AQA

A-level CHEMISTRY 7405/3

Paper 3

Mark scheme

June 2019

Version: 1.0 Final

196A74053/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead 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

AS and A-Level Chemistry
Mark Scheme Instructions for 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 extra information in the 'Comments' column 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.

You should mark according to the contents of the mark scheme. If you are in any doubt about applying the mark scheme to a particular response, consult your Team Leader.

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 might confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

The use of M1, M2, M3 etc in the right-hand column refers to the marking points in the order in which they appear in the mark scheme. So, M1 refers to the first marking point, M2 the second marking point etc.

2. Emboldening

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.

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 'List' 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 (often prefaced by 'Ignore' in the mark scheme) are not penalised.

For example, in a question requiring 2 answers for 2 marks:

Correct answers	Incorrect answers (i.e. incorrect rather than neutral)	Mark (2)	Comment
1	0	1	
1	1	1	They have not exceeded the maximum number of responses so there is no penalty.
1	2	0	They have exceeded the maximum number of responses so the extra incorrect response cancels the correct one.
2	0	2	
2	1	1	
2	2	0	
3	0	2	The maximum mark is 2
3	1	1	The incorrect response cancels out one of the two correct responses that gained credit.
3	2	0	Two incorrect responses cancel out the two marks gained.
3	3	0	

3.2 Marking procedure for calculations

Full marks should be awarded for a correct numerical answer, without any working shown, unless the question states 'Show your working' or 'justify your answer'. In this case, the mark scheme will clearly indicate what is required to gain full credit.

If an answer to a calculation is incorrect and working is shown, process mark(s) can usually be gained by correct substitution / working and this is shown in the 'Comments' column or by each stage of a longer calculation.

3.3 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ECF or consequential in the marking scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the marking scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

3.4 Equations

In questions requiring students to write equations, state symbols are generally ignored unless otherwise stated in the 'Comments' column.

Examiners should also credit correct equations using multiples and fractions unless otherwise stated in the 'Comments' column.

3.5 Oxidation states

In general, the sign for an oxidation state will be assumed to be positive unless specifically shown to be negative.

3.6 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.

3.7 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term or if the question requires correct IUPAC nomenclature.

3.8 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.

3.9 Ignore / Insufficient / Do <u>not</u> allow

Ignore or insufficient 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.

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.

3.10 Marking crossed out work

Crossed out work that **has not been** replaced should be marked as if it were not crossed out, if possible. Where crossed out work **has been** replaced, the replacement work and not the crossed out work should be marked.

3.11 Reagents

The command word "Identify", allows the student to choose to use **either** the name or the formula of a reagent in their answer. In some circumstances, the list principle may apply when both the name and the formula are used. Specific details will be given in mark schemes.

The guiding principle is that a reagent is a chemical which can be taken out of a bottle or container. Failure to identify complete reagents **will be penalised**, but follow-on marks (e.g. for a subsequent equation or observation) can be scored from an incorrect attempt (possibly an incomplete reagent) at the correct reagent. Specific details will be given in mark schemes.

For example, **no credit** would be given for

- the cyanide ion or CN^- when the reagent should be potassium cyanide or KCN;
- the hydroxide ion or OH^- when the reagent should be sodium hydroxide or NaOH;

- the $Ag(NH_3)_2^+$ ion when the reagent should be Tollens' reagent (or ammoniacal silver nitrate). In this example, no credit is given for the ion, but credit could be given for a correct observation following on from the use of the ion. Specific details will be given in mark schemes.

In the event that a student provides, for example, **both** KCN and cyanide ion, it would be usual to ignore the reference to the cyanide ion (because this is not contradictory) and credit the KCN. Specific details will be given in mark schemes.

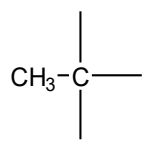
3.12 Organic structures

Where students are asked to draw organic structures, unless a specific type is required in the question and stated in the mark scheme, these may be given as displayed, structural or skeletal formulas or a combination of all three as long as the result is unambiguous.

