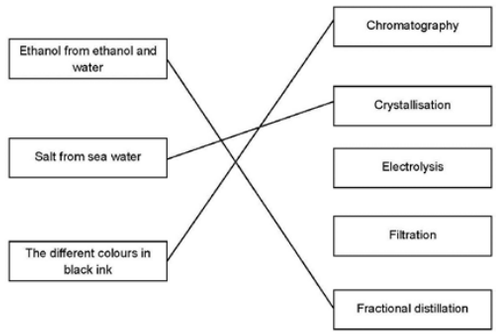
Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

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.

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1			1 1 1	AO1 4.1.1.2
01.2	include a (filter) funnel	allow funnel drawn on the diagram ignore clamp stand	1	AO3 4.1.1.2
01.3	evaporate condense	must be this order	1 1	AO1 4.1.1.2
01.4	$\frac{2}{20} \times 100$ = 10 (%)	an answer of 10 (%) scores **2** marks an answer of 11.1(%) **or** 90 (%) scores **1** mark	1 1	AO2 4.2.2.7
01.5	an alloy		1	AO1 4.2.2.7
01.6	the layers in the mixture are distorted		1	AO1 4.2.2.7

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	8000 nm^3		1	AO2 4.2.4.1
Total			**11**	

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	7		1	AO1 4.1.2.6
02.2	small molecule		1	AO2 4.1.2.6 4.2.2.4
02.3	F_2		1	AO1 4.1.1.1 4.1.2.6
02.4	the reactivity decreases (going down Group 7)	allow the reactivity decreases from chlorine to iodine	1	AO1 4.1.2.6
	(because) chlorine displaces bromine and iodine	allow (because) chlorine has two reactions allow (because) neither bromine nor iodine can displace chlorine	1	AO3 4.1.2.6
	(and) bromine displaces iodine **or** iodine does not react	allow (and) bromine has one reaction **or** iodine has no reactions allow (and) iodine cannot displace bromine	1	AO3 4.1.2.6
02.5	80		1	AO2 4.3.1.2

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	(1.2 kg =) 1200 (g) **or** (900 g =) 0.9 (kg)	an answer of 75 (%) scores **2** marks	1	AO2 4.3.3.1
	$(\frac{900}{1200} \times 100) = 75(\%)$ **or** $(\frac{0.9}{1.2} \times 100) = 75(\%)$	allow an answer correctly calculated from: $(\frac{900}{\text{incorrect attempt at conversion of 1.2}} \times 100)$ **or** $(\frac{\text{incorrect attempt at conversion of 900}}{1.2} \times 100)$	1	
Total			**9**	

4.5.2.2 Fuel cells

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	nucleus neutron neutron electron proton	must be in this order	1 1 1 1 1	AO1 4.1.1.3 4.1.1.4 4.1.1.5
03.2	(A_r) $\frac{(63 \times 70) + (65 \times 30)}{100}$ = 63.6	an answer of 63.6 scores **2** marks	1 1	AO2 4.1.1.6
03.3	copper / Cu	allow ecf from answer to question **03.2**	1	AO2 4.1.1.1
03.4	$\frac{1.2 \times 10^{-10}}{10\,000}$ **or** $1.2 \times 10^{-10} \times 1 \times 10^{-4}$ $= 1.2 \times 10^{-14}$ (m)	an answer of 1.2×10^{-14} (m) scores **2** marks a correct answer not in standard form scores **1** mark	1 1	AO2 4.1.1.5
Total			**10**	

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	3.6 (cm^3)		1	AO2 4.4.3.4
04.2	hydrogen line only		1	AO3 4.4.3.4
04.3	both lines		1	AO3 4.4.3.4
04.4	graphite has delocalised electrons		1	AO1 4.2.3.2
04.5	**cathode** zinc (1) **anode** chlorine (1) hydrogen (1) bromine (1)	do **not** accept chloride allow **1** mark if chlorine and zinc the wrong way around do **not** accept bromide allow **1** mark if bromine and hydrogen the wrong way around	1+1 1+1	AO2 4.4.3.2 4.4.3.4
Total			**8**	

