Markscheme

November 2025

Chemistry

Standard level

Paper 2

12 pages

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 underlined 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.

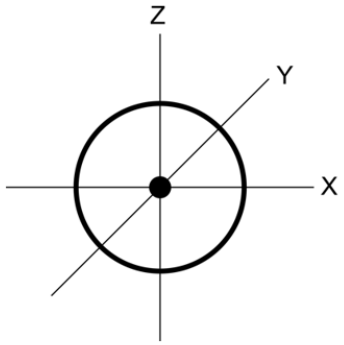
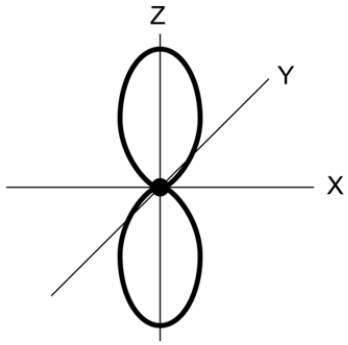
14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the "Notes" column.

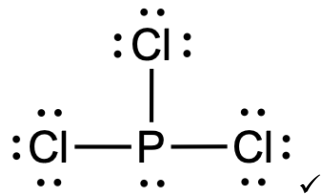
15. If a question specifically asks for the name of a substance, do not award a mark for a correct formula unless directed otherwise in the "Notes" column. Similarly, if the formula is specifically asked for, do not award a mark for a correct name unless directed otherwise in the "Notes" column.

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.

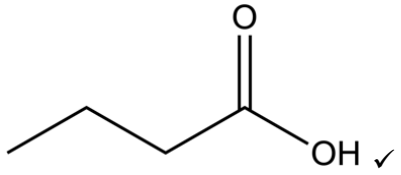
Ignore missing or incorrect state symbols in an equation unless directed otherwise in the "Notes" column.

Question			Answers	Notes	Total
1.	(a)	(i)	3p  3s  2p  2s  1s  *correct labels* ✓ *correct electron configuration* ✓	*3rd shell orbitals must be higher than 2nd shell for M2.*	**2**

1.	**(a)**	**(ii)**	 s-orbital  p-orbital *correct shape AND label for each.* ✓. ✓	*The p orbital must be aligned with an axis and the node must be at or close to the origin.* *Accept p-orbital aligned to any of the three axes.*	**2**
1.	**(a)**	**(iii)**	«electron removed from» higher orbital/shell/energy level / further away from the nucleus. ✓ more shielded/lower attractive force «between the nucleus and outer electron ». ✓	*Do not accept increase in atomic radius on its own for M1*	**2**
1.	**(b)**	**(i)**	«(7.75/30.97) × 6.02 x10^{23}» = 1.51 ×10^{23} ✓		**1**
1.	**(b)**	**(ii)**	«13.75 -7.75 = 6.00g of oxygen» «7.75/30.97, 6.00/16.00 =» = 0.250 mol P ***AND*** 0.375 mol O ✓ «0.375/0.250 =»1.5 ✓ P_2O_3 ✓	Award [1] for P_2O_3, if no working shown.	**3**
1.	**(b)**	**(iii)**	«empirical mass = 109.94 g mol^{-1}/ (219.88 ÷ 109.94 = 2)» P_4O_6 ✓	*Working must be shown*	**1**
1.	**(b)**	**(iv)**	simple / molecular ***AND*** «polar» covalent ✓ London dispersion forces/dipole-dipole / intermolecular forces are weak ✓		**2**

1.	**(b)**	**(v)**	«3.4−2.2 =1.2, (3.4+2.2)/2 = 2.8» Electronegativity difference is 1.2. ***AND*** Average electronegativity is 2.8 ✓ polar covalent ✓		**2**
1.	**(c)**		«3» covalent bonds ***AND*** «1» coordination bond ✓ covalent bond is a pair of shared electrons ***OR*** «electrostatic» attraction between shared pair of electrons and «positively charged» nuclei ***AND*** a coordination bond is a pair of shared electrons that originate on one atom ✓		**2**
1.	**(d)**		 ✓	*Accept any combination of lines and dots/crosses to represent electron pairs.*	**1**

