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 (58%)	25.	B (75%)
2.	D (64%)	26.	B (60%)
3.	A (43%)	27.	C (73%)
4.	B (76%)	28.	D (57%)
5.	D (63%)	29.	A (66%)
6.	C (55%)	30.	A (37%)
7.	A (45%)	31.	B (56%)
8.	C (52%)	32.	C (72%)
9.	A (72%)	33.	C (88%)
10.	A (57%)	34.	D (42%)
11.	B (64%)	35.	C (43%)
12.	B (69%)	36.	C (45%)
13.	D (55%)		
14.	A (97%)		
15.	B (83%)		
16.	A (66%)		
17.	A (59%)		
18.	B (50%)		
19.	D (60%)		
20.	D (71%)		
21.	C (68%)		
22.	D (50%)		
23.	B (70%)		
24.	C (77%)		

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) It is the metallic bond between delocalised electrons and barium ions. 2

(b) (i) Ammonia is less dense than air. 1

(ii) Ammonia is soluble in water. 1

(c) (i) White solid forms. / White precipitate forms. / Heat evolves. 1

(ii) (1) When $H_2SO_4(aq)$ is added, $BaSO_4(s)$ and $H_2O(l)$ are formed, the concentration of mobile ions in the mixture decreases. 1

(2) Excess $H^+(aq)$ and $SO_4^{2-}(aq)$ ions are introduced into the solution. / The concentrations of $H^+(aq)$ and $SO_4^{2-}(aq)$ ions in the solution increase. / The concentration of mobile ions in the solution increases when $H_2SO_4(aq)$ is in excess. 1

2. (a) • Copper is not so easily oxidised / corroded as iron. 1
• Copper has a lower tendency to lose electrons than iron. 1

(b) (i) It is to lower the melting point of soldering materials. 1

(ii) Lead is / Compounds of lead are toxic / poisonous. 1

(c) $(1.0 \times 10^{-8} \times 1000) \div 207.2$ 2
$= 4.83 \times 10^{-8}$ mol dm^{-3}

3. (a) A propene molecule has C=C bond whereas propane molecule has not. 1

(b) • $HO_2C(CH_2)_4CO_2H$ has two $-CO_2H$ groups to react with $-NH_2$ group but $CH_3(CH_2)_4CO_2H$ has only one $-CO_2H$ group. 1
• Each $HO_2C(CH_2)_4CO_2H$ molecule can react with two $H_2N(CH_2)_6NH_2$ molecules to form a chain but $CH_3(CH_2)_4CO_2H$ cannot. 1

(c) • The O atom in H_2O has lone pairs of electrons. 1
• H^+ does not have electrons in its outermost shell. 1
• Dative covalent bond formed between the O atom in H_2O and H^+ by sharing electron pair. 1

Marks

4. (a) (i) **A**: $OH^-(aq)$ ions are preferentially discharged to give a colourless gas oxygen. 1

(ii) **B**:
- $H^+(aq)$ ions are preferentially discharged to give a colourless gas hydrogen. 1
- The solution turns pink as $[OH^-(aq)] > [H^+(aq)]$ when $H^+(aq)$ ions are consumed. 1

(b) $2H_2O \rightarrow 2H_2 + O_2$ 1

(c) (i) **A**: No change. $OH^-(aq)$ ions are still preferentially discharged to give a colourless gas oxygen. 1

(ii) **B:**
- No change. $H^+(aq)$ ions, the only cations, are discharged to give a colourless gas hydrogen. 1
- No colour change in the solution / The solution will not turn into pink as it is still acidic, despite the decrease in $[H^+(aq)]$ / as $H^+(aq)$ is in excess. 1

5. • Both molecules of H_2 and F_2 are held by weak van der Waals' forces. 1
- The van der Waals' forces between F_2 are stronger that those between H_2 because larger size of F_2 than H_2. 1
- Hydrogen bond exists among HF molecules and hydrogen bond is stronger than van der Waals' forces. 1

6. (a) oxidising and corrosive 1

(b) (i) The reaction between concentrated sulphuric acid and NaOH(aq) is highly exothermic. 1

