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 contents with care.

Chemistry
Paper 1

SECTION A

Question No. Part I	Key	Question No. Part II	Key
1.	A (46%)	25.	B (49%)
2.	D (77%)	26.	C (14%)
3.	B (73%)	27.	A (60%)
4.	D (74%)	28.	D (78%)
5.	C (70%)	29.	C (60%)
6.	A (72%)	30.	D (85%)
7.	B (87%)	31.	B (61%)
8.	D (88%)	32.	A (68%)
9.	B (87%)	33.	*
10.	B (82%)	34.	C (62%)
11.	B (77%)	35.	B (69%)
12.	C (66%)	36.	C (60%)
13.	C (58%)		
14.	A (79%)		
15.	A (60%)		
16.	D (38%)		
17.	A (73%)		
18.	C (68%)		
19.	B (73%)		
20.	B (55%)		
21.	D (55%)		
22.	C (84%)		
23.	D (53%)		
24.	C (59%)		

* This item was deleted.

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

General note on item deletion

It is normal for the HKEAA to delete a small number of items from its multiple-choice question papers if they prove unsatisfactory. In practice, there are a number of reasons why this is considered necessary. By far the most common reason for deleting an item is that the item fails to discriminate between weak and able candidates – in other words, the majority of the candidates involved had to rely on guesswork in answering that question. If such an item is retained, the measurement process is rendered less effective. Where items have been deleted in the live papers, they are still included in this series of publications. They are indicated as deleted items. Such items may be discussed in the examination reports.

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) 1

(b) Van der Waals' forces 1

(c) 4

Element	Natural source	Method of extraction
Argon	The atmosphere / Air	Fractional distillation of liquefied air
Chlorine	Rock salt / Sea water / Ocean	Electrolysis of sea water

2. (a) A white precipitate is firstly formed, the precipitate dissolves in the presence of excess $CO_2(g)$. 1
$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$ 1
$CaCO_3(s) + CO_2(g) + H_2O(l) \rightarrow Ca(HCO_3)_2(aq)$ 1

(b) The solution changes from orange to green. 1
$Cr_2O_7^{2-}(aq) + 3SO_3^{2-}(aq) + 8H^+(aq) \rightarrow 2Cr^{3+}(aq) + 3SO_4^{2-}(aq) + 4H_2O(l)$ 1

3. (a) Iron is less reactive than aluminium. 1

(b) (i) 2

	Fe	O
Mass	1.67	0.64
Atom ratio	1.67 / 55.8	0.64 / 16
	= 0.03	= 0.04

Empirical formula = Fe_3O_4

(ii) $Fe_3O_4(s) + 4CO(g) \rightarrow 3Fe(s) + 4CO_2(g)$ 1

(iii) Perform the experiment in a fume cupboard. 1

(c) Zn is more reactive / a stronger reducing agent than Fe. 1
For galvanised iron object with the zinc layer broken, iron will be protected from corrosion as zinc will be preferentially oxidised. 1

(d) The surface of the aluminium object is oxidised to $Al_2O_3(s)$ / aluminium oxide. 1
$Al_2O_3(s)$ is impermeable to water / oxygen, thus corrosion of aluminium is inhibited. 1

Marks

4. (a) A cell that can be recharged. 1

(b) It can provide a high current / voltage / power to start up the engine. 1

(c) Lead / Lead compounds are toxic. / Sulphuric acid is corrosive / irritant. 1

(d) (i) Pour a small amount of the concentrated sulphuric acid to a large amount of water. 2
Wear goggle / face shield / safety spectacles / safety glasses / gloves. 1

(ii) Number of mole of sulphuric acid = 2.48 / 98.1 = 0.0253 2
Molarity of sulphuric acid = 0.0253 / 0.005 = 5.06 (M)

5.
- Equation: $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ 1
- Explanation: Ammonia ionises / dissociates slightly in water. / The ionisation / dissociation of ammonia in water is incomplete. 1
- Method: Measure respectively the pH / electrical conductivity / enthalpy change of neutralisation / temperature rise in neutralisation of both NH_3(aq) and NaOH(aq). 1
- Observation: pH / electrical conductivity / enthalpy change of neutralisation / temperature rise in neutralisation of NH_3(aq) is lower than that of NaOH(aq). 1
- Fair comparison: 1
  pH – same concentration of NH_3(aq) and NaOH(aq)
  electrical conductivity – same concentration of NH_3(aq) and NaOH(aq)
  enthalpy change of neutralisation – same amount of NH_3(aq) and NaOH(aq)
  temperature rise in neutralisation – same volume and concentration of NH_3(aq) and NaOH(aq)
- Communication mark 1

6. (a) substitution reaction 1

(b) Light / *hυ* / ultra-violet / UV / heat / radical initiator 1

(c) Orange / brown colour fades away. / 1
Orange / brown colour changes to colourless slowly.

