Marking Schemes

This document was prepared for markers' reference. It should not be regarded as a set of model answers. Candidates and teachers who were not involved in the marking process are advised to interpret its content with care.

Chemistry
Paper 1

SECTION A

Question No.	Key	Question No.	Key
Part I		**Part II**	
1.	C (92%)	25.	C (66%)
2.	A (68%)	26.	B (69%)
3.	B (40%)	27.	D (78%)
4.	B (83%)	28.	D (66%)
5.	A (59%)	29.	B (50%)
6.	C (69%)	30.	A (75%)
7.	B (83%)	31.	C (58%)
8.	B (82%)	32.	C (74%)
9.	C (76%)	33.	A (81%)
10.	C (83%)	34.	D (64%)
11.	A (69%)	35.	B (86%)
12.	D (43%)	36.	A (72%)
13.	D (70%)		
14.	A (78%)		
15.	B (24%)		
16.	D (67%)		
17.	C (81%)		
18.	B (84%)		
19.	A (70%)		
20.	D (49%)		
21.	D (53%)		
22.	C (72%)		
23.	D (80%)		
24.	A (78%)		

Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.

General Marking Instructions

1. In order to maintain a uniform standard in marking, markers should adhere to the marking scheme agreed at the markers' meeting.

2. The marking scheme may not exhaust all possible answers for each question. Markers should exercise their professional discretion and judgment in accepting alternative answers that are not in the marking scheme but are correct and well reasoned.

3. In questions asking for a specified number of reasons or examples etc. and a candidate gives more than the required number, the extra answers should not be marked. For instance, in a question asking candidates to provide two examples, and if a candidate gives three answers, only the first two should be marked.

4. In cases where a candidate answers more questions than required, the answers to all questions should be marked. However, the excess answer(s) receiving the lowest score(s) will be disregarded in the calculation of the final mark.

5. Award zero marks for answers which are contradictory.

6. Chemical equations should be balanced except those in reaction schemes for organic synthesis. For energetics, the chemical equations given should include the correct state symbols of the chemical species involved.

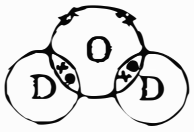
7. In the question paper, questions which assess candidates' communication skills are marked with an asterisk (*). For these questions, the mark for effective communication (1 mark per question) will be awarded if candidates can produce answers which are easily understandable. No marks for effective communication will be awarded if the answers produced by candidates contain a lot of irrelevant materials and/or wrong concepts in chemistry.

SECTION B

Part I

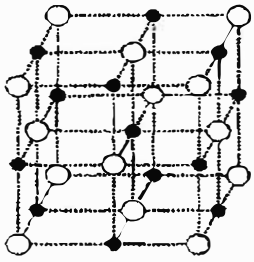
Marks

1. (a) Protium and deuterium have same number of protons but different numbers of neutrons. / Protium and deuterium have same atomic number but different mass numbers. 1

(b) 
 1

(c) (i) Any TWO of the following (1 mark for each point): 2
- Colourless gas evolves.
- Sodium metal dissolves. / Sodium drags / moves on the surface of $D_2O(l)$.
- Sparks are observed. / Flame is observed. / Sodium burns. / Heat evolves. / White fume evolves. / Hissing sound is heard.

(ii) $2Na + 2D_2O \rightarrow 2NaOD + D_2$ 1

2. (a)  1

(b) (i) Total mass of 4 Na^+ ions and 4 Cl^- ions 1
$= (23.0 + 35.5) \times 4 / L = 234 / L$ (g)

(ii) $234 / L = 2.17 \times 1.80 \times 10^{-22}$ 2
$L = 5.99 \times 10^{23}$ (mol^{-1})

3. (a) (i) bromine in organic solvent 1

(ii) • $CH_3–CH=CH–CH_3 + Br_2 \rightarrow CH_3–(CHBr)_2–CH_3$ 1
• But-2-ene / An alkene reacts with Br_2, and Br_2 is decolourised / all Br_2 is consumed / a colourless product is formed. 1