(ii) red to orange 1

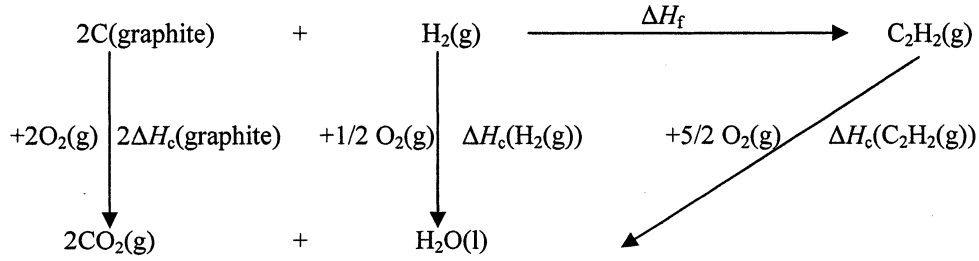
(iii) Number of moles of NaOH(aq) used = $0.189 \times 22.20 \times 10^{-3} = 4.20 \times 10^{-3}$ 3
Concentration of the concentrated sulphuric acid
$= 4.20 \times 10^{-3} \div (2 \times 25 \times 10^{-3}) \times (1000 \div 5)$
$= 16.8$ mol dm^{-3}

(c) Copper dissolves. / The solution turns blue. / A colourless / choking gas evolves. 1
$Cu + 2H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2$ 1

Marks

7. (a) The reaction between carbon and hydrogen does not only give ethyne. 1

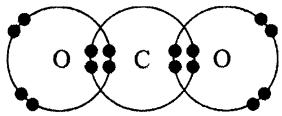
(b) The total enthalpy change of a chemical reaction is independent of the pathway between the initial and final states. 1

(c) (i) 
 2

(ii) (1) 298K and 1 atm 1

(2) Standard enthalpy change of formation of $C_2H_2(g) = 2\times(-394) + (-286) - (-1300)$
$= +226$ kJ mol^{-1} 2

8. (a) $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ 1

(b) 
 1

(c) • 'For': Using carbon capture techniques, the CO_2 produced in power stations can be trapped, thus the emission of CO_2 into the atmosphere will be reduced. 1
• 'Against': The electricity used in powering cars is mainly produced by burning of fossil fuels, and the CO_2 so produced will still be emitted into the atmosphere. 1

(d) limited supply of air or oxygen 1

(e) (i) catalytic converter 1

(ii) particulates / suspended particulates / sulphur dioxide 1

9. Chemical knowledge 4
- Acidified $K_2Cr_2O_7$(aq) test: Only $HOCH_2CH_2CH_2OH$ will produce a colour change from orange to green.
- Br_2(in organic solvent) test: Only $CH_2{=}CHCO_2H$ will produce a colour change from brown / orange to colourless.
- Add each liquid into water, and then perform Mg / Zn test: Only $CH_3CH_2CO_2H$ or $CH_2{=}CHCO_2H$ reacts to give a colourless gas hydrogen.
- $CH_3CO_2CH_3$ gives negative results in all the above three chemical tests.

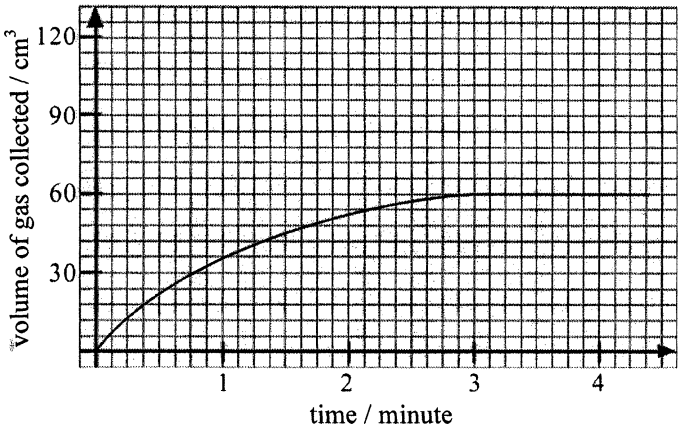
Communication mark 1

Part II

Marks

10. (a) $(60 \div 24000) \times 2 = 0.005\ y$ 2
$y = 1.0$ mol dm^{-3}

(b) 2



(c) 60 cm^3 of gas would still be collected because the number of moles of H_2O_2(aq) is the same for both experiments. 1

(d) Follow the change in total pressure / mass in the system. 1

11. (a) $K_c = [H^+(aq)]\,[A^-(aq)] / [HA(aq)]$ 1
where HA represents 4-nitrophenol and A^- represents 4-nitrophenoxide ion.