4.5.2.2 Fuel cells

PMT

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	gas		1	AO1 4.2.2.2
05.2	the gas escapes	allow carbon dioxide escapes do **not** accept references to evaporation	1	AO1 4.3.1.3
05.3	5.12 (g)		1	AO2 4.3.1.3
05.4	4.00 (g) trial 1	allow 2.89 written in either space, or ringed in the table, unless contradicted by mass of copper carbonate or trial number	1	AO3 4.3.1.3
05.5	reheat (and reweigh) until constant mass	 an answer of heat to constant mass scores **2** marks if no other mark scored allow for **1** mark heat for longer **or** (heat at a) higher temperature **alternative approach**: (1) continue heating and pass gas through limewater (1) until the (lime)water stops bubbling **or** until the limewater no longer turns cloudy	1 1	AO3 4.3.1.3

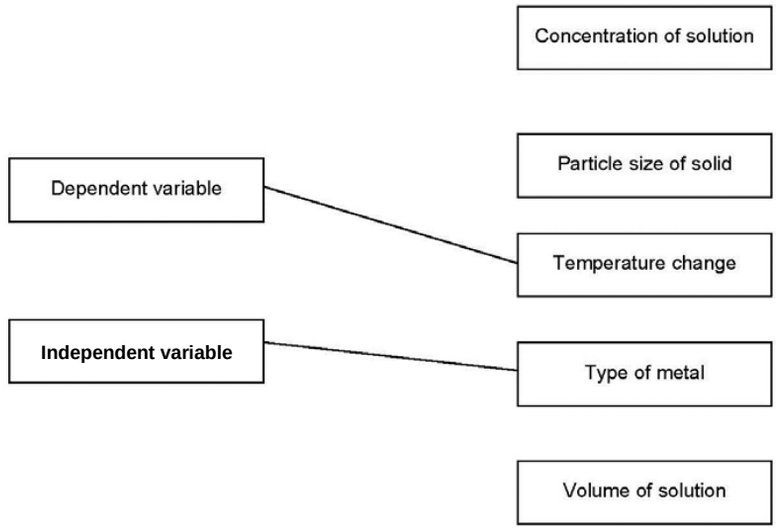
4.5.2.2 Fuel cells

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	straight line of best fit	must touch at least 5 of the 6 plots	1	AO2 4.3.1.3
05.7	correct value read from line of best fit in Figure 8	allow tolerance of ± ½ small square	1	AO2 4.3.1.3
05.8	(mass =) $168 \times \frac{\text{answer from question } \mathbf{05.7}}{8.4}$	a correctly calculated value from their answer to question **05.7** scores **2** marks allow (mass =) answer from question **05.7** × 20	1	AO2 4.3.1.3
	correctly calculated value (g)		1	
Total			**10**	

4.5.2.2 Fuel cells

PMT

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	 allow **one** mark if answers are reversed		1 1	AO1 4.5.1.1
06.2	polystyrene is a better insulator		1	AO3 4.5.1.1
06.3	both bars labelled both bars correctly plotted	 allow tolerance of ± ½ small square ignore width and spacing of bars if no other mark scored, allow **1** mark for any one bar correctly plotted and labelled	1 1	AO2 4.5.1.1

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	temperature increases **or** temperature does not decrease	ignore because it is exothermic allow (because) energy / 'heat' is transferred to the surroundings energy / 'heat' is not taken in from the surroundings allow the energy of the products is less than the energy of the reactants	1	AO3 4.5.1.1
06.5	(most reactive) magnesium (zinc) nickel	this order only	1	AO3 4.5.1.1 4.4.1.2
06.6	suitable method described the observations / measurements required to place in order an indication of how results would be used to place the unknown metal in the reactivity series **approaches that could be used:** **approach 1:** add the unknown metal to copper sulfate solution (1) measure temperature change (1) place the metals in order of temperature change (1)		1 1 1	AO3 4.4.1.2 4.5.1.1