(b) • Gas X may be ammonia / NH_3. 1
• $NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$ 1
• $OH^-(aq)$ turns phenolphthalein pink. / Ammonia / The gas / The solution is alkaline, and it turns phenolphthalein pink. 1

Marks

4. (a) (i)
- Dissolve the solid by adding deionised / distilled water to the solid in a beaker. 1
- Transfer the solution with rinsing with deionised / distilled water into a 250.0 cm^3 volumetric flask and add deionised / distilled water to the graduation mark of the flask and shake thoroughly. 1

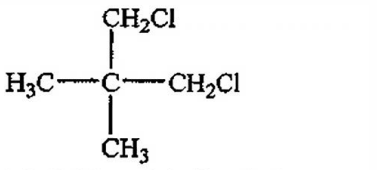
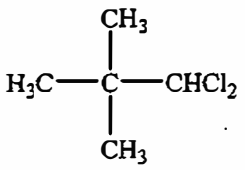
(ii) molarity of the standard solution = (1.12 / 204.1) ÷ 0.2500 2
= 0.022 (M)

(b)
- If it ionises completely in water, $[H^+(aq)] = 0.060$ M then the pH will be 1.22. 1
- However, the actual pH (3.30) is higher than 1.22, therefore the –COOH group in potassium hydrogenphthalate only ionises partly in water. 1

5. (a) chlorine / Cl_2 1

(b) light / *hν* / ultra-violet / UV / radical initiator 1

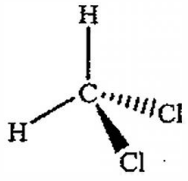
(c) substitution reaction 1

(d) (i)  or  1

1,3-dichloro-2,2-dimethylpropane 1,1-dichloro-2,2-dimethylpropane 1

(ii) The structure other to the answer in (i) 1

(iii) structural isomer 1

6. (a)  1

(b) (i) The polarities of bonds in CCl_4 cancel out each other while those in CH_2Cl_2 do not. 1

(ii)
- CCl_4 has a larger molecular size than that of CH_2Cl_2. 1
- Therefore, it has stronger van der Waals' forces between molecules / intermolecular forces, and hence a higher boiling point. 1

Marks

7. (a) (i) Separate the $CuSO_4(aq)$ and $MgSO_4(aq)$. / Allow ions to pass through. / Complete the circuit. 1

(ii) Yes. The multimeter reading is positive showing electrons flowing from Mg to Cu through the external circuit as Mg loses electrons more readily than Cu. 1

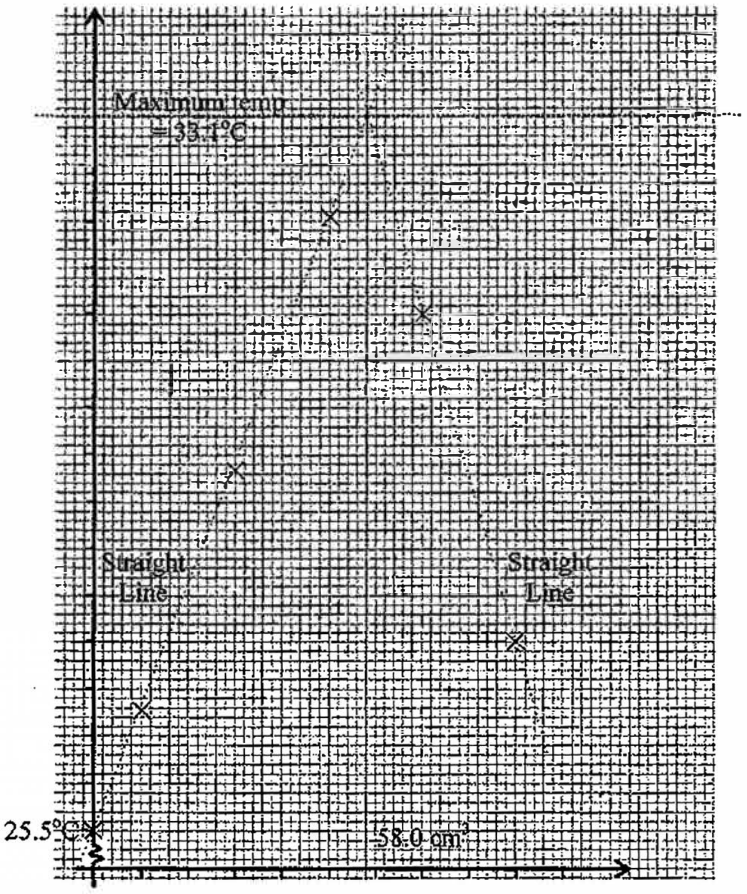
(iii) $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ 1

