Diploma Programme
Programme du diplôme
Programa del Diploma

# Markscheme

## November 2025

## Chemistry

## Standard level

## Paper 2

11 pages

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## Subject Details: Chemistry Standard Level Paper 2 Markscheme

Candidates are required to answer **ALL** questions. Maximum total = **[50 marks]**.

**1.** Each row in the "Question" column relates to the smallest subpart of the question.

**2.** The maximum mark for each question subpart is indicated in the "Total" column.

**3.** Each marking point in the "Answers" column is shown by means of a tick (✓) at the end of the marking point.

**4.** A question subpart may have more marking points than the total allows. This will be indicated by "**max**" written after the mark in the "Total" column. The related rubric, if necessary, will be outlined in the "Notes" column.

**5.** An alternative word is indicated in the "Answers" column by a slash (/). Either word can be accepted.

**6.** An alternative answer is indicated in the "Answers" column by "***OR***". Either answer can be accepted.

**7.** An alternative markscheme is indicated in the "Answers" column under heading **ALTERNATIVE 1** *etc*. Either alternative can be accepted.

**8.** Words inside chevrons **« »** in the "Answers" column are not necessary to gain the mark.

**9.** Words that are <u>underlined</u> are essential for the mark.

**10.** The order of marking points does not have to be as in the "Answers" column, unless stated otherwise in the "Notes" column.

**11.** If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the "Answers" column then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by ***OWTTE*** (or words to that effect) in the "Notes" column.

**12.** Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

**13.** Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script.

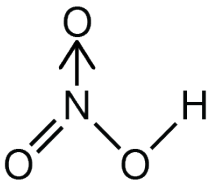
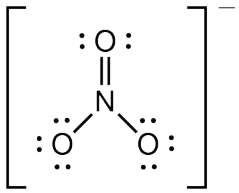
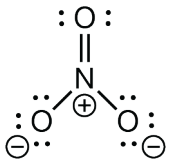
**14.** Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the "Notes" column.

**15.** If a question specifically asks for the name of a substance, do not award a mark for a correct formula unless directed otherwise in the "Notes" column. Similarly, if the formula is specifically asked for, do not award a mark for a correct name unless directed otherwise in the "Notes" column.

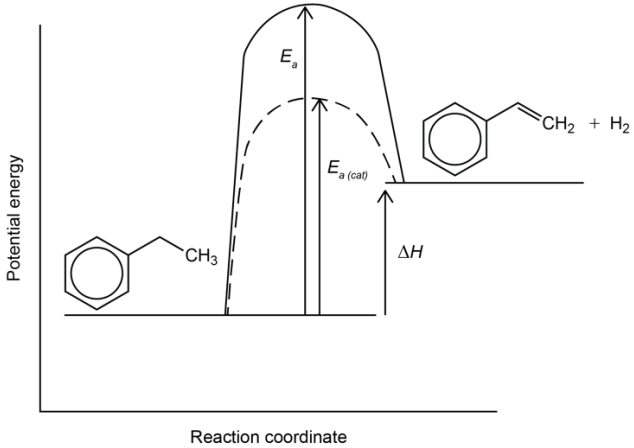
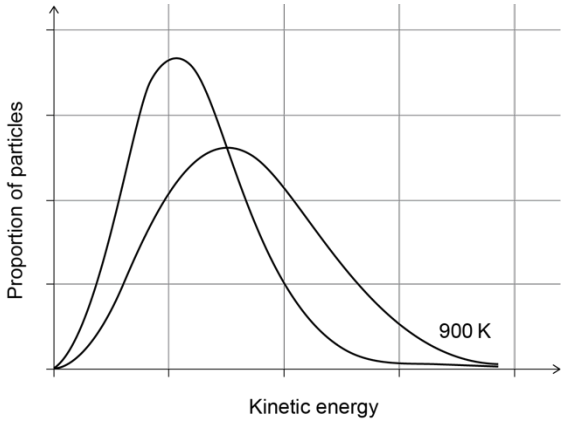
**16.** If a question asks for an equation for a reaction, a balanced symbol equation is usually expected, do not award a mark for a word equation or an unbalanced equation unless directed otherwise in the "Notes" column.

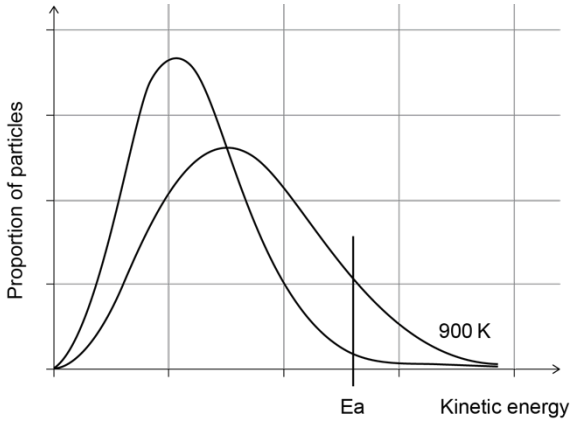
Ignore missing or incorrect state symbols in an equation unless directed otherwise in the "Notes" column.

