Marking Scheme

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.	C (74%)	25.	A (73%)
2.	D (75%)	26.	B (68%)
3.	A (19%)	27.	D (62%)
4.	D (62%)	28.	A (67%)
5.	C (84%)	29.	B (55%)
6.	C (64%)	30.	C (77%)
7.	B (32%)	31.	D (28%)
8.	B (78%)	32.	D (48%)
9.	A (76%)	33.	C (49%)
10.	D (70%)	34.	A (63%)
11.	C (61%)	35.	D (80%)
12.	D (48%)	36.	C (66%)
13.	C (76%)		
14.	A (68%)		
15.	B (70%)		
16.	A (88%)		
17.	A (88%)		
18.	B (66%)		
19.	D (38%)		
20.	A (63%)		
21.	D (32%)		
22.	B (62%)		
23.	B (74%)		
24.	D (51%)		

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

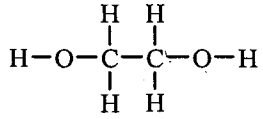
1. (a) (i) Layers of graphite are only held together by van der Waals' forces. 1

(ii) Graphene can conduct electricity because it has delocalised electrons. 1

(iii)  1

(b) Not agree. Graphene layer has of a giant covalent structure. / A large amount of energy is needed during melting to destroy the large amount of strong covalent bonds between atoms. 1

(c)
- C_{60} has a spherical structure. 1
- C_{60} has a simple molecular structure. 1
- The van der Waals' forces between C_{60} molecules are of comparable strength as those in molecules of organic solvents. 1

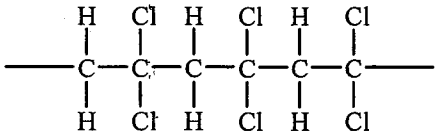
2.  1

It is soluble in water because:
- It has a small molecular size. 1
- The hydroxyl groups in it can form hydrogen bonds with water. 1

3. (a) Add in $Br_2(aq)$ / acidified $KMnO_4(aq)$ / neutral or alkaline $KMnO_4(aq)$. 1
Reddish brown $Br_2(aq)$ decolourised / Purple $KMnO_4(aq)$ decolourised / Purple $KMnO_4(aq)$ turns brown. 1

(b) (i) 1,1-dichloroethene 1

(ii) addition polymerisation 1

(iii)  1

(c) 'Saran' is more heat resistant. 1
It is because the polar attraction force between 'Saran' polymer chains is stronger than that between PE. 1

(d) Incineration of food wrap made from 'Saran' will produce toxic gases while that made from PE will not. 1

Marks

4. • Silver can be obtained by heating oxide of silver directly, while copper and magnesium cannot be obtained by similar method. 1
• By heating with charcoal, oxide of copper can be reduced to copper, while magnesium cannot be obtained by similar method. 1
• Magnesium can only be obtained by electrolysis of its oxide in molten state. 1
• As more stable is the metal oxide, the more reactive is the metal. So, the order of reactivity is: magnesium > copper > silver 1
• Communication mark 1

5. (a) Wearing protective gloves / plastic gloves / gown / safety goggles 1

(b) The statement is not correct. The strength of an acid is not related to its concentration. 1

(c) Concentrated sulphuric acid reacts with copper to liberate a colourless gas. 1
Concentrated nitric acid reacts with copper to liberate a brown gas. 1
When concentrated ethanoic acid is added to copper granules, there are no observable changes / no reactions occur. 1

6. (a) (i) Components having different boiling points can be separated from each other by fractional distillation. 1
The longer the carbon chain, the higher is the boiling point. 1

(ii) Cracking of heavy oil / heavy hydrocarbons 1

(iii) The enthalpy change when one mole of a compound burns completely under standard conditions / 25°C and 1 atm. 1

$C_8H_{18}(l) + \frac{25}{2} O_2(g) \rightarrow 8CO_2(g) + 9H_2O(l)$ 1

(b) (i) Catalytic converter 1

(ii) The standard enthalpy change of the reaction 3
$= 2(-394) - 2(-110.5) - 2(90.3)$
$= -747.6 \text{ kJ mol}^{-1}$

Marks

7. (a) Mass of HCl in 1000 cm^3 of the concentrated acid = 1180 x 36% = 425 g — 2
Formula mass of HCl = 36.5
Concentration = 425 / 36.5 = 11.6 mol dm^{-3}