(b) (i) $Br_2(aq) + 2e^- \rightarrow 2Br^-(aq)$ 1

(ii) The size of the electrode decreases. / Colour around the electrode deepens. 1

(iii) • less negative 1
• Iodine gains electrons less readily than bromine. 1

8. (a) 1



(b) (i) No. of moles of NaOH(aq) used = $1.0 \times (58.0 \div 1000) = 0.058$ 2
$\because$ At equivalent point, no. of moles of NaOH(aq) used = No. of moles of HCl(aq) reacted
$\therefore$ No. of moles of HCl(aq) reacted = 0.058
Concentration of HCl(aq) = $0.058 \div (42.0 \div 1000) = 1.38$ mol dm^{-3}

(ii) Energy released during the reaction = $100.0 \times 1.0 \times 4.18 \times (33.1 - 25.5) = 3176.8$ J 2
Enthalpy change of neutralisation = $-3176.8 \div (0.058 \times 1000) = -54.77$ (kJ mol^{-1})

(c) The term means the enthalpy change when an acid solution and a base / an alkali solution react together under standard conditions to produce 1 mole of water. 1

Marks

9. (a) (i) Prevents the iron from contacting with air / oxygen / water. 1

(ii) Yes. These iron cans corrode more readily as tin is less reactive than iron. 1

(iii) Zinc ions are toxic and may contaminate the food. 1

(b) (i) Aluminium has an impervious / impermeable layer of oxide / aluminium oxide on the surface. 1

(ii) anodisation 1

(iii) It has a low density / is malleable / is easy to mould / recycle / dye. 1

10. Chemical knowledge 4

- Dissolve the sample in distilled water.
- Add excess Zn(s) to the sample solution.
- Filter to collect $ZnSO_4(aq)$.
- Evaporate the filtrate, allow $ZnSO_4$ solid to crystallise out / collect crystals and then dry with filter paper / in a desiccator.

Communication mark 1

Part II

Marks

11. (a) $CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + CO_2(g) + H_2O(l)$ / $CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + CO_2(g) + H_2O(l)$ — 1

(b) (i) $(82.8 - 82.0)\ g / (12 - 2)\ min$ — 2
$= 0.08\ g\ min^{-1}$
OR
$(82.8–82.0)g / [(12–2)\times 60]s$
$=1.33\times10^{-3}\ g\ s^{-1}$

(ii) • The slope / curvature of the tangent of the curve at t=0 for Trial 2 is larger than that for Trial 1. — 1
• It shows a higher initial rate of reaction as the concentration of HNO_3 / H^+ in Trial 2 is higher than that in Trial 1. — 1
OR
• The decrease in mass for Trial 1 is smaller than that for Trial 2.
• Less CO_2 is given out in Trial 1 because the number of moles of HNO_3 / H^+ used in Trial 1 is less than that in Trial 2.