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>1.</td><td>(a)</td><td></td><td>Any one of:<br><br>forms nitrous acid / $HNO_2$ / nitric acid / $HNO_3$ ✓<br>contributes to acid rain ✓<br>catalyses decomposition of ozone / contributes to ozone hole/depletion ✓<br>«respiratory» irritant/toxic ✓</td><td>Accept suitable equations showing acid rain formation or ozone depletion.<br><br>Accept photochemical smog/forms $NO_2$.</td><td>1 max</td></tr>
<tr><td>1.</td><td>(b)</td><td></td><td>$T = 200 + 273$ «K» ✓<br>«$n = PV/RT$»<br>«$n = \frac{(1.0\times10^{5})(1.0\times10^{-3})}{8.31(200+273)}$»<br>«$n$ =» 0.025 «mol» ✓<br>«0.10% × 0.025 =» $2.5\times10^{-5}$ «mol» ✓</td><td>Award [3] for correct final answer.</td><td>3</td></tr>
<tr><td>1.</td><td>(c)</td><td></td><td><table><tr><th>Element</th><th>Initial oxidation state</th><th>Final oxidation state</th></tr><tr><td>N/Nitrogen</td><td>+2</td><td>0</td></tr></table><br>N/nitrogen AND +2 → 0 ✓</td><td>Accept II but not 2 or 2+ instead of +2.</td><td>1</td></tr>
</table>

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| 2. | (a) | (i) |  ✓ | *Accept other forms of labelling instead of an arrow. Mark is for identifying the bond.* | 1 |
| 2. | (a) | (ii) | $Na_2CO_3(s) + 2HNO_3(aq) \rightarrow 2NaNO_3(aq) + H_2O(l) + CO_2(g)$ ✓ | | 1 |
| 2. | (b) | (i) |  ***OR***  ✓ | *Accept any combination of dots or crosses to represent electrons, or lines to represent electron pairs.*<br><br>*Charge must be shown, but square brackets are **not** required.*<br><br>*Do **not** accept delocalized structure.* | 1 |
| 2. | (b) | (ii) | $Ni(NO_3)_2$ ✓ | | 1 |

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| 3. | (a) | (i) | «mol styrene = $\frac{90}{100} \times \frac{1000}{8(12.01)+10(1.01)}$ »<br>«mol styrene =» 8.48 «mol» ✓<br>«mass styrene = 8.48 × (8(12.01) + 8(1.01)) = 882.88»<br>«mass styrene =» 880 «g» ✓ | *Award **[2]** for correct final answer in range 880-890 «g».* | 2 |
| 3. | (a) | (ii) | «$100 \times \frac{104.16}{106.18}$ »<br>= 98.1% ✓ | | 1 |

| | | | | | |
|---|---|---|---|---|---|
| **3.** | **(b)** | |  <br>two curves, each passing through a maximum ***AND*** *reaching* same energy level ✓<br>endothermic enthalpy change labelled ✓<br>both activation energies correctly labelled ✓ | *Do **not** penalize curve showing multiple steps for the catalysis in M1.*<br><br>*Accept double-headed arrows or lines in M2 and M3, but not arrows pointing down.* | **3** |
| **3.** | **(c)** | **(i)** |  <br>curve with peak higher ***AND*** to left ***AND*** decreasing at lower KE ✓ | *Do **not** award mark if line crosses x axis or rises above the 900K curve at high energy.* | **1** |

| | | | | | |
|---|---|---|---|---|---|
| **3.** | **(c)** | **(ii)** |  <br>✓ | *Accept a correct label on x-axis or on a drawn line.* | **1** |
| **3.** | **(c)** | **(iii)** | correct reference to area under curve «to right of $E_a$» ✓<br>fewer particles with E ≥ $E_a$ ✓ | | **2** |
| **3.** | **(c)** | **(iv)** | shifts left/to reactants ***AND*** more moles/molecules «gas» in products ✓ | | **1** |
| **3.** | **(c)** | **(v)** | «forward» reaction is endothermic ***AND*** shifts to left/reactants<br>***OR***<br>$E_{a\ fwd} > E_{a\ rev}$, so forward reaction more affected by temperature ***AND*** shifts to left/reactants ✓ | *Accept "exothermic reverse reaction is favoured".* | **1** |

