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 contained questions mainly on Topics IX to XII. All questions in both sections were compulsory.

Section A (multiple-choice questions)

This section consisted of 36 multiple-choice questions. The mean score was 23.1. Candidates' performance was generally good. Some misconceptions of candidates were revealed from their performance in the following items:

1. For Q.15, just below half of the candidates correctly chose the answer D. It indicates that candidates were unfamiliar with the steps in calculation. The correct answer could be obtained as follows:

$$\Delta H_c\,[CO(g)] = -80 \div (7.89 \div 28) = -284 \text{ kJ mol}^{-1}$$

And $\Delta H_f\,[CO_2(g)] = -394 \text{ kJ mol}^{-1}$

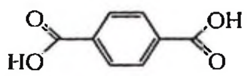
$$\therefore \Delta H_f\,[CO(g)] = (-394) - (-284) = -110 \text{ kJ mol}^{-1}$$

Q.15 When 7.89 g of carbon monoxide gas burns completely, 80 kJ of heat is released. Under those experimental conditions, the enthalpy change of formation of carbon dioxide gas is -394 kJ mol^{-1}. What is the enthalpy change of formation of carbon monoxide gas under the same experimental conditions ?

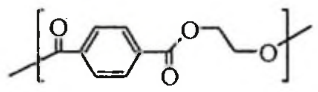
(Relative atomic masses: C = 12.0, O = 16.0)

A.	-678 kJ mol^{-1}	(14%)
B.	-474 kJ mol^{-1}	(16%)
C.	-314 kJ mol^{-1}	(24%)
D. *	-110 kJ mol^{-1}	(46%)

2. For Q.20, less than half of the candidates correctly chose the answer B. Candidates should note that the polymer given in the item is a condensation polymer that can be formed from the following two monomers:

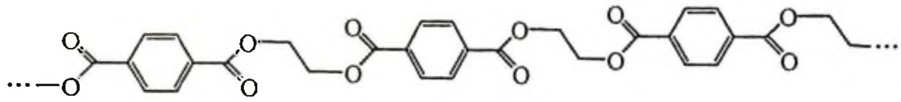



The repeating unit of the polymer should be :

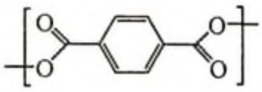


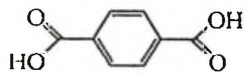
Thus, statement (1) is wrong, statement (2) is correct and statement (3) is wrong.

Q.20 The structure of a portion of a polymer is shown below :



Which of the following statements concerning the polymer is / are correct ?

(1)  is the repeating unit of it.

(2)  is a monomer of it.

(3) $HOCH_2COOH$ is a monomer of it.

A.	(1) only	(38%)
B. *	(2) only	(43%)
C.	(1) and (3) only	(10%)
D.	(2) and (3) only	(9%)

3. For Q.34, about one third of the candidates correctly chose the answer D. Candidates should note that two immiscible liquids can separate into two layers, but a polar liquid can mix well with an aqueous solution. In mixture (1), $HCOONa$ and CH_3CH_2OH formed after reaction can mix well with excess $NaOH(aq)$. In mixture (2), $CH_3CH_2CH_2OH$ formed after reaction can mix well with excess concentrated $NaOH(aq)$. In mixture (3), CH_3CH_2COOH formed after reaction can mix well with excess acidified $K_2Cr_2O_7(aq)$. Thus, all three mixtures would not separate into two liquid layers after heating under reflux for a period of time.

Q.34 Which of the following mixtures would NOT separate into two liquid layers after heating under reflux for a period of time?

(1) $HCOOCH_2CH_3(l)$ and excess $NaOH(aq)$
(2) $CH_3CH_2CH_2Cl(l)$ and excess concentrated $NaOH(aq)$
(3) $CH_3CH_2CHO(l)$ and excess acidified $K_2Cr_2O_7(aq)$

A.	(1) and (2) only	(14%)
B.	(1) and (3) only	(21%)
C.	(2) and (3) only	(28%)
D.*	(1), (2) and (3)	(37%)

Section B (conventional questions)