(d) Br atom does not have the stable noble gas electronic configuration. / 1
Br atom does not have the stable octet electronic configuration. /
The electronic configuration of Br atom does not fulfill the octet rule.

(e) (i) CH_2Br_2 / $CHBr_3$ / CBr_4 1

(ii) Use large excess amount of CH_4. / 1
Br_2 is the limiting reactant.

Marks

7. (a) Oily dirt hinders the conduction of electricity / hinders the plating of copper on the object. 1

(b) Electrolyte is a compound that conducts electricity when melted or dissolved in water. / 1
Electrolyte is a substance that consists of mobile ions when melted or dissolved in water. /
Electrolyte is a substance that undergoes decomposition when electricity is passing through it.

(c) Cu^{2+}, SO_4^{2-}, H^+, OH^- 1

(d) Copper(II) ion has higher oxidising power than hydrogen ion. / 1
Copper(II) ion undergoes reduction more readily than hydrogen ion.

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

(f) No observable change 1

(g) Number of mole of electrons involved = $2.28 \times 10^{22} / 6.02 \times 10^{23} = 0.0379$ 2
Mass of copper formed = $0.0379 \times 63.5 / 2 = 1.20$ (g)

8. (a) C_nH_{2n+2} 1

(b) (i)

		Marks
Covalent bond(s) broken	C-H and O=O	1
Covalent bond(s) formed	C=O and H-O	1

(ii) The total energy released in the bond forming process is larger than the total energy absorbed in the bond breaking process. 1

(iii) $\Delta H_c^\circ = \Delta H_f^\circ [CO_2(g)] + 2\Delta H_f^\circ [H_2O(l)] - \Delta H_f^\circ [CH_4(g)]$ 2
$= (-393.5) + 2(-285.9) - (-74.8)$
$= -890.5$ (kJ mol^{-1})

(c)
- Natural gas burns more completely but coal does not. / 1
Burning coal would produce soot / carbon monoxide but burning natural gas would not.
- Compared with natural gas, coal contains more impurities. / 1
Burning coal would produce more pollutants, such as SO_2, metal compound dust.

Part II

Marks

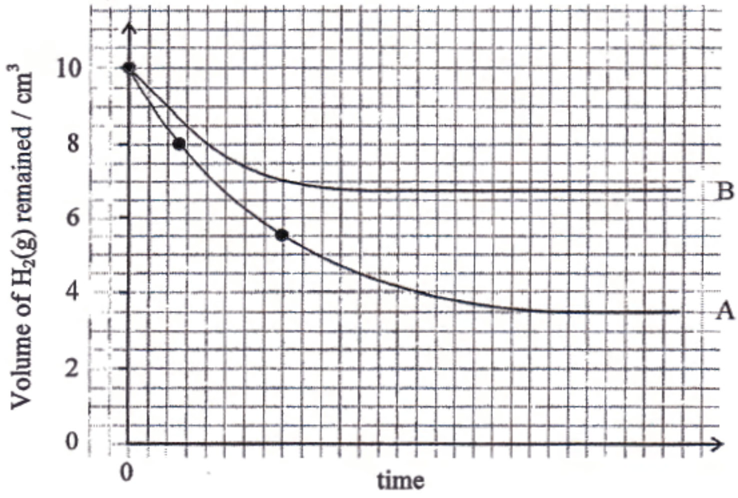
9. (a) save cost on chemicals / minimise chemical hazards / save time on carrying out experiment / reduce the consumption of chemicals / reduce chemical waste — 1

(b) Prevent sucking back of water. /
Prevent water from entering the reacting flask. — 1

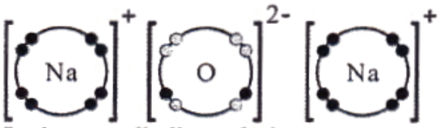
(c) Water level inside the measuring cylinder rises. /
The gas volume inside the measuring cylinder reduces. — 1

