MAJLIS PEPERIKSAAN MALAYSIA
Malaysian Examinations Council

PELANGI

Laporan Peperiksaan STPM 2023

Chemistry (962)

Chemistry 962/1

OVERALL PERFORMANCE

For Semester 1, 2,972 candidates sat for the examination for this subject and 55.11% of them obtained a full pass.

The achievement of the candidates for this subject according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	4.27	5.15	9.12	12.62	7.67	7.13	9.15	7.74	8.13	4.12	24.90

RESPONSES OF CANDIDATES

SECTION A: *Multiple-Choice Questions*

Answer keys

Question number	Key	Question number	Key	Question number	Key
1	**B**	6	**B**	11	**B**
2	**C**	7	**A**	12	**D**
3	**C**	8	**D**	13	**C**
4	**B**	9	**B**	14	**B**
5	**A**	10	**C**	15	**C**

General comments

The performance of the candidates was good. All the questions were in the medium range with 30% to 70% of the candidates obtaining the correct answers.

SECTIONS B AND C: *Structured and Essay Questions*

General comments

In general, the presentation of answers was quite systematically organised. Good candidates managed to answer based on the questions asked. Excellent candidates could give well organised solutions and explanation for the questions, moderate candidates were able to present their answer well in the questions whereas weak candidates could only answer some straightforward questions or low cognitive level questions. Most of the candidates were only able to answer parts of the whole question. In general, good candidates were able to produce precise and concise answers. They were able to write correct formula, answered the correct significant figures and presented their answers systematically.

Comments on the individual questions

Question 16

The question asked about mole concept and stoichiometry to test the understanding of candidates in writing balanced chemical equation, solving stoichiometry problems for the decomposition of $KClO_3$ produces KCl and O_2, determine formula mass of salt and identify cation of salt by using stoichiometry concepts.

In part (*a*)(i), the candidates were required to write balance chemical equation for decomposition of $KClO_3$, according to the description given in the question. The correct chemical equation was

$$2KClO_3(s) \longrightarrow 2KCl(s) + 3O_2(g)$$

The common mistake done by the candidates are as follows:

- Using reversible arrow for the decomposition reaction,

$$2KClO_3 \rightleftharpoons 2KCl + 3O_2$$

- Incorrectly writing the physical state of $KClO_3$ and KCl. For example, $KClO_3$(aq) and KCl(aq) are aqueous instead of solid state.
- Using a fraction in balancing the chemical equation. The coefficient number for O_2 is $\frac{3}{2}$ rather than 3.

In part (*a*)(ii), many candidates were able to calculate volume of O_2 gas formed by applying the stoichiometric method. However, some candidates did not give the final answer in the correct significant figure which is two significant figures or unit in dm^3. Some candidates did not write the unit at the final answer. The correct answer is 9.0 dm^3. A few candidates used formula, PV = nRT to calculate the volume of O_2 at standard temperature and pressure. However, the temperature was wrongly calculated as (25 + 273) = 298 K instead of (20 + 273) = 293 K.

In part (*b*)(i), some candidates were unable to determine the formula mass of *X*. Many candidates were confused between formula mass and relative molecular mass. Therefore, the candidates determined the relative atomic mass of cation, instead of formula mass of *X*. Some candidates calculated the molar mass of cation as 24.2, followed by calculating the formula mass of *X* by adding (2 × 79.90) = 159.8. However, they did not give the correct unit for the final answer, which was 184 or 184.0 instead of 184 g mol^{-1}.

In part (*b*)(ii), most of the candidates were unable to identify the cation of *X* which is Mg^{2+}. Some candidates gave the answer as cation is magnesium or $MgBr_2$ instead of magnesium ion or Mg^{2+}. Most candidates were unable to determine the molar mass of cation, thus unable to suggest the cation in *X*.

Question 17

The question asked about the concepts involving reaction kinetics to test the candidates on the relationship between half-life of first order reactions, solving problems involving rate of reactions, writing reaction mechanism and determine the order of reaction based on reaction mechanism.

In part (*a*)(i), most of the candidates were able to calculate the half-life of N_2O_4 by applying the correct formula. However, some candidates did not write the correct symbol for half-life such as T instead of $t_{½}$. They were also unable to give the correct significant figures and unit for the final answer.

In part (*a*)(ii), only a few candidates were able to write the correct formula of rate equation and gave the final answer in correct significant figures and unit. Most candidates were unable to determine the order of reaction based on unit of rate constant as given in the question.

In part (*b*)(i), a few candidates were able to write the equations with the correct phases for the second step as $2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$ and the overall equation as $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$. Although the question clearly described oxidation of SO_2 to SO_3 and gave the first step of mechanism, most of the candidates were unable to write the equation for the second step of the mechanism.

In part (*b*)(ii), some candidates were able to state the order of the reaction by referring to NO_2 as zero order because NO_2 was a catalyst.

Question 18

The question asked to explain the electronic configuration of atom and ions according to aufbau's principle, Pauli exclusion principle and Hund's rule. Candidates also need to identify elements in Periodic Table based on proton number.