In general

- Displayed formulae must show all of the bonds and all of the atoms in the molecule, but need not show correct bond angles.
- Skeletal formulae must show carbon atoms by an angle or suitable intersection in the skeleton chain. Functional groups must be shown and it is essential that all atoms other than C atoms are shown in these (except H atoms in the functional groups of aldehydes, secondary amines and N-substituted amides which do not need to be shown).
- Structures must not be ambiguous, e.g. 1-bromopropane should be shown as $CH_3CH_2CH_2Br$ and not as the molecular formula C_3H_7Br which could also represent the isomeric 2-bromopropane.
- Bonds should be drawn correctly between the relevant atoms. This principle applies in all cases where the attached functional group contains a carbon atom, e.g nitrile, carboxylic acid, aldehyde and acid chloride. The carbon-carbon bond should be clearly shown. Wrongly bonded atoms will be penalised **on every occasion**. (see the examples below)
- The same principle should also be applied to the structure of alcohols. For example, if students show the alcohol functional group as C ─ HO, they should be penalised **on every occasion**.
- Latitude should be given to the representation of C ─ C bonds in alkyl groups, given that CH_3─ is considered to be interchangeable with H_3C─ even though the latter would be preferred.
- Similar latitude should be given to the representation of amines where NH_2─ C will be allowed, although H_2N─ C would be preferred.
- Poor presentation of vertical C ─ CH_3 bonds or vertical C ─ NH_2 bonds should **not** be penalised. For other functional groups, such as ─ OH and ─ CN, the limit of tolerance is the half-way position between the vertical bond and the relevant atoms in the attached group.

By way of illustration, the following would apply.



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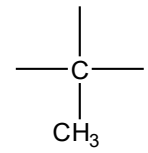

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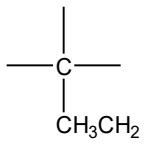

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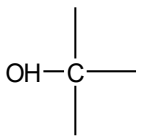

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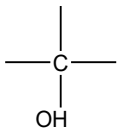

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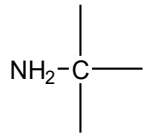

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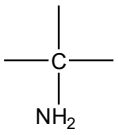

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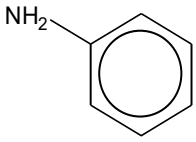

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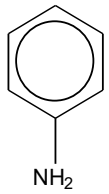

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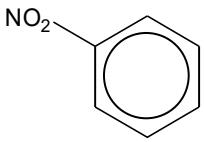

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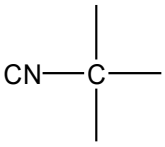

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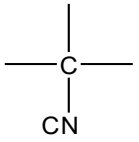

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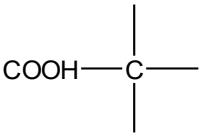

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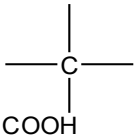

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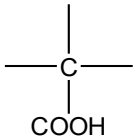

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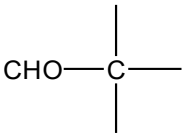

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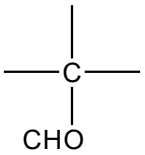

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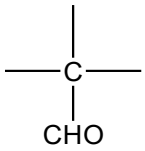

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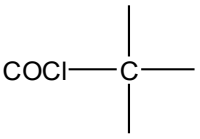

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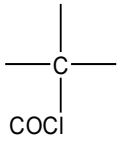


not allowed

- Representation of CH_2 by $C–H_2$ will be penalised
- Some examples are given here of **structures** for specific compounds that should **not** gain credit (but, exceptions may be made in the context of balancing equations)

CH_3COH	for	ethanal
CH_3CH_2HO	for	ethanol
$OHCH_2CH_3$	for	ethanol
C_2H_6O	for	ethanol
CH_2CH_2	for	ethene
$CH_2.CH_2$	for	ethene
$CH_2:CH_2$	for	ethene

- Each of the following **should gain credit** as alternatives to correct representations of the structures.