(c) Use same mass of calcium carbonate of different sizes to perform the experiment, all other conditions of the experiment should be kept unchanged. — 1

12. (a) $[Fe(SCN)^{2+}(aq)] / [Fe^{3+}(aq)][SCN^-(aq)]$ — 1

(b) $Fe^{3+}(aq) + SCN^-(aq) \rightleftharpoons Fe(SCN)^{2+}(aq)$ — 3
$0.020 - x \quad 0.010 - x \quad x$
$x / (0.020 - x)(0.010 - x) = 1.08 \times 10^3$
$x = 0.0217$ mol dm^{-3} (rejected since larger than both 0.020 and 0.010)
$x = 9.21 \times 10^{-3}$ mol dm^{-3}

(c) Increasing of K_c means that the equilibrium position shifts to the right / product side, hence the ΔH should be positive. — 1

(d) • $Na_2SO_3(s)$ added reacts with $Fe^{3+}(aq)$ so as to decrease the concentration of $Fe^{3+}(aq)$. — 1
• The equilibrium position shifts to the left / reactant side. The concentration of $Fe(SCN)^{2+}$ decreases, so the colour of the mixture becomes paler. — 1

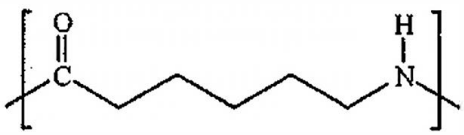
Marks

13. (a) (i) ethanal / acetaldehyde / CH_3CHO 1

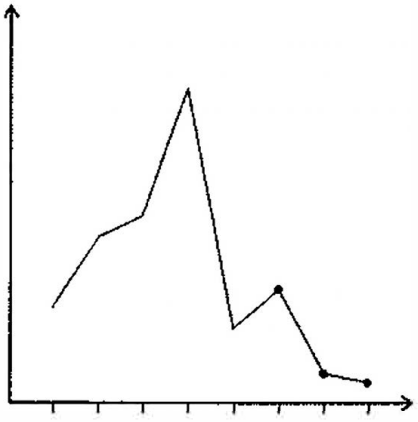
(ii) It is because ethanal has a low boiling point / is volatile, so was easily distilled off / vaporised out and cannot be further oxidised to give ethanoic acid. 1

(b) (i) ethanamide 1

(ii) 1. PCl_3 2. NH_3 1

(c) (i)  1

(ii) As there is no losing of small molecules during the polymerisation, it can be regarded as no condensation is involved. 1

14. (a)  1

(b) The metallic bond in Mg is stronger than that in Na as Mg has more delocalised electrons / more outermost shell electrons than Na. OR
The metallic bond in Mg is stronger than that in Na as Mg has two outermost shell delocalised electrons while Na has one only. 1

(c) • Melting of Si needs high energy to break the strong covalent bonds between Si atoms in the giant covalent structure. 1
• Melting of P only needs smaller energy to break the weak intermolecular forces. / P has a simple molecular structure, there are weak van der Waals' forces between molecules. 1

15. Chemical knowledge (1 mark for each point, a maximum of 4 marks) 4
- It reduces the water surface tension so that water can spread and wet the surfaces.
- The hydrocarbon tails of the detergent particles dissolve in oil (hydrophobic).
- The ionic heads of the detergent particles dissolve in water (hydrophilic).
- Water molecules attract the hydrophilic ionic heads and bring the oil into water.
- By stirring, the oil breaks up into tiny droplets and these droplets cannot come together again due to the repulsion between ionic heads / negative charges.

Communication mark 1

Paper 2

Marks

1. (a) (i) The Haber process produces ammonia / NH_3 which can make fertilisers to increase crop yield. 1

(ii) (1) $CH_4 + H_2O \rightarrow CO + 3H_2$ 1

(2) It is because biomass is a renewable energy resource. 1

(iii) • Comparing Trial 3 with Trial 2 (both same in [B(aq)], doubling the [A(aq)] leads to a double of the initial rate. Hence, the order of reaction with respect to A(aq) = 1. 1

• Comparing Trial 1 with Trial 2 (both same in [A(aq)], doubling the [B(aq)] leads to four times of the initial rate. Hence, the order of reaction with respect to B(aq) = 2. 1

(b) (i) • Use concentrated sodium chloride solution / brine as electrolyte. 1

• Anode : $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ 1

• Cathode : $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ 1

• The membrane is permeable to cations but not anions. 1

(ii) $Cl_2(g) + 2NaOH(aq) \rightarrow NaOCl(aq) + NaCl(aq) + H_2O(l)$ 1

(iii) Atom economy for Reaction (I) = 32 / 108.5 = 29.5 % 2
Atom economy for Reaction (II) =32 / 68 = 47.1 %
Reaction (II) is greener as it has a higher atom economy.