Question Number	Performance in General
1	The performance of candidates in this question was good. In part (a), about half of the candidates were able to draw the correct electron diagram for a C_2H_2 molecule. Some candidates did not read the question carefully and wrongly drew the electron diagram for a C_2H_4 molecule, and some candidates wrongly drew lone pairs on the carbon atoms. In part (b), about half of the candidates were able to write the correct chemical equation for the complete combustion of acetylene. Some candidates failed to balance the chemical equation correctly. In part (c)(i), almost all candidates were able to state gas **A** is hydrogen. In part (c)(ii), about two thirds of the candidates were able to explain why Reaction (I) is dangerous with the characteristics of gas **A**. In part (d), about a third of the candidates were able to state the correct use of $Ca(OH)_2$ in daily life. Some candidates merely gave a vague answer, such as 'for cleaning'.
2	The performance of candidates in this question was satisfactory. In part (a), about two thirds of the candidates were able to recognise that Br_2 is formed at the graphite anode and state the expected observation. In part (b), about two thirds of the candidates were able to give the correct half equation for the reduction of Pb^{2+} at the graphite cathode. Some candidates wrongly considered that Pb is oxidised to Pb^{2+} at the cathode. In part (c), about half of the candidates were able to give the correct half equation for the oxidation of OH^- occurred at the platinum anode. In part (d), about two thirds of the candidates were able to state that H_2 is formed at the platinum cathode. In part (e), just below half of the candidates were able to state that Cu^{2+} is formed at the copper anode. Some candidates wrongly stated that SO_2 is formed at the anode. In part (f), about half of the candidates were able to correctly state the expected observation occurred at the copper cathode. In part (g), only about a quarter of the candidates were able to give a correct justification for the reaction occurred at the copper cathode. Some candidates did not read the question carefully and gave a half equation instead of justification in their answers.
3	The performance of candidates in this question was satisfactory. In part (a), about half of the candidates were able to state the correct meaning of the term 'isotope'. In part (b), about two thirds of the candidates were able to calculate the abundance of ^{29}Si correctly. In part (c)(i), about two thirds of the candidates were able to correctly explain why silicon dioxide has a high melting point. Most of the candidates were able to state that SiO_2 has a giant covalent structure, however, some candidates wrongly stated that SiO_2 molecules are linked by strong covalent bonds. In part (c)(ii), about half of the candidates were able to give a correct calculation. Some candidates did not clearly show the deduction for SiO_2 is limiting in their answers. In addition, some candidates wrongly considered Mg to be the limiting reactant. In part (d), about half of the candidates were able to correctly state the name or the formula of the mineral shown in the diagram.
4	The performance of candidates in this question was good. In part (a), about two thirds of the candidates were able to state the correct systematic name for **X**. Some candidates wrongly wrote the molecular formula. In part (b), about three quarters of the candidates were able to suggest an appropriate chemical test with corresponding expected observations to distinguish **X** and butane. Some candidates only stated the chemical reagent without describing the expected observations. In part (c)(i), about three quarters of the candidates were able to correctly explain why **X** can form a polymer. In part (c)(ii), about half of the candidates were able to draw the correct repeating unit of **Z**. Some candidates wrongly gave the structure of the monomer. Furthermore, some candidates wrongly included 'n' in the answer and gave a structural formula for the polymer. In part (d)(i), about three quarters of the candidates were able to draw the correct structure of **Y**. In part (d)(ii), about two thirds of the candidates were able to recognise that decane has the highest boiling point and give a correct explanation. Some candidates failed to state that the molecules are attracted by van der Waals' forces, and some candidates only compared butane and **Y** without mentioning decane.

