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. The mean score was 24.9. Candidates' performance was generally good. Some misconceptions of candidates were revealed from their performance in the following items:

1. For Q.3, in option A, red wine turning sour involves the oxidation of ethanol to ethanoic acid. In option C, combusting natural gas involves the oxidation of fuels to carbon dioxide and water. In option D, removing nitrogen oxides in the catalytic converter involves the reduction of nitrogen oxides to nitrogen. All the above three options do involve oxidation and reduction. However, for option B, removing rust using white vinegar only involves the neutralisation of rust (an iron oxide) with ethanoic acid and that does not involve oxidation and reduction. Therefore, B is the correct answer.

   Q.3 Which of the following processes does NOT involve oxidation and reduction ?

A.	red wine turning sour	(17%)
B.*	removing rust using white vinegar	(40%)
C.	combusting natural gas in a power station	(35%)
D.	removing nitrogen oxides in the catalytic converter of a car	(8%)

2. For Q.15, it should be noted that in order to slow down the corrosion of an iron-made object, the object should be made as the cathode of a chemical cell, namely cathodic protection. However, many candidates wrongly thought that the object should be connected to the cathode of a chemical cell. This may explain why so many candidates chose option D over B.

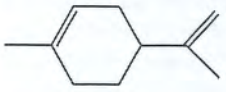
   Q.15 Which of the following methods can slow down the corrosion of an iron-made object ?

   (1) Connect it to a piece of lead.
   (2) Plate a layer of copper coating completely onto its surface.
   (3) Connect it to the cathode of a chemical cell.

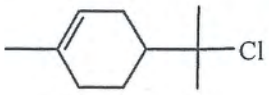
A.	(1) only	(4%)
B.*	(2) only	(24%)
C.	(1) and (3) only	(9%)
D.	(2) and (3) only	(63%)

3. For Q.29, many candidates did not apply the Markovnikov's rule to predict the major product in the addition reaction of HCl(g) to limonene. According to Markovnikov's rule, the hydrogen atom is added to the carbon with the greatest number of hydrogen atoms while the Cl component is added to the carbon with the least number of hydrogen atoms. Based on the rule, B is the correct answer.

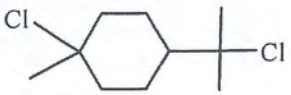
Q.29 The structure of limonene is shown below :



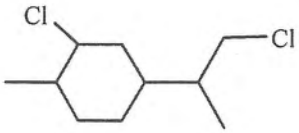
It reacts with excess HCl(g) to give **Z** as the major product. Which of the following is **Z** ?

A. 

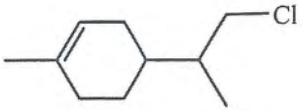
(12%)

B.* 

(50%)

C. 

(25%)

D. 

(13%)

Section B (conventional questions)

Question Number	Performance in General
1	The performance of candidates in this question was good. In part (a), a very high proportion of the candidates were able to correctly explain why protium and deuterium are isotopes. In part (b), about three quarters of the candidates were able to give the correct electron diagram for a D_2O molecule. A small number of the candidates wrongly considered D_2O to be an ionic compound and gave an incorrect electron diagram. In part (c)(i), about three quarters of the candidates were able to state the correct expected observations for the reaction between sodium metal and liquid D_2O. A small number of the candidates wrongly stated that white precipitate was formed in the reaction. In part (c)(ii), about a third of the candidates were able to give a correct chemical equation for the reaction between sodium and D_2O. However, about a third of the candidates wrongly considered that Na_2O, instead of NaOD, was formed in the reaction.
2	The performance of candidates in this question was fair. In part (a), about three quarters of the candidates were able to complete the diagram of the structure of sodium chloride crystal. A small number of the candidates wrongly thought that the particle positions in the three layers are identical, or missed 1 or 2 particles from the diagram. In part (b)(i), about a quarter of the candidates were able to correctly express the total mass of 4 Na^+ and 4 Cl^- ions in terms of the Avogadro's constant. In part (b)(ii), about a third of the candidates were able to calculate the Avogadro's constant correctly.
3	The performance of candidates in this question was satisfactory. In part (a)(i), about two thirds of the candidates were able to correctly give bromine as the answer. A small number of the candidates possibly did not read the question carefully and mistakenly gave aqueous bromine as the answer. There was also a small number of the candidates who wrongly identified the orange solution as potassium dichromate solution. In part (a)(ii), about a third of the candidates were able to give the correct chemical equation for the reaction. A small number of the candidates gave incorrect structures of but-2-ene or the reaction product. A small number of the candidates only wrote down the chemical equation without giving an explanation for the colour change. In part (b), about two thirds of the candidates were able to give a correct and complete answer. A small number of the candidates just stated that the gas is NH_3, or wrote down a chemical equation, without further elaboration. A small number of the candidates wrongly gave NaOH as the answer, not realising that NaOH is a solid at room temperature. A very small number of the candidates wrongly stated that NH_4^+ is alkaline.
4	The performance of candidates in this question was good. In part (a)(i), about two thirds of the candidates were able to correctly and completely described how a standard solution of potassium hydrogenphthalate can be prepared in a laboratory. Some candidates failed to state the use of distilled water or deionised water to dissolve the solid when preparing the solution. A small number of the candidates wrongly suggested dissolving the solid directly in the volumetric flask. A few candidates wrongly suggested using a pipette to transfer 250.0 cm^3 of the solution from the beaker to a volumetric flask. In part (a)(ii), about three quarters of the candidates were able to calculate the molarity of the standard solution. In part (b), about two thirds of the candidates were able to correctly state and explain that the –COOH group in potassium hydrogenphthalate is not completely ionised.