(b) (i) • Weigh accurately the amount of sodium carbonate needed and dissolve it using deionised water / distilled water. — 1
• Transfer all the solution made to a volumetric flask, add deionised water / distilled water to the graduation mark of the flask, and mix the content thoroughly. — 1

(ii) No. of mole of H^+ present in the diluted acid = 1.06 x (10/1000) x 2 — 3
= 0.0212
Concentration of the acid in the bottle = [0.0212 / (20.30/1000)] x 10
= 10.4 mol dm^{-3}

(c) Some HCl(g) escaped from the concentrated acid. — 1

8. (a) (i) The electrode dissolves / becomes smaller / becomes thinner gradually. — 1

(ii) Colourless gas / bubbles given out. — 1

(b) (i) $4OH^- \rightarrow 2H_2O + O_2 + 4\ e^-$ — 1

(ii) $Ag^+ + e^- \rightarrow Ag$ — 1

(c)

electrode **W**	electrode **Z**
anode	cathode

— 1

(d) Electrons would not flow through the electric wires / no observable changes on all electrodes / no reaction occurs because ethanol is not an electrolyte / cannot conduct electricity. — 1

9. (a) (i) A blue precipitate is obtained. — 1

(ii) $Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$ / $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$ — 1

(b) (i) Purple acidified potassium permanganate solution is decolourised / turns into colourless. — 1

(ii) (1) Redox / oxidation-reduction / reduction of acidified potassium permanganate — 1

(2) $2MnO_4^-(aq) + 5SO_3^{2-}(aq) + 6H^+(aq) \rightarrow 2Mn^{2+}(aq) + 5SO_4^{2-}(aq) + 3H_2O(l)$ — 1

Part II

Marks

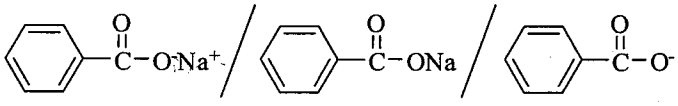
10. • Proper way to follow the progress of the reaction (e.g. measure the volume of CO_2 evolved / measure the loss in mass of the reaction mixture over a certain time interval / measure the pressure of the CO_2 formed in a sealed reaction container.) 1
• Dilute 1M HCl to different concentrations by adding water. 1
• Repeat the experiment with the diluted HCl. 1
• State one condition for performing fair comparison (e.g $CaCO_3$ used should be of the same amount / under same experimental conditions such as same temperature or pressure) 1
• Communication mark 1

11. (a) Vanadium exhibits variable oxidation numbers and its ions in aqueous solutions carry colours. 1

(b) (i) 1 mol of $VO_2^+(aq)$ ions gains 2 mol of electrons from 1 mol of $SO_2(g)$ to become 1 mol of $V^{3+}(aq)$ ions. 1
$V^{3+}(aq)$ ion is green in colour. 1

(ii) $SO_2(g) + VO_2^+(aq) \rightarrow SO_4^{2-}(aq) + V^{3+}(aq)$ 1

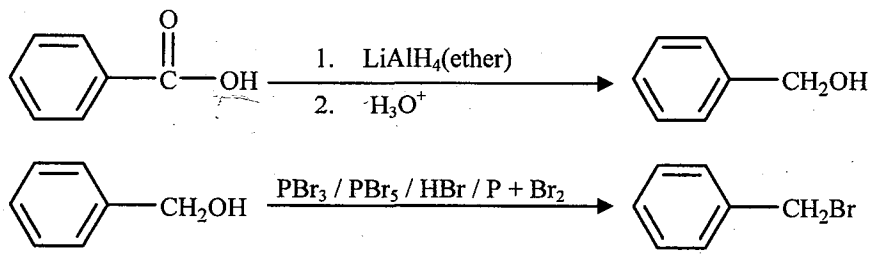
12. (a) (i) alkaline hydrolysis 1

(ii)  1

(iii) $HCl(aq) / H_2SO_4(aq)$ 1

(iv) **X** (sodium benzoate) is an ionic compound which has stronger interactions with water. / Benzoic acid exists as molecules which have weaker intermolecular interactions with water. / 1
X is an ionic compound while benzoic acid exists as molecules.

