



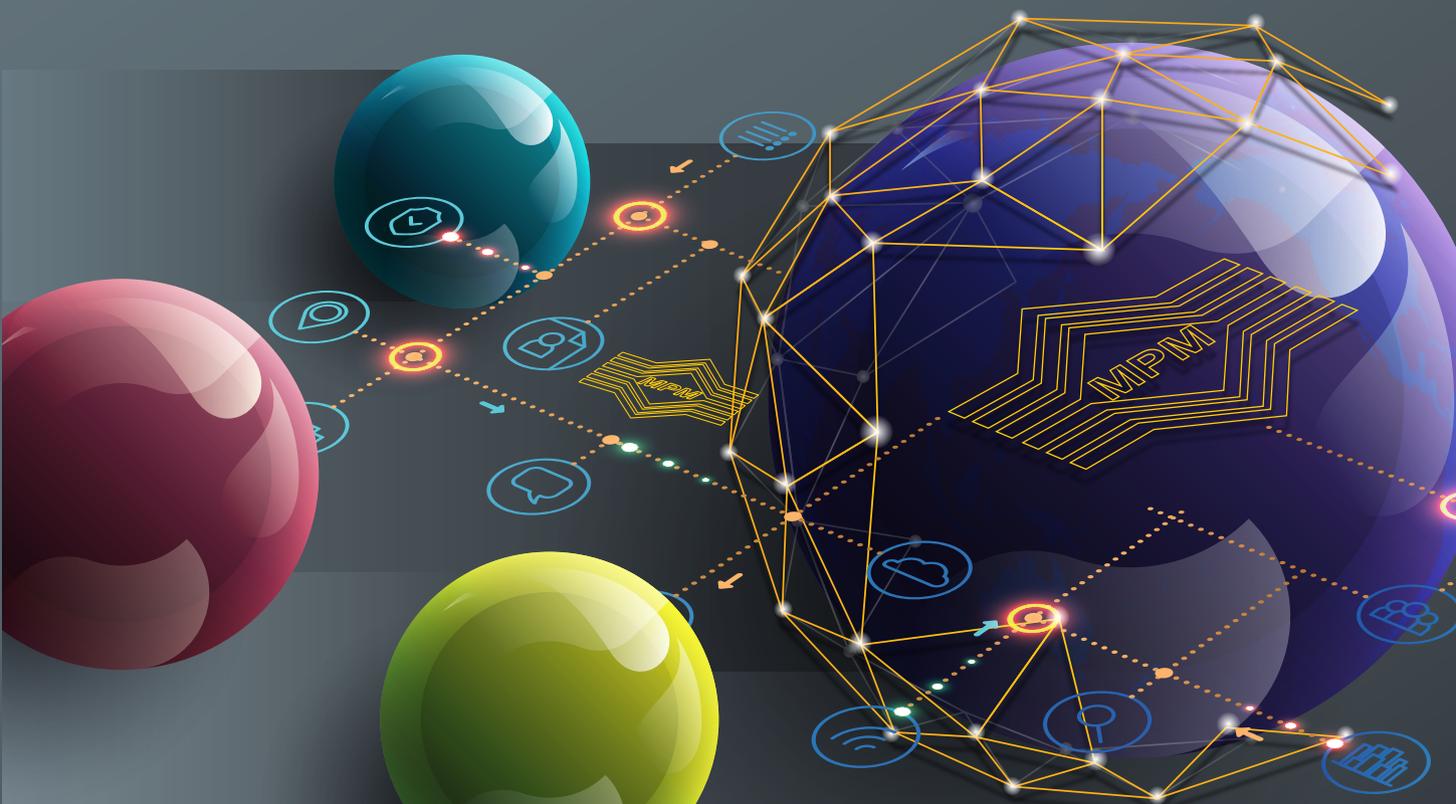
MAJLIS PEPERIKSAAN MALAYSIA



# LAPORAN PEPERIKSAAN STPM & MUET 2021

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## Chemistry (962)



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# CHEMISTRY (962/1)

## OVERALL PERFORMANCE

For Semester 1, 3 568 candidates sat for the examination for this subject and 69.65% 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	5.80	8.77	9.59	15.84	13.42	4.60	11.63	3.64	6.98	2.89	16.84

SEMESTER 1

## RESPONSES OF CANDIDATES

### SECTION A: *Multiple-Choice*

#### *Answer Keys*

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

### SECTION B AND C: *Structured and Essay Questions*

#### *General comments*

In general, the candidates produced scripts of average quality. Most of the candidates could understand tasks required in the questions. Almost all the candidates answered the tasks required in the questions and expressed their ideas clearly.

## Comments on the individual questions

### Question 16

The question asked about the mole concept and stoichiometry to test the understanding of candidates in equation writing, calculation of concentration of solution and determination of percentage purity of substance.

In part (a), many candidates were able to write the balanced equation for the reaction. A few candidates wrongly stated the phases for barium peroxide as  $\text{BaO}_2(\text{aq})$  or  $\text{BaO}_2(\text{g})$  and hydrogen peroxide as  $\text{H}_2\text{O}_2(\text{l})$ .

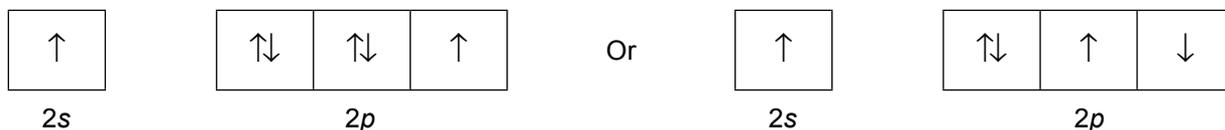
In part (b), many candidates were unable to calculate the concentration of  $\text{H}_2\text{O}_2$ . Most of them calculated the mole of  $\text{MnO}_4^-$  using molar mass of the ion instead of the molar mass of  $\text{KMnO}_4$ . The candidates failed to use the stoichiometric molar ratio to determine the concentration of  $\text{H}_2\text{O}_2$ .

In part (c), most of the candidates were unable to calculate the percentage purity of  $\text{BaO}_2$  because many of them failed to deduce the mole of  $\text{BaO}_2$  from the mole of  $\text{H}_2\text{O}_2$  obtained in part (b) and the equation in part (a). A few candidates wrongly used the mole of impure  $\text{BaO}_2$  to calculate the percentage purity of  $\text{BaO}_2$  sample. Some of the candidates were able to calculate the percentage of purity, but unfortunately, the answer was not given in two significant figures.