In part (*a*), the majority of the candidates were able to write the electronic configuration of titanium correctly. However, some candidates wrote electronic configuration of Ti as $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$ instead of $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$ or $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$. Many candidates were able to explain the three rules or principles to fill electrons into the orbitals, but no specific examples were given for each rule. Many candidates used the wrong term such as orbital of lower energy instead of orbital of the lowest energy or lowest energy orbital and shell/subshell instead of orbital in describing aufbau's principle. Many candidates were able to define Pauli exclusion principle correctly. However, some candidates used the term parallel spin or spin in opposite direction, instead of opposite spin. Only a few candidates were able to give specific example for the arrangement of electrons by using Pauli exclusion principle, which used 1*s*, 2*s*, 3*s* or 4*s* orbital. Many candidates used wrong orbital such as *p* or *d* orbitals. Some candidates were able to define Hund's rule correctly by using the correct term, which were degenerate orbital or orbital with equivalent energy and singly with parallel spin. Many candidates gave incomplete definition of Hund's rule and they did not use the term parallel spin or singly. Only a few candidates stated that 3*d* orbitals were degenerate orbital. However, most of the candidates who attempted this question did not explain this or gave 2*p* and 3*p* as further explanation. Only a few candidates explained the arrangement of electron in 3*d* orbitals, either in drawing or explanation.

In part (*b*), most candidates were able to write the correct electronic configuration and mention that two electrons were removed from 4s orbitals of titanium but unable to explain why electrons were removed from 4*s* not 3*d*. None of the candidates mentioned that when electrons filled in 3*d* orbitals, it will repel the electrons in 4*s* orbitals. Hence, 4*s* electrons were pushed to a higher level.

In part (*c*)(i), most of the candidates were able to identify *X* as gallium, Ga, and stated the position of *X* as Group 13 and Period 4. However, many candidates gave incorrect spelling of gallium, for example galium.

In part (*c*)(ii), most of the candidates were able to identify *Y* as nickel and wrote the correct electronic configuration. Only a few candidates were unable to state *Y* as nickel or Ni. Some candidates gave the wrong electronic configuration of nickel as $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$ instead of $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$.

Question 19

The question tested candidates in solving numerical problems by applying ideal gas equation or Dalton's law of partial pressure, identifying, and explaining the characteristics of ideal gas, physical characteristic of liquids and comparison on the electrical conductivity of carbon allotropes.

In part (*a*)(i), more candidates were able to determine the total pressure of N_2 and He in the vessel, substituting the total number of moles of gases as 9.0 mol. They were able to write ideal gas equation, PV=nRT and solved the question correctly. A few candidates used Dalton's law, $P_{total} = P_{He} + P_{N2}$ instead of the ideal gas equation to solve the problem. The candidates were not able to round up the total pressure of the gas mixture to two significant figures. For example, the answer given as 8975 Pa or 8.97 kPa. The correct answers should be 9.0 kPa or 9.0 × 103 Pa.

In part (*a*)(ii), many candidates were able to state helium behaved almost like an ideal gas but they were not able to give the explanation and compare the size of helium atom and nitrogen atom. They were unable to explain that helium has smaller atomic size, the volume of helium atom was negligible, and its intermolecular forces was very weak or insignificant or can be ignored.

In part (*a*)(iii), most candidates were unable to sketch Maxwell-Boltzmann distribution correctly because they wrongly labelled the x-axis and/or y-axis. Only a few candidates managed to sketch the distribution of molecular speeds for nitrogen and helium. The y-axis was labelled as fraction of molecules/number of moles instead of number of particles/molecules/atoms while the x-axis was labelled as energy or speed or temperature instead of molecular speed. Besides that, candidates correctly drew the curve of N_2 but not He. The peak of He was too high compared to N_2 which exceeded 50% than N_2.

In part (*b*)(i), many candidates were unable to give the accurate observation with the correct scientific term. Many candidates stated that the rate of evaporation of *P* was higher than *Q* or boiling point of liquid *P* was lower than *Q*, but failed to mention that P is more volatile than *Q*. Many candidates did not relate the volatility with strength of intermolecular forces or force of attraction in liquid *P* as the intermolecular forces in P was weaker than *Q*.

In part (*b*)(ii), many candidates were able to explain that graphite conducts electricity because carbon atom in graphite undergoes sp^2 hybridisation while in diamond undergoes sp^3 hybridisation. Only three valence electrons of carbon atom were used in bonding while in diamond all the four valence electrons of carbon atom were used in bonding with other carbon atoms. The majority of the candidates were weak in explaining the electrical conductivity of graphite and diamond. Most of the candidates were able to state that the type of hybridisation of carbon atoms in graphite and diamond were sp^2 and sp^3. The most common incorrect terms used by candidates were free moving electrons, delocalised electrons, free mobile electrons, free moving ions instead of free delocalised electrons.

Question 20

This question tested candidates on solving equilibrium problems, mole concepts and solubility of salt. Most candidates did not master this topic.