(v) Filter the mixture to obtain the solid benzoic acid. Wash it with deionised water and then dry in oven. 1

(b)  3

Marks

13. (a) (i)

	$2NO(g)$	+	$O_2(g)$	$\rightleftharpoons$	$2NO_2(g)$
Initial conc.:	1.02/50 = 0.0204		1.29/50 = 0.0258		0
Equil. conc.:	0.0204 x 0.39 = 0.007956		0.0258–0.006222 = 0.019578		0.0204 x 0.61 = 0.012444

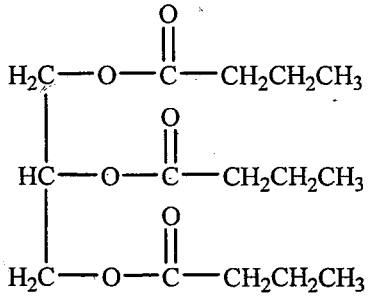
$$K_c = \frac{(0.012444)^2}{(0.007956)^2(0.019578)} \quad / \quad K_c = \frac{[NO_2]^2}{[NO]^2[O_2]}$$

$= 125\ dm^3\ mol^{-1}$ 3

(ii) No change, because K_c is independent of concentration / only depends on temperature. 1

(b) As revealed from the data, when temperature increases, K_c decreases. Therefore the forward reaction is exothermic. / 1
As higher temperature favours endothermic side of reaction, so the forward reaction is exothermic.

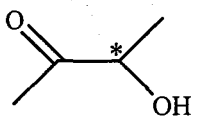
14. (a)



1

(b) methylpropanoic acid 1

(c) (i)



1

(ii) Correct chemical reagent 1
Correct observations with **comparison** between the tests on **Q** and **Z** 1

Possible tests and the corresponding observations:

$Cr_2O_7^{2-}$ / H^+	**Q** – no change; **Z** – from orange to green
MnO_4^- / H^+	**Q** – no change; **Z** – from purple to colourless
MnO_4^- / OH^-	**Q** – no change; **Z** – formation of brown ppt.
2,4-DNP	**Q** – no change; **Z** – formation of orange ppt.
CH_3CH_2OH / H^+ / heat	**Q** – fruity smell compound formed; **Z** – no change
CH_3COOH / H^+ / heat	**Q** – no change; **Z** – fruity smell compound formed
CO_3^{2-}	**Q** – formation of gas (CO_2); **Z** – no change
HCO_3^-	**Q** – formation of gas (CO_2); **Z** – no change

(2,4-DNP = 2,4-dinitrophenylhydrazine)

(d) hydrogenation / addition of hydrogen 1

Paper 2

Marks

1. (a) (i) 'Activation energy' refers to the minimum energy possessed by the colliding reactant particles in order that a reaction can occur. 1

(ii)
- Yeast provides enzyme / catalyst. 1
- At high temperature, the enzyme (yeast) is denatured / destroyed so that it cannot function as a catalyst. 1

(iii) It is to solve the problems of inadequate or shrinking supply of vitamin C. 1

(iv) Any two: chlorine, hydrogen, sodium hydroxide 1

(b) (i) 'Initial rate' is the instantaneous rate at the start of a reaction. 1

(ii)
- Follow the colour intensity of the solution / by colorimetry. 1
- The solution changes from colourless to brown. 1

(iii)
- The initial rate is directly proportional to $[BrO_3^-(aq)]$. 1
- Therefore, the order of reaction with respect to $BrO_3^-(aq) = 1$ 1

(iv) (1) Rate = $k[BrO_3^-][I^-][H^+]^y$ 2

$$\frac{\text{initial rate 1}}{\text{initial rate 2}} = \frac{(0.17)(0.15)}{(0.17)(0.30)}\left(\frac{0.10}{0.20}\right)^y = \frac{2.30\times10^{-3}}{1.84\times10^{-2}}$$

$y = 2$

The reaction is second order with respect to $H^+(aq)$.

