

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.	A (81%)	25.	C (77%)
2.	C (88%)	26.	B (60%)
3.	D (59%)	27.	D (67%)
4.	C (75%)	28.	C (58%)
5.	B (86%)	29.	C (26%)
6.	B (59%)	30.	D (68%)
7.	A (58%)	31.	A (34%)
8.	A (66%)	32.	B (66%)
9.	C (77%)	33.	D (72%)
10.	B (63%)	34.	B (77%)
11.	A (84%)	35.	A (64%)
12.	B (50%)	36.	A (65%)
13.	C (51%)		
14.	D (75%)		
15.	B (36%)		
16.	A (68%)		
17.	C (73%)		
18.	A (85%)		
19.	C (27%)		
20.	D (38%)		
21.	C (72%)		
22.	D (49%)		
23.	C (77%)		
24.	D (58%)		

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

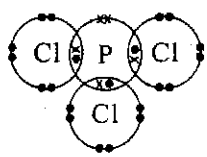
General Marking Instructions

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

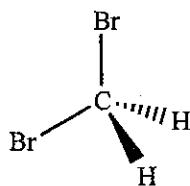
Part I

Marks

1. (a) 2, 8, 5 1
- (b) Chlorine exists as isotopes. / There are chlorine atoms with same number of protons but different number of neutrons. 1
- (c) (i) Number of moles of P : Number of moles of Cl = $0.226/31.0 : 0.774/35.5$ 2
 $= 1 : 3$
 Molecular formula is $(\text{PCl}_3)_n$
 $(31.0 + 35.5 \times 3)n < 250$
 $n = 1$
 Molecular formula is PCl_3
- (ii)  1
2. (a) To increase the electrical conductivity of the filter paper / To increase the number of mobile ions / To provide mobile ions 1
- (b) pale green 1
- (c) Blue colour appears around the middle of the filter paper. 1
 $\text{Fe}^{2+}(\text{aq})$ ions move towards negative pole and $\text{Fe}(\text{CN})_6^{3-}(\text{aq})$ ions move towards positive pole forming a blue compound. 1
- (d) The colour around the middle of the filter paper remains unchanged. 1
 $\text{Fe}^{2+}(\text{aq})$ ions and $\text{Fe}(\text{CN})_6^{3-}(\text{aq})$ ions do not migrate towards each other. / $\text{K}^+(\text{aq})$ ions and $\text{SO}_4^{2-}(\text{aq})$ ions migrate towards each other but do not form coloured compounds. 1
3. (a) cracking 1
 To produce alkenes / To produce smaller hydrocarbons from larger hydrocarbons /
 To convert heavy oil to petrol 1
- (b) The reaction will be faster when using broken unglazed porcelain instead of a large piece of unglazed porcelain due to larger surface area. 1
- (c) (i) $\text{C}_8\text{H}_{18} \rightarrow \text{C}_2\text{H}_6 + 2\text{CH}_3\text{CH}=\text{CH}_2$ / $\text{C}_8\text{H}_{18} \rightarrow \text{C}_2\text{H}_6 + 2\text{C}_3\text{H}_6$ 1
- (ii) (1) Orange / brown Br_2 solution turns to colourless. 1
- (2) $\text{CH}_3\text{CHBrCH}_2\text{Br}$ 1
- (d) The delivery tube should be taken out of the water level before removing the heating source, otherwise sucking back will happen / the boiling tube will be cracked. 1

4. (a) (i) $S=C=S$ 1

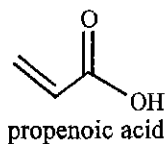
(ii) 1



(b) • C—H and C—Br bonds are polar. 1
 • C and H / C and Br have different electronegativities. / 1
 C is more electron-withdrawing than H / Br is more electron-withdrawing than C.