(d) Number of moles of methyl oleate used = $0.08 / 296 = 2.70 \times 10^{-4}$
Minimum volume of $H_2(g)$ required = $(0.08 / 296) \times 24000\ cm^3 = 6.49\ cm^3$ — 3

(e) (i)& (ii) — 2

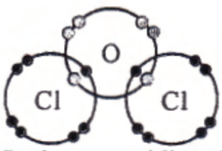


10. (a) (i) — 1



It gives an alkaline solution. — 1

(ii) — 1



It gives an acidic solution. — 1

(b) Any TWO of the following: — 2

- Fe can have variable oxidation numbers – Fe^{2+}, Fe^{3+}
- Fe can act as a catalyst – e.g., Fe in Haber Process
- Fe forms coloured compounds – $Fe^{2+}(aq)$ is green / $Fe^{3+}(aq)$ is yellow

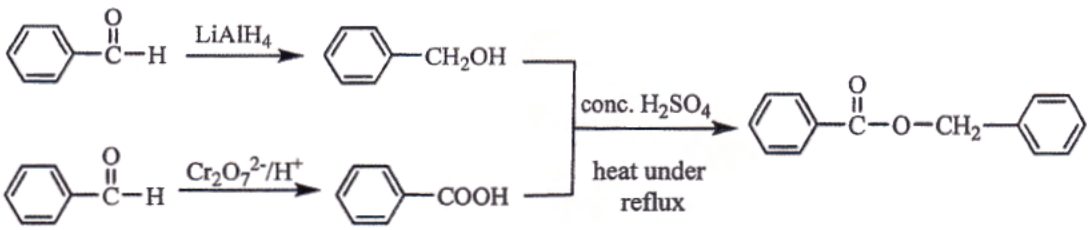
11\. (a) (i) $-\log[H^+(aq)] = 7.0$
$[H^+(aq)] = 10^{-7}$ mol dm^{-3} / 10^{-7} M — 1

(ii) $[OH^-(aq)] = [H^+(aq)] = 10^{-7}$ mol dm^{-3} — 2
$[H_3O^+(aq)][OH^-(aq)]$
$= 10^{-7} \times 10^{-7}$
$= 10^{-14}$ (mol^2 dm^{-6})

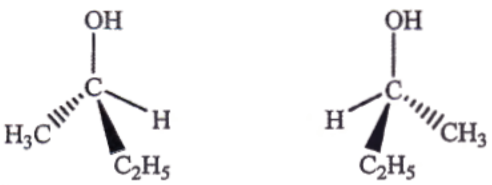
(b) Because $[H_2O(l)] >> [H^+(aq)]$ or $[OH^-(aq)]$ — 1

(c) The pH of water would be less than 7. — 1
The dissociation of $H_2O(l)$ is endothermic. Increasing the temperature will shift the equilibrium position to the right. — 1

12\. — 3



13\. • — 1



- Chiral centre — 1
- Non-superimposable on its mirror image — 1
- Optically active — 1
- Communication mark — 1

Marks

1. (a) (i) (1) No effect — 1

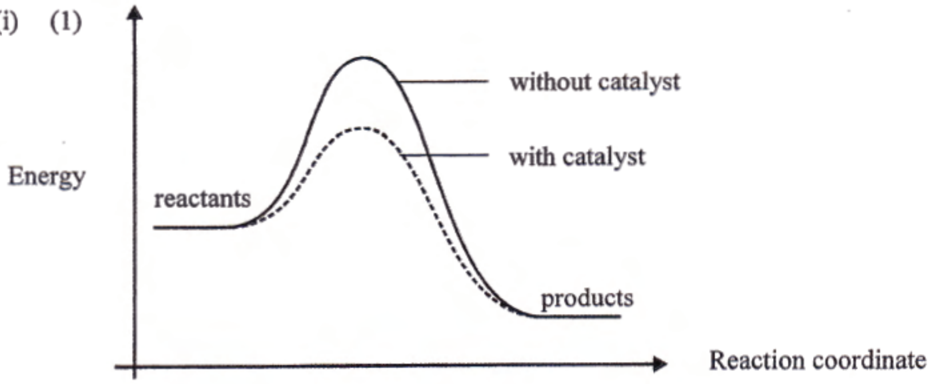
(2) Rate = $k[CH_3COCH_3(aq)][H^+(aq)]$ — 1

(ii) $3H_2 + N_2 \rightleftharpoons 2NH_3$ — 1

(iii) $\log \frac{k_2}{k_1} = \frac{Ea}{2.3R}(\frac{1}{T_1} - \frac{1}{T_2})$ OR $\log 2 = \frac{Ea}{2.3R}(\frac{1}{298} - \frac{1}{308})$ — 2

$Ea = 52.8 \text{ kJ mol}^{-1}$

(b) (i) (1) — 3



(2) Catalysts can be poisoned. — 1

(ii) Any TWO of the following: — 2
- A catalyst / enzyme is used.
- The reagent (O_2) used is non-toxic.
- The feedstock (sugars) is renewable.
- The wastes formed are biodegradable.