In part (*a*), the majority of the candidates were able to write expression of equilibrium constant and relate to PCO_2. The candidates were able to calculate the mole of CO_2 by using ideal gas equation, PV=nRT but unable to relate mole of CO_2 to mole of reacted $CaCO_3$. Some candidates calculated mole percents instead of weight percent of unreacted $CaCO_3$. Some candidates were able to determine the percentage of unreacted $CaCO_3$ to two significant figures which was 34%.

Common mistakes made by candidates were as follows:

- Small letter p for pressure, pV = nRT instead of PV = nRT
- Calculate the percentage of unreacted $CaCO_3$ by using the number of moles of remaining $CaCO_3$ without relating it to the mass of $CaCO_3$

In part (*b*), many candidates were able to write balanced chemical equation and calculate the number of moles of Ag^+ and CrO_4^{2-} correctly. However, many candidates were unable to determine the formation of precipitation of Ag_2CrO_4 by comparing Q with K_{sp}. They were able to write the solubility equation of Ag_2CrO_4 with reversible arrow and physical states. Many candidates wrongly calculated the concentration of Ag^+ and CrO_4^{2-}. Nevertheless, a few candidates were able to conclude formation of red precipitate by comparing Q with K_{sp}, which was $Q > K_{sp}$.

Common mistakes made by candidates were as follows:

- The solubility equilibrium equation for Ag_2CrO_4 was written without the physical states of the species or without reversible arrow
- Wrongly calculated the concentration of Ag^+ and CrO_4^{2-}
- Calculate ionic product, Q by using the number of moles of Ag^+ and CrO_4^{2-} instead of using concentrations of Ag^+ and CrO_4^{2-}
- Multiplied the concentration of Ag^+ by two before squaring it in the calculation of ionic product, Q
- Wrote $Q = [Ag^+][CrO_4^{2-}]$ or $Q = [2Ag^+]^2[CrO_4^{2-}]$ instead of $Q = [Ag^+]^2[CrO_4^{2-}]$
- Wrongly conclude the formation of red precipitate by comparing Q with K_{sp}, which was $Q < K_{sp}$

Chemistry 962/2

OVERALL PERFORMANCE

For Semester 2, 2,807 candidates sat for the examination for this subject and 55.61% of them obtained a full pass.

The achievement of the candidates for this subject according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	5.27	4.38	6.09	8.05	9.33	10.40	12.08	6.87	3.71	3.81	30.0

RESPONSES OF CANDIDATES

SECTION A: *Multiple-Choice Questions*

Answer keys

Question number	Key	Question number	Key	Question number	Key
1	**D**	6	**B**	11	**B**
2	**B**	7	**C**	12	**C**
3	**A**	8	**D**	13	**C**
4	**C**	9	**A**	14	**B**
5	**B**	10	**D**	15	**B**

General comments

The performance of the candidates was good. All the questions were in the medium range with 30% to 70% of the candidates obtaining the correct answers.

SECTIONS B AND C: *Structured and Essay Questions*

General comments

In general, candidates had moderate performance. The performance of candidates was varied based on their ability to understand the fundamental of the topics tested. Most of the candidates could understand tasks required in the questions and expressed their ideas clearly in English. Most candidates could use the language quite well to explain observations and present their answers. Hence, most of their answers written in acceptable or understandable manner. The performance of the candidates was fairly good in questions 16, 17, 19 and 20. Some candidates did not answer the question based on the question asked but just gave a general statement.

Comments on the individual questions

Question 16

The question asked about Group 2 of the Periodic Table to test the understanding of the thermal decomposition of Group 2 carbonates and Group 2 nitrates, reactivity of Group 2 oxides with water, and usage of compound of Group 2.

In part (*a*)(i), the majority of the candidates demonstrated a good understanding of the decomposition of $CaCO_3$ to produce CaO and CO_2. Most candidates were able to write a balanced equation for the decomposition of $CaCO_3$ correctly.

In part (*a*)(ii), the majority of the candidates were able to identify *Q*, as CaO and *R* as $Ca(OH)_2$.

In part (*a*)(iii), most of the candidates were able to state the uses of $Ca(OH)_2$ in agriculture to adjust soil acidity and raise soil pH levels. However, a few candidates did not mention whether *R* was basic or alkaline solution.

In part (*b*)(i), many candidates were unable to write a balanced equation for the decomposition of $Sr(NO_3)_2$ when heated in fireworks. Most candidates gave unbalanced chemical equation such as

$$Sr(NO_3)_2 \longrightarrow SrO + 2NO_2 + \frac{1}{2}O_2.$$

In part (b)(ii), most candidates were able to identify the Group 2 nitrate which was barium nitrate, $Ba(NO_3)_2$.

In part (*c*)(i), most candidates were able to write the chemical formula of the salt which was $BaSO_4$. Some candidates lose mark because they gave the name of the salt, barium sulphate instead of $BaSO_4$. The common incorrect answers given by candidates were $BaCl_2$ and $Ba(NO_3)_2$.

