Markscheme

May 2024

Chemistry

Standard

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 <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.

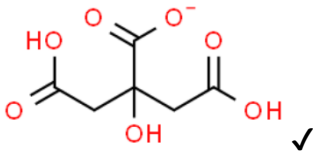
16. If a question asks for an equation for a reaction, a balanced symbol equation is usually expected, do not award a mark for a word equation or an unbalanced equation unless directed otherwise in the "Notes" column.

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

Question			Answers	Notes	Total
1.	(a)	(i)	mol (citric acid) = $\frac{0.45}{192.14}$ = 0.00234 ✓ mol ($NaHCO_3$) = $\frac{0.25}{84.01}$ = 0.00298 ✓ 0.00298÷3 = 0.000992 mol therefore $NaHCO_3$ is LR✓	*Award 1 mark for 2 correct masses of reactants or molar masses* *Accept sodium hydrogen carbonate for M3* *Only award M3 if it is correctly based on previous mole calculations*	**3**
1.	(a)	(ii)	1:1, so 0.00298 mol ✓ $\frac{(0.00298 \cdot 8.31 \cdot 298)}{100}$ = 0.0738 « dm^3 »✓		**2**
1.	(a)	(iii)	$100 \cdot \frac{0.043}{0.0738}$ = 58.4 % ✓		**1**
1.	(b)	(i)	three ✓		**1**

(continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	(b)	(ii)	 ✓ [Source: With permission from The Royal Society of Chemistry]		1
1.	(b)	(iii)	weak ***AND*** organic/carboxylic acid /has -COOH ✓	*Accept weak **AND** partially dissociated.*	1
1.	(c)		-log(0.0025) = 2.60 ✓	*Accept 2.6*	1

Question			Answers	Notes	Total
2.	(a)	(i)	400.00 * 4.18 * 21.0 = 35 112 = 35 100 J ✓	*Accept 35.1 kJ*	1
2.	(a)	(ii)	21±1 ✓ « $100 * \frac{0.02}{400.00}$ + $100 * \frac{1.0}{21}$ = 0.005 + 4.76 = » 4.77 % ✓	*Accept 4.76 (if only temperature uncertainty used).* *Accept correct final answer for 2 marks*	2

(continued…)

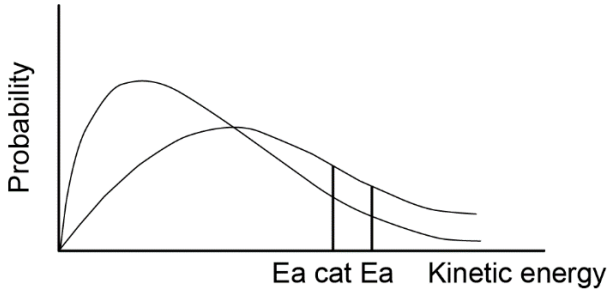
(Question 2 continued)

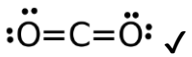
Question			Answers	Notes	Total
2.	**(a)**	**(iii)**	repeat experiment ***AND*** take average ✓	*Accept increase amount of water* *Accept allow experiment to run longer to have greater ΔT* *Accept more precise thermometer / temperature probe / digital thermometer.* *Accept more precise balance /scale* *Do not accept more precise equipment without names.* *Do not accept references to accuracy*	**1**
2.	**(b)**	**(i)**	36.03 + 8.08 + 16.00 = 60.11 1.80/60.11 = 0.0299 ✓ –35100/0.0299 = –1200 kJ mol^{-1} ✓ *Assumption: (any one from)* - propan-1-ol only ingredient to release heat - gel is pure propan-1-ol - no heat loss - all heat transferred to water - no heat absorbed by copper - complete combustion ✓	*Accept –1000 to –1004 kJ mol^{-1} if 30 000 used.* *M2 can only be awarded for exothermic answer.*	**3**
2.	**(b)**	**(ii)**	« $\frac{100(-1200--2021)}{-2021}$ = – » 40.6% ✓	*Accept answers in the range of 40-43%* *Ignore negative signs* *Accept 50% if 30 kJ used in 2bi*	**1**

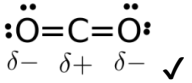
(continues...)