$CH_2 = CH_2$	for	ethene, $H_2C=CH_2$
$CH_3CHOHCH_3$	for	propan-2-ol, $CH_3CH(OH)CH_3$

- In most cases, the use of "sticks" to represent C ─ H bonds in a structure should **not** be penalised. The exceptions to this when "sticks" will be penalised include
  - structures in mechanisms where the C ─ H bond is essential (e.g. elimination reactions in halogenoalkanes and alcohols)
  - when a displayed formula is required
  - when a skeletal structure is required or has been drawn by the candidate

3.13 Organic names

As a general principle, non-IUPAC names or incorrect spelling or incomplete names should **not** gain credit. Some illustrations are given here.

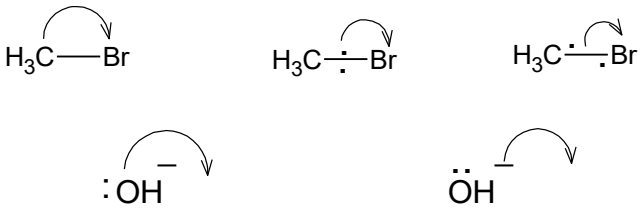
Unnecessary but not wrong numbers will **not** be penalised such as the number '2' in 2-methylpropane or the number '1' in 2-chlorobutan-1-oic acid.

but-2-ol	should be **butan-2-ol**
2-hydroxybutane	should be **butan-2-ol**
butane-2-ol	should be **butan-2-ol**
2-butanol	should be **butan-2-ol**
ethan-1,2-diol	should be **ethane-1,2-diol**
2-methpropan-2-ol	should be **2-methylpropan-2-ol**
2-methylbutan-3-ol	should be **3-methylbutan-2-ol**
3-methylpentan	should be **3-methylpentane**
3-mythylpentane	should be **3-methylpentane**
3-methypentane	should be **3-methylpentane**
propanitrile	should be **propanenitrile**
aminethane	should be **ethylamine** (although aminoethane can gain credit)
2-methyl-3-bromobutane	should be **2-bromo-3-methylbutane**
3-bromo-2-methylbutane	should be **2-bromo-3-methylbutane**
3-methyl-2-bromobutane	should be **2-bromo-3-methylbutane**
2-methylbut-3-ene	should be **3-methylbut-1-ene**
difluorodichloromethane	should be **dichlorodifluoromethane**

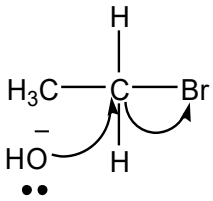
3.14 Organic reaction mechanisms

Curly arrows should originate either from a lone pair of electrons or from a bond.

The following representations should not gain credit **and will be penalised each time** within a clip.



For example, the following would score zero marks



When the curly arrow is showing the formation of a bond to an atom, the arrow can go directly to the relevant atom, alongside the relevant atom or **more than half-way** towards the relevant atom.

In free-radical substitution

- the absence of a radical dot should be penalised **once only** within a clip.
- the use of half-headed arrows is not required, but the use of double-headed arrows or the incorrect use of half-headed arrows in free-radical mechanisms should be penalised **once only** within a clip

The correct use of skeletal formulae in mechanisms is acceptable, but where a C-H bond breaks, both the bond and the H must be drawn to gain credit.

3.15 Extended responses

For questions marked using a 'Levels of Response' mark scheme:

Level of response mark schemes are broken down into three levels, each of which has a descriptor. Each descriptor contains two statements. The first statement is the Chemistry content statement and the second statement is the communication statement.

Determining a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the Chemistry content descriptor for that level. The descriptor for the level indicates the 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 and not look to pick holes in 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.

Once the level has been decided, the mark within the level is determined by the communication statement:

• If the answer completely matches the communication descriptor, award the higher mark within the level.

• If the answer does not completely match the communication descriptor, award the lower mark within the level.