In part (*c*)(ii), the majority of candidates were unable to explain the suitability of $BaSO_4$ to be consumed as barium meal which was due to $BaSO_4$ that is insoluble in water. Many candidates just mention $BaSO_4$ was insoluble or insoluble salt, instead of insoluble in water.

Question 17

This question asked about Group 17 of The Periodic Table to test the stability of hydrides of Group 17, reaction of halogen with cold NaOH and industrial uses of halogens.

In part (*a*)(i), most of the candidates were able to identify *X*. They have the idea that HI was a stronger acid than HBr. Therefore, I or iodine was identified as *X*. Some candidates answered *X* as iodide, I^-, HI, or I_2 instead of iodine or I.

In part (*a*)(ii), most candidates were able to write chemical equation for the decomposition reaction. They were able to give the correct formula for the reactants and products. However, instead of reversible arrow, most of the candidates used irreversible arrow when writing chemical equations.

For example, $2HI \rightarrow H_2 + I_2$, instead of $2HI \rightleftharpoons H_2 + I_2$.

A few candidates also wrote the equation backwards.

In part (*a*)(iii), most of the candidates were able to relate the strength of the acid with covalent bond length and bond strength. Candidates were able to state that H-I covalent bond was longer and weaker than H–Br bond. Some candidates used incorrect adjectives to describe bond length and bond strength and did not mention or show the covalent bond, H–*X*.

In part (*b*)(i), many candidates did not perform well in this part and lose marks because they were unable to write a balanced equation for the reaction between Cl_2 and NaOH. Candidates were unable to suggest the products form. Some candidates stated only NaCl and H_2O or NaOCl and H_2O as the products instead of NaCl, NaOCl and H_2O.

In part (*b*)(ii), many candidates were able to give the correct formula of the industrial product as NaOCl. However, some of the candidates made mistakes by suggesting NaCl as the industrial product.

In part (*b*)(iii), many candidates were able to state the usage of NaOCl as bleaching agent or disinfectant. However, those candidates who suggested NaCl in part (b)(ii) stated the usage as table salt. Some candidates made a mistake by suggesting the usage of NaOCl as sterilised water.

Question 18

The question asked about chemical energetics to test the calculation of the enthalpy change of reaction between $KHCO_3$ and HCl using calorimetry method. Candidates also need to determine the enthalpy change for decomposition of $KHCO_3$ by drawing energy level diagram for the reaction involved.

In part (*a*)(i), many candidates were unable to answer this question well. Many candidates calculated the number of moles of $KHCO_3$ but omitted the calculation for the number of moles of HCl. These candidates correctly used the formula $q = mc\Delta T$ or $q = mc\theta$ in their calculations. Some candidates lose marks for using the formula $Q = mc\Delta T$ instead of $q = mc\Delta T$, wrong mass in the substitution, not writing the positive sign and fail to round off the final answer to three significant figures.

In part (*a*)(ii), the majority of the candidates were unable to draw an energy level diagram since candidates were unable to relate the decomposition of $KHCO_3$ salt, K_2CO_3, and the acid-base reactions for both salts with HCl.

In part (*b*), many candidates were able to calculate the mole of butane correctly, but unable to proceed to determine the mass of water. Only a few candidates were able to calculate the mass of water, which was 383 g.

Question 19

The question tested on the concepts of electrochemistry. Candidates needed to relate the change in cell potential with the concentration of the solution and predict the spontaneity of a reaction when the pH of solution was changed. In the second part, candidates needed to apply Faraday's law to determine the amount of current used in the electrolysis of aqueous solution.

In part (*a*)(ii), most candidates were able to predict the change in electrode potential but a few of them made mistakes by writing standard cell potential E°cell instead of cell potential, E_{cell}.

In part (*a*)(ii), most candidates knew that the cell reaction was spontaneous when E_{cell} was positive. However, most candidates failed to predict the spontaneity of a reaction because they only calculated the $E^{\circ}_{cell} = -0.03$ V without using the Nernst equation when pH = 3 or $[H^+] = 1.0 \times 10^{-3}$ mol dm^{-3} as required by the question. Some candidates used Nernst equation but unable to write the overall cell reaction equation properly.

In part (*b*)(i), most candidates were able to identify O_2 which was released at the anode and H_2 at the cathode but a few answered incorrectly in the reverse order or stated SO_2 gas was released at anode.

In part (*b*)(ii), most candidates correctly used the formula Q = It for the calculation but only a few candidates were able to determine the current flow. Some candidates were able to show correct calculations but did not the answer in correct significant figures, 0.16 A. Some candidates used the wrong molar volume, 22.4 $dm^3\ mol^{-1}$, instead of 24.0 $dm^3\ mol^{-1}$.

In part (*b*)(iii), a few candidates were able to answer the volume of gas collected at the anode, while many candidates could not write the correct equation that occurs at the anode. Additionally, they failed to relate the volume ratio of H_2 at the cathode to O_2 at the anode as 2:1.

