GCSE

COMBINED SCIENCE: TRILOGY

Higher Tier Chemistry Paper 2

Mark scheme Practice Paper Series – Set 2 SGC/S2/C/2H

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This mark scheme is an original resource written for sciencegcse.co.uk to accompany the Set 2 practice paper SGC/S2/C/2H. It is not an AQA mark scheme and has not been produced or endorsed by AQA. It follows the structure and conventions of AQA GCSE science mark schemes so that students and teachers can mark the practice paper in the same way that a real paper is marked.

Marking should be carried out using the Information to Examiners on the following pages. The paper has not been standardised, so raw marks should not be converted into grades using any published grade boundaries.

Specification references are to the AQA GCSE Combined Science: Trilogy (8464) specification, Chemistry section 5.6–5.10. AO = assessment objective; WS = working scientifically; MS = mathematical skills; RP = required practical.

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 answer(s) expected, including alternative acceptable wording, in the **Answers** column
- guidance on which answers are and are not creditworthy in the **Extra information** column
- the assessment objective (AO) and specification reference for each marking point.

Award marks positively. Do not deduct marks for incorrect additional material unless it contradicts a correct answer (see 3.1). Marks are awarded for what the student has written, not for what they might have meant.

2. Emboldening and underlining

2.1 Where a list of acceptable answers is given and more than one mark is available, **any two from** (or similar) is used, followed by the acceptable answers.

2.2 A bold **and** indicates that both parts of the answer are needed to gain the mark.

2.3 Alternative answers acceptable for the same mark are separated by **or**. Different words that are acceptable within a marking point are separated by a forward slash (/).

2.4 Words in bold in the Answers column are the essential words that must be present, or their equivalent, for the mark to be awarded.

3. Marking points

3.1 Marking of lists
When a fixed number of responses is requested but extra responses are given, consider the whole list. Each incorrect response or contradiction cancels one otherwise available correct response, up to the mark limit; the score cannot fall below zero. Neutral material identified by **ignore** does not cancel a correct response. Do not apply this rule as a penalty for extra relevant detail in an extended answer.

3.2 Marking procedure for calculations
A correct final answer can receive the marks indicated in the question-specific scheme without every intermediate step being written. Do not award full marks if the working shown contradicts that answer. Where the question specifically requires a method, demonstration or working, apply that requirement. Credit correct stages when the final answer is wrong, including consequential steps where permitted. A printed unit may only be replaced by another unit when the numerical value is converted consistently.

3.3 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.

3.4 Errors carried forward
Use an earlier incorrect value in a later part where ECF is allowed by the question-specific scheme. Within a calculation, credit later correct stages that use an earlier incorrect value consistently, subject to any stated limits. Do not repeatedly penalise the same error.

3.5 Phonetic spelling
Accept a misspelling when the intended scientific term is clear, including when a term is being recalled. Do not accept wording that could instead name a different scientific term.

3.6 Brackets
Words shown in brackets in the Answers column are not required to gain the mark but help to set the context.

3.7 Allow
Answers that are acceptable but which would not normally be expected are shown as **allow**.

3.8 Ignore
Statements shown as **ignore** are neither creditworthy nor penalised. Mark the rest of the answer normally.

3.9 Do not accept
Statements shown as **do not accept** are incorrect and, where they contradict or replace the expected answer, mean the mark is not awarded.

4. Level of response marking instructions

Extended-response questions (question 02.1 in this paper) are marked using a level of response mark scheme. The scheme has three levels, each covering two marks, plus a level descriptor and indicative content.

Step 1 – Determine a level. Read the whole answer and decide which level descriptor best fits it. Use a 'best-fit' approach: an answer does not need to meet every part of a descriptor to be placed in that level, and a weak part of the answer need not prevent it from reaching the higher level if the overall quality matches the descriptor.

Step 2 – Determine a mark within the level. Award the higher mark in the level if the answer meets the descriptor fully and the points made are well linked; award the lower mark if the answer only just meets the descriptor or contains minor errors or omissions.