(b) In the solution, $2.4 = -log\,[H^+(aq)]$ 2
$[H^+(aq)] = 4.0 \times 10^{-3}$ mol dm^{-3}
$8.0 \times 10^{-8} = 4.0 \times 10^{-3}\,[A^-(aq)] / [HA(aq)]$
$[HA(aq)] / [A^-(aq)] = 50000$

(c) • The equilibrium position will shift to right when H^+(aq) ions are consumed by NaOH(aq). 1
• HA is colourless while A^- is yellow. Increase in $[A^-]$ causes the solution changes from colourless to yellow (or the colour / yellow colour becomes more intense). 1

(d) indicator 1

Marks

12. (a) $CH_3CH_2CH(Br)CH_2CH_3$ 1

(b) (i)
- The –OH group in **B** after reacting with HBr will change to the –Br group in **C**, and there is no chiral carbon due to no optical activity. 1
- Thus the structure of **B** is $CH_3CH_2CH(OH)CH_2CH_3$. 1

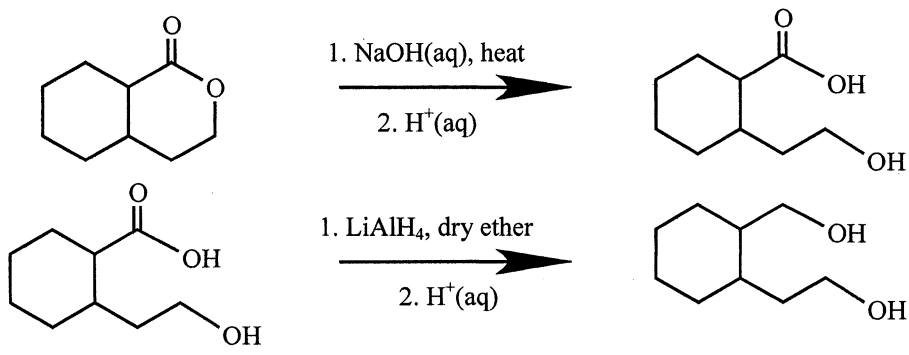
(ii) Substitution 1

(c) (i) **A** has a C=C double bond as there are 2 hydrogen atoms less in **A** as compared with **B**. Moreover, **A** is optically active and it has a chiral carbon. 1

A has the structure $CH_2=CH\overset{*}{C}H(OH)CH_2CH_3$. 1

(ii) H_2 / Pd (heat) or H_2 / Pt (heat) or H_2 / Ni (heat) 1

13. 3



14. Chemical knowledge 5
- $2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 16H^+(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$
- Manganese exhibits variable oxidation numbers. The oxidation number of manganese changes from +7 in $MnO_4^-(aq)$ ions to +2 in $Mn^{2+}(aq)$ ions in the reaction.
- Manganese forms coloured ions in aqueous solutions. $MnO_4^-(aq)$ ions exhibit purple / $Mn^{2+}(aq)$ ions exhibit pale pink.
- From the graph, it shows that the reaction rate increases when $Mn^{2+}(aq)$ ions form / when the reaction proceeds.
- It shows that $Mn^{2+}(aq)$ ions act as a catalyst for the reaction.

Communication mark 1

Paper 2

Marks

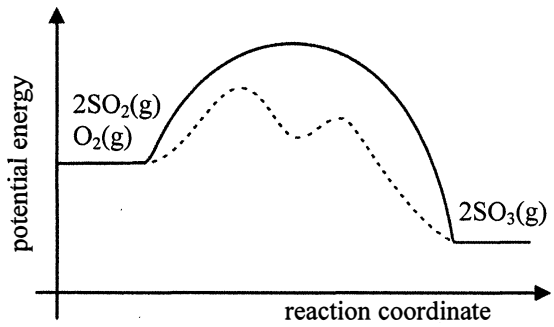
1. (a) (i) (1) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ 1

(2) The reaction mixture is cooled to condense ammonia to liquid. 1

(ii) The order of reaction with respect to **A** is zero. 1
From the graph, rate of change of [**A**] is independent from [**A**]. 1

(iii) flammable 1

(b) (i) 3



(ii) (1) Impurities in the reaction mixture may poison the catalyst. 1

(2) (I) Lowering the temperature makes the reaction proceed at a slower rate. 1

(II) The percentage conversion is already very high. Increasing the pressure can only lead to a small increase in the percentage conversion but very high cost is needed. 1

(3) Oxygen is used in a slight excess because oxygen is more readily available. 1

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

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

(2) $Na^+ + e^- \rightarrow Na$ 1

(3) Mercury is poisonous. 1

(iii) Let rate = $k[CO]^m[Cl_2]^n$ 2
From doubling [CO] while keeping $[Cl_2]$ unchanged,
$2.83 = 2^m$
$m = 1.5$

