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. Part I	Key	Question No. Part II	Key
1.	B (56%)	25.	D (76%)
2.	C (70%)	26.	B (71%)
3.	D (78%)	27.	A (57%)
4.	D (60%)	28.	B (69%)
5.	C (80%)	29.	B (48%)
6.	B (65%)	30.	D (83%)
7.	B (68%)	31.	B (43%)
8.	C (82%)	32.	D (45%)
9.	A (59%)	33.	A (58%)
10.	A (63%)	34.	C (55%)
11.	D (50%)	35.	A (59%)
12.	B (79%)	36.	C (65%)
13.	B (75%)		
14	C (49%)		
15.	C (83%)		
16.	A (65%)		
17.	D (42%)		
18.	A (66%)		
19.	D (68%)		
20.	A (63%)		
21.	B (41%)		
22.	A (72%)		
23.	C (47%)		
24.	C (48%)		

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.

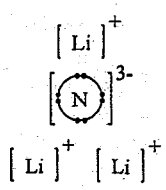
SECTION B

Part I

Marks

1. (a) (i) $6.0\,x + 7.0\,(1-x) = 6.9$ 2
$x = 0.1 = 10.0\%$

(ii) 1

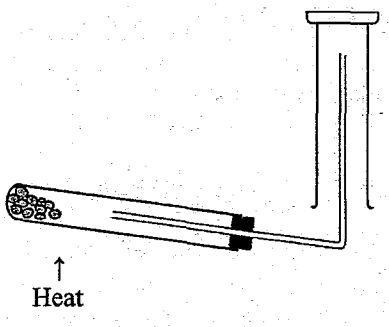


(b) (i) $6Li + N_2 \rightarrow 2Li_3N$ 1

(ii) $y / 6.9 = 3 \times (1.25 / 34.7)$ 2
$y = 0.746$ g

(c) lithium oxide / lithium peroxide 1

2. (a) 2



(b) (i) Ammonia is soluble in water / Ammonia reacts with water to form aqueous ammonia. 1
As all ammonia dissolves, the atmospheric pressure forces the water in the trough to inject into the flask through the glass tube. 1

(ii) The water in the flask turns from colourless to pink. 1
It is because aqueous ammonia is alkaline. 1

Marks

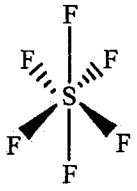
3. (a) The electrostatic attraction between Ba^{2+} and Cl^- in $BaCl_2$ is ionic bond while intermolecular attraction between OCl_2 molecules are van der Waals' forces. / $BaCl_2$ is an ionic compound while OCl_2 has a simple molecular structure. 1

As ionic bond is much stronger than van der Waals' forces / intermolecular forces between OCl_2 molecules, $BaCl_2$ would have a higher melting point than OCl_2. 1

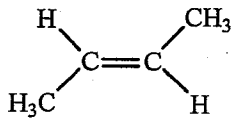
(b) • Both molecules of PH_3 and CH_4 are held by van der Waals' forces / intermolecular forces. 1

• The van der Waals' forces between PH_3 are stronger that that between CH_4 because of the larger molecular size of PH_3 than CH_4. / Intermolecular forces between PH_3 molecules are stronger than that between CH_4 molecules as PH_3 is polar while CH_4 is non-polar. 1

• Hydrogen bond exists among NH_3 molecules that is stronger than van der Waals' forces. 1

(c)  1

4. (a) Petroleum is formed when large quantities of dead marine organisms, such as planktons and algaes, that are buried underneath sedimentary rock and subjected to intense heat and pressure for a long time. 2

(b) (i)  1

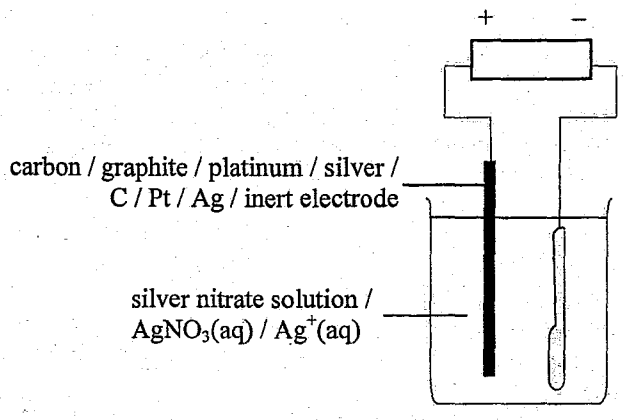
(ii) but-1-ene or methylpropene 1

(c) (i) Pass excess H_2 to ethene in the presence of Pt / Pd / Ni. / catalytic hydrogenation 1