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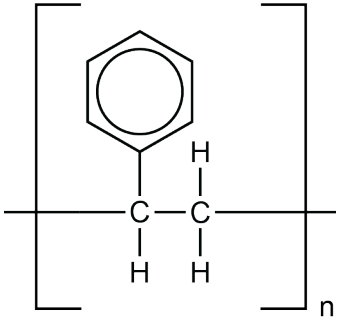
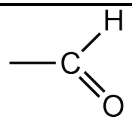
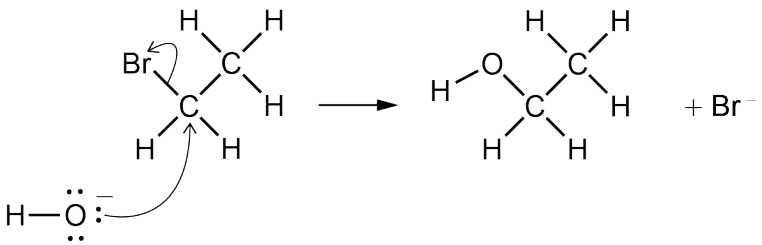
|---|---|---|---|---|---|
| **3.** | **(d)** | **(i)** |  <br>correct structure ✓<br>continuation bonds «through brackets» ✓ | *Accept $C_6H_5$ for benzene ring.* | **2** |
| **3.** | **(d)** | **(ii)** | addition ✓ | | **1** |
| **3.** | **(e)** | **(i)** | isomers ✓ | *Accept "same molecular formula".* | **1** |
| **3.** | **(e)** | **(ii)** | **Full structural formula** / **Functional group name** / **Homologous series**<br>  / carbonyl / aldehyde<br>structure ✓<br>carbonyl ***AND*** aldehyde ✓ | *Accept R/C attached to functional group in the full structural formula. Central C must have 4 bonds for M1.* | **2** |
| **3.** | **(e)** | **(iii)** | reflux ✓<br>oxidizing agent / oxidises B✓ | *Accept heat **OR** acidified for M1.* | **2** |

| | | | | | |
|---|---|---|---|---|---|
| **3.** | **(f)** | **(i)** | $\frac{[C_6H_5COO^-][H^+]}{[C_6H_5COOH]}$ | *Accept $H_3O^+$ for $H^+$.* | **1** |
| **3.** | **(f)** | **(ii)** | 20 «$cm^3$» | | **1** |
| **3.** | **(f)** | **(iii)** | «(0.020 × 0.010) ÷ 0.010 =»<br>0.020 «mol $dm^{-3}$» ✓ | | **1** |

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| **4.** | **(a)** | | nucleophilic substitution ✓ | *Accept $S_N2$, but **not** $S_N1$.* | **1** |
| **4.** | **(b)** | |  <br>curly arrow from lone pair or – to C ✓<br>curly arrow from bond to Br ✓<br>structural formulas of both organic reactant and product correct ✓ | *Do **not** accept condensed structural formulas.*<br>*Do **not** penalize if a candidate has SN1 mechanism if arrows are correctly placed.* | **3** |
| **4.** | **(c)** | | broken (C-Br)/285 ***AND*** formed (C-O)/358<br>***OR***<br>broken (5(414)+346+285+463) / 3164 ***AND*** formed (5(414)+346+358+463) / 3237 ✓<br><br>«$\Delta H$ = bond(s) broken – bond(s) formed =» –73 «kJ $mol^{-1}$» ✓ | *Award **[2]** for correct final answer.*<br>*Award **[1 max]** for +73 «kJ $mol^{-1}$».* | **2** |

| Question | | | Answers | Notes | Total |
|---|---|---|---|---|---|
| **5.** | **(a)** | | «two» more neutrons/n in $^{81}Br$ ✓ | | **1** |
| **5.** | **(b)** | | $79 \times 50.75\% + 81 \times 49.25\%$ ✓<br>$= 79.99$ ✓ | *Award **[2]** for correct final answer.*<br><br>*Do **not** accept 79.90, the value in the data booklet.* | **2** |
| **5.** | **(c)** | **(i)** | [Ar] $3d^{10}\,4s^2\,4p^5$ / [Ar] $4s^2\,3d^{10}\,4p^5$ ✓ | *Do **not** accept full electron configuration.* | **1** |
| **5.** | **(c)** | **(ii)** | «single» shared <u>pair</u> «of electrons» ✓ | *Accept Lewis formula.*<br><br>*Do **not** accept just "covalent".* | **1** |
| **5.** | **(c)** | **(iii)** | all have «only» London/dispersion forces ✓<br>stronger for molecules with more electrons ✓ | *Accept greater size/molar mass/M for M2.*<br>*M2 only awarded if IMF has been mentioned.* | **2** |
| **5.** | **(c)** | **(iv)** | *Equation:* $Br_2(aq) + 2I^-(aq) \rightarrow 2Br^-(aq) + I_2(aq)$ ✓<br>*Colour change:* yellow/orange ***AND*** to red/brown ✓ | *Accept that color is becoming darker-darker orange etc, but do **not** accept purple.*<br><br>*Accept correct equation that includes a cation.* | **2** |

| | | | | | |
|---|---|---|---|---|---|
| **5.** | **(c)** | **(v)** | bromine less easily reduced / weaker oxidising agent ✓ | *Accept converse argument.*<br><br>*Do **not** accept just "chlorine is more reactive".*<br><br>*Accept valid answer that reactivity decreases down group 17 or referring to $E^{\ominus}$.* | **1** |
| **5.** | **(c)** | **(vi)** | *Product at anode:* bromine / $Br_2(g)$ ✓<br>*Product at cathode:* cobalt / Co(s) ✓ | *Award **[1]** for correct products at incorrect electrodes.*<br><br>*Do **not** accept ions.* | **2** |