



National
Qualifications
2019

2019 Chemistry

Advanced Higher

Finalised Marking Instructions

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General marking principles for Advanced Higher Chemistry

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.

- (a) Marks for each candidate response must **always** be assigned in line with these general marking principles and the detailed marking instructions for this assessment.
- (b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.
- (c) If a specific candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.
- (d) Where a candidate makes an error at an early stage in a multi stage calculation, credit should normally be given for correct follow on working in subsequent stages, unless the error significantly reduces the complexity of the remaining stages. The same principle should be applied in questions which require several stages of non-mathematical reasoning. The exception to this rule is where the marking instructions for a numerical question assign separate “concept marks” and an “arithmetic mark”. In such situations, the marking instructions will give clear guidance on the assignment of partial marks.
- (e) In many cases, marks can still be awarded for inaccurate or unconventional spelling or vocabulary as long as the meaning of the word(s) is conveyed. For example, responses that include ‘distilling’ for ‘distillation’, or ‘it gets hotter’ for ‘the temperature rises’, should be accepted. Exceptions to this rule will be given in the Additional Guidance column of the Detailed Marking Instructions.
- (f) If a correct answer and a wrong answer are present, it should be treated as a cancelling error and no marks should be given. For example, in response to the question, ‘State the colour seen when blue Fehling’s solution is warmed with an aldehyde’, the answer ‘red green’ gains no marks.
However, if a correct answer and additional information, which does not conflict, are present, the additional information should be ignored, whether correct or not. For example, in response to a question concerned with melting point, ‘State why the tube should not be made of copper’, the response ‘Copper has a low melting point and is coloured grey’ would **not** be treated as having a cancelling error.
- (g) Full marks are usually awarded for the correct answer to a calculation without working and the partial marks shown in the Detailed Marking Instructions are for use when working is given but the final answer is incorrect. An exception is when candidates are asked to ‘Find, by calculation’, when full marks cannot be awarded for the correct answer without working.
- (h) Significant figures.
If the data in a question is given to three significant figures, the final answer should also have three significant figures. However one fewer significant figure and up to two more significant figures is acceptable.

For example if a correct final answer is 8.16 J then 8.2 J, 8.158 J and 8.1576 J would also be acceptable. Answers out with this range would not be acceptable and one mark would not be awarded.

This marking instruction must only be applied a maximum of once per paper and cannot be applied if instruction (i) has already been applied in the paper.

- (i) Units
In most questions units are not required. However, if the candidate writes units then they must be correct.
An incorrect unit would not be acceptable and one mark would not be awarded.

This marking instruction must only be applied a maximum of once per paper and cannot be applied if instruction (h) has already been applied in the paper.

- (j) Intermediate rounding.
Ideally, calculated intermediate values should not be rounded. However if the candidate has correctly rounded, the calculated intermediate values can have one significant figure fewer than the data given in the question but no fewer.
For example, if the data in a question is given to three significant figures, the intermediate value should have no fewer than two significant figures.
- (k) Ignore the omission of one H atom from a full structural formula provided the bond is shown or the omission of one bond provided the attached H atom is shown.
- (l) If a structural formula is asked for, CH₃ and CH₃CH₂ are acceptable as methyl and ethyl groups respectively.

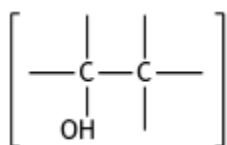
If a name is asked for such as 3-methylhexane, then 3,methyl-hexane would be acceptable, i.e. ignore incorrect use of commas and dashes.

- (m) With structures involving an -OH or an -NH₂ group, a mark should only be awarded if the "O" or "N" are bonded to a carbon, i.e. not OH-CH₂ and NH₂-CH₂.

When drawing structural formulae, a mark should only be awarded if the bond points to the appropriate atom.

This marking instruction must only be applied a maximum of once per question.

The example below would be incorrect.