The exemplar materials used during standardisation will help you to determine the appropriate level. There will be an exemplar in the standardising materials which will correspond with each level of the mark scheme and for each mark within each level. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the exemplar 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 exemplar.

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 chemically valid points. Students may not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme. The mark scheme will state how much chemical content is required for the highest level.

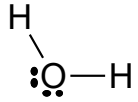
An answer which contains nothing of relevance to the question must be awarded no marks.

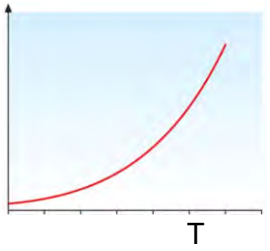
For other extended response answers:

Where a mark scheme includes linkage words (such as 'therefore', 'so', 'because' etc), these are optional. However, a student's marks for the question may be limited if they do not demonstrate the ability to construct and develop a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. In particular answers in the form of bullet pointed lists may not be awarded full marks if there is no indication of logical flow between each point or if points are in an illogical order.

The mark schemes for some questions state that the maximum mark available for an extended response answer is limited if the answer is not coherent, relevant, substantiated and logically structured. During the standardisation process, the Lead Examiner will provide marked exemplar material to demonstrate answers which have not met these criteria. You should use these exemplars as a comparison when marking student answers.

Question	Answers	Additional Comments/Guidelines	Mark
01.1	$S_2O_3^{2-} + 2H^+ \rightarrow SO_2 + S + H_2O$	ALLOW $S_2O_3^{2-} + 2H_3O^+ \rightarrow SO_2 + S + 3H_2O$ ALLOW $½S_2O_3^{2-} + H^+ \rightarrow ½SO_2 + ½S + ½H_2O$ ALLOW $½S_2O_3^{2-} + H_3O^+ \rightarrow ½SO_2 + ½S + 1½H_2O$ IGNORE state symbols NOT multiples NOT if any spectator ions included (unless crossed out)	1
01.2	**M1** acid(ic) / acidity / produces H^+	**M1** ALLOW low(ers) pH IGNORE toxic / soluble IGNORE sulfurous / sulfuric / H_2SO_4 IGNORE rain IGNORE proton donor (unless qualified, e.g. reacts with water to form a proton donor) NOT any other named acid	1
	M2 $SO_2 + H_2O \rightarrow H_2SO_3 / H^+ + HSO_3^-$	**M2** ALLOW $SO_2 + H_2O \rightarrow 2H^+ + SO_3^{2-}$ ALLOW $SO_2 + 2H_2O \rightarrow H_3O^+ + HSO_3^-$ ALLOW $SO_2 + 3H_2O \rightarrow 2H_3O^+ + SO_3^{2-}$ ALLOW multiples IGNORE state symbols	1

01.3	**M1** 	**M1** bent shape and 2 lone pairs on O ALLOW any suitable representation of lone pairs (e.g. dots, crosses, lobes with/without dots/crosses)	1
	M2 104½°	**M2** ALLOW 104-105°	1
	M3 lone pairs repel more (strongly) than bond(ing) pairs	**M3** ALLOW non-bonding pair for lone pair ALLOW covalent bond for bond(ing) pair ALLOW shared pair for bond(ing) pair ALLOW OH bond for bond(ing) pair ALLOW bond for bond(ing) pair NOT OH or O-H without the word bond for bond(ing) pair	1
	M4 so bond angle reduced from/less than 109½° / tetrahedral	**M4** ALLOW bond angle reduced from 120° if bent with one lone pair in **M1** ALLOW reduced from 109° ALLOW reduced by 2.5° per lone pair or 5° if **M2** correct	