(iv) (1) The atom economy of the reaction is 100%. / No solvent is required in the reaction. 1

(2) The reactants are poisonous. 1

Marks

2. (a) (i) Cross-linkages / covalent bonds / disulphur linkages are formed between polymer chains. 1
With cross-linkages, the polymer chains cannot slip easily over each other. 1

(ii) The structure of HDPE is less branched than that of LDPE. 1

(iii) **A** exhibits liquid crystal behaviour. A molecule of **A** has a rigid central part, a polar group / ester group and a long alkyl chain. 2

(b) (i) (1) coordination number = 12 1

(2) number of Cu atoms = $12 \times (1/4) + 1 = 4$ 1

(ii) (1) hexagonal close-packed 1

(2) Similarity: coordination number (12) / close-packed structures 1

(3) Difference:
- Cu : A-B-C type packing 1
- Zn : A-B type packing 1

(iii) brass 1

(c) (i) $CH_2=C(CH_3)CO_2CH_3$ 1
petroleum / crude oil 1

(ii) contact lens 1

(iii) (1) Thermoplastic is a type of plastic that becomes soft when heated; becomes hard when cooled. 1

(2)
- Production: Raw material is biomass. 1
- Disposal: PHB is biodegradable. 1

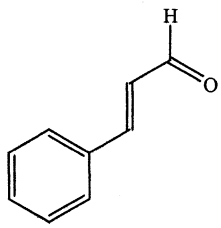
(iv) (1) Small molecules (e.g. H_2O) would be eliminated in the reaction. 1

(2) Disposal: PHB undergoes hydrolysis in the presence of acids / alkalis. 1

Marks

3. (a) (i) Flame tests are carried out. 1
Sodium ions give an intense golden yellow flame while potassium ions give a lilac flame. 1

(ii) Add a piece of filter paper which is soaked with acidified $K_2Cr_2O_7(aq)$ to the gas. 1
The filter paper turns from orange to green. 1

(iii) 

1

(b) (i) From pale yellow to pale pink 1

(ii) (1) $(37.62+37.58+37.60) \div 3 = 37.60\ cm^3$ 1

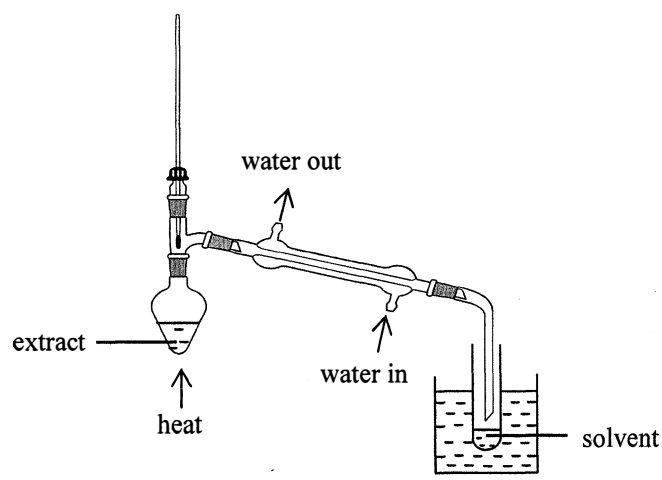
(2) Number of moles of $Fe^{2+}(aq)$ ions formed in Step (1) 3
$= 0.0282 \times 37.60 \times 10^{-3} \times 5 \times 10 = 0.0530$
Number of moles of $Fe^{3+}(aq)$ ions reacted in Step (1) = 0.0530
Number of moles of $HONH_2(aq)$ reacted = $0.875 \div 33.0 = 0.0265$
Mole ratio of $HONH_2(aq)$: $Fe^{3+}(aq)$ = 1 : 2

(3) The oxidation number of iron changes from +3 to +2 and the oxidation number of N in $HONH_2(aq)$ is −1. 2
Since the mole ratio of $HONH_2(aq)$: $Fe^{3+}(aq)$ = 1 : 2, the oxidation number of N in this oxide = −1+2 = +1

(iii) N_2O 1

(c) (i) (1) The solvent will not lose during heating. 1

(2) 2



(3) column chromatography 1

(ii) **W** 1
It has >C=O group: It has a strong absorption peak at around 1700 cm^{-1} in its IR spectrum. 1
It has no –COOH group: It does not react with $NaHCO_3(aq)$. 1