Marking instructions for each question

Section 1

| Question | Response | Mark |
|----------|----------|------|
| 1. | B | 1 |
| 2. | D | 1 |
| 3. | C | 1 |
| 4. | A | 1 |
| 5. | D | 1 |
| 6. | D | 1 |
| 7. | B | 1 |
| 8. | D | 1 |
| 9. | A | 1 |
| 10. | C | 1 |
| 11. | C | 1 |
| 12. | B | 1 |
| 13. | A | 1 |
| 14. | B | 1 |
| 15. | C | 1 |
| 16. | A | 1 |
| 17. | C | 1 |
| 18. | C | 1 |
| 19. | D | 1 |
| 20. | B | 1 |
| 21. | C | 1 |
| 22. | B | 1 |
| 23. | B | 1 |
| 24. | A | 1 |
| 25. | C | 1 |
| 26. | A | 1 |
| 27. | D | 1 |
| 28. | C | 1 |
| 29. | D | 1 |
| 30. | A | 1 |

Section 2

| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|--|--|----------|--|
| 1. | (a) | | Any one of the 2p electrons | 1 | Only 1 electron to be circled |
| | (b) | | $103 \text{ (kJ mol}^{-1}\text{)}$ (2) Partial marking $\Delta G = \Delta H - T\Delta S$ OR correct substitution of values (1) | 2 | 100/103.3/103.34 also acceptable Unit not required but must be correct if given |
| | (c) | | 3.20×10^{-5} (2) Partial marking $25.6 = -2.30 \times 8.31 \times 10^{-3} \times 298 \times \log_{10} K$ (1) OR $-4.49464 (= \log_{10} K)$ (1) OR $K = 10^{-4.49464}$ (1) OR A correctly calculated value of K from an incorrectly calculated value of $\log_{10} K$ (1) | 2 | $3.2/3.202/3.2016 \times 10^{-5}$ also acceptable |

| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|------|---|----------|---|
| 2. | (a) | | The number of species/molecules/particles/ions/ moles of reactant(s) involved in the rate determining step/slowest step | 1 | The number of reactants in the rate determining step without reference to moles would not be awarded the mark |
| | (b) | (i) | $2/2^{\text{nd}}/\text{second}$ | 1 | |
| | | (ii) | Rate = $k[\text{H}_2\text{O}_2][\text{I}^-]$ OR Rate = $k[\text{H}_2\text{O}_2]^1[\text{I}^-]^1$ | 1 | State symbols not required but if given must be correct K instead of k is not acceptable Charge on I^- must be shown Square brackets must be used |
| | (c) | | $\text{H}_2\text{O}_2(\text{aq}) + 2\text{I}^-(\text{aq}) + 2\text{H}_3\text{O}^+(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + 4\text{H}_2\text{O}(\text{l})$ | 1 | State symbols not required but if given must be correct |

| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|-------|--|----------|--|
| 3. | (a) | | <p>5 cm³ (1)</p> <p>Correct procedure involving pipette/ burette and making up to the mark (with deionised/distilled water) (1)</p> | 2 | |
| | (b) | (i) | (Deionised/distilled) water | 1 | |
| | | (ii) | <p>The absorbance/value was outwith the calibration range/line</p> <p>OR</p> <p>To bring the absorbance/value to within the calibration range/line</p> | 1 | Must make reference to the calibration range or line |
| | | (iii) | <p>71 (%) (3)</p> <p>Partial marking</p> <p>Up to 2 marks may be awarded for any two of the following</p> <p>Concentration of Cu²⁺ = 0.032 (mol l⁻¹)</p> <p>OR</p> <p>Correct value from [Cu²⁺] × 0.25 × 2 × 63.5</p> <p>OR</p> <p>Correctly calculating a % from a calculated mass of copper</p> | 3 | 70/71.0/71.05 are also acceptable |