(iii) Any TWO of the following: — 2
- In route (2), the ethanoic acid produced is more pure.
- The rate of fermentation / aerial oxidation in route (1) is slower.
- Route (2) does not consume food but route (1) does.

(c) (i) Concentrated sodium chloride (NaCl) solution / brine — 1

(ii) Site should be near the sea because easy to get the raw material. — 1

(iii) $2NaCl + 2H_2O \rightarrow Cl_2 + H_2 + 2NaOH$ — 1

(iv) Mercury is poisonous. — 1

(v) In membrane cell, more pure sodium hydroxide can be obtained, but not for diaphragm cell. — 1

(vi) Chlorine bleach can react with hydrochloric acid to give poisonous chlorine gas. — 1
$ClO^- + 2H^+ + Cl^- \rightarrow H_2O + Cl_2$ — 1

Marks

2. (a) (i) (1) The smallest part of a lattice / crystal, which by repetition of itself, can generate the whole lattice / crystal. 1

(2) Number of Cu atoms $= 8(\frac{1}{8}) + 6(\frac{1}{2})$ 1

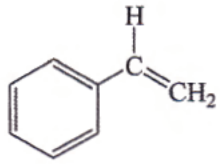
$= 4$

(ii) electric socket 1

(iii) Conc. HNO_3 is corrosive. 1

NO_2 is poisonous. 1

(b) (i) 1



(ii) Addition polymerisation 1

(iii) (1) The air inside the expanded PS is good insulator of heat. 1

(2) injection moulding 1

(3)
- Expanded PS occupies a very large volume. Hence collection, transportation and storage of the wastes are problematic. 1
- Sorting and cleaning of the expanded PS wastes are uneconomical. 1

(iv) The less orderly arranged repeating units of HIPS make the polymer molecules pack not as close as that in PS. 1

The intermolecular attractions between the polymer molecules of HIPS are weaker than that in PS. 1

(c) (i) The molecules in smectic phase have a certain degree of two-dimensional order and form well-defined layers. 1

(ii)
- The two polarisers at the two sides of the liquid crystal layer are perpendicular to each other. 1
- When a voltage is applied to the liquid crystal layer, the liquid crystal molecules align with the electric field. 1
- The polarised light will pass through the liquid crystal layer without rotation of the plane of polarisation. 1
- The polarised light is completely blocked by the second polariser, giving a black pixel. 1

(iii) (1) Nanomaterials are materials with particle sizes less than 100 nm / between 1 – 100/1000 nm. 1

(2) As the particle sizes of nanomaterials are so small, using them to make displays can increase the number of pixels in a given area / the phosphors for high-definition display units. 1

Marks

3. (a) (i) Add acidified silver nitrate solution. 1
Pale yellow precipitate formed. 1

(ii) Chromatography 1

(iii) Add dilute HCl(aq) to the mixture for dissolving the Fe_2O_3. 1
Collect the copper powder from filtering the mixture obtained. 1

(b) (i) yellow / orange / red precipitate 1

(ii) Add acidified $K_2Cr_2O_7$(aq). 1
Only Y turns the solution from orange to green. 1

(iii) A significant peak appears at m/Z 105 ($C_6H_5CO^+$) or 43 (CH_3CO^+) in mass spectrum of X only. 1
A significant peak appears at m/Z 91 ($C_6H_5CH_2^+$) or 29 (HCO^+) in mass spectrum of Y only. 1

(iv) Both compounds show a characteristic absorption in wavenumber range (1680 to 1800 cm^{-1}) which is characteristic of carbonyl group. 1
As the two compounds do not possess other different functional groups, they cannot be differentiated from each other using the given information. 1

(c) (i) (1) $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$ 1
OR $(NH_4)_2SO_4 + 2NaOH \rightarrow 2NH_3 + Na_2SO_4 + 2H_2O$