Question 20

The question asked about Periodicity to test the understanding of the properties of Period 3 elements in terms of atomic radius and ionisation energy. The second part of this question asked about the acidic oxides of Period 3 elements and their reactions with water.

In part (*a*)(i), many candidates were able to explain the trend in atomic radii across Period 3. However, some candidates did not earn full marks because they incorrectly wrote that the attraction between the nucleus and electrons gets stronger, instead of specifying valence electrons.

In part (*a*)(ii), many candidates were able to write electronic configuration or valence electronic configuration of Mg, Al, P and S. The candidates were also able to explain the complete filled 3*s* orbital of Mg was more stable than partially filled 3*p* orbitals of Al. They were able to explain the extra stability of half-filled 3*p* orbitals of P compared to partially filled 3*p* orbitals of S. However, candidates hardly compared from where the electron was removed. For example, candidates should explain that in P, the first electron was removed from half-filled 3*p* orbitals whereas in S, the first electron was removed from partially filled 3*p* orbitals. A few of candidates were able to explain the factors that affect first ionisation energy but failed to elaborate the anomalies in the first ionisation energies between Mg and Al and between P and S, as required.

In part (*b*)(i), many candidates were able to write molecular formula of acidic oxides as SiO_2, P_4O_6/P_4O_{10}, and SO_2/SO_3. Some careless candidates mistakenly included Cl_2O or Cl_2O_7, not realising that Cl2 cannot react with oxygen gas. A few weak candidates listed all the oxides of Period 3 as acidic oxides resulting in mark deduction.

In part (*b*)(ii), many candidates were able to write the chemical equations for the reaction of water with oxides. However, many candidates made a mistake by writing the chemical equation for the reaction of SiO_2 with water, instead of SiO_2 does not react with water. Many candidates were able to write the chemical equation for the reaction between SO_2 or SO_3 and water but unable to write the chemical equations for P_4O_6 or P_4O_{10} with water.

Chemistry 962/3

OVERALL PERFORMANCE

For Semester 3, 2 781 candidates sat for the examination for this subject and 47.87% of them obtained a full pass.

The achievement of the candidates for this subject according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	7.41	5.03	5.00	7.16	9.03	6.90	7.34	4.53	5.18	2.80	39.63

RESPONSES OF CANDIDATES

SECTION A: *Multiple-Choice Questions*

Answer keys

Question number	Key	Question number	Key	Question number	Key
1	**D**	6	**B**	11	**C**
2	**D**	7	**A**	12	**C**
3	**D**	8	**B**	13	**D**
4	**C**	9	**B**	14	**C**
5	**A**	10	**A**	15	**A**

General comments

The performance of the candidates was good. All the questions were in the medium range with 30% to 70% of the candidates obtaining the correct answers.

SECTIONS B AND C: *Structured and Essay Questions*

General comments

In general, candidates had moderate performance. The performance of candidate was varied based on their ability to understand the fundamental of the topics tested. In general, the presentation of answers was quite systematically organised. Some of the candidates were able to plan their answers coherently and systematically. Most of the candidates could understand tasks required in the questions and expressed their ideas clearly in English. Most candidates could use the language quite well to explain observations and present their answers. Hence, most of their answer written in acceptable or understandable manner. The performance of the candidates was fairly good in questions 16, 17 and 18.

Comments on the individual questions

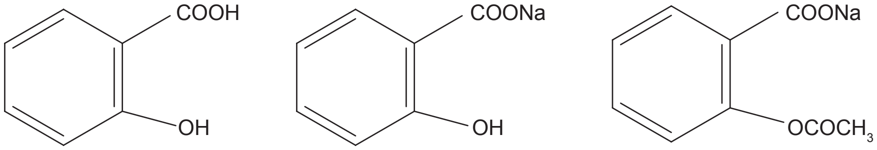
Question 16

The question tested the understanding of candidates in identifying functional groups and reactions of aspirin and wintergreen oil.

In part (*a*), the majority of the candidates were unable to state the functional groups of wintergreen oil and aspirin correctly. Most candidates gave carboalkoxy functional group as ester, which was the class of compound. Most of the candidates were able to give benzene ring as another functional group. However, some candidates gave aromatic ring instead of benzene ring as another functional group in wintergreen oil and aspirin.

In part (*b*), most candidates were able to give Na_2CO_3 or $NaHCO_3$ as the reagent to differentiate between aspirin and wintergreen oil. They were also able to give the correct observation. However, weak candidates gave HCl, Tollens' reagent, Lucas reagent or iodoform reagent as the answer, and lose marks due to frequent errors in stating no reaction as the observation for wintergreen oil. Most candidates correctly indicated that aspirin was more acidic than wintergreen oil. Some candidates were missing the important keyword which was more/less acidic than.

In part (*c*), many candidates were able to write structural formulae of products and chemical equation instead. Many candidates were unable to give the correct hydrolysis products. Some candidates gave one product only and missed out CH_3COONa. Examples of the wrong products given by the candidates were:



CH_3COOH H_2O

Question 17

The question tested the understanding of candidates to identify types of polymerisation, draw the structural formulae of the products of alkaline hydrolysis of Kevlar, name the functional group in Kevlar, state the similarity in chemical properties of Kevlar and terylene, and determine polymers that can form intermolecular hydrogen bonding.