(c) The intermolecular forces between CS_2 / CO_2 molecules are van der Waals' forces. 1
 As CS_2 has greater molecular size than CO_2 , the van der Waals' forces between CS_2 molecules are stronger than those between CO_2 molecules. 1

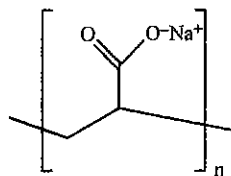
5. (a) 1



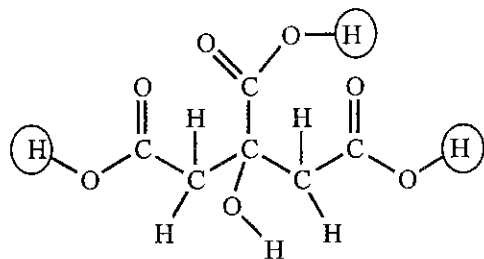
(b) addition 1

(c) B is a mixture of polymer molecules with different lengths. 1

(d) 1



6. (a)



1

(b) (i) volumetric flask

1

(ii) Number of moles of NaOH(aq) = 0.123 x 0.01845

3

Number of moles of citric acid reacting with NaOH(aq) = 0.123 x 0.01845 ÷ 3

Number of moles of citric acid in the sample = 0.123 x 0.01845 ÷ 3 x 10

Percentage by mass of citric acid in the solid sample

= (0.123 x 0.01845 ÷ 3 x 10 x 192.0 ÷ 1.65) x 100%

= 88.0 %

(c) (i) Colourless gas bubbles form. / Effervescence occurs.

1

(ii) $\text{H}^+ + \text{NaHCO}_3 \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{Na}^+$

1

7. (a) constant pressure

1

(b) It is very difficult for Mg(s), C(s) and O₂(g) to react directly to form MgCO₃(s).

1

(c) (i) Heat loss to surrounding / PS cup absorbs heat.

1

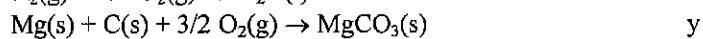
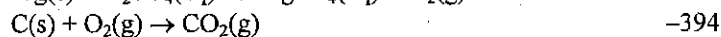
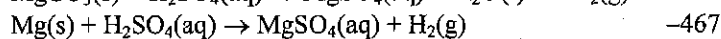
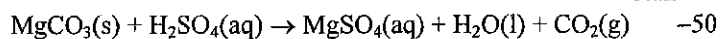
(ii) No, because insoluble CaSO₄ will be formed.

1

(d)

Standard enthalpy change / kJ mol⁻¹

3



$$y - 50 = -467 - 394 - 286$$

$$y = -1097 \text{ kJ mol}^{-1}$$

8. (a) (i) Reddish brown gas is observed.

1

(ii) $\text{Sr}^{2+} + 2\text{e}^- \rightarrow \text{Sr}$

1

(b) Bromine gas formed is toxic / poisonous.

1

(c) (i) Oxidation number of Mn decreases / changes from +4 to +3.

1

Therefore MnO₂(s) is the oxidising agent.

1

(ii) $2\text{MnO}_2(\text{s}) + 2\text{NH}_4^+(\text{aq}) + 2\text{e}^- \rightarrow \text{Mn}_2\text{O}_3(\text{s}) + 2\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$

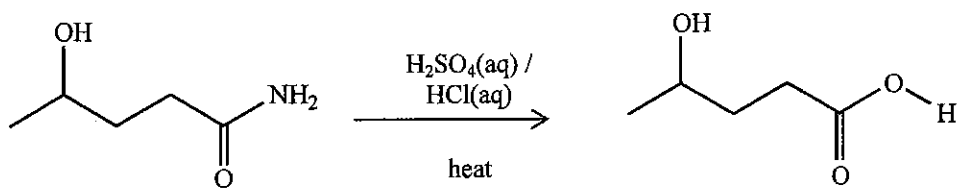
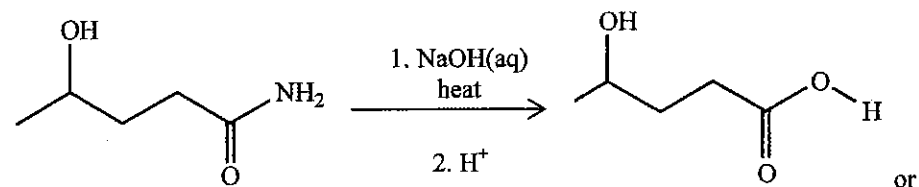
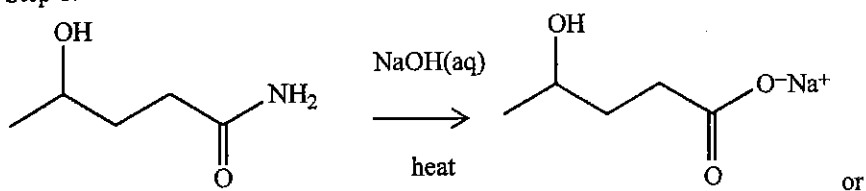
1