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6 cont.	**approach 2:** add the metal to salt solutions of the other metals **or** heat the metal with oxides of the other metals (1) measure temperature change (only if salt solutions used) **or** observe whether a chemical change occurs (1) compare temperature change or whether there is a reaction to place in correct order (1) **approach 3:** add all of the metals to an acid (1) measure temperature change or means of comparing rate of reaction (1) place the metals in order of temperature change or rate of reaction (1) **approach 4:** set up electrochemical cells with the unknown metal as one electrode and each of the other metals as the other electrode (1) measure the voltage of the cell (1) place the metals in order of voltage (1)			
06.7	D		1	AO1 4.5.1.2
06.8	C		1	AO1 4.5.1.2
Total			**12**	

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	sodium oxide	allow Na_2O	1	AO2 4.1.1.1 4.1.2.5 4.4.1.1
07.2	oxidation		1	AO1 4.4.1.1
07.3	13		1	AO1 4.4.2.4
07.4	sodium hydroxide		1	AO2 4.1.1.1
07.5	OH^-		1	AO1 4.4.2.4
07.6	(volume =) $\frac{250}{1000}$ or ¼ or 0.25 (dm^3) **or** (mass per cm^3 =) $\frac{40}{1000}$ (g) or 0.04 (g) ($\frac{250}{1000}$ × 40 =) 10 (g)	an answer of 10 (g) scores **2** marks	1 1	AO2 4.3.2.5

4.5.2.2 Fuel cells

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.7	all points correct	allow a tolerance of ± ½ a small square allow **1** mark for 3 points correct ignore any attempt at a line of best fit	2	AO2 4.1.2.5
07.8	39 (°C)	allow any value from 34 to 46 (°C)	1	AO2 4.1.2.5
Total			**10**	

4.5.2.2 Fuel cells

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	any **one** from: • metal • (metal) hydroxide • (metal) carbonate • alkali	allow named example allow correct formula ignore base allow ammonium hydroxide allow ammonium carbonate allow soluble base allow ammonia	1	AO1 4.4.2.1 4.4.2.2 4.4.2.3
08.2	$Ca(NO_3)_2$	allow $Ca^{2+}(NO_3^-)_2$	1	AO2 4.4.2.2

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Mark	AO / Spec. Ref.
01.3	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 4.4.2.3
	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 • use magnesium oxide and sulfuric acid • add sulfuric acid to a beaker • warm sulfuric acid • add magnesium oxide • stir • continue adding until magnesium oxide is in excess • filter • using a filter paper and funnel • to remove excess magnesium oxide • heat solution in an evaporating basin • to crystallisation point • leave to crystallise • pat dry with filter paper credit may be given for diagrams		
Total		**8**	

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	FeS_2	do **not** accept equations	1	AO2 4.2.1.3
09.2	26 30 26	must be this order	1 1 1	AO2 4.1.1.4 4.1.1.5
09.3	any **two** from: • iron has a high(er) melting / boiling point • iron is dense(r) • iron is hard(er) • iron is strong(er) • iron is less reactive • iron has ions with different charges • iron forms coloured compounds • iron can be a catalyst	allow the converse statements for sodium allow transition metal for iron allow Group 1 metal for sodium ignore references to atomic structure ignore iron rusts allow iron is less malleable / ductile allow specific reactions showing difference in reactivity allow iron is magnetic	2	AO1 4.1.2.5 4.1.3.1 4.1.3.2