Question Number	Performance in General
5	The performance of candidates in this question was good. In part (a), about two thirds of the candidates were able to give a correct reagent for the reaction. Some candidates wrongly gave $Cl_2(aq)$ or HCl as the answers. In part (b), about three quarters of the candidates were able to state that light is required for the reaction. Some candidates did not read the question carefully, and gave 'heat' as the answer. In part (c), about three quarters of the candidates were able to name 'substitution' for the reaction type. Some candidates wrongly gave 'addition reaction' as the answer, or wrongly spelt 'substitution'. In part (d)(i) and (ii), about half of the candidates were able to give the correct structures of the compounds, and just under half of the candidates were able to give the correct systematic name of one of the compounds. However, some candidates gave the structures of two identical compounds for part (i) & (ii). In part (d)(iii), about three quarters of the candidates were able to state the correct type of isomerism exhibited by the two compounds. Some candidates wrongly stated that the two compounds are enantiomers.
6	The performance of candidates in this question was good. In part (a), a very high proportion of the candidates were able to draw the required three-dimensional structure. In part (b), just less than half of the candidates were able to explain why CH_2Cl_2 is a polar molecule but CCl_4 is not. In addition, about half of the candidates were able to explain fully why CCl_4 has a higher boiling point than that of CH_2Cl_2. Some candidates wrongly explained the difference in boiling points using erroneous answers like 'CCl_4 is already a liquid' and 'CCl_4 has strong covalent bonds in its molecule while CH_2Cl_2 has weak van der Waals' forces between molecules'.
7	The performance of candidates in this question was satisfactory. In part (a), about three quarters of the candidates were able to state the use of the porous pot and write the half equation to represent the change that occurs at the cathode. However, only a small number of the candidates were able to deduce the correct direction of how electrons flow through the external circuit. In part (b)(i), just under half of the candidates were able to write the half equation required. In part (b)(ii), about two thirds of the candidates were able to state the expected observation. In part (b)(iii), about a third of the candidates were able to select the correct change in the multimeter reading and give an explanation.
8	The performance of candidates in this question was satisfactory. In part (a), about three quarters of the candidates were able to show how to estimate the maximum temperature using the graph provided. Some candidates wrongly linked up all the data points instead of using two straight lines. In part (b)(i), about three quarters of the candidates were able to calculate the number of mole of NaOH(aq) and the concentration of HCl(aq). However, in part (b)(ii), only about a third of the candidates were able to determine the exact enthalpy change of neutralisation. A common mistake was the omission of the negative sign. In part (c), only about a third of the candidates were able to include all the key terms like '1 mole of water', 'acid', 'base' and 'standard conditions' in their answers.
9	The performance of candidates in this question was satisfactory. In part (a)(i), about three quarters of the candidates were able to describe the principle of this kind of corrosion prevention. In part (a)(ii), about half of the candidates were able to give the correct explanation. Some candidates incorrectly suggested that 'iron is the sacrificial metal'. In part (a)(iii), about two thirds of the candidates were able to state that zinc ions are poisonous, but some candidates suggested wrong answers like 'lead is poisonous'. In part (b)(i), about half of the candidates were able to explain the phenomenon using the appropriate chemistry principle. However, in part (b)(ii), some candidates wrongly used the same principle to explain how aluminium and tin can prevent iron from corrosion. In part (b)(iii), only about a quarter of the candidates were able to suggest the advantage of using aluminium to make cans.