Question Number	Performance in General
5	The performance of candidates in this question was satisfactory. In part (a), less than one third of the candidates were able to suggest why the combustion of hexamine is exothermic using precise descriptions of the breaking and forming of covalent bonds. In part (b)(i), less than one third of the candidates were able to write the required thermochemical equation. Many candidates did not include the standard enthalpy change of formation as required. In part (b)(ii), more than two thirds of the candidates were able to calculate the standard enthalpy change of combustion of hexamine using the data provided. In part (c), more than two thirds of the candidates were able to calculate the enthalpy change of combustion of hexamine using the experimental data provided.
6	The performance of candidates in this question was satisfactory. In part (a)(i), only a very small number of the candidates were able to suggest why the reaction tube is placed in a downward slanted position. Some candidates erroneously regarded that the arrangement of the reaction tube allowed dry ammonia to pass over lead(II) oxide more efficiently. In part (a)(ii), about two thirds of the candidates were able to suggest why the experiment is performed in a fume cupboard. In part (b), about two thirds of the candidates were able to write the required chemical equation. In part (c), more than one third of the candidates were able to explain why ammonia is the reducing agent in terms of change in oxidation numbers. In part (d)(i), a very high percentage of the candidates were able to write the required chemical equation. In part (d)(ii)(1), about half of the candidates were able to complete the set-up diagram by drawing a Bunsen burner and giving it the correct label. In part (d)(ii)(2), only about a quarter of the candidates were able to write the name 'crucible' correctly.
7	The performance of candidates in this question was fair. In part (a), just below half of the candidates were able to describe the correct procedures to prepare the standard solution. Some candidates incorrectly suggested the use of 'burette, 'conical flask' etc. In part (b), about two thirds of the candidates were able to state the correct colour change. Many of the candidates erroneously regarded the end point colour as 'red'. In part (c), about a quarter of the candidates were able to calculate a reasonable average volume of hydrochloric acid used in the titrations. In part (d), just below half of the candidates were able to calculate the concentration of hydrochloric acid (in g dm^{-3}) in the sample.
8	The performance of candidates in this question was poor. About a third of the candidates were able to describe how to use the materials and equipment provided to set up experiments to confirm the order of reducing power of Zn, Cu and Ag. Some candidates simply recalled information from the metal reactivity series instead of using the expected experimental observations. In addition, some candidates did not understand that the sign of voltage readings on the multimeter is related to how the electrochemical cells are constructed, i.e. the voltage reading on the multimeter will be positive when the Zn strip is connected to the negative terminal, and vice versa.
9	The performance of candidates in this question was satisfactory. In part (a), a very high percentage of the candidates were able to write the correct expression for the equilibrium constant. In part (b)(i), about two thirds of the candidates were able to give the correct number of moles of CH_4 at equilibrium. In part (b)(ii), just below half of the candidates were able to calculate the equilibrium constant correctly. A small number of the candidates failed to notice that the volume of the reaction mixture was 2.0 dm^3, so that they omitted this data in their calculations. Some candidates gave an incorrect unit in their answers. In part (b)(iii), about half of the candidates were able to state and explain that the equilibrium constant would remain unchanged. A small number of the candidates wrongly stated that K_c changes as the equilibrium position shifts.

Question Number	Performance in General
10	The performance of candidates in this question was satisfactory. In part (a)(i), just below half of the candidates were able to give a correct explanation. A small number of the candidates wrongly considered CO_2 to be a reagent which would react with the tablet. In part (a)(ii), about two thirds of the candidates were able to draw a correctly labelled diagram for a gas syringe connecting to the reaction set-up. In part (b)(i), about half of the candidates were able to perform the calculation correctly. A small number of the candidates wrongly used '50 dm^3' for the volume of CO_2 formed or the molar mass of citric acid in their calculations. In part (b)(ii), a very high percentage of the candidates were able to draw a correct curve to show the expected experimental result.
11	The performance of candidates in this question was fair. In part (a), about a quarter of the candidates were able to state the Markovnikov's rule correctly. A small number of the candidates wrongly stated that the rule is related to substitution reaction. In part (b), about two thirds of the candidates were able to draw the correct structure of **X**. Some candidates wrongly gave the structure of an isomer of **X**. In part (c), about three quarters of the candidates were able to give the correct answer of **U**. In part (d)(i), about a third of the candidates were able to draw a correct three-dimensional diagram for the structure of an enantiomer of **Y**. Some candidates wrongly gave the structure of a molecule without a chiral centre. In part (d)(ii), about a third of the candidates were able to state that an optically active compound can rotate the plane of plane polarised light. Some candidates only stated that **Y** has a chiral centre that is bonded to four different atoms or groups, but did not mention its optical activity. In part (e), about half of the candidates were able to suggest an appropriate chemical test to distinguish **Z** and 2-methylbutan-2-ol and state the expected observations. A small number of the candidates were able to suggest a correct reagent, but did not state the correct expected observations.
12	The performance of candidates in this question was fair. In part (a)(i), about half of the candidates were able to correctly suggest why silicon dioxide is classified as an acidic oxide. A small number of the candidates wrongly stated that silicon dioxide is soluble in water. In part (a)(ii), about half of the candidates were able to give a correct answer. A small number of the candidates merely stated that the concentration of H^+ is equal to the concentration of OH^- in water, but did not mention the properties of SiO_2. In part (b), about a third of the candidates were able to provide a correct explanation with an appropriate chemical equation. Many candidates gave an incorrect chemical formula for phosphorus(V) oxide, or wrongly stated that phosphorus acid (H_3PO_3), instead of phosphoric acid, is formed. In part (c), about a third of the candidates were able to give a correct and complete answer. Many candidates wrongly stated 'the oxidation number of Cu is 0 in copper metal' as an example to demonstrate that copper exhibits variable oxidation numbers. Some candidates wrote 'transition metals have different colours' instead of 'transition metals form coloured ions and compounds'.
13	The performance of candidates in this question was fair. Even though only a small number of the candidates were able to give a correct and complete answer, the majority of candidates were able to state that small molecules are eliminated in condensation polymerisation. About a third of the candidates were able to give the correct structures of the two monomers. Some candidates wrongly gave the structure of the monomer with an amine group at one end and a carboxyl group at the other end. Only a small number of the candidates explicitly stated that the monomers should be bifunctional.