4.5.2.2 Fuel cells

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	carbon is more reactive (than nickel)	allow converse	1	AO1 4.4.1.2 4.4.1.3
	(so) carbon will displace / replace nickel (from nickel oxide) **or** (so) carbon will remove oxygen (from nickel oxide)	allow (so) nickel ions gain electrons allow (so) carbon transfers electrons to nickel (ions)	1	
09.5		an answer of 67.8 (%) scores **3** marks an answer of 67.8160919 (%) or correctly rounded answer to 2, 4 or more sig figs scores **2** marks an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps		AO2 4.3.3.2
	(total M_r of reactants =) 87		1	
	(percentage atom economy) $= \frac{59}{87} \times 100$	allow (percentage atom economy) $= \frac{59}{\text{incorrectly calculated } M_r} \times 100$	1	
	= 67.8 (%)	allow an answer from an incorrect calculation to 3 sig figs	1	
Total			**11**	

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	copper, zinc, sodium chloride solution		1	AO2 4.5.2.1
10.2	a reactant is used up	allow the reaction stops allow electrolyte / electrode / ions / metal / metal hydroxide / alkali for reactant	1	AO1 4.5.2.1
10.3	the reaction is not reversible		1	AO1 4.5.2.1
10.4	$2H_2 + O_2 \rightarrow 2H_2O$	allow fractions / multiples allow **1** mark for O_2	2	AO1 AO2 4.1.1.1 4.5.2.2

4.5.2.2 Fuel cells

MARK SCHEME – GCSE CHEMISTRY – 8462/1F – JUNE 2018

<table>
<tr><th>Question</th><th>Answers</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td rowspan="5">10.5</td><td>Level 3: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.</td><td>5–6</td><td>AO3</td></tr>
<tr><td>Level 2: Some logically linked reasons are given. There may also be a simple judgement.</td><td>3–4</td><td>AO3</td></tr>
<tr><td>Level 1: Relevant points are made. This is not logically linked.</td><td>1–2</td><td>AO2</td></tr>
<tr><td>No relevant content</td><td>0</td><td></td></tr>
<tr><td>Indicative content

reasons why fuel cells could be judged as better
<table>
<tr><th>from the table</th><th>from other knowledge</th></tr>
<tr><td>• time for refuelling a fuel cell is faster than recharging
or
a fuel cell does not need to be recharged
• a fuel cell has a greater range</td><td>• hydrogen can be renewable if made by electrolysis using renewable energy
• lithium-ion batteries can catch fire
• produces only water
or
no pollutants produced
• lithium-ion batteries may release toxic chemicals on disposal
• lithium-ion batteries (eventually cannot be recharged so) have a finite life</td></tr>
</table>
reasons why the lithium-ion battery could be judged as better
<table>
<tr><th>from the table</th><th>from other knowledge</th></tr>
<tr><td>• lithium-ion uses energy more efficiently
• cost of lithium-ion car much less
• cost of recharging much less than refuelling with hydrogen</td><td>• hydrogen is often made from fossil fuels so is not renewable
• charging points are more widely available than hydrogen filling stations
• hydrogen takes up a lot of space
or
is difficult to store
• hydrogen can be highly flammable / explosive
• no emissions produced
• (catalyst in the hydrogen fuel-cell eventually becomes poisoned so) have a finite life</td></tr>
</table></td><td></td><td>4.4.3.4
4.5.2.1
4.5.2.2</td></tr>
<tr><td>Total</td><td></td><td></td><td>11</td></tr>
</table>

Answer 03 · Examiner comments

Question 10 (standard demand)

10.1 54% of students recognised that there had to be two different metals, and that water alone would not be suitable as the electrolyte. The next most popular answer was 'zinc, zinc, water' which missed both of the essentials. A significant number of students ticked more than one box.

10.2 This is a new area of the specification and students found it difficult. 24% of students answered correctly. Many mixed up the answers to questions **10.2** and **10.3**, and many thought that charge, energy, or electrons run out.

10.3 11% of students achieved this mark. This question required students to demonstrate their knowledge of statements from the specification.

10.4 25% of students achieved both marks. Many realised that the missing reactant was oxygen, but were unable to write its formula correctly so lost both marks. A few achieved a single mark for writing the correct formula for oxygen without correctly balancing the equation.