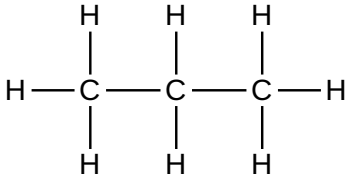
The indicative content is not a checklist: students need not include every point to reach the top level, and other relevant, correct points should be credited. An answer that lists points without linking them into a coherent answer should be placed in a lower level than one that develops and connects them.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	(in chemistry) a pure substance is a single element or compound (not mixed with any other substance)	allow made of only one substance	1	AO1 5.8.1.1
	honey contains more than one substance / is a mixture	allow honey contains different sugars and water ignore honey is natural	1	AO2 5.8.1.1
01.2	B		1	AO3 5.8.1.1 WS 3.5
	it melts over a range of temperatures / it melts below 169 °C	the reason mark depends on **B** being chosen allow **A** melts at the same temperature as pure paracetamol	1	AO3 5.8.1.1 WS 3.5
01.3	any **one** from: • fuels • cleaning agents • paints • alloys • fertilisers • foods	allow a named example, e.g. petrol, washing-up liquid, brass, steel do not accept medicines / tablets (given in the question) do not accept a pure substance, e.g. water	1	AO1 5.8.1.2
01.4	total mass = 560 (mg)	an answer of 89.3 (%) scores **2** marks	1	AO2 5.8.1.2 MS 1c
	500 ÷ 560 × 100 = **89.3** (%)	allow 89 (%) allow ECF from an incorrect total mass	1	AO2 5.8.1.2 MS 1c
01.5	the properties of a formulation depend on the amount / proportion of each substance	allow the quantities in a formulation are carefully measured	1	AO2 5.8.1.2
	doubling the binder changes the proportions, so the tablet would have different properties, e.g. it may not break up as quickly	allow the percentage of paracetamol in the tablet would decrease allow the tablet may release the medicine more slowly	1	AO2 5.8.1.2
		Total	**9**	

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>02.1</td><td>
<table>
<tr><td>Level 3
(5–6 marks)</td><td>A coherent method is described with relevant detail, which demonstrates a broad understanding of the techniques and procedures. The steps are in a logical order and would give valid results: the concentration is changed by mixing different volumes of the sodium thiosulfate solution with water to the same total volume, the same volume of acid is used, and the time for the cross to disappear is measured for each concentration.</td></tr>
<tr><td>Level 2
(3–4 marks)</td><td>The bulk of a method is described with mostly relevant detail. The method may not be in a completely logical order and may be missing some detail, for example how the concentration is changed or which variables are kept the same.</td></tr>
<tr><td>Level 1
(1–2 marks)</td><td>Simple statements are made about some of the steps, for example add acid to the sodium thiosulfate and time how long the cross takes to disappear. The response may lack a logical structure and would not give valid results.</td></tr>
<tr><td>0 marks</td><td>No relevant content.</td></tr>
</table>
</td><td></td><td>6</td><td>AO1
5.6.1.2
RP</td></tr>
<tr><td></td><td>Indicative content
• measure a volume of sodium thiosulfate solution with a measuring cylinder, e.g. 10 cm^3
• add water to make the total volume 50 cm^3
• put the mixture in the conical flask and put the flask on the cross
• measure a fixed volume of hydrochloric acid with a different measuring cylinder, e.g. 10 cm^3
• add the acid to the flask, swirl, and start the stopwatch at the same time
• look down through the mixture from above
• stop the stopwatch when the cross can no longer be seen
• repeat with different volumes of sodium thiosulfate solution, e.g. 10, 20, 30, 40 and 50 cm^3, each made up to 50 cm^3 with water
• keep the volume and concentration of the acid, the total volume, the temperature and the cross the same
• the same person should judge when the cross disappears
• repeat each concentration and calculate a mean time
• rinse the flask between experiments
• work in a well-ventilated room because sulfur dioxide is produced / wear eye protection
To reach Level 3 the method must change the concentration by dilution to the same total volume (or another valid way), keep the volume of acid the same and time how long the cross takes to disappear.</td><td></td><td></td><td></td></tr>
<tr><td>02.2</td><td>(29 + 31) ÷ 2</td><td>an answer of 30 (s) scores 2 marks</td><td>1</td><td>AO2
5.6.1.2
RP
MS 2b</td></tr>
</table>