(ii) Ethene turns Br_2(in CH_3CCl_3) from brown / orange to colourless while ethane does not. 2

Marks

5. (a)



2

(b) • Connect zinc/magnesium blocks to the surface of the pipelines. / sacrificial protection 1
• Zinc/Magnesium can release electrons more readily than iron. 1
OR
• Connect the negative electrode of a D.C. source to the surface of the pipelines. / cathodic protection
• The electrons provided by the D.C. source prevent iron from releasing electrons.

6. (a) (i) $6CO_2(g) + 6H_2O(l) \rightarrow C_6H_{12}O_6(s) + 6O_2(g)$ 1

(ii) $\Delta H = -1274 - 6 \times (-394-286)$ 2
$= +2806 \text{ kJ mol}^{-1}$

(iii) Light energy changes to chemical energy. 1

(b) (i) Let C be the heat capacity of the calorimeter. 3
$-715 \times (1.58 / 32.0) = -C \times 18.5$
$\Delta H \times (1.02 / 100.0) = -C \times 25.8$
$\Delta H = -4826.8 \text{ kJ mol}^{-1}$

(ii) Some methanol or heptane evaporates. / incomplete combustion 1

7. (a) conical flask 1

(b) yellow to orange 1

(c) Number of moles of $B_4O_7^{2-}(aq) = 0.125 \times 0.01898 \times ½ = 1.187 \times 10^{-3}$ 3
$(201.2 + 18n) = 0.452 / 1.187 \times 10^{-3}$
$n = 10$

(d) (i) solutions with accurately known concentrations 1

(ii) It can be used to determine the concentration of another reagent / number of water of crystallisation / molar mass, etc. 1

Marks

8. (a) An acid which can almost completely ionise in water. 1

(b) (i) chlorine / $Cl_2(g)$ 1

(ii) It is a redox reaction: oxidation number of Cl changes from -1 to 0 / of Mn changes from +7 to +2 / Cl^- transfers electrons to MnO_4^- / MnO_4^- is reduced and Cl^- is oxidised. 1

(c) The filter paper turns brown. 1
$2I^- + Cl_2 \rightarrow 2Cl^- + I_2$ 1

(d) The experiment should be performed in a fume cupboard as chlorine gas is toxic. 1

9. Chemical knowledge (1 mark for each point, a maximum of 4 marks) 4

- Compounds with C=C bonds can undergo addition polymerisation.
- No small molecules will be eliminated during addition polymerisation.
- High temperature / High pressure / Catalyst is used.
- Structure of the monomer : $CF_2=CF_2$
- Structure of the repeating unit : $-CF_2-CF_2-$ OR the polymer : $-[CF_2-CF_2]_n-$

Communication mark 1

Part II

Marks

10. Step One: (1) $LiAlH_4$ (2) H_3O^+ 1
Intermediate: $HOCH_2CH_2CH_2CH_2CH_2OH$ 1
Step Two: PCl_3 / PCl_5 / HCl / $SOCl_2$ 1

11. (a) (i) colour intensity / absorbance 1

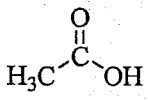
(ii) On the graph, plot a tangent at time = 0 on the curve. 1
The initial rate equals to the slope of the tangent. 1

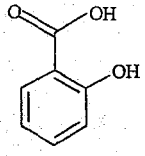
(iii) The absorbance is directly proportional to $[Br_2(aq)]$ / number of Br_2 molecules in the reaction mixture. The $[Br_2(aq)]$ / number of Br_2 molecules in the reaction mixture at **A** is higher than that at **B**. Therefore the frequency of effective collisions between molecules at **A** is higher than that at **B**. 2

(b) At different time, measure the volume of CO_2 gas formed / total pressure of the system / mass of the reaction mixture. 1

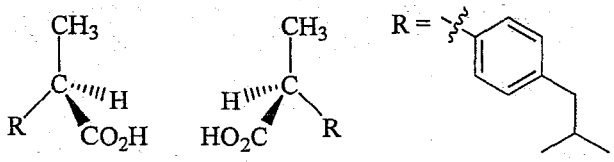
12. (a) Reduce fever / inflammation / risk of heart disease. 1

(b) -COOH group of aspirin reacts with hydrogencarbonate ions in water to give a soluble sodium salt / soluble ions / soluble $-COO^-$. 2

(c) (i)  1

 1

(ii) Hydrolysis of ester in acidic medium is reversible. Equilibrium will be attained if the reaction mixture is heated under reflux for a long time. 1

(d)  2

Marks

13. (a) None of the final concentrations of **X**(g), **Y**(g) and **Z**(g) is equal to zero. / 1
X(g), **Y**(g), **Z**(g) co-exist in the system, and their concentrations remain unchanged after a long period of time. /
The concentration of the reactant **Y**(g) is still not equal to zero after a long period of time.