<table>
<tr>
<td rowspan="5">01.4</td>
<td colspan="2">This question is marked using levels of response. Refer to the Mark Scheme Instructions for examiners for guidance on how to mark this question</td>
<td rowspan="5">Indicative Chemistry content
Stage 1 Method
(1a) Idea of using disappearing cross or colorimetry
(1b) Puts acid or thiosulfate into container on/with cross or in colorimeter
(1c) Add second reactant and start timing
Stage 2 Measurements
(2a) Repeat at different temperatures (if number of temperatures stated, must be more than two)
(2b) Record time, t, for cross to disappear / defined reading on colorimeter
(2c) Idea of ensuring other variables (cross, volumes, concentrations) kept constant (apart from T)
Stage 3 Use of Results
(3a) 1/t (or 1000/time, etc) is a measure of rate
(3b) plot of rate (or 1/t etc) (y-axis) against T (x-axis) (can come from labelled axes on sketch) (IGNORE T against rate)
(3c) sketch of plot as shown (ALLOW 3c if axes not labelled but NOT if incorrectly labelled)
rate (or 1/t etc)
 
T</td>
<td rowspan="5">6</td>
</tr>
<tr>
<td>Level 3

5-6 marks</td>
<td>All stages are covered and the explanation of each stage is correct and virtually complete.
(6 v 5) Answer is well structured, with no repetition or irrelevant points. Accurate and clear expression of ideas with no errors in use of technical terms.</td>
</tr>
<tr>
<td>Level 2

3-4 marks</td>
<td>All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies
OR two stages covered and the explanations are generally correct and virtually complete
(4 v 3) Answer has some structure. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. If any, only minor errors in use of technical terms.</td>
</tr>
<tr>
<td>Level 1

1-2 marks</td>
<td>Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies
OR only one stage is covered but the explanation is generally correct and virtually complete
(2 v 1) Answer includes statements which are presented in a logical order and/or linked.</td>
</tr>
<tr>
<td>Level 0

0 marks</td>
<td>Insufficient correct Chemistry to warrant a mark</td>
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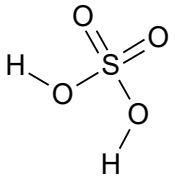
Question	Answers	Additional Comments/Guidelines	Mark
02.1		IGNORE shape / bond angles IGNORE lone pair(s) on O atoms NOT lone pair(s) on S atom	1
02.2	Equation 1: $H_2SO_4 \rightarrow HSO_4^- + H^+$ / $H_2SO_4 + H_2O \rightarrow HSO_4^- + H_3O^+$ Equation 2: $HSO_4^- \rightleftharpoons SO_4^{2-} + H^+$ / $HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$	IGNORE state symbols in both equations ALLOW multiples in both equations Equation 1: NOT $\rightleftharpoons$ Equation 2: NOT $\rightarrow$ *or* $\leftrightarrow$ ALLOW $\leftrightharpoons$ *or* $\rightleftarrows$ *or* $\leftrightarrows$	1 1