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	= **30** (s)	an answer of 32.7 (the anomalous result included) scores 1 mark	1	AO2 5.6.1.2 RP MS 2b
02.3	point plotted correctly at (20, 60)	allow ± half a small square	1	AO2 5.6.1.2 RP MS 4a, 4c
	point plotted correctly at (40, 30)	allow ECF from 02.2 allow ± half a small square	1	AO2 5.6.1.2 RP MS 4a, 4c
	a smooth curve of best fit that passes through or close to all the points	do not accept points joined dot to dot or a straight line	1	AO2 5.6.1.2 RP MS 4a, 4c
02.4	(at a higher concentration) there are more (reacting) particles in the same volume	do not accept the particles move faster	1	AO1 5.6.1.3
	so the particles collide more frequently	allow more collisions per second / more successful collisions per second ignore more collisions unless linked to time	1	AO1 5.6.1.3
02.5	yes: the mean time for 50 g/dm^3 (25 s) is shorter than the mean time for 40 g/dm^3 (30 s)	allow ECF from 02.2	1	AO3 5.6.1.2 RP WS 3.5, 3.7
	the repeat results do not overlap (24–26 s and 29–31 s), supporting a difference in rate under these conditions	allow the difference between the means is bigger than the spread of the repeats ignore the anomalous result (38 s)	1	AO3 5.6.1.2 RP WS 3.5, 3.7
		Total	**15**	
03.1	plants / trees took in carbon dioxide (from the atmosphere) for photosynthesis	ignore algae	1	AO1 5.9.1.4
	their remains were buried and compressed over millions of years, forming coal	allow the plants died, were buried under sediment and turned into coal	1	AO1 5.9.1.4
03.2	moles of CH_4 = 8 000 000 ÷ 16 = 500 000 (mol)	an answer of 32 (tonnes) scores **3** marks allow the mass-ratio method: 16 tonnes of methane reacts with 2 × 32 = 64 tonnes of oxygen, so 8.0 × 64 ÷ 16	1	AO2 5.3.2.2 (HT) MS 1a, 1c
	moles of O_2 = 2 × 500 000 = 1 000 000 (mol)		1	AO2 5.3.2.2 (HT) MS 1a, 1c

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	mass of O_2 = 1 000 000 × 32 = 32 000 000 g = **32** (tonnes)	allow ECF from earlier steps an answer of 16 (tonnes) (2 : 1 ratio not used) scores 2 marks	1	AO2 5.3.2.2 (HT) MS 1a, 1c
03.3	carbon dioxide released for each MJ of energy from methane = 2.75 ÷ 55 = 0.050 (kg)	the energy for each kg of carbon dioxide (methane 20 MJ, coal 10.7 MJ) scores both of the first two marks allow any other comparison for the same energy, e.g. 55 MJ from coal releases 5.1 kg of carbon dioxide compared with 2.75 kg from methane	1	AO2 5.9.2.4 MS 1a
	carbon dioxide released for each MJ of energy from coal = 2.80 ÷ 30 = 0.093 (kg)	allow 0.0933 / 0.09	1	AO2 5.9.2.4 MS 1a
	so methane releases about half (54%) as much carbon dioxide as coal for the same energy: the statement is approximately correct / slightly overstated	allow ECF from incorrect values the conclusion must be based on a comparison for the same energy a conclusion based only on the mass of carbon dioxide for each kg of fuel (2.75 kg and 2.80 kg) does not score this mark	1	AO3 5.9.2.4
03.4	less carbon dioxide enters the atmosphere, reducing the enhanced greenhouse effect	allow less infrared radiation is absorbed by carbon dioxide in the atmosphere ignore carbon dioxide is stored underground on its own (given in the question)	1	AO2 5.9.2.1, 5.9.2.4
		Total	**9**	
04.1	any **three** from: • the crude oil is heated so that it evaporates / vaporises • the vapours rise up the column • the column is hotter at the bottom and cooler at the top • the fractions condense at different heights / when they cool below their boiling points • hydrocarbons with similar boiling points / similar numbers of carbon atoms condense together • substances with very high boiling points (bitumen) do not evaporate and leave at the bottom	ignore references to cracking	3	AO1 5.7.1.2
04.2	fuel oil molecules are larger / have longer carbon chains	allow fuel oil molecules have more carbon atoms	1	AO1 5.7.1.3 5.2.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	so the intermolecular forces (between fuel oil molecules) are stronger and need more energy to overcome	allow forces between the molecules do not accept covalent bonds break / stronger bonds	1	AO1 5.7.1.3 5.2.2.4
04.3		all the atoms and all the bonds must be shown allow bonds drawn at an angle	1	AO1 5.7.1.1
04.4	the hydrocarbons are vaporised		1	AO1 5.7.1.4
	the vapour is passed over a hot catalyst	allow a heated catalyst such as aluminium oxide	1	AO1 5.7.1.4
	the large molecules split into smaller molecules, producing alkanes and alkenes	allow shorter-chain hydrocarbons including unsaturated hydrocarbons	1	AO1 5.7.1.4
		Total	**9**	
05.1	any **two** from: • giving values to the effects of pollutants needs value judgements / is subjective • some values are difficult to measure or estimate • an LCA may include only some of the stages (selective / abbreviated LCA) • an LCA can be used to support a claim, e.g. in advertising	ignore LCAs are expensive	2	AO1 5.10.2.1
05.2	energy for one paper cup = 350 + 200 + 20 = 570 (kJ)	an answer of 40 scores **3** marks	1	AO2 5.10.2.1 MS 1a, 3d
	energy for a mug used *n* times = 15 300 + 180*n* / energy saved on each use = 570 − 180 = 390 (kJ)		1	AO2 5.10.2.1 MS 1a, 3d
	15 300 ÷ 390 = 39.2, so the minimum number of uses is **40**	an answer of 39 or 39.2 scores 2 marks allow a correct trial-and-improvement method, e.g. 40 uses: mug 22 500 kJ, paper cups 22 800 kJ allow ECF from an incorrect total for one paper cup or for the one-off energy of the mug	1	AO2 5.10.2.1 MS 1a, 3d