Question Number	Performance in General
10	The performance of candidates in this question was fair. Only a small number of the candidates provided a comprehensive description on how to obtain the zinc sulphate crystals. A high percentage of the candidates failed to point out that the key step of separation is the use of excess amount of zinc powder, and did not present their answers in a systematic way.
11	The performance of candidates in this question was good. In part (a), about three quarters of the candidates were able to give the correct chemical equation for the reaction between nitric acid and calcium carbonate. Some candidates were not able to balance the equation correctly. In part (b)(i), half of the candidates were able to calculate the average rate of the reaction, and give an answer with a correct unit. However, some candidates wrongly interpreted the data from the graph, made wrong rounding errors or answers using an incorrect unit. In part (b)(ii), just below half of the candidates were able to correctly state and explain the difference in the shape of the curves. Many candidates were not able to explain the difference by using precise concepts and terminology. For example, some candidates explained that the reactions proceeded with different rates because the volumes of HNO_3 used were different, instead of the concentrations of HNO_3 in the reaction mixture were different. In part (c), about two thirds of the candidates were able to suggest an appropriate way to study the effect of surface area of solid reactant on the rate of reaction.
12	The performance of candidates in this question was fair. In part (a), a very high proportion of the candidates were able to give the correct expression for the equilibrium constant. In part (b), about a third of the candidates were able to perform the calculation correctly and give the answer with a correct unit. Some candidates failed to work out the correct initial concentrations for the species in the mixture. In part (c), only about a quarter of the candidates were able to give a correct and complete answer. In part (d), a quarter of the candidates were able to give a correct and complete explanation for the observation. Some candidates wrongly stated that Na_2SO_3 reacts with $Fe(SCN)^{2+}$ to cause a decrease in concentration of $Fe(SCN)^{2+}$, or that this decrease results in the colour of the mixture becoming paler.
13	The performance of candidates in this question was fair. In part (a)(i), about two thirds of the candidates were able to correctly state that the organic product is ethanal. In part (a)(ii), only a small number of the candidates were able to correctly explain why ethanol, instead of ethanoic acid, is collected from the reaction. Some candidates only stated that the boiling point of ethanal is low without giving any further elaboration. A small number of the candidates wrongly stated that $K_2Cr_2O_7$ is only a weak oxidising agent and not strong enough to oxidise ethanol to ethanoic acid. In part (b)(i), about half of the candidates were able to give the correct systematic name of the amide formed. Some candidates misspelt the name of the compound. In part (b)(ii), just below half of the candidates were able to suggest the correct reagent and condition for the reaction. Some candidates failed to state that the reagents PCl_3 and NH_3 should be used in two separate steps. In part (c)(i), only a small number of the candidates were able to draw the correct repeating unit for the polymer. Many candidates failed to recognise that the repeating unit should break between NH and CO in the structure. In part (c)(ii), just below half of the candidates were able to give the correct answer. Some candidates gave vague answers like 'no loss of atoms / substances in the polymerisation'.

Question Number	Performance in General
14	The performance of candidates in this question was satisfactory. In part (a), just below half of the candidates were able to give a correct sketch. Some candidates wrongly considered that the melting point of sulphur is lower than that of phosphorus. In part (b), about a third of the candidates were able to correctly explain why the melting point of Mg is higher than that of Na. Some candidates just stated that Mg has stronger metallic bonds because Mg atoms have more electrons than Na atoms, without mentioning outermost shell electrons or delocalised electrons. In part (c), about half of the candidates were able to give a correct and complete answer. Some candidates only stated that Si and P have different structures (giant covalent structure / simple molecular structure) without mentioning the types of bond breaking involved in the melting process. Some candidates mixed up 'atoms' and 'molecules'.
15	The performance of candidates in this question was fair. Only a small number of the candidates were able to give a complete answer. Some candidates failed to mention that the detergent can reduce the surface tension of water. Some candidates did not mention or describe clearly that the repulsion between the negative charges of ionic heads prevents the oil droplets to come together again. Some candidates wrongly stated Na^+ or $---SO_4^-Na^+$ as the ionic head. Some candidates did not clearly refer to the structure of the detergent and just gave 'hydrophilic head / hydrophobic tail' without mentioning 'ionic part / hydrocarbon part'.

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	98	The performance of candidates in part (a) was good. In part (a)(i), about two thirds of the candidates were able to suggest that the ammonia produced from the Haber process can be used to manufacture fertilisers, contributing to an increase in crop yield. In part (a)(ii)(1), about two thirds of the candidates were able to write the chemical equation for the formation of syngas from methane. In part (a)(ii)(2), about a third of candidates were able to suggest biomass as a renewable energy resource leading to an advancement of methanol production technology. In part (a)(iii), a very high proportion of the candidates were able to deduce the respective order of reaction to **A**(aq) and **B**(aq). The performance of candidates in part (b) was satisfactory. In part (b)(i), about half of the candidates were able to describe the production of hydrogen, chlorine and sodium hydroxide in a membrane electrolytic cell. It would be expected that the answer should include the raw material (i.e. brine), chemical equations and the function of the ion-selective membrane. Some candidates failed to give the raw material and / or the two half equations in the production of hydrogen and chlorine. In part (b)(ii), about a third of the candidates were able to write the chemical equation for the production of sodium hypochlorite. In part (b)(iii), about three quarters of the candidates were able to calculate the respective atom economy of Reactions (I) and (II) and use the result to determine which of them could be considered as greener. The performance of candidates in part (c) was satisfactory. In part (c)(i), about half of the candidates were able to state a feedstock such as limestone for $CaCO_3(s)$. In part (c)(ii), just below half of the candidates were able to state that the exothermic reaction between carbon and air would result in a higher average temperature in zone **B** than in zone **A**. In part (c)(iii), about two thirds of the candidates were able to give two reasons in terms of cost and equilibrium position to account for not using a higher operation pressure. In part (c)(iv), just below half of the candidates were able to calculate the ratio of the rate constant at 1500 K to the rate constant at 1200 K for the decomposition of $CaCO_3(s)$. Some candidates failed to use the Arrhenius equation in their calculations. In part (c)(v), about half of the candidates were able to suggest that why the decomposition of $CaCO_3(s)$ mainly occurs in zone **B**.