(2) Rate of consumption of BrO_3^- = 1/3 × rate of formation of I_2 1

Based on Trial 1, initial rate of consumption of $BrO_3^-(aq)$

$= 2.30 \times 10^{-3} \times 1/3$

$= 7.67 \times 10^{-4}$ mol dm^{-3} s^{-1}

(c) (i) The ammonia produced by the Haber process can be used to manufacture fertilisers / explosives, etc. 1

(ii) Natural gas remains the more convenient / cheap way to provide hydrogen as feedstock for the production of ammonia in the Haber process. 1

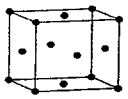
(iii) Provide a larger surface area that makes the catalyst more effective. 1

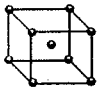
(iv)
- equilibrium position / yield 1
- reaction rate 1

(v) Any unreacted reactants are reused / recycled so that they can react again. / Removing ammonia from the product mixture so as to shift the equilibrium position to the product side. 1

(vi) As the demand for mining the natural nitrate to produce fertilisers drops drastically, the mining work was no longer profitable / mining work might be closed / it could lead to a high unemployment rate. 1

Marks

2. (a) (i) (1)  1

(2)  1

(ii) Any two: 2
- With a fairly rigid molecular backbone containing double bonds defining the long axis of the molecule
- many liquid-crystalline materials have benzene rings
- rod-like or disc-like molecules
- polar groups

(iii) Thermoplastics: polyvinyl chloride, polystyrene 1
Thermosetting plastics: urea-methanal

(b) (i) (1) Both of them have giant structures. 1

(2) Silicates are natural materials, while ceramics are synthetic materials. 1

(ii) (1) $Si_2O_5^{2-}$ 1

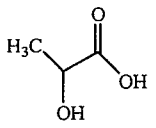
(2)
- Talc: Sheet structure in which the sheets are held together by van der Waals' forces. 1
- Quartz: Si and O atoms joined by a giant network / strong covalent bonds. 1
- A small amount of energy can make the sheets slip over one another in talc, while a large amount of energy is needed to break the giant network in quartz. 1

(iii) High hardness 1

(c) (i) Blow moulding 1

(ii)
- low density polyethene (LDPE) and high density polyethene (HDPE) 1
- As the bottle for cough syrup is hard, HDPE is more suitable. HDPE molecules have a linear structure that pack more closely. 1
  OR
  As the bottle for cough syrup is soft, LDPE is more suitable. LDPE molecules are highly branched that cannot pack closely.

(iii)
- The polar PET molecules are held together by much stronger polar-polar interactions. 1
- The non-polar PE (HDPE) molecules are held together by van der Waal's forces. 1

(iv) (1)  1

(2) PLA is made from renewable resources, while PE and PET are made from non-renewable petroleum products. 1
OR
PLA is biodegradable, while PE and PET are non-biodegradable.

(3) PLA is made from agricultural products. Massive production of PLA may affect the supply of food. 1

Marks

3. (a) (i) (1)
- Place HCl(g) near NH_3(conc). 1
- Dense white fume is observed. 1

(2)
- Add 2,4-dinitrophenylhydrazine. 1
- Yellow/ orange/ red precipitate is formed. 1

(ii) anhydrous magnesium sulphate 1

(b) (i) To ensure the reaction go to completion. 1

(ii) (1) No more gas is given out. / All solids are dissolved. 1

(2) Brown precipitate formed. 1

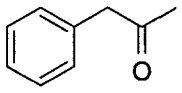
(iii) No. of mole of CaC_2O_4 formed in step 6: 3
2.374 / 128.1 = 0.01853
Mass of $CaCO_3$ in the limestone sample:
0.01853 x 100.1 = 1.855 g
Percentage of $CaCO_3$ by mass in the limestone sample:
1.855 g / 2.025 g = 91.60 (%)

(iv) Gravimetric analysis 1

(c) (i)
- Dissolve the sample in pentane and shake the solution with $NaHCO_3$(aq) in a separating funnel. 1
- Collect the organic layer and carry out fractional distillation. 1

(ii)
- The spectrum does not show strong absorption at about 3230-3670 cm^{-1}, ruling out the presence of a hydroxyl group (the possibility of being an alcohol) 1
The absence of absorption at 2070-2250 cm^{-1} ruled out the presence of C≡C group.
The absence of absorption at 1610 - 1680 cm^{-1} ruled out the presence of C=C group.
- The spectrum has a strong absorption at 1730 cm^{-1}, which corresponds to C=O stretching. The compound may contain an aldehyde group or a ketone group. 1
- The negative result in Tollens' test ruled out the presence of aldehyde group in the compound. The compound may contain a ketone group. 1

(iii) m/z = 43: $[CH_3CO]^+$ 1
m/z = 134: $[C_7H_7COCH_3]^+$ 1

(iv)  1

Other possible structures: