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.	Key	Question No.	Key
Part I		**Part II**	
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)

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

4

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)

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

Empirical formula = Fe_3O_4 2

(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 / *hν* / 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)

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) $\Delta H_c^\ominus = \Delta H_f^\ominus [CO_2(g)] + 2\Delta H_f^\ominus [H_2O(l)] - \Delta H_f^\ominus [CH_4(g)]$ 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

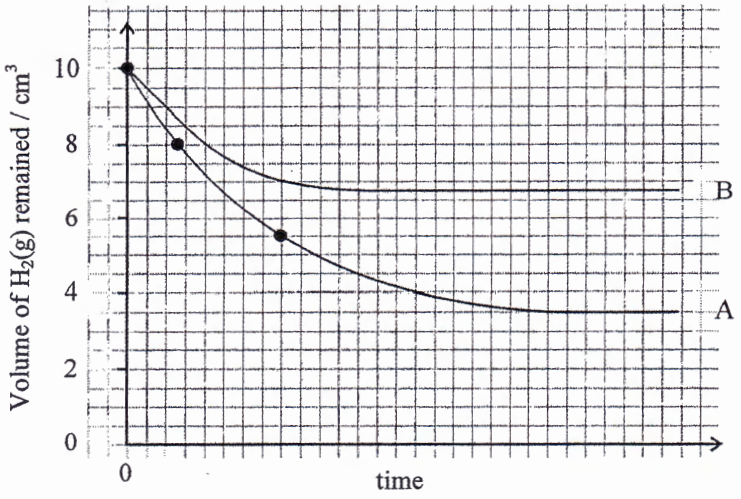
9. (a) save cost on chemicals / minimise chemical hazards / save time on carrying out experiment / reduce the consumption of chemicals / reduce chemical waste — 1

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

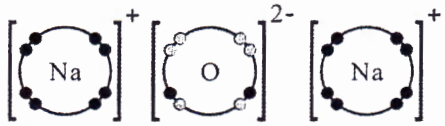
(c) Water level inside the measuring cylinder rises. / The gas volume inside the measuring cylinder reduces. — 1

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

(e) (i)& (ii) — 2

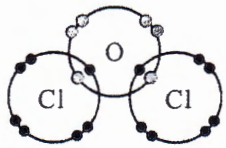


10. (a) (i) — 1



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

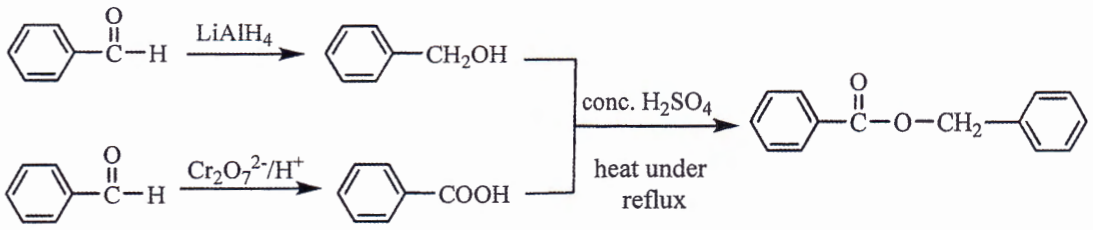
Marks

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. 

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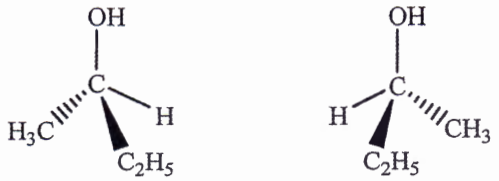
13. • 

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

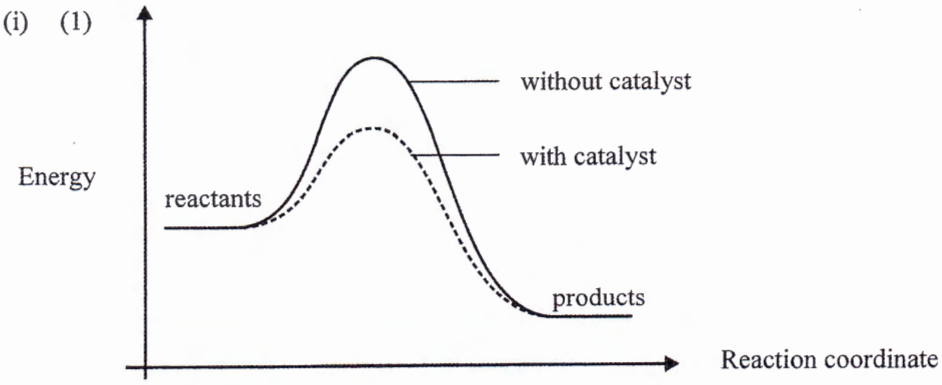
(2) Rate = $k[CH_3COCH_3(aq)][H^+(aq)]$ 1

(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

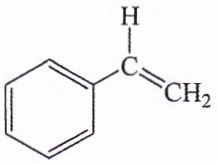
Marks

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 $= 8(\frac{1}{8}) + 6(\frac{1}{2})$
$= 4$ 1

(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 = $0.03645 \times 14 = 0.5103$ (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