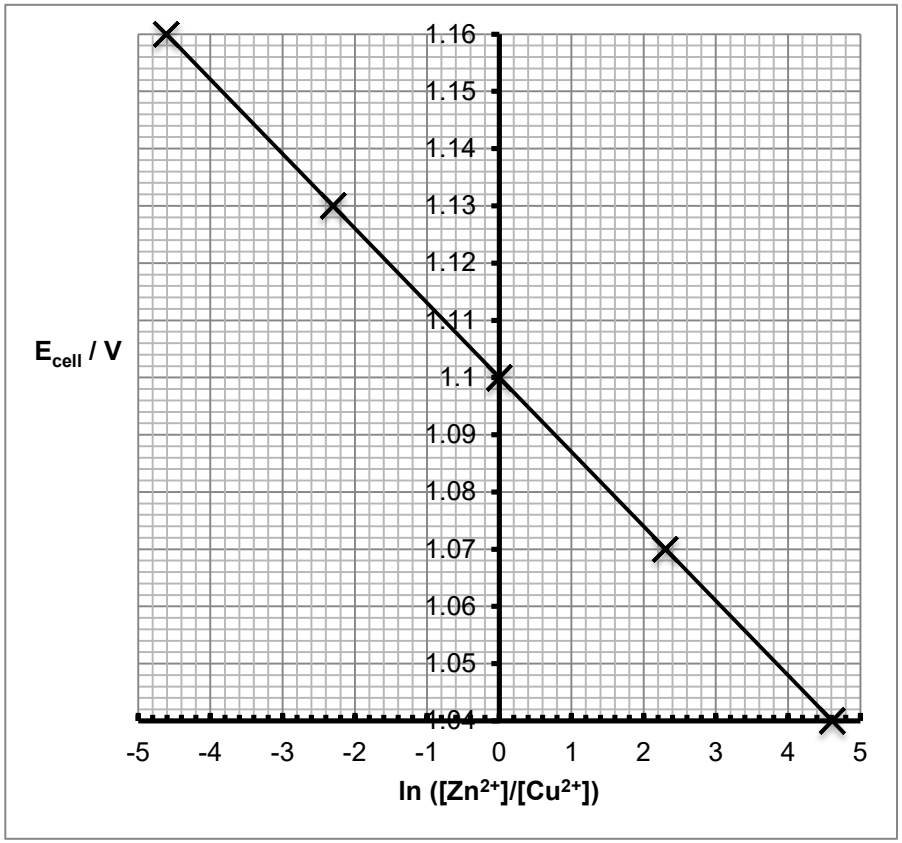
02.3	**M1** weigh solid and transfer using a method that allows exact mass to be known (there should be two weighings, one of which could be zeroing, and method could be by difference or with washings or directly weighed into container) **M2** dissolve in water in suitable container (NOT in 250 cm^3 of water) **M3** transfer with washings into 250 cm^3 volumetric/graduated flask **M4** make up to mark / 250 cm^3 AND THEN shake / invert / mix	**M1** IGNORE any mass quoted NOT if any other solid added **M2** NOT if any other solution added **M3** Reference to 250 cm^3 can appear anywhere **M4** ALLOW if conical flask used NOT if beaker used **Alternative method (M2-4)** **M2** in 250 cm^3 volumetric/graduated flask **M3** dissolve (NOT in 250 cm^3 of water) **M4** make up to mark / 250 cm^3 AND THEN shake/invert/mix	1 1 1 1

02.4	**M1** $[H^+] = 10^{-1.72}$ (= 0.0191 (mol dm^{-3}))	Correct answer scores **M1-5** (must be 3sf)	
	M2 amount $NaHSO_4$ = 0.605/120.1 (= 5.04 x 10^{-3} (mol))		1
	M3 initial $[NaHSO_4] = [HSO_4^-]$ = **M2** x 10 (= 5.04 x 10^{-2} (mol dm^{-3}))	**Alternative method** that does not subtract 0.0191:	1
	M4 $K_a = \frac{[H^+][SO_4^{2-}]}{[HSO_4^-]}$ or $K_a = \frac{[H^+]^2}{[HSO_4^-]}$	7.21 x 10^{-3} (7.15 – 7.26 x 10^{-3}) scores **M1-5**	1
	$K_a = \frac{0.0191^2}{0.0504 - 0.0191}$	(where **M4** $K_a = \frac{0.0191^2}{0.0504}$)	
	M5 K_a = 1.17 x 10^{-2} (1.15 – 1.18 x 10^{-2}) must be 3sf	If not correct answer:	1
	M6 mol dm^{-3}	For **M1-3**, if answer is shown, it must be correct (ignore sf)	1
		ALLOW ECF from **M1/2/3** to **M4/5** (but not from **M3** to **M5** if omission of **M3** gives negative **M5**)	1
		NOT ECF from incorrect K_a expression in **M4** to **M5**	
		M6 If not mol dm^{-3}, ALLOW ECF for units from incorrect K_a expression in **M4**	
		7.21 x 10^{-2} (7.15 – 7.26 x 10^{-2}) gives **M1,2,4,5** (by alternative method omitting **M3**)	