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	any **three** from: • the statement is only true if each mug is used at least 40 times / a mug that breaks or is lost sooner is worse • washing uses water and detergents / produces waste water, which is not included in the table • the table only compares energy, not other impacts, e.g. use of raw materials or pollution • paper cups are made from a renewable resource (wood) • broken ceramic mugs cannot easily be recycled / go to landfill • a justified conclusion, e.g. mugs are better only if they are reused many times	max 2 marks if no justified conclusion is given ignore paper cups can be recycled / composted, unless qualified (most cups have a plastic lining)	3	AO3 5.10.2.1
		Total	**8**	
06.1	water that is safe to drink	allow drinking water do not accept pure water	1	AO1 5.10.1.2
06.2	any **four** from: • reverse osmosis needs less energy (4 kWh compared with 18 kWh for each m^3) • reverse osmosis turns a greater percentage of the sea water into potable water (45% compared with 25%) • distillation gives water with a lower concentration of dissolved salts (20 compared with 250 mg/dm^3) • but both methods give water below the limit of 500 mg/dm^3, so both are suitable • distillation can use waste heat from a power station, so it may not need extra fuel • the membranes for reverse osmosis must be replaced, which costs money / produces waste • a justified conclusion, e.g. reverse osmosis is better unless waste heat is available	to gain all 4 marks, both methods must be considered and data from the table must be used max 3 marks if no justified conclusion is given	4	AO3 5.10.1.2
06.3	900 ÷ 0.45 / 900 × 100 ÷ 45	an answer of 2000 (m^3) scores **2** marks	1	AO2 5.10.1.2 MS 1c
	= **2000** (m^3)		1	AO2 5.10.1.2 MS 1c

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	50 cm^3 of the water contains only 12.5 mg (0.0125 g) of dissolved salts, which is too small a mass to measure accurately with this balance	allow the mass of solid would be about 0.01 g, so the percentage error would be very large	1	AO3 5.10.1.2 RP WS 2.7, 3.7
	evaporate a much larger volume of water, e.g. 1 dm^3 / use a more precise balance (e.g. to 0.001 g)		1	AO3 5.10.1.2 RP WS 2.7, 3.7
		Total	**9**	
07.1	a tangent drawn to the curve at 100 s		1	AO2 5.6.1.1 (HT) MS 4e, 1b
	gradient calculated from the tangent (change in amount ÷ change in time)		1	AO2 5.6.1.1 (HT) MS 4e, 1b
	2.5×10^{-3} to 3.3×10^{-3} (mol/s)	the answer must be in standard form for this mark a line that crosses the curve at 100 s is not a tangent	1	AO2 5.6.1.1 (HT) MS 4e, 1b
07.2	(dynamic) equilibrium has been reached	do not accept the reaction has stopped	1	AO1 5.6.2.3
	the forward and reverse reactions happen at the same rate	allow hydrogen iodide is made at the same rate as it decomposes	1	AO1 5.6.2.3
07.3	a line that starts at the origin, is steeper at the start and levels off sooner		1	AO2 5.6.2.6 (HT) 5.6.1.2
	the line levels off at a lower amount of hydrogen iodide (below 0.78 mol)	do not accept a line that levels off higher	1	AO2 5.6.2.6 (HT) 5.6.1.2
07.4	there are two molecules of gas on each side of the equation	allow the same number of moles of gas on both sides	1	AO2 5.6.2.7 (HT)
	so changing the pressure does not favour either reaction / does not move the position of equilibrium		1	AO2 5.6.2.7 (HT)
07.5	the amount of iodine decreases		1	AO2 5.6.2.5 (HT)
	(the position of) equilibrium moves to the right / the forward reaction is favoured, using up some of the added hydrogen	allow to reduce the concentration of hydrogen / to oppose the change	1	AO2 5.6.2.5 (HT)
		Total	**11**	
		TOTAL FOR PAPER	**70**	