(Question 2 continued)

Question			Answers	Notes	Total
2.	**(b)**	**(iii)**	heat loss ***AND*** insulate the calorimeter ✓	*Accept heat loss **AND** decrease distance between calorimeter and flame.* *Accept heat loss **AND** use screens to prevent drafts / OWTTE.* *Accept heat loss and use a closed system / food calorimeter* *Accept heat loss and use a calorimeter with a low heat capacity.* *Do not accept Styrofoam / coffee cup calorimeter* *Do not accept "add a lid"*	**1**
2.	**(c)**	**(i)**	alcohol ✓ hydroxyl ✓	*Award **[1 max]** for both answers, but the wrong way around.* *Accept "hydroxy", but not "hydroxide"* *Ignore references to R-OH or other formula*	**2**
2.	**(c)**	**(ii)**	hydrogen bonding ✓		**1**
2.	**(c)**	**(iii)**	London/dispersion forces ✓	*Accept instantaneous / induced dipoles.* *Do not accept van der Waals' forces*	**1**

Question			Answers	Notes	Total
3.	**(a)**		$\frac{[CO]\,[H_2]^3}{[CH_4]\,[H_2O]}$ ✓	*Square brackets required*	**1**
3.	**(b)**		shifts right/towards products ***AND*** endothermic/$\Delta H>0$ ✓		**1**
3.	**(c)**		temp labelled appropriately (*eg*: low, high / T1, T2) ✓ Ea line ✓ more molecules with KE > Ea at higher T ✓	*Higher temperature line must be identified eg: T2 > T1*	**3**
3.	**(d)**		 two Ea lines appropriately labelled, *eg*: Ea and Ea cat ✓		**1**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>4.</td><td>(a)</td><td>(i)</td><td>+2 AND +4 ✓</td><td>Accept II/2 AND IV/4
Do not accept 2+ and 4+</td><td>1</td></tr>
<tr><td>4.</td><td>(a)</td><td>(ii)</td><td><table><tr><td></td><td>CO(g)</td><td>$H_2O(g)$</td></tr><tr><td>Oxidising or reducing agent?</td><td>reducing</td><td>oxidising</td></tr><tr><td>Species oxidised or reduced?</td><td>oxidised</td><td>reduced</td></tr></table>✓✓</td><td>Award [1] for every two correct.</td><td>2</td></tr>
<tr><td>4.</td><td>(b)</td><td>(i)</td><td>  ✓</td><td>Accept any combination of dots and crosses or lines.

Ignore non linear drawing of correct Lewis structure.</td><td>1</td></tr>
<tr><td>4.</td><td>(b)</td><td>(ii)</td><td>  ✓</td><td>Accept only one correct δ+ and δ-</td><td>1</td></tr>
<tr><td>4.</td><td>(b)</td><td>(iii)</td><td>linear AND two domains «repel» ✓

non-polar AND polar bonds cancel / symmetrical distribution of charge ✓</td><td>Accept OWTTE two domains

Accept non polar and no net dipole

Award [1] mark if correctly states “linear and non-polar" without correct explanations.</td><td>2</td></tr>
</table>

(continued…)

(Question 4 continued)

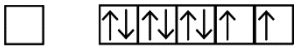
Question			Answers	Notes	Total
4.	**(b)**	**(iv)**	CO_2 greenhouse gas ***OR*** CO_2 absorbs IR ✓ global warming/climate change ***OR*** doesn't cause local pollution, but acts on a global scale / *OWTTE* ✓	*Accept ocean acidification for M2*	**2**
4.	**(b)**	**(v)**	less ***AND*** exothermic/energy released «combustion of CO to form CO_2 » ***OR*** CO is less stable as it has a higher enthalpy ✓	*Accept CO burns in air/oxygen*	**1**

Question			Answers	Notes	Total
5.	**(a)**		$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$ ***OR*** $[Ne]\ 3s^2\ 3p^4$ ✓	*Do not accept subscripts instead of superscripts*	**1**
5.	**(b)**		*Any one of:* insulator/non-conductor «of electricity/heat» ***OR*** brittle ***OR*** dull ✓	*Accept other **physical** property.* *Do not accept answers based on electron configuration*	**1**

(continued…)

(Question 5 continued)

Question			Answers	Notes	Total
5.	**(c)**		$SO_2 + H_2O \rightarrow H_2SO_3$ ***OR*** $SO_3 + H_2O \rightarrow H_2SO_4$ ✓		**1**

Question			Answers	Notes	Total
6.	**(a)**		« 58 * 0.68 + 60 * 0.26 + 61 * 0.010 + 62 * 0.04 + 64 * 0.01 = » 58.77 ✓	*Do not accept 58.69 (in data booklet)*	**1**
6.	**(b)**	**(i)**	$^{58}_{28}Ni^{2+}$ ✓		**1**
6.	**(b)**	**(ii)**	 4s 3d ✓	*Accept single or double headed arrows* *Do not award ECF from 6b(i)*	**1**
6.	**(b)**	**(iii)**	electrostatic attraction between « oppositely charged » ions ✓ ions unable to move / held in lattice unless melted *OR* Ions can only move when solid is melted✓	*Do not accept just "ionic bonding" for M1.* *Accept delocalised ions (not electrons)*	**2**

Question			Answers	Notes	Total
7.	**(a)**		bond length: C-C > benzene > C=C ***AND*** bond strength: C-C < benzene < C=C ✓	*Do not just accept values from the data booklet without a comparison of the **3** bonds in each answer*	**1**
7.	**(b)**		resonance ✓ undisrupted ***OR*** stability maintained ✓	*Accept delocalised electrons*	**2**