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 fair. In part (a)(i), just under half of the candidates were able to state the activation energy for the formation of HCOOH(l). Many candidates wrongly suggested that the activation energy would be +77 kJ mol^{-1}. In part (a)(ii), about a quarter of the candidates were able to calculate the rate constant for the reaction at 37°C in terms of k_1. Many candidates did not convert the activation energy 65 kJ mol^{-1} to 65000 J mol^{-1} in their calculations. In part (a)(iii)(1), about two thirds of the candidates were able to state the order of reaction with respect to B. In part (a)(iii)(2), about a third of the candidates were able to state the unit of k_2 correctly. The performance of candidates in part (b) was satisfactory. In part (b)(i), just under half of the candidates were able to explain why N_2(g) and H_2(g) need to be purified is to prevent the catalyst from being poisoned. In part (b)(ii), about two thirds of the candidates were able to explain why the unreacted N_2(g) and H_2(g) are passed again to the reaction chamber with reference to the conservation of the reactants. In part (b)(iii), about a third of the candidates were able to suggest that the much higher boiling point of ammonia than the other gases makes ammonia become a liquid in the condenser. Some candidates mentioned that ammonia would more easily be condensed without referring to the boiling points of the gases. In part (b)(iv)(1), a very high percentage of the candidates were able to suggest a correct catalyst to be used in the Haber process. In part (b)(iv)(2), about half of the candidates were able to explain why the reaction becomes faster when a catalyst is used with the aid of a Maxwell-Boltzmann distribution curve. Some candidates wrongly suggested that the catalyst would lower the activation energy of the uncatalysed pathway while some candidates wrongly used energy profiles instead of a Maxwell-Boltzmann distribution curve. The performance of candidates in part (c) was good. In part (c)(i), a very high percentage of the candidates were able to state one potential hazard of methanol. Some candidates just stated that methanol is harmful without giving an explicit description of the hazard. In part (c)(ii), just below half of the candidates were able to suggest one correct source of methane. In part (c)(iii)(1), about two thirds of the candidates were able to explain why the forward reaction is endothermic with reference to Graph 1. In part (c)(iii)(2), about two thirds of the candidates were able to explain the effect of pressure on the percentage conversion of CH_4(g) with reference to Graph 2 and the aid of a chemical equation. In part (c)(iv), about three quarters of the candidates were able to write a chemical equation for the reaction between CO(g) and H_2(g).