(b) $2\mathbf{Y}(g) \rightleftharpoons 3\mathbf{X}(g) + \mathbf{Z}(g)$ 3

$Kc = [\mathbf{X}(g)]^3 [\mathbf{Z}(g)] / [\mathbf{Y}(g)]^2$
$= (0.60)^3 (0.20) / (0.30)^2$
$= 0.48 \text{ mol}^2 \text{ dm}^{-6}$

(c) The statement is incorrect. At the 25th minute after the reaction has started, the reaction attained dynamic equilibrium. The rate of forward reaction is equal to the rate of backward reaction and not equal to zero. 1

14. Chemical knowledge 5

- $Na_2O(s)$ dissolves in water to give $NaOH(aq)$ /
  $Na_2O(s)$ reacts with $HCl(aq)$ to give $NaCl(aq)$ and $H_2O(l)$ /
  $Na_2O(s) + H_2O(l) \rightarrow 2NaOH(aq)$ /
  $Na_2O(s) + 2HCl(l) \rightarrow 2NaCl(aq) + H_2O(l)$
- $Al_2O_3(s)$ reacts with $HCl(aq)$ to give $AlCl_3(aq)$ and $H_2O(l)$ /
  $Al_2O_3(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2O(l)$
- $Al_2O_3(s)$ reacts with $NaOH(aq)$ to give $NaAl(OH)_4(aq)$ /
  $Al_2O_3(s) + 2NaOH(aq) + 3H_2O(l) \rightarrow 2NaAl(OH)_4(aq)$ /
  $Al_2O_3(s) + 2NaOH(aq) \rightarrow 2Na[AlO_2](aq) + H_2O(l)$
- $SO_2(g)$ dissolves in water to give $H_2SO_3(aq)$ /
  $SO_2(g)$ reacts with $NaOH(aq)$ to give $Na_2SO_3(aq)$ and $H_2O(l)$ /
  $SO_2(g) + H_2O(l) \rightarrow H_2SO_3(aq)$ /
  $SO_2(g) + 2NaOH(aq) \rightarrow Na_2SO_3(aq) + H_2O(l)$
- Na_2O is a basic (alkaline) oxide, Al_2O_3 is an amphoteric oxide, and SO_2 is an acidic oxide.

Communication mark 1

Paper 2

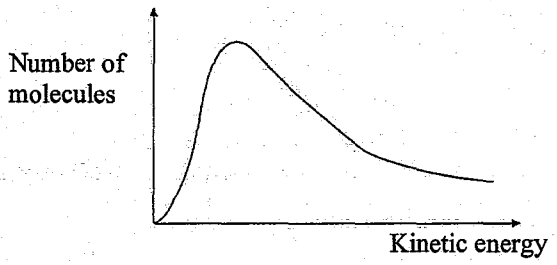
Marks

1. (a) (i) $2H^+(aq) + 2e^- \rightarrow H_2(g)$ 1

OR $2H_2O(l) + 2e^- \rightarrow 2OH^-(aq) + H_2(g)$

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

(ii) 2



(iii) glucose 1

(b) (i) (1) $Cu / ZnO / Al_2O_3$ 1

(2) May be due to higher activation energy. 1

(3) Number of moles of gaseous products is less than that of gaseous reactants. 1
Increasing the pressure will shift the equilibrium position to the right. 1

(ii) (1) This reaction does not involve poisonous reagent but the original one involves poisonous CO. 1

(2) It reduces the amount of atmospheric carbon dioxide and hence may alleviate global warming. 1

(iii) $CH_3OH(g) + CO(g) \rightarrow CH_3CO_2H(g)$ 1

(c) (i) Order of reaction is not affected by temperature change. 1

(ii) From line ℓ_1 on the graph, 2
slope = [(–1.4) – (–2)] ÷ [(0)–(–0.6)] = 1
It is first order with respect to $N_2O_5(g)$.