In part (*a*), most of the candidates were able to describe the type of polymerisation. Some candidates gave condensation and addition polymerisation as the type of polymerization and due the presence of many functional groups.

In part (*b*), some candidates were able to give the correct hydrolysis products. Most candidates gave p-phenylenediamine as one the products. A few of the candidates gave p-phthalic acid as the second product instead of dicarboxylate ions/salt.

In part (*c*), majority of the candidates were unable to give carboxamide as the functional group of kevlar apart from benzene ring. Most candidates gave either amide, ester, amine, carboxyl and carbonyl groups as the answer.

In part (*d*), some candidates were able to state the similar chemical property between kevlar and terylene which can be hydrolysed or undergo hydrolysis. Many candidates stated the physical properties such as high boiling point, high melting point, soluble in water, high tensile strength, insoluble in water or soluble in organic solvent.

In part (*e*), the majority of the candidates were able to determine kevlar as the polymer that forms intermolecular hydrogen bond with the correct reasoning. Some of the candidates gave the wrong reasoning such as amide group, C=O group, hydrogen atom and hydrogen bonds formed between the hydrogen atom and nitrogen atom in Kevlar instead of hydrogen atom was bonded to nitrogen (H–N).

Question 18

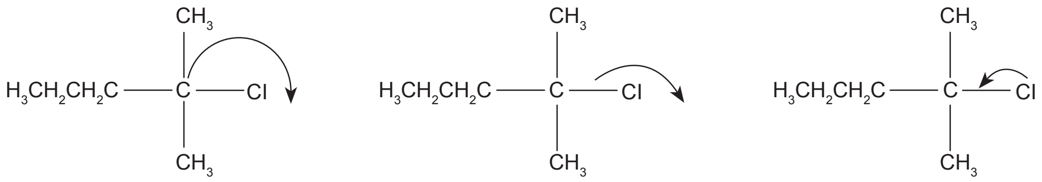
The question tested on the capability of the candidates to extract the information given in the question and deduce the structural formulae of *P*, *Q*, *R* and *S*. The question also tested on the understanding of the reaction of haloalkane with Mg, the reaction of Grignard reagent with ketones, the reaction of alcohol with Lucas reagent and $SOCl_2$ to form the haloalkane. Candidates also needed to identify the nucleophilic substitution reaction and wrote its mechanism.

In part (*a*), most of the candidates were able to draw the structural formulae of compounds *P*, *Q*, *R* and *S*. Many candidates were not able to deduce that compound *P* was a haloalkane because they cannot relate compound *P* reacted with Mg to form compound *Q*, a Grignard reagent. Most candidates were able to write the chemical equations involved. The candidates lose marks due to spelling of the Grignard reagent wrongly, only draw the structural formulae without deduction statements, wrote Mg in dry ether in the chemical equation and wrote $(CH_3)_2CO$ and H_2O/H^+ as the reagents in one step reaction for the formation of compound *R*.

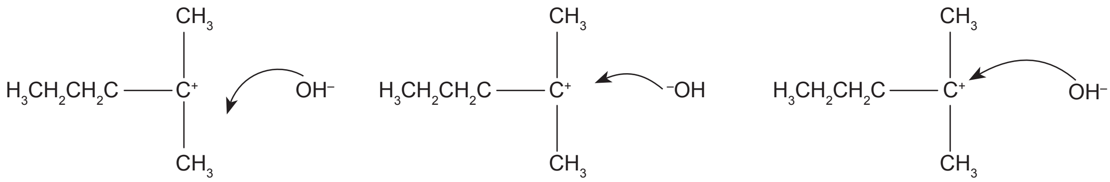
In part (*b*), most all candidates were able to name the reaction as S_N1. Most candidates could write S_N1 mechanism correctly and indicated the rate determining step.

The common mistakes were as follows:

- The positions of the arrows when writing reaction mechanism



- Write OH^- instead of –OH and gave the wrong arrow for nucleophile attack



- Use a half-head arrow "⇀" instead of a full-head arrow "→".
- Wrote the structural formulae of '$CH_3CH_2CH_2$—' as C_3H_7
- Wrote the intermediate in the square bracket i.e. [intermediate]

Question 19

The question tested on the understanding of the candidates about the type of hybridisation, type of stereoisomerism of hydrocarbon *K*, and wrote the chemical equations for reaction between hydrocarbon *K* with bromine water and hot acidified potassium manganate(VII) solution respectively. Candidates also needed to write mechanism for the reaction between hydrocarbon *K* and Br_2 in CH_2Cl_2.

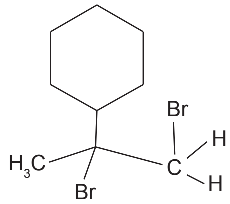
In part (*a*), majority of the candidates were able to identify the hybridisation of hydrocarbon *K*.