(2) $NH_3 + H^+ \rightarrow NH_4^+$ 1
OR $NH_3 + HCl \rightarrow NH_4Cl$

(ii) from red to orange 1

(iii) Number of moles of KOH used in the titration = $0.100 \times 13.55 \times 10^{-3}$ 4
Number of moles of H^+ ions remained after Step (2) = $0.100 \times 13.55 \times 10^{-3} \times 10$
= 0.01355
Number of moles of H^+ ions used in Step (2) = $1.00 \times 50 \times 10^{-3}$
= 0.05
Number of moles of NH_3 liberated = 0.05 – 0.01355
= 0.03645
Mass of N in the sample = 0.03645 × 14 = 0.5103 (g)
Percentage by mass of N in the sample = $\frac{0.5103}{3} \times 100 = 17.01$ (%)

(iv) The amount of nitrogen determined may come from other nitrogen-containing substances present in milk powder. 1

Candidates' Performance

Paper 1

Paper 1 consisted of two sections, Section A (multiple-choice questions) and Section B (conventional questions). Sections A and B each comprised two parts, Part I and Part II. Part I contained questions mainly on Topics I to VIII of the curriculum, while Part II mainly on Topics IX to XII. All questions in both sections were compulsory.

Section A (multiple-choice questions)

This section consists of 36 multiple-choice questions. Without counting the deleted one, the mean score was 23. Candidates' performance was generally good. Some misconceptions of candidates were revealed from their performance in the following items:

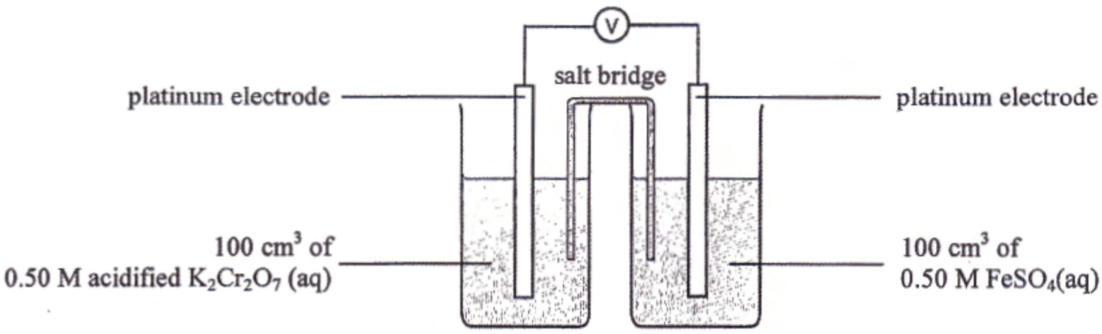
1. For Q.1, less than half of the candidates correctly chose the key A which suggests that many candidates did not have a clear understanding of acid solutions. The pH of an acid solution is zero if the concentration of the H^+(aq) ions in it equals 1 M. Carbon dioxide is an acidic compound even though it does not contain hydrogen as its constituent element because it ionises in water to give H^+(aq) ions. There is no need to display a 'corrosive' hazard warning label on reagent bottles containing very dilute acid solutions.

Q1. Which of the following statements is correct ?

A.* All aqueous solutions contain H^+(aq) ions. (46%)
B. The pH of all acid solutions is greater than zero. (22%)
C. All acidic compounds contain hydrogen as their constituent elements. (19%)
D. A 'corrosive' hazard warning label must be displayed on all reagent bottles containing acid solution. (13%)

2. For Q.16, more than half of the candidates failed to choose the key D. Candidates should consider the overall equation for the electrochemical reaction of this question. As the mole ratio of 'Fe^{2+}(aq) to $Cr_2O_7^{2-}$(aq)' in the overall equation is '6 : 1', the molarity of Fe^{2+}(aq) after that period of time should then be '0.5–6(0.5–0.47)', i.e. the concentration is 0.32 M.

Q16. Consider the following set-up at the start of an experiment :



After a period of time, the concentration of $K_2Cr_2O_7$(aq) drops to 0.47 M. What is the concentration of $FeSO_4$(aq) at that time ?

A. 0.53 M (23%)
B. 0.47 M (25%)
C. 0.41 M (14%)
D.* 0.32 M (38%)

3. For Q.26, the performance of candidates is very poor. As the compound contains two C=C bonds, there may then be 4 kinds of geometric arrangement: **cis-cis, trans-trans, cis-trans, trans-cis**. However, as it is a symmetric compound, the **cis-trans** and **trans-cis** arrangements are in fact of the same geometry, leaving a total of 3 geometrical isomers only.

Q26. How many geometrical isomers does $H_3C-CH=CH-CH=CH-CH_3$ have ?

A.	0	(14%)
B.	2	(44%)
C.*	3	(14%)
D.	4	(28%)

4. For Q.33, the item was deleted due to insufficient discrimination. Candidates might have had different interpretations of the term 'rate of formation of $H_2(g)$' in the equilibrium reaction system, and hence lowered the discrimination power of the item.

Q33. Consider the following equilibrium reaction system in a closed container of fixed volume :

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g) \qquad \Delta H < 0$$

Which of the following, when applied to the system, would lead to an increase in the rate of formation of $H_2(g)$?

(1) adding CO(g)
(2) increasing the temperature
(3) adding a suitable catalyst

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

Section B (conventional questions)

Question Number	Performance in General
1	The performance of candidates in this question was good. Around three quarters of the candidates were able to draw the electron diagram for a molecule of argon. However, some wrongly used 'Ag' or 'At' as the symbol. In part (c), some candidates mentioned 'distillation of air' but omitted the key word 'fractional'.
2	The performance of candidates in this question was fair. In part (a), about half of the candidates failed to describe the further change upon the addition of excess $CO_2(g)$. Moreover, they were not able to give the correct formulae for $Ca(OH)_2(aq)$ and $Ca(HCO_3)_2(aq)$, or the required chemical equations. In part (b), slightly more than half of the candidates gave the correct colour change, but many of them were not able to write the correct chemical equation. Quite a number of them erroneously included permanganate solution / $KMnO_4(aq)$ / $MnO_4^-(aq)$ in their answers.
3	The performance of candidates in this question was fair. In part (b), about half of the candidates were able to determine the empirical formula required, but many of them did not write a correct chemical equation for the reaction between $Fe_3O_4(s)$ and $CO(g)$. In parts (c) and (d), more than half of the candidates were able to explain the respective principles on the prevention of corrosion in galvanised iron and anodised aluminium. However, a few failed to distinguish the difference between these two principles.
4	The performance of candidates largely varied in different parts of this question. Candidates' performance in parts (a) and (d)(ii) was very good; in particular, they demonstrated a good mastery of the calculation on molarity. In parts (b) and (c), more than half of the candidates demonstrated a weak understanding about lead-acid accumulators. In part (d)(i), many candidates incorrectly suggested a procedure of using apparatus like a pipette or a volumetric flask for the dilution of concentrated sulphuric acid.
5	The performance of candidates in this question was fair. About two thirds of the candidates were able to state that NH_3 is a weak alkali because it ionises slightly in water, and about half of them were able to give the correct chemical equation. About a third of the candidates were able to suggest an appropriate experimental method for demonstrating that NH_3 is a weaker alkali than NaOH but, about half made conceptual mistakes. Common mistakes included 'comparing the rates of neutralisation between HCl and NH_3 / NaOH', 'comparing the amounts of HCl needed to neutralise a sample of NH_3 / NaOH', and 'comparing the voltages generated by the chemical cells constructed with NH_3 / NaOH as the electrolyte', etc. Some candidates stated an incorrect instrument for carrying out measurements, such as using a voltmeter to measure the current of a circuit. Lastly, about a third of the candidates were not able to state the appropriate conditions for carrying out a fair test.
6	The performance of candidates in this question was fair. In part (a), about two thirds of the candidates were able to give the correct answer. However, some of them misspelt the answer 'substitution' as 'subsituation'. Candidates' performance in parts (b) and (c) was very good. In part (d), more than half of the candidates were able to give the correct answer. However, some of them wrongly stated the given bromine atom / radical as a bromide ion (Br^-). The performance of the candidates in part (e)(i) was good, although some candidates wrongly gave 'CH_3', 'CCl_4' or '1,2-dibromomethane' as the answer. In part (e)(ii), about half of the candidates failed to correctly state that excess amount of methane was needed to meet the requirement.

Question Number	Performance in General
7	The performance of candidates in this question was fair. In part (a), about forty percent of the candidates wrongly stated the electroplated object would be contaminated by oily dirt. In part (b), about half of the candidates were able to give the correct answer. Some candidates wrongly stated that electrolytes can conduct electricity by allowing electrons to pass through, or just simply stated that electrolytes can conduct electricity but without any further elaboration. The performance of the candidates in part (c) was very good, although a few of them omitted H^+ and OH^- in their answers. In part (d), about half of the candidates were able to give the correct answer. However, some of them were confused about the relative oxidising power of copper(II) ions and hydrogen ions. The performance of the candidates in part (e) was good, although some candidates wrongly gave the half equation of the change occurred at the cathode. The performance of the candidates in part (f) was poor. Only about a third of them were able to give the correct answer. A small number of them wrongly stated the colour of the solution would become deeper or paler. Also, a small number of candidates wrongly stated the expected changes at the electrodes (change in size / reddish-brown substance plated on the surface) without referring to the observable changes that would occur in the solution. In part (g), the performance of the candidates was satisfactory. However, about a third of them failed to recognise that it takes 2 moles of electrons to reduce 1 mole of Cu^{2+}.
8	The performance of candidates in this question was fair. In part (a), more than eighty percent of the candidates were able to give the correct answer. The performance of candidates in part (b) (i) was poor. A small number of candidates wrongly gave the chemical formulae (CO_2, H_2O) without explicitly indicating the bonds formed or broken. Some of them missed one or two species in their answers. There were also a small number of candidates who failed to state the double bonds in O_2 and CO_2, and wrongly stated the bonds as O—O and C—O. The performance of candidates in part (b)(ii) was very poor. About a quarter of the candidates stated the energy involved in bond forming is larger than that involved in bond breaking, without stating which process releases energy and which absorbs energy. A small number of candidates wrongly stated that energy is released in bond breaking and absorbed in bond forming. The performance of candidates in part (b)(iii) was good. However, some of them failed to give the correct answer because they used the incorrect '+ / –' sign for the energy terms, or missed the coefficient '2' in the term for ΔH_f° [$H_2O(l)$] in the calculation. The performance of candidates in part (c) was very poor. Less than half of the candidates were able to give correct reasons for using more natural gas to generate electricity than coal.
9	The performance of candidates in this question was poor. In part (a), about two thirds of the candidates were able to give the correct answer. However, a small number of the candidates wrongly stated performing the experiment in micro-scale could increase the rate of the reaction. The performance of candidates in part (b) was very poor. Some of the candidates wrongly stated that hydrogen is less dense than air, so placing the tubing at the uppermost position of the inverted measuring cylinder could collect more pure hydrogen from the cylinder. The performance of candidates in part (c) was good. However, some candidates wrongly stated that gas bubbles would be formed in the cylinder. In part (d), about two thirds of the candidates were able to give the correct answer. Some candidates gave the incorrect unit for the answer, such as 6.49 dm^3 or 0.00649 mol dm^{-3}. The performance of part (e) was poor. Only about a third of the candidates were able to give the correct answer.

Question Number	Performance in General
10	The performance of candidates in this question was satisfactory. About half of the candidates were able to give the correct answers in part (a)(i). Some candidates wrongly gave a "covalent-like" electron diagram for Na_2O. Some candidates failed to give the correct number of the outermost shell electrons or correct ionic charge for the O^{2-} ion. A small number of candidates wrongly stated that the reaction of sodium oxide with water would give sodium hydroxide and hydrogen gas. In part (a) (ii), about two thirds of the candidates were able to give the correct electron diagram for Cl_2O. Some candidates omitted the lone pair electrons on the oxygen atom. About a quarter of the candidates only stated whether Cl_2O is soluble in water without mentioning its acidic property. A small number of candidates wrongly stated that the reaction of Cl_2O with water would give HCl(aq) or a mixture of HCl(aq) and HOCl(aq). The performance of candidates in part (b) was satisfactory. Some candidates failed to give specific examples to illustrate their answers. Some candidates misspelt the term 'Haber Process' as 'Habour Process' or 'Harbour Process'.
11	The performance of candidates in this question was very poor. In part (a)(i), only about half of the candidates were able to give the correct answer. Some candidates failed to give the correct unit for the answer. The performance of candidates in part (a)(ii) was very poor. Only about a third of the candidates were able to recognise that the concentrations of H^+ and OH^- were equal in water. A high proportion of candidates failed to give the answer with a correct unit. In part (b), less than twenty percent of the candidates were able to give the correct answer. Many of them wrongly stated 'water is only a solvent so $[H_2O]$ is a constant'. The performance of candidates in part (c) was very poor, and only a very small number of the candidates were able to give the correct answer. About half of them wrongly stated that although the equilibrium position shifted to the right and $[H^+]$ increased, as $[H^+]$ was still equal to $[OH^-]$ and the water was then still neutral. Therefore, the pH would remain as 7.
12	The performance of candidates in this question was poor. About half of the candidates omitted either the oxidation (oxidation of benzaldehyde to give benzoic acid) or reduction (reduction of benzaldehyde to give phenylmethanol) step in their answers. Some candidates omitted 'acidified' for potassium dichromate solution. In the esterification step, some candidates gave the incorrect catalyst (H^+ or H_2SO_4(aq)) or omitted 'heating' for the reaction.
13	The performance of candidates in this question was fair. Less than half of the candidates were able to give the correct answer in a systematic way and with appropriate / correct terminologies. Common mistakes included 'a molecule having a chiral carbon atom which connected to four different molecules', 'the molecules rotate to different directions under plane-polarised light' and 'the molecule is superimposable with its mirror image'. Many candidates failed to recognise the correct meaning of the term 'superimposable', or spell the word correctly. There were also a high proportion of candidates who failed to demonstrate an accurate understanding of the optical activities of chiral molecules.