9. • Dissolve the solids separately in water. 1
 • Add aqueous ammonia / NaOH(aq) to each of the solutions obtained until excess. 1
 • White precipitate formed initially for all of them. But only the precipitate of ZnSO₄ dissolves in excess aqueous ammonia / NaOH(aq). 1
 • Heat respectively the two remaining solids in a test tube and place a piece of dry CoCl₂ paper in the mouth of the tube. 1
 • Only MgSO₄ · 7H₂O can turn dry CoCl₂ paper from blue to pink. 1
 • Communication mark 1

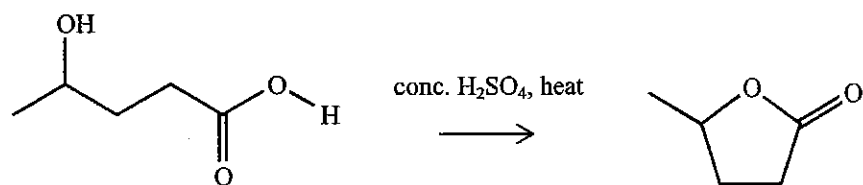
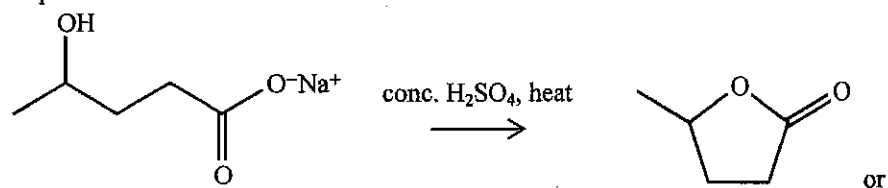
Part II

10. (a) At dynamic equilibrium, the rate of forward reaction is equal to the rate of backward reaction, and not equals zero. / 1
 At dynamic equilibrium, reactants are converted to products and products are converted to reactants at equal rate. No net change is observed.
- (b) $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ 3
 Initial 2.0 mol 2.0 mol
 At equil. 2.0-2x 2.0-x 2x
 where 2x = 1.8 thus x = 0.9
 $878 = [1.8/V]^2 / [0.2/V]^2 [1.1/V]$
 $V = 11.92 \text{ dm}^3$
- (c) (i) Decrease. The reaction is exothermic. Increase in temperature will cause the equilibrium position to shift to the left. 1
 (ii) No change. A catalyst will increase the rate of forward reaction and that of backward reaction to the same extent. / A catalyst has no effect on the equilibrium position. 1
11. (a) To ensure fair comparisons between the trials. / 1
 To ensure the concentration of NaOH(aq) is the only variable. /
 The volume of NaOH(aq) used can represent the concentration of NaOH(aq) in the reaction mixtures.
- (b) $[\text{OH}^-(\text{aq})] = 2.0 \times (4.0/5.0) = 1.6 \text{ mol dm}^{-3}$ 3
 $[\text{H}^+(\text{aq})] \times 1.6 = 1.0 \times 10^{-14}$
 $[\text{H}^+(\text{aq})] = 6.25 \times 10^{-15} \text{ mol dm}^{-3}$
 $\text{pH} = -\log(6.25 \times 10^{-15}) = 14.2$
- (c) The concentration of NaOH(aq) 1
 The shorter the time for the pink colour disappeared, the faster the reaction. An increase in concentration of NaOH(aq) will result in an increase in the reaction rate. 1
- (d) Using colorimeter / measuring relative transmittance / absorbance of the mixture 1

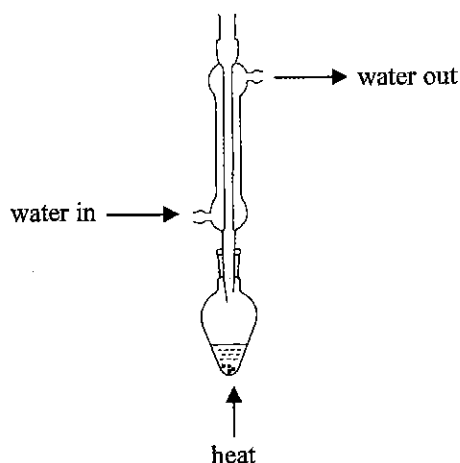
12. Step 1:



Step 2:



13. (a)



2

(b) $\text{LiAlH}_4 / \text{H}_2$ (catalyst - Pt)

1

(c) enantiomers / optical isomers

1

(d) optical activity /

P and Q rotate plane-polarised light to opposite directions to the same degree / extent.