| Question | | | Expected response | Max mark | Additional guidance | | | | | | | | |
|----------------|-------------------------------|-------------|--|----------|---|----------------|------------------------------|------|-------------------------------|----------------|------------------|---|--|
| 4. | (a) | (i) | A proton/hydrogen ion/H ⁺ acceptor | 1 | | | | | | | | | |
| | | (ii) | <table><tr><td>Acid</td><td>H₂O₂</td></tr><tr><td>Conjugate base</td><td>HO₂⁻</td></tr></table> OR <table><tr><td>Acid</td><td>H₃O⁺</td></tr><tr><td>Conjugate base</td><td>H₂O</td></tr></table> | Acid | H ₂ O ₂ | Conjugate base | HO ₂ ⁻ | Acid | H ₃ O ⁺ | Conjugate base | H ₂ O | 1 | State symbols not required but if given must be correct Charges must be shown |
| Acid | H ₂ O ₂ | | | | | | | | | | | | |
| Conjugate base | HO ₂ ⁻ | | | | | | | | | | | | |
| Acid | H ₃ O ⁺ | | | | | | | | | | | | |
| Conjugate base | H ₂ O | | | | | | | | | | | | |
| | (b) | | B(OH) ₃ accepts (a pair of non-bonding) electrons and water donates (a pair of non-bonding) electrons OR B(OH) ₃ accepts (a pair of non-bonding) electrons from water OR Water donates (a pair of non-bonding) electrons to B(OH) ₃ | 1 | Both species must be mentioned | | | | | | | | |
| | (c) | (i) | As the number of chlorine (atoms) increase the strength of the acid increases. OR As the number of chlorine (atoms) decreases the strength of the acid decreases. | 1 | Answers relating only to K _a /pH value are unacceptable Mention of chlorine molecules/ions/chloride is a cancelling error | | | | | | | | |
| | | (ii) (A) | 0.08 (mol l ⁻¹) | 1 | Unit not required but must be correct if given | | | | | | | | |
| | | (ii) (B) | 2 Partial marking One mark may be awarded for pH = ½pK _a - ½logc OR Correct substitution of values OR pK _a = 2.80 OR calculation of [H ⁺] | 2 | 1.9/1.95 also acceptable Allow follow through | | | | | | | | |

| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|--|---|----------|---|
| 4. | (d) | | <p>This is an open ended question</p> <p>1 mark: The student has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. The student has made some statement(s) that is/are relevant to the situation, showing that at least a little of the chemistry within the context is understood.</p> <p>2 marks: The student has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. The student makes some statement(s) that is/are relevant to the situation, showing that the context is understood.</p> <p>3 marks: The maximum available mark would be awarded to a student who has demonstrated, at an appropriate level, a good understanding, of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the context. This does not mean the answer has to be what might be termed an “excellent” answer or a “complete” one.</p> | 3 | <p>Zero marks should be awarded if the student has demonstrated an understanding of the chemistry that is below the appropriate level.</p> <p>Zero marks should also be awarded if the student merely restates the chemistry given in the question.</p> |

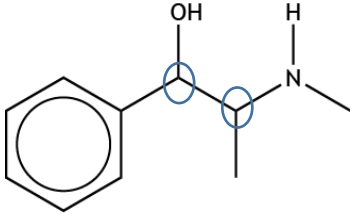
| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|------|---|----------|--|
| 5. | (a) | | Heat/high temperature | 1 | Electrical discharge or light are not acceptable on their own but are not cancelling errors |
| | (b) | (i) | Hexaaquazinc(II) | 1 | Must have brackets |
| | | (ii) | Full/complete d subshell/ 10 d electrons/ $3d^{10}$ /no d-d transitions possible (1) It does not absorb visible light OR It only absorbs ultraviolet/UV light (1) | 2 | The first mark may not be awarded if the candidate implies that the d orbitals are not split or empty or that the energy gap between the d orbitals is too large Any mention of HOMO-LUMO or emission is a cancelling error for the second mark |
| | (c) | (i) | 2.04×10^{-16} (J) | 1 | $2.0/2.042/2.0420 \times 10^{-16}$ are also acceptable Unit not required but must be correct if given |
| | | (ii) | Method 1 19.0 (eV) (2) Partial marking One mark can be awarded for: $E = 2.04 \times 10^{-16} \times 6.24 \times 10^{18} = 1272.9$ OR Correct subtraction involving incorrect values (1) Method 2 21.0 (eV) (2) Partial marking One mark can be awarded for: correct subtraction of correct values in J $1254 \times 1.60 \times 10^{-19} = 2.0064 \times 10^{-16}$ (J) $E_b = 2.04 \times 10^{-16} - 2.0064 \times 10^{-16}$ $E_b = 3.36 \times 10^{-18}$ (J) OR multiplication of a calculated E_b in Joules by 6.24×10^{18} (1) | 2 | 19/18.96 also acceptable Unit not required but must be correct if given Method 2 21/20.97/20.966 also acceptable Unit not required but must be correct if given |

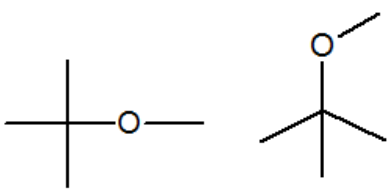
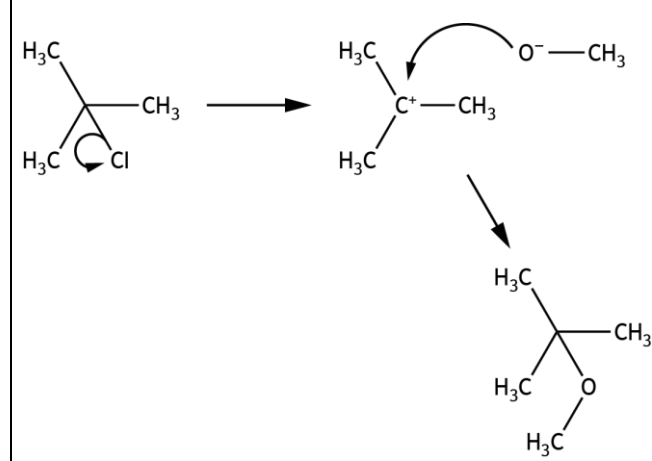
| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|--|---|----------|--|
| 6. | (a) | | <p>6.4 (mol l⁻¹) (3)</p> <p>Partial marking</p> <p>Up to 2 marks may be awarded for any two of the following</p> <p>8.5 × 10⁻⁵ (mol Cr₂O₇²⁻ reacted with C₂H₅OH)</p> <p>OR</p> <p>Correct subtraction of 1.65 × 10⁻⁴ from an incorrectly calculated number of moles of Cr₂O₇²⁻</p> <p>OR</p> <p>Use of 3:2 mole ratio on an incorrect number of moles of Cr₂O₇²⁻</p> <p>OR</p> <p>Multiplication of an incorrect number of moles by 1000 and dividing by 0.02 / multiplication by 50,000</p> | 3 | <p>6/6.38/6.375 also acceptable</p> <p>Unit not required but if given must be correct.</p> |
| | (b) | | To ensure all the ethanol reacted. | 1 | <p>To ensure the reaction goes to completion is unacceptable on its own</p> <p>Ethanol is the limiting reactant is unacceptable on its own</p> <p>Vodka instead of ethanol is unacceptable</p> |
| | (c) | | <p>Other ingredients/impurities in the vodka may be reacting with dichromate</p> <p>OR</p> <p>Concentration of dichromate was greater (than 0.010 mol l⁻¹)</p> | 1 | Different dichromate concentration is unacceptable on its own |
| | (d) | | <p>Use a known concentration/standard solution of ethanol</p> <p>OR</p> <p>Use pure ethanol</p> | 1 | |

| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|------|---|----------|--|
| 7. | (a) | | Under vacuum/suction/reduced pressure OR Acceptable diagram indicating vacuum/suction/reduced pressure | 1 | A mark should not be awarded for “use a Buchner funnel/flask” without further explanation |
| | (b) | (i) | End on overlap of (two atomic) orbitals OR Acceptable labelled diagram | 1 | Any mention of overlap of molecular orbitals is a cancelling error. |
| | | (ii) | Mixing an s (atomic) orbital with two p (atomic) orbitals | 1 | Any mention of forming molecular orbitals is a cancelling error. |
| | (c) | | Electrons promoted/move from HOMO to LUMO (1) The complementary colour(s) (to red) is absorbed OR Blue/green light is absorbed (1) | 2 | Direction of electron transition must be given Any mention of emission/giving out or dropping energy levels is a cancelling error for the second mark |
| | (d) | (i) | Similar polarities/both polar/similar intermolecular forces OR Forms hydrogen bonds with alizarin OR Does not react with alizarin OR Volatile/low boiling point/ evaporates easily OR Dissolves alizarin but not other substances (in the root) | 1 | Both non-polar is not acceptable Alizarin dissolves in methanol is not a sufficiently detailed response on its own |

| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|---------------------|---|----------|---|
| 7. | (d) | (ii) (A) | Vibrate/bend/stretch (1) Different bonds/functional groups absorb at different wavenumber/wavelength/frequency/energy (1) | 2 | |
| | | (ii) (B) | Circle one/both OH group(s) | 1 | |
| | | (ii) (C) (I) | 2.946×10^{-6} (m) | 1 | $2.95/2.9455/2.94551 \times 10^{-6}$ are also acceptable Unit not required but if given must be correct |
| | | (ii) (C) (II) | 40.6 (kJ mol ⁻¹) Partial marking One partial mark can be awarded for correct equations - $c=f\lambda$ and $E = hf$ OR substitution into the correct equations | 2 | 41/40.64/40.644 also acceptable Unit not required but must be correct if given Allow follow through |

| Question | | | Expected response | Max mark | Additional guidance |
|----------|--|--|---|----------|---|
| 8. | | | <p>This is an open ended question</p> <p>1 mark: The student has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. The student has made some statement(s) that is/are relevant to the situation, showing that at least a little of the chemistry within the context is understood.</p> <p>2 marks: The student has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. The student makes some statement(s) that is/are relevant to the situation, showing that the context is understood.</p> <p>3 marks: The maximum available mark would be awarded to a student who has demonstrated, at an appropriate level, a good understanding, of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the context. This does not mean the answer has to be what might be termed an “excellent” answer or a “complete” one.</p> | 3 | <p>Zero marks should be awarded if the student has demonstrated an understanding of the chemistry that is below the appropriate level.</p> <p>Zero marks should also be awarded if the student merely restates the chemistry given in the question.</p> |

| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|------|---|----------|---|
| 9. | (a) | (i) |  <p>Any one of the two circled above.</p> | 1 | |
| | | (ii) | Non-superimposable mirror images of each other | 1 | The idea of both non-superimposable and mirror images is required |
| | (b) | (i) | (nucleophilic) substitution | 1 | Electrophilic substitution is unacceptable |
| | | (ii) | <p>7.58 g (3)</p> <p>Partial marking</p> <p>One partial mark may be awarded for one of the following</p> <p>10.6 (g) (Correct theoretical yield)</p> <p>OR</p> <p>Calculation of mass from an incorrect theoretical yield (1)</p> <p>Correct unit for a calculated final mass (1)</p> | 3 | 7.6/7.585/7.5845 also acceptable |

| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|-------|---|----------|---|
| 10. | (a) | | Ethers | 1 | |
| | (b) | (i) | Skeletal formula of compound X  | 1 | |
| | | (ii) | 2-methoxy-2-methylpropane 2-methoxymethylpropane 2-methyl-2-methoxypropane Methyl-2-methoxypropane | 1 | |
| | (c) | (i) | Methanol/CH ₃ OH/CH ₄ O | 1 | |
| | | (ii) |  <p>1 mark for intermediate and one mark for both curly arrows being correct</p> | 2 | <p>An incorrectly drawn methoxide ion is a cancelling error for the intermediate mark.</p> <p>The final product is not required.</p> <p>An S_N2 mechanism is awarded zero marks.</p> <p>Zero marks are awarded for a general mechanism.</p> |
| | | (iii) | Formation of a stable (tertiary) carbocation/inductive stabilisation OR steric hindrance or description | 1 | |

| Question | | | Expected response | Max mark | Additional guidance |
|----------|-----|--|--|----------|---------------------|
| 10. | (d) | | Any correct structure that is an isomer and has a chiral centre For example, pentan-2-ol/3-methylbutan-2-ol/ 2-methylbutan-1-ol/ 2-methoxybutane | 1 | |
| | (e) | | One line at 1·5-0·9 (1) Relative intensity 9 (1) | 2 | |

[END OF MARKING INSTRUCTIONS]