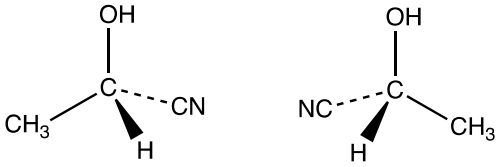
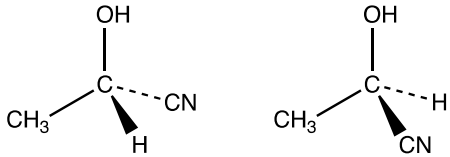
02.5	**M1** ($HSO_4^- \rightleftharpoons SO_4^{2-} + H^+$) equilibrium moves/shifts left (to counteract / remove increased $[SO_4^{2-}]$)	**M1** ALLOW H^+ reacts with SO_4^{2-}/sulfate	
		IGNORE favours the reverse / left / backwards reaction	
		NOT base / A^- / sodium sulfate in place of SO_4^{2-}/sulfate	1
	M2 so $[H^+]$ decreases	**M2** ALLOW fewer H^+ (ions) or amount of H^+ lower or removes H^+	1
		M2 independent of **M1**	

Question	Answers	Additional Comments/Guidelines	Mark
03.1	salt bridge	ALLOW description of salt bridge, e.g. filter paper / string / wick soaked in suitable solution U tube (NOT YouTube) filled with suitable solution / gel NOT U tube alone	1
03.2	complete the circuit	ALLOW ions to flow / move / transfer ALLOW to balance charge / to maintain electrical neutrality IGNORE current / charge to flow NOT electrons to flow	1
03.3	**B** = platinum	ALLOW Pt / platinum black	1

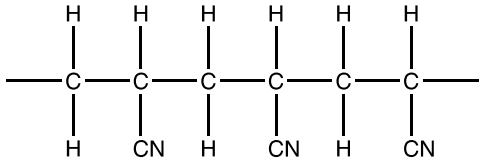
03.4			
	M1 C HCl 1 mol dm^{-3} **M2** D H_2 / hydrogen 100 kPa **M3** E $FeCl_2$ and $FeCl_3$ 1 mol dm^{-3} **M4** 298 K (any mention)	NOT incorrect state symbols ALLOW M or molar or mol/dm^3 for mol dm^{-3} **M1** ALLOW 1 mol dm^{-3} H^+ ALLOW 0.5 mol dm^{-3} H_2SO_4 ALLOW 1 mol dm^{-3} HNO_3 IGNORE 100 kPa **M2** ALLOW 1 bar NOT 1 atm / 101 kPa NOT H for hydrogen NOT 1 mol dm^{-3} **M3** ALLOW 1 mol dm^{-3} Fe^{2+} and Fe^{3+} ALLOW other identified Fe(II) and Fe(III) compounds with appropriate concentrations, e.g. 1 mol dm^{-3} $FeSO_4$ and 0.5 mol dm^{-3} $Fe_2(SO_4)_3$ IGNORE 100 kPa	1 1 1 1
03.5	**M1** $H_2 + 2Fe^{3+} \rightarrow 2H^+ + 2Fe^{2+}$ **M2** replace voltmeter with lamp/wire/ammeter owtte	**M1** IGNORE state symbols ALLOW multiples / fractions ALLOW equation with equilibrium sign if forward reaction shown is in this direction **M2** ALLOW remove voltmeter	1 1

03.6	**M1** missing value (+) 2.3(0)  **M2** suitable scales (plotted points use at least half of grid) **M3** points plotted correctly (± ½ small square per point) and best fit line drawn (within one small square of each point)	**M2** ALLOW scales which use half the grid for plotted points **M3** If **M1** incorrect, should be plotted accordingly and best fit line ignore if anomalous	1 1 1