Paper 2

Paper 2 consisted of three sections. Section A contained questions set on Topic XIII 'Industrial Chemistry', Section B on Topic XIV 'Materials Chemistry' and Section C on Topic XV 'Analytical Chemistry'. Candidates were required to attempt all questions in two of the sections.

Question Number	Popularity (%)	Performance in General
Section A: 1	49	The performance of candidates in part (a) was satisfactory. However, about a third of the candidates were not able to write the rate equation from the given information, while about half of them were not able to give a chemical equation for the Haber process, and most of them were not able to calculate the activation energy. The performance of candidates in part (b) was poor. Many candidates were not able to draw the energy profiles in the same sketch and only about a third of them were able to suggest that the catalyst may be poisoned upon prolonged usage. Moreover, many candidates were not able to suggest reasons for considering the fermentation route as a green process. The performance of candidates in part (c) was fair. Eighty percent of the candidates were able to point out that a mercury electrolytic cell is not considered as environmentally friendly owing to the poisonous nature of mercury. Moreover, just under half of the candidates were able to suggest that brine or concentrated sodium chloride solution as the raw material for the chloroalkali industry and about two thirds of the candidates were able to suggest a criterion in choosing a site for building the plant. However, only about a quarter of candidates were able to give an overall equation for the electrolysis and state the advantage of a membrane electrolytic cell over a diaphragm electrolytic cell.
Section B: 2	3	The performance of candidates in part (a) was very poor. Ninety percent of the candidates failed to explain the meaning of the term 'unit cell', and seventy percent of them were not able to deduce the number of copper atoms in the given unit cell. The incorrect answer '14' was common, suggesting that candidates had not sufficiently mastered the topic. The performance of candidates in part (b) was poor. About half of the candidates were able to draw the structure of styrene, but more than forty percent of them did not give the correct name of the type of polymerisation involved. Incorrect answers like 'condensation polymerisation' were common. The performance of candidates in part (c) was very poor. Only about ten percent of the candidates were able to describe how molecules in the smectic phase of liquid crystal are arranged, and to explain why the pixel appears black when voltage is applied.
Section C: 3	48	The performance of candidates in part (a) was very poor. Only forty percent of the candidates were able to give a chemical test for the presence of $Br^-(aq)$, and twenty percent of them correctly suggested chromatography as the instrumental technique for determining the octane content in a petrol sample. Sixty percent of the candidates were not able to suggest a practical method in obtaining copper powder from a mixture of copper powder and iron(III) oxide. Most of them wrongly suggested adding dilute nitric acid or concentrated sulphuric acid to the mixture, or heating the mixture with carbon. The performance of candidates in part (b) was satisfactory. About two thirds of the candidates were able to give the observation upon treatment of **X** and **Y** with 2,4-dinitrophenylhydrazine and outline a distinguishing chemical test between **X** and **Y**. Lastly, about sixty percent of the candidates were not able to state how **X** and **Y** could be distinguished from one another by mass spectrometry but not by infra-red spectroscopy. The performance of candidates in part (c) was fair. More than two thirds of the candidates were able to write the chemical equations in Step (2). Just below half of the candidates were able to state the colour change at the end-point. However, many of them failed to calculate the percentage of nitrogen in the milk powder sample.