(iii) $log\ k = -2$ 2
$k = 0.01\ s^{-1}$

(iv) The y-intercepts of ℓ_1 and ℓ_2 are –1.4 and –2 respectively. 3
Since the y-intercept = $log\ k$,
(–2) – (–1.4) = Ea (1/360 – 1/345) / 2.3 x 8.31
Ea = 94.95 kJ mol^{-1}

Marks

2. (a) (i) • Catalyst is used. 1
• High atom economy / atom economy = 172 ÷ 208 = 82.7% 1

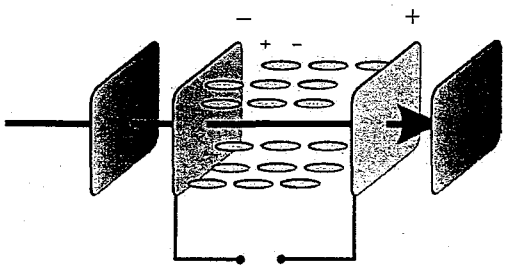
(ii) (1) chitin 1

(2) It can form extensive inter-molecular hydrogen bonds. 1

(iii) **A** 1

(b) (i) cholesteric liquid crystal 1
The molecules are arranged along a long axis and in positions such that they are slightly twisted from the molecules next to them giving rise to a helical-like arrangement. 1

(ii) (1)



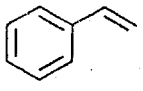
voltage applied

Show: With the applied voltage, the molecules arrange in lines. 1
Show: The polarity of the molecules and that of electrodes are opposite. 1

(2) Polarisers are perpendicular to each other. 1
The polarised light passes through the liquid crystal layer without rotating the plane of polarisation. The polarised light is completely blocked by the polariser at the right, giving a dark pixel. 1

(iii) When temperature is higher than the upper end of the operation range, the liquid crystal will liquefy. 1

(c) (i) $HOCH_2CH_2OCH_2CH_2OH$ 1
HOOC–CH=CH–COOH / Cl–CO–CH=CH–CO–Cl 1

(ii) (1)  1

(2) thermosetting / hardening under formation with heating 1

(3) Adjust the relative amounts of **X** and **A**. 1
The rigidity depends on its degree of cross-linking. 1

(iii) (1) compression moulding 1

(2) **Y** will not corrode easily but iron will. / **Y** is less dense than iron. 1

Marks

3. (a) (i) calcium ion / Ca^{2+} 1

(ii) Add $Ba(NO_3)_2(aq)$ acidified with $HNO_3(aq)$ to the sample, 1
white precipitate forms for $K_2SO_4(aq)$ whereas no precipitate will form for $K_2SO_3(aq)$. 1

(iii) 'R_f value' of a substance is the ratio between the migration distance of the substance and the migration distance of the solvent front during chromatography. 2

(b) (i) Place the dissolved sample into a 250.0 cm^3 volumetric flask. 1
Deionised water should be added to the mark of the volumetric flask. Shake the solution thoroughly. 1

(ii) $ClO_3^-(aq) + 6I^-(aq) + 6H^+(aq) \rightarrow Cl^-(aq) + 3I_2(aq) + 3H_2O(l)$ 1

(iii) The solution turns from blue to colourless. 1

(iv) $I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$ 3
number of moles of $I_2(aq) = 0.112 \times 0.02788 \times ½ = 0.001561$
number of moles of $NaClO_3$ in the sample $= 0.001561 \div 3 \times (250.0 / 10.00) = 0.01301$
percentage by mass of $NaClO_3$ in the sample
$= 0.01301 \times 106.5 \div 1.63 \times 100\% = 85.0\ \%$

(c) (i) Boiling points of **X** and **Y** are too close. 1

(ii) (1) Absorption peak at wavenumber about 1700 cm^{-1} corresponds to a C=O group. / 1
Absorption peak at wavenumber about 1650 cm^{-1} corresponds to a C=C group.

(2) At m/z = 43: CH_3CO^+ 1
At m/z = 55: CH_2CHCO^+ 1

(3) CH_2=$CHCOCH_3$ 1

(iii) • positive result for 2,4-dinitrophenylhydrazine test: presence of carbonyl group 1
• negative result for Tollens' reagent test: not an aldehyde 1
• **Y** may be $CH_3CH_2COCH_3$ / butanone. 1