In part (*b*), most of the candidates were unable to describe stereoisomerism of hydrocarbon *K* as geometrical isomerism, thus could not draw label and the cis and trans isomers of hydrocarbon *K*. Only a few candidates were able to draw correctly the *cis* and *trans* isomers. Most candidates stated that hydrocarbon *K* has both geometrical and optical isomerism. Most candidates mention that hydrocarbon *K* has carbon-carbon double bond instead of plane of cyclic structure.

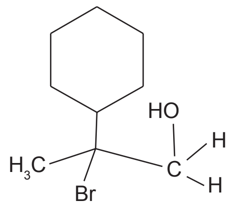
In part (*c*), most of the candidates were able to write the equation of hydrocarbon *K* with bromine water and with hot acidified $KMnO_4$ solution respectively. Some candidates gave one of the products which was ethanal for the reaction with hot acidified $KMnO_4$ solution. The answer should be CO_2 as ethanal is further oxidised to CO_2.

The common mistakes were as follows:

- Wrote Br_2 + H_2O as the reagent in the chemical equation
- Wrote Br_2(aq) as the reagent when writing chemical equation
- Used Br_2 in CCl_4 as the reagent and reaction condition
- Gave dibrominated product as the answer



- Gave anti Markovnikov product as the answer

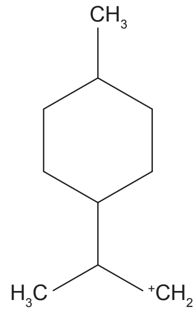


- Used symbol of oxidation [O] in the chemical equation for the reaction with hot acidified $KMnO_4$ solution

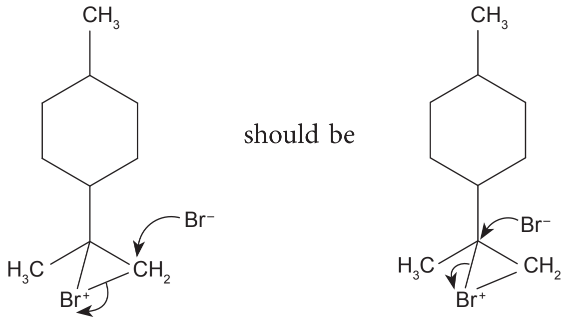
In part (*d*), the majority of the candidates were able to write the mechanism with the correct arrows.

The common mistakes were as follows:

- gave free radical substitution mechanism.
- Wrong intermediate and positive charge of H instead of C



- Attack at wrong carbon of bromonium ion



- Used a half-head arrow "⇀" instead of a full-head arrow "→" to represent the electron flow in the mechanism reaction

Question 20

The question tested the candidates on the synthetic pathway for the formation of *N*,*N*-dimethyl-2-phenylpropanamide from a suitable carboxylic acid via reaction scheme, compared the relative acidity of the carboxylic acids with different electron withdrawing and donating groups, number of electron withdrawing groups attached to α-carbon, and drew the structural formulae of 2-aminopropanoic acid, 2-amino-3-phenylpropanoic acid and dipeptide.

In part (*a*), most candidates were able to give the correct reaction scheme for the preparation of *N*,*N*-dimethyl-2-phenylpropanamide. However, some candidates were unable to propose the reaction scheme for the preparation of the *N*,*N*-dimethyl-2-phenylpropanamide. Besides, a few of the candidates wrote equations instead of reaction scheme in showing the synthesis of *N*, *N*-dimethyl-2-phenylpropanamide.

In part (*b*), many candidates failed to give the correct arrangement for relative acidity of the carboxylic acids. They were also unable to explain the reasoning of the arrangement. The candidates did not relate the presence of the electron donating group, $CH_3CH_2CH_2$— with relative stability of carboxylate ions/ conjugate base. They did not mention Cl as an electron withdrawing group and $CH_3CH_2CH_2$— as an electron donating group. Most of the candidates did not relate the stability of conjugate base of benzoic acid due to resonance effect. Some candidates did not compare between non-chlorinated and chlorinated carboxylic acids.

In part (*c*), the majority of the candidates, were able draw the structural formulae of compounds *A* and *B* based on the IUPAC nomenclature given. Most candidates were able to draw the structural formulae of the dipeptides and label the peptide linkage. However, some candidates gave one dipeptide only and a few candidates labelled the peptide linkage as dipeptide link.

PAPER 962/5 (WRITTEN PRACTICAL TEST)

General comments

In general, the performance of the candidates was not good.

Comments on individual questions

Question 1

The question tested the candidates on knowledge of mole concept in problem solving of titrimetric. The question asked to calculate the concentration of HCl from a stock solution by dilution and the procedures required for dilution of HCl from the stock solution. The molarity of a solution of metal carbonate, X_2CO_3, which was titrated with HCl was calculated based on the stoichiometric ratio obtained from the balanced equation of the reaction.

In part (*a*)(i), most candidates were unable to calculate the concentration of HCl from the stock solution.