(c) (i) limestone / marble 1

(ii) Carbon burns in air to produce heat. 1

(iii) • High operation pressure needs high construction cost. 1

• High operation pressure shifts the equilibrium position to the left, decreasing the yield. 1

(iv) 3

$$\log\left(\frac{k_2}{k_1}\right) = \frac{E_a}{2.3R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\log\left(\frac{k_2}{k_1}\right) = \frac{160\times10^3}{2.3\times8.31}\left(\frac{1}{1200} - \frac{1}{1500}\right)$$

$$\frac{k_2}{k_1} = 24.8$$

(v) Higher temperature shifts the equilibrium position to the right, increasing the yield. 1

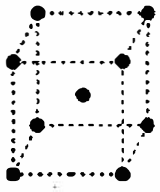
Marks

2. (a) (i) • Cellulose consists of many polar hydroxyl groups. 1
• The hydroxyl groups attract water molecules by hydrogen bonds. 1

(ii)  1

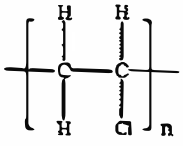
(iii) • Catalyst is used. 1
• High atom economy (100%) 1

(b) (i) body-centred cubic 1

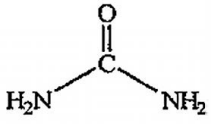
 1

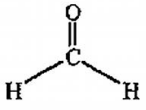
(ii) Alloy **B**
• It does not contain poisonous lead compounds. 1
• Its melting point is relatively low. 1

(iii) Brass is harder / is more corrosion resistant / has a more appealing appearance than copper. 1

(iv) (1)  1

(2) extrusion moulding 1

(c) (i) (1)  1

 1

(2) condensation polymerisation 1

(ii) (1) sulphur 1

(2) vulcanisation 1

(iii) (1) **Z** is elastic whereas **X** is rigid. 1

(2) • **Z** has a cross-linking structure whereas **Y** has a linear structure. 1
• Hence, **Z** is more heat-resistant / abrasion-resistant than **Y**. 1

Marks

3. (a) (i) • IR Peak at 2070 – 2250 cm^{-1} corresponds to C≡C. 1
• Relative molecular mass of 40.0 confirms it to be $HC{\equiv}CCH_3$. 1

(ii) immiscible with water / low boiling point / easily evaporate 1

(iii) • Heat with Tollen's reagent. 1
• Only A gives silver mirror. 1

(b) (i) It is to prevent the formation of solid Ag_2CO_3 etc. 1

(ii)  1

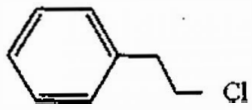
Correct labelling :
Burette, conical flask, KSCN(aq), acidified bacon sample with $AgNO_3$(aq) 1

(iii) No. of mole of KSCN(aq) = No. of mole of Ag^+(aq) left in the mixture = No. of mole of Ag^+(aq) reacted with KSCN(aq) = 0.1×0.00942 4
No. of mole of AgCl formed
$= 1.0 \times 0.0025 - 0.1 \times 0.00942 = 0.001558$
Percentage by mass of sodium = $(0.001558 \times 23.0 / 2.0) \times 100\%$
$= 1.79\%$

(c) (i) (1) • Different substances have different adsorptivity to the stationary phase. 1
• They have different solubility in mobile phase. 1

(2) column chromatography 1

(ii) The chemical species for the peak at m/z = 91 may be $C_6H_5CH_2^+$. 1
The chemical species for the peak at m/z = 140 may be $C_6H_5CH_2CH_2{}^{35}Cl^+$. 1
(or m/z = 142 may be $C_6H_5CH_2CH_2{}^{37}Cl^+$)
Possible structure :



1

(iii) (1) High levels of dioxins may cause cancer. 1

(2) Modern instrumentation is accurate and sensitive enough to measure very low levels of dioxins. 1