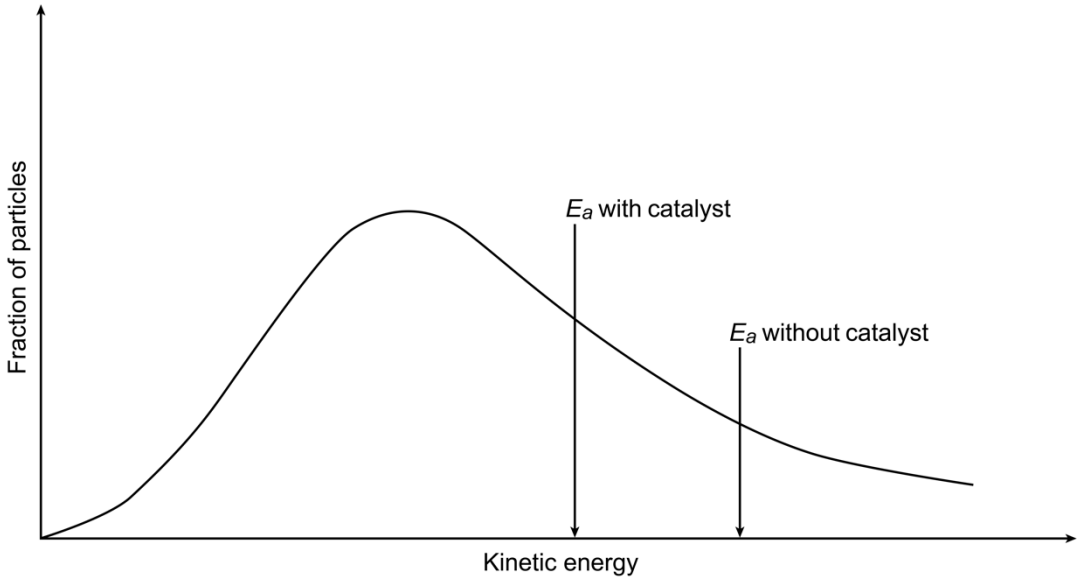
Question			Answers	Notes	Total
2.	(a)	(i)	nitrous acid/HNO_2 is not fully dissociated/is a weak acid. ***OR*** HCl is fully dissociated/is a strong acid.✓ «HNO_2» lower concentration of H^+ ions ***OR*** «HCl» higher concentration of H^+ ions. ✓		**2**
2.	(a)	(ii)	effervescence/bubbles «of hydrogen/H_2» ✓ rate of effervescence/production of bubbles/hydrogen production higher for HCl. ***OR*** higher/more volume of «hydrogen/H_2» gas produced in a shorter time for HCl. ✓	*Do **not** accept "hydrogen/H_2 gas produced" alone for M1.*	**2**
2.	(a)	(iii)	conjugate acid H_3O^+«(aq)» ***AND*** conjugate base H_2O«(l)» ✓ conjugate acid HNO_2«(aq)» ***AND*** conjugate base NO_2^-«(aq)» ✓		**2**
2.	(a)	(iv)	+3 ✓	*Accept (III).* *Do **not** accept 3+ or 3.*	**1**
2.	(b)	(i)	IUPAC/ international system to name substances/ systematic naming. ✓ names based on their structure/ following rules based on their structure. ✓		**2**

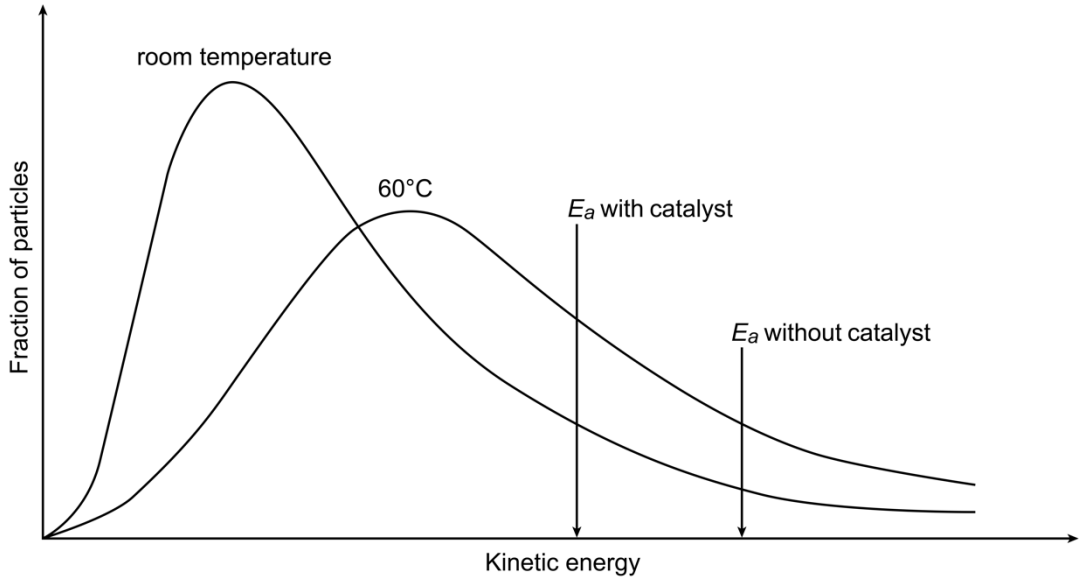
2.	**(b)**	**(ii)**	carboxyl ✓ phenyl «ring» ✓	*Do **not** accept carboxylic acid/benzene/aromatic ring*	**2**
2.	**(b)**	**(iii)**	 ✓ butanoic acid ✓	*Accept any valid isomer of $C_4H_8O_2$ that is **not** an ester for M1 or M2* *Do **not** accept molecular formula for M1.*	**2**
2.	**(b)**	**(iv)**	increases rate of reaction ✓ lowers activation energy / by providing an alternative/lower energy pathway / greater number of particles have energy greater than activation energy ✓		**2**
2.	**(b)**	**(v)**	ultraviolet/UV«light»	*Accept sunlight.* *Do **NOT** accept light.* *Accept heat.*	**1**