03.7	**M1** gradient = –0.013 (must be negative) **M2** **M1** = (–) 4.3 x 10^{-5} T or T = $\frac{\mathbf{M1}}{(-)4.3\ x\ 10^{-5}}$ **M3** T = 302 or 303 (K)	**M1** ALLOW –0.0125 to –0.0136 ALLOW ECF from graph if outside this range **M3** temperature must match gradient unless –0.016 used (ALLOW positive temperature if positive gradient used) at least 2sf Correct **M3** also scores **M2** NOT negative temperature **M3** **(**Alternate gradient = –0.016 gives) T = 372 (K)	1 1 1 1
03.8	**M1** E = –0.8(0) V **M2** non standard conditions or concentration (of Zn^{2+}) not 1 (mol dm^{-3}) or concentration (of Zn^{2+}) less than 1 (mol dm^{-3})	**M2** ALLOW temperature is not 298K NOT concentration (of Zn^{2+}) greater than 1 (mol dm^{-3}) NOT concentration (of Zn^{2+}) is different	1 1

Question	Answers	Additional Comments/Guidelines	Mark
04.1	nucleophilic addition	both words needed NOT any additional names	1
04.2	**M1** racemic (mixture) / racemate **M2** planar (around) carbonyl / C=O **M3** (equal chance of) attack from each side (by CN^-) **M4** a correct structure of 2-hydroxypropanenitrile **M5** correct 3D representations of both isomers, e.g.  	**M2** NOT molecule is planar ALLOW flat for planar **M4** any correct 2D or 3D structure **M5** must show at least one wedge bond and one dash bond in each structure and any bonds in the plane cannot be at 180º to each other second structure could be drawn as mirror image of first **or** with same orientation with two groups swapped round, e.g.  ALLOW ECF for second structure from incorrect first structure, providing molecule is chiral	1 1 1 1 1

04.3	**M1** conc H_2SO_4 or conc H_3PO_4 **M2** heat / 170°C	**M1** ALLOW conc to come from conditions line **M2** depends on attempt at correct reagent in **M1** ALLOW high temperature / hot / 100-300°C / 373 – 573 K / reflux IGNORE references to pressure IGNORE warm NOT ethanolic / alcoholic **Alternative answer** **M1** Al_2O_3 **M2** pass vapour over hot Al_2O_3	1 1

04.4		MUST show trailing bonds IGNORE any brackets or n NOT C–N or C=N if CN group displayed ALLOW structures with CN on either C in each of the three units ALLOW $–CH_2–CH(CN)–CH_2–CH(CN)–CH_2–CH(CN)–$	1

Question	Answers	Additional Comments/Guidelines	Mark
05.1	$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$	ALLOW $Fe + 2H^+ \rightarrow Fe^{2+} + H_2$ ALLOW $Fe + 2H^+ + SO_4^{2-} \rightarrow Fe^{2+} + SO_4^{2-} + H_2$ ALLOW $Fe + H_2SO_4 \rightarrow Fe^{2+} + SO_4^{2-} + H_2$ ALLOW $Fe + 2H^+ + SO_4^{2-} \rightarrow FeSO_4 + H_2$ ALLOW multiples IGNORE state symbols	1
05.2	22.65 (cm^3)		1
05.3	$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$	ALLOW multiples IGNORE state symbols NOT if electrons shown	1
05.4	colourless / (pale) green to (hint of) pink	NOT …. to purple ALLOW …. to pale / hint of purple	1
05.5	pipette burette	both needed ALLOW (graduated/volumetric) pipette ALLOW (graduated/volumetric) burette NOT dropping pipette	1

05.6	1.47(%)	ALLOW 1.5(%)	1

Question	Marking Guidance	Mark	Comments
6	**C**	1	
7	**A**	1	
8	**D**	1	
9	**A**	1	
10	**C**	1	
11	**B**	1	
12	**B**	1	
13	**A**	1	
14	**B**	1	
15	**B**	1	
16	**A**	1	
17	**A**	1	
18	**D**	1	
19	**B**	1	
20	**B**	1	

21	**A**	1	
22	**C**	1	
23	**B**	1	
24	**A**	1	
25	**B**	1	
26	**C**	1	
27	**D**	1	
28	**A**	1	
29	**D**	1	
30	**C**	1	
31	**D**	1	
32	**A**	1	
33	**D**	1	
34	**D**	1	
35	**D**	1	