1

(e) Correct chemical reagent

1

Correct observations with comparison between the tests on acetophenone and P

1

Possible tests and the corresponding observations:

$\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$	acetophenone – no change; P – from orange to green
$\text{MnO}_4^- / \text{H}^+$	acetophenone – no change; P – from purple to colourless
MnO_4^-	acetophenone – no change; P – formation of brown ppt.
$\text{MnO}_4^- / \text{OH}^-$	acetophenone – no change; P – formation of brown ppt.
2,4-DNP	acetophenone – formation of orange ppt.; P – no change
$\text{CH}_3\text{COOH} / \text{H}^+ / \text{heat}$	acetophenone – no change; P – pleasant odour substance formed

2,4-DNP = 2,4-dinitrophenylhydrazine

14. Electrical conductivity: aluminium > sodium > silicon = sulphur (or: silicon > sulphur)

1

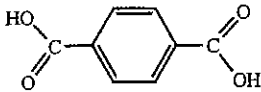
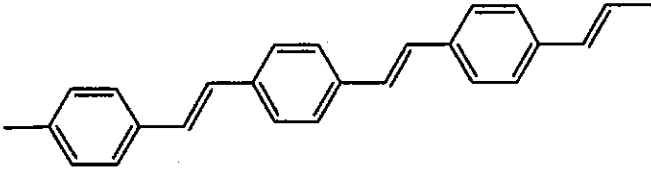
Any 3 of the following items, each 1 mark

3

- Both aluminium and sodium have giant metallic structures with delocalised electrons so that electrical conductivity of them is high.
- The number of delocalised electrons of aluminium is more than that of sodium so that electrical conductivity of aluminium is higher than that of sodium.
- Silicon has giant covalent structure and its electrons are not mobile and cannot conduct electricity. OR
Silicon has giant covalent structure and its electrons are not mobile. But silicon is a semi-metal and can conduct electricity in some conditions.
- Sulphur has simple molecular structure and its electrons are not mobile and cannot conduct electricity.
- Communication mark

1

1. (a) (i) • Higher temperature will have a higher rate of reaction. 1
 • But the forward reaction is exothermic, increasing the temperature will shift the equilibrium position to the left. 1
 Therefore, the operating temperature is set at 300°C.
- (ii) total number of particles / total number of molecules 1
- (iii) (1) carbon monoxide / CO and hydrogen / H₂ 1
 (2) methanol / CH₃OH 1
- (b) (i) fractional distillation of liquefied air 1
- (ii) • The hot gas from reaction chamber can help heat up the hydrogen and nitrogen. 1
 • It is to save energy. 1
- (iii) Number of moles of N₂(g) = 420000/28; Number of moles of H₂ = 96000/2 3
 Mole ratio of N₂(g) to H₂(g) = 420000/28 : 96000/2 = 1 : 3.2,
 N₂(g) is the limiting reagent.
 Mass of NH₃(g) produced = 420000/28 x 2 x 17 x 15%
 = 76.5 kg
- (iv) (1) 4NH₃ + 5O₂ → 4NO + 6H₂O 1
 (2) 4NO₂ + O₂ + 2H₂O → 4HNO₃ 1
- (c) (i) (1) • Compare experiments 1 & 3, [sucrose] remains the same but [HCl] is three times, rate is also three times. Therefore reaction order with respect to HCl is one. 1
 • Compare experiments 1 & 2, [sucrose] and [HCl] is doubled, the rate is quadrupled. Therefore reaction order with respect to sucrose is also one. 1
- (2) rate = k [C₁₂H₂₂O₁₁(aq)] [HCl(aq)] 1
- (3) With data from Trial 1,
 $6.0 \times 10^{-7} = k (0.010) (0.10)$
 $k = 6.0 \times 10^{-4} \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$ 1
- (ii) Acts as a catalyst. 1
- (iii) • Need not to separate fructose from the mixture after enzymatic hydrolysis of starch but the hydrolysis of sucrose needs to do so. 1
 • Higher atom economy as glucose is the only product from the enzymatic hydrolysis of starch. 1