2.	**(b)**	**(vi)**	$C_2H_6 + Cl\bullet \rightarrow \bullet C_2H_5 + HCl$ ✓ $\bullet C_2H_5 + Cl_2 \rightarrow C_2H_5Cl + Cl\bullet$ ✓ $Cl\bullet + \bullet C_2H_5 \rightarrow C_2H_5Cl$ ***OR*** $2Cl\bullet \rightarrow Cl_2$ ***OR*** $2\bullet C_2H_5 \rightarrow C_4H_{10}$✓	*Award **[2 max]** if the radical is not shown or is missed in any step.*	**3**
2.	**(c)**	**(i)**	***Alternative 1:*** *«bonds broken»* *1½ O=O + 4C–H + Cl–Cl / 1½×498 + 4×414 + 242 / 2645 «kJ mol^{-1}»* ✓ *«bonds formed»* *C=O + 2C-O + 2H-O + 2H–Cl / 804 + 2×358 + 2×463 + 2×431 / 3308 «kJ mol^{-1}»* ✓ *ΔH = «2645 – 3308 =» –663 «kJ mol^{-1}» (correct calculation: reactants-products)* ✓ ***OR*** ***Alternative 2:*** *«Bonds broken» [12(414) + 2(346) + 242 + 1.5(498)] = 6649*✓ *«Bonds formed» [8(414) + 804 +2(358) +2(346) + 2(431) +2(463)] = 7312.* ✓ *ΔH = «6649 – 7312 =» –663 «kJ mol^{-1}» (correct calculation: reactants-products)* ✓	*Award **[3]** for correct final answer.* *Award **[2 max]** for +663 «kJ mol^{-1}».* *Accept breaking and remaking all the other bonds.*	**3**
2.	**(c)**	**(ii)**	bond enthalpy values are averages / not specific to this reaction ***OR*** bond enthalpies apply to gases but this reaction involves liquids ***OR*** the second set of data was specific to the reaction. ✓		**1**

2.	**(d)**		$\frac{88.12\,g\,mol^{-1}}{2 \times 30.08\,g\,mol^{-1} + 70.90\,g\,mol^{-1} + {}^{3}/_{2} \times 32.00\,g\,mol^{-1} / (88.12/179.06)} \times 100$ ✓ 49.21% ✓	*Award **[2]** for correct final answer.*	**2**

Question			**Answers**	**Notes**	**Total**
3.	**(a)**	**(i)**	«K =» $\frac{[C_4H_8O_2]\,[H_2O]}{[C_2H_6O]\,[C_2H_4O_2]}$ ✓	*Do not accept expression without H_2O.*	**1**
3.	**(a)**	**(ii)**	«amount of» ethanol = 0.2 «mol» ✓ «amount of» ethyl ethanoate = 0.4 «mol» ***AND*** «amount of» water = 0.4 «mol» ✓		**2**
3.	**(a)**	**(iii)**	value would be higher ***AND*** reaction is exothermic in the forward direction/equilibrium will shift to the right ✓		**1**

3.	**(b)**	**(i)**	 correct shape curve starting at the origin, without touching the x axis at high energy. ✓ (E_a) catalysed < (E_a) uncatalysed on x axis. ✓		**2**

3.	**(b)**	**(ii)**	 curve with peak higher ***AND*** to left ***AND*** decreasing at lower KE and labelled. ✓	*Accept the correct label on either or both curves.* *Do **not** award mark if line crosses x axis or rises above the 60 C curve at high energy.*	**1**