10.5 This 'extended response' question discriminated well, with 51% of students scoring four or more marks. Many students limited themselves to level 2 as they just used the table, without bringing in any of their own knowledge, or failed to give a judgement on which method is better.

Many students wasted space quoting data from the table. A statement such as 'you can go further with a hydrogen fuel cell before stopping to refuel' is shorter, and gains more credit, than 'you can go 415 miles between refuelling with a hydrogen fuel cell car but 240 miles between recharges of a lithium-ion battery car'.

A lot of repetition was seen; once you have said that one thing is **more** expensive, you do not need to say that the other is cheaper. There were many vague statements about something being 'better for the environment' without saying how or why.

There was also some misinterpretation of the data on distance travelled per unit of energy. Some students thought this referred to energy per mile or something similar, so though incorrectly that the fuel cell was better.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

4.5.2.2 Fuel cells

Answer 04 · Examiner comments

June 2019 | 8462/1F | Original Q4

Question 4 (low and standard demand)

04.1 Students found the identification of control variables very difficult with almost two-thirds of students scoring 0 marks.

Students were quite often imprecise in their description of the control variables. The use of the word amount is unlikely to gain credit and students should be encouraged to use scientific terminology such as 'volume'.

The most common control variables given were the volume of solution and the concentration of solution.

04.2 Almost 90% of students were able to use the voltages to place the metals in the correct order of reactivity.

04.3 Students found this question difficult. Approximately 15% of students gained one mark for predicting that the voltage of the cell would be 0 V. Only 7% of students were then able to give a reason why the voltage would be 0V and score the second mark.

04.4 Approximately a half of students scored the mark for using 8 cells to make the battery. However, less than a quarter scored the mark for connecting them together. Alternative terms for 'connect' were often too imprecise.

04.5 Over 90% of students identified an electric toy as the most suitable use for a non-rechargeable cell.

04.6 Students found this question very difficult with almost two-thirds of students scoring 0 marks.

The most common correct responses were:

- lasts longer (advantage of hydrogen fuel cell)
- hydrogen is flammable / explosive (disadvantage).

A common misconception was that a hydrogen fuel cell is single use, often expressed as 'cannot be recharged'.

Responses that did not include sufficient detail to be credited included:

Answer 04 · Examiner comments

June 2019 | 8462/1F | Original Q4

- better for the environment
- cheaper
- more expensive (unqualified).

4.5.2.2 Fuel cells

Answer 07 · Examiner comments

June 2025 | 8462/1F | Original Q3

Question 3 (low and standard demand)

03.1 Two thirds of students were able to identify sodium chloride solution as the only possible electrolyte. Water was the more popular distractor, but a surprising number chose solid potassium bromide.

03.2 This was answered less successfully, with only an eighth of students scoring both marks. Even those who identified **B** as copper were often unable to give a correct reason for their choice. Many students chose **D** on the grounds that it has the highest voltage, completely missing the point that the two metals must be different in order to produce a voltage. Others suggested **D** on the grounds that it is a good conductor. A surprising number thought that a voltage of zero meant that the metal was a non-conductor. Those who did give the correct answer usually gave the reason that it does not produce a voltage, which was an acceptable alternative to the voltage being 0.0 V.

03.3 This was very well answered, with 5 sixths of students giving the correct order. A few reversed the order and some swapped **A** and **C**.

03.4 This was answered correctly by the vast majority of students. There was a multitude of ways of establishing that 4 cells were needed, rather than simply dividing the total voltage required by the voltage produced by one cell.

03.5 Fewer than a half of students knew that the product is water, with all three options being chosen many times.

03.6 Fewer than one in six students knew that the reaction would be reversed. 'Reversible' was also accepted. Most tried to answer in terms of endothermic or exothermic, without anything to base that choice on, and many gave the name of a substance, often ammonia, perhaps referring back to the previous question.