In part (*a*)(ii), some candidates stated the wrong procedures by giving the step taken in titration rather than the procedures of dilution form a stock solution.

By using the formula $\frac{M_aV_a}{M_bV_b} = \frac{1}{1}$; Therefore, $M_aV_a = M_bV_b$.

Some candidates wrongly used 250 cm^3 instead of 25 cm^3 as the V_a, the volume of HCl, supposedly 25 cm^3 which was pipetted in the conical flask for the titration.

In part (*b*)(i) and (*b*)(ii), some candidates were able to calculate the average titre. Other candidates did not include rough reading to calculate the average calculation. The common mistakes in this part were a volume of the HCl was one decimal place rather than two decimal places as shown in the table given. For example, volume of HCl solution used in cm^3 was given as 23.0 instead of 23.00 in the table. In this part, most of the candidates were able to calculate the average titre.

$$\text{Average titre} = \left(\frac{22.90 + 23.10 + 23.00}{3}\right) = 23.00 \text{ cm}^3$$

In part (*c*), most candidates were unable to show their understanding, knowledge, and application of mole concept in problem solving of titrimetry, particularly involving calculation of the concentration of X_2CO_3 and the relative atomic mass of *X*.

Question 2

The question tested the candidates on the kinetic reaction experiment.

In part (*a*), most candidates were able to answer the question by completing the data in the table given.

In part (*b*), some were candidates quite confused about the colour change for the starch solution as an indicator in the titration. The clear or colourless solution should turn dark blue or deep blue as the colour changes at the end point of the titration. However, the answer given was blue-black to colourless.

In part (*c*), most candidates were unable to state the colour changes from colourless to deep blue during the titration. Therefore, the reason for the appearance of blue colour was wrongly explained as the formation of starch-iodine complex. Most candidates were not able to state a formation of starch-iodine complex as a reason for the appearance of colour in the reaction mixture in (*b*)(ii).

In part (*d*), the majority of the candidates were unable to write the ionic equation for the reaction between I_2 and $S_2O_3^{2-}$. Some candidates wrote the chemical equation.

In part (*e*)(i) and (*e*)(ii), most candidates were unable to give a suitable apparatus to measure the solution of 25.0 cm^3 of aqueous I^- solution using pipette and burette for 10.00 cm^3 of $Na_2S_2O_3$ solution

In part (*f*), the majority of the candidates were unable to state the suitable method for measuring the temperature in two different conditions. For 17 °C, the conical flask containing the reactants immersed in a cold-water bath and for 47 °C, the conical flask containing the reactants immersed in a hot water bath.

In part (*g*), most candidates were unable to state the reaction rate for the appearance of iodine was represented by $\frac{1}{t}$ in the experiment.

In part (*h*), some candidates were able to plot a linear graph with the correct axes and unit, included four points as calculated in the table given.

In part (*i*), some candidates did not mention the rate of the reaction at 45 °C was doubled the rate of reaction at 35 °C.

Question 3

The question tested the candidates on fundamentals and concepts of organic chemistry based on the observations.

In part (*a*)(i) and (*a*)(ii), most candidates were unable to deduce KA 1 contained *d*-metal ions or transition metal ions which was Fe^{2+}/ Ni^{2+}/ Cr^{2+}.

In part (*b*), some candidates were unable to identify the cation in the KA 1 as Ni^{2+} based on the reaction between the green solution and NH_3(aq) and between the green solution and NaOH(aq).

In part (*c*), the reaction between aqueous KA 1 and NaOH(aq) produced a green precipitate which was nickel(II) hydroxide, $Ni(OH)_2$. In part (*c*)(i), some candidates were able to identify the precipitate formed. In part (*c*)(ii), only a few candidates were able to write an ionic equation for the reaction, $Ni^{2+} + 2OH^- \longrightarrow Ni(OH)_2$. In part (*c*)(iii), Ni(III) hydroxide or $Ni(OH)_3$ was the black precipitate produced in the reaction when the green precipitate produced in part (*c*)(ii) reacted with NaOCl(aq).

In part (*d*), some candidates were able to name the green precipitate as Ni(II) carbonate when Na_2CO_3(aq) was added to aqueous KA 1.

In part (*e*)(i) and (*e*)(ii), most candidates were unable to identify the complex ion formed in the blue solution was $[Ni(NH_3)_6]^{2+}$ and name the complex ion as hexaaminenickel(II) ion.

In part (*f*)(i) and (*f*)(ii), most candidates were unable to state the acid-base property of the gas as alkaline which was ammonia, NH_3.

In part (*f*)(iii), most candidates were unable to identify the anion in KA 1 as NO_3^-.

In part (*g*)(i), the majority of the candidates were unable to identify the anion, NO_3^-, in KA 1 based on the reactions of aqueous KA 1 with Devarda's alloy and diluted HCl(aq).

In part (*g*)(ii), most candidates were unable to describe another confirmatory test for the anion in part (*g*)(i) as heat copper with concentrated sulphuric acid, a brown, pungent gas.

Laporan Peperiksaan

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