Question Number	Popularity (%)	Performance in General
Section B: 2	6	The performance of candidates in part (a) was fair. In part (a)(i), only a small number of the candidates were able to make use of the molecular structures of cellulose and chitin to explain their different behaviours in water. In part (a)(ii), about half of the candidates were able to state the use of liquid crystal in daily life. In part (a)(iii)(1), less than half of the candidates were able to draw the repeating unit of natural rubber. In part (a)(iii)(2), more than half of the candidates were able to suggest improved physical properties like hardness or rigidity. The performance of candidates in part (b) was poor. In part (b)(i), about one third of the candidates were able to calculate the atom economy of the synthesis. Some candidates erroneously regarded the atom economy as 100% without considering that there are two different products in the synthesis. In part (b)(ii), only a very small number of the candidates were able to explain that the synthesis is not a green reaction as hazardous chemicals like HCN and CH_3OH are used. In part (b)(iii), about a quarter of the candidates were able to write the chemical equation for the formation of PMMA from its monomer. In part (b)(iv)(1), about one third of the candidates were able to describe the meaning of the term 'thermosetting plastics'. In part (b)(iv)(2), only a small number of the candidates were able to explain why PMMA is not a thermosetting plastic using relevant intermolecular forces. In part (b)(v), only a very small number of the candidates were able to state a property of PMMA, such as high light transmittance, which means it is commonly used for making artificial glass or contact lenses. The performance of candidates in part (c) was poor. In part (c)(i)(1), only a small number of the candidates were able to suggest that the advantage of using corn starch for making disposable lunch boxes is related to its renewable nature. In part (c)(i)(2), only a very small number of the candidates were able to explain why PLA is biodegradable with reference to the presence of ester groups in the molecular structure of PLA. In part (c)(ii)(1), only a small number of the candidates were able to suggest **X** would be chromium. In part (c)(ii)(2), less than one third of the candidates were able to suggest **Y** would be carbon and explain how carbon can increase the hardness of stainless steel. In part (c)(ii)(3), about one third of the candidates were able to state the correct coordination number of an iron atom in a cubic close-packed crystal structure.

Question Number	Popularity (%)	Performance in General
Section C: 3	96	The performance of candidates in part (a) was satisfactory. In part (a)(i), about half of the candidates were able to suggest how to distinguish $Al_2(SO_4)_3(aq)$ and $ZnSO_4(aq)$. Some candidates wrongly suggested the use of excess $NaOH(aq)$ despite that both would form a colourless solution. In part (a)(ii), about a third of the candidates were able to suggest how to distinguish $(CH_3)_3COH(l)$ and $CH_3COOH(l)$. Many candidates wrongly used acidified sodium dichromate solution to distinguish the two compounds without noticing that both $(CH_3)_3COH(l)$ and $CH_3COOH(l)$ could not be further oxidised by this reagent. Some candidates correctly used $NaHCO_3$ or Na_2CO_3 to distinguish the two compounds, but without mentioning that aqueous solutions have to be used. In part (a)(iii), about three quarters of the candidates were able to state the expected observation of adding 2,4-dinitrophenylhydrazine to propanone. The performance of candidates in part (b) was fair. In part (b)(i), below half of the candidates were able to describe the steps in removing the phosphoric acid from the mixture. Many candidates were not able to state a correct chemical reagent that can react with phosphoric acid to form a water-soluble salt which can stay in the aqueous layer. Some candidates did not mention the use of a separating funnel in liquid-liquid extraction. In part (b)(ii)(1), below half of the candidates were able to draw a labelled diagram for the set-up of the fractional distillation. Many candidates did not draw packing materials, such as glass beads, in the fractionating column and some candidates did not label the heat source. In part (b)(ii)(2), below half of the candidates were able to make use of boiling point and infra-red spectroscopy to support the statement that 'the distillate is cyclohexene, and without the presence of any cyclohexanol'. Many candidates did not make use of the boiling point of cyclohexene to support the statement. The performance of candidates in part (c) was satisfactory. In part (c)(i), about three quarters of the candidates were able to deduce the molecular formula of **A**. In part (c)(ii), below half of the candidates were able to deduce the structural formula of ester **A**. Some candidates were not able to identify that the peak at m/z =105 corresponds to $C_6H_5CO^+$. In part (c)(iii)(1), below half of the candidates were able to write a chemical equation for the reaction between **A** and $NaOH(aq)$. Many candidates inappropriately used the molecular formula to represent **A** in the chemical equation, without indicating its functional group. Some candidates wrongly wrote the structure of the product as $C_6H_5COO^-Na$ or $C_6H_5COONa^-$. In part (c)(iii)(2), about two thirds of the candidates were able to calculate the percentage by mass of **A** in the sample.