2. (a) (i) Cellulose is biodegradable. 1
- (ii) Molecules in liquid crystals 1
 • are usually long and rigid rod-like / long and disk-like. 1
 • contains C=C / N=N double bonds. 1
- (iii) • Many benzene rings in the structure can make it rigid. 1
 • There are many strong intermolecular hydrogen bonds between the polymer molecules. 1
- (b) (i) face-centred cubic / cubic close-packed 1
- (ii) $(1 \div 4) \times 12 + 1$ 1
 = 4 1
- (iii) 12 1
- (iv) • 18-carat gold is an alloy which is harder than pure gold. 1
 • Different kinds of metal atoms in alloy have different size making the atom layers difficult to slide over one another. 1
- (v) stained glass 1
- (c) (i) (1) HOCH₂CH₂CH₂CH₂OH 1
 1
- (2) Condensation polymerisation 1
- (3) Extrusion moulding / injection moulding 1
- (ii) • resistant to chemicals 1
 • resistant to tear and wear 1
- (iii) (1)  1
- (2) Optically inactive because there is no chiral centres. 1

3. (a) (i) Sodium hydroxide solid is deliquescent. / 1
Sodium hydroxide solid would absorb carbon dioxide gas from air.
- (ii) • Add a few drops of HCl(aq). 1
• Pale yellowish-green gas evolved which turns moist blue litmus paper red and then bleaches it. 1
- (iii) • Similarity: Both show an absorption peak at 3230–3670 cm^{-1} (O–H groups). 1
• Difference: Only chitin shows an absorption peak at 1680–1800 cm^{-1} (C=O groups). 1
- (b) (i) (1) $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 6\text{Fe}^{2+}(\text{aq}) + 14\text{H}^+(\text{aq}) \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 6\text{Fe}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$ 1
- (2) Number of moles of $\text{Fe}^{2+} = 0.0642 \times 26.88 \times 10^{-3}$ 2
 $= 0.0017257 \text{ mol}$
 $[\text{Cr}_2\text{O}_7^{2-}(\text{aq})] \times 25.00 \times 10^{-3} \times 6 = 0.0017257$
 $[\text{Cr}_2\text{O}_7^{2-}(\text{aq})] = 0.0115 \text{ mol dm}^{-3}$
- (ii) (1) Blue filter allows blue light to pass through and the orange $\text{Na}_2\text{Cr}_2\text{O}_7(\text{aq})$ solution absorbs blue light to a large extent. 1
- (2) The absorbance is directly proportional to the concentration of $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$. 1
- (3) Absorbance = 0.26, $[\text{Cr}_2\text{O}_7^{2-}(\text{aq})]$ found from the graph = $7.0 \times 10^{-4} \text{ mol dm}^{-3}$ 2
 $[\text{Cr}_2\text{O}_7^{2-}(\text{aq})]$ in sample B = $7.0 \times 10^{-4} \times (100) = 0.07 \text{ mol dm}^{-3}$
- (iii) Colorimetry is more appropriate. 1
The very low colour intensity of the solution can still be determined by colorimetry.
- (c) (i) The mass spectra of X and Y are recorded respectively. 1
• In the mass spectrum of X, a significant peak at $m/z = 43$ appears for CH_3CO^+ ions which does not appear in the mass spectrum of Y. 1
• In the mass spectrum of Y, a significant peak at $m/z = 119$ appears for $\text{C}_6\text{H}_5\text{CH}_2\text{CO}^+$ ions which does not appear in the mass spectrum of X. 1
- (ii) (1) • $\text{Na}_2\text{CO}_3(\text{aq})$ is added to the solution of X and Y in dichloromethane. 1
• The mixture is shaken in a separating funnel. 1
The mixture in the separating funnel is allowed to settle, and the aqueous layer is then separated from the organic layer.
• Dilute $\text{H}_2\text{SO}_4(\text{aq})$ is added to the aqueous layer until no more precipitate is formed. 1
• Solid Y can be obtained by filtration. 1
- (2) Measure the melting point of the solid obtained. 1
If the melting point of the solid is 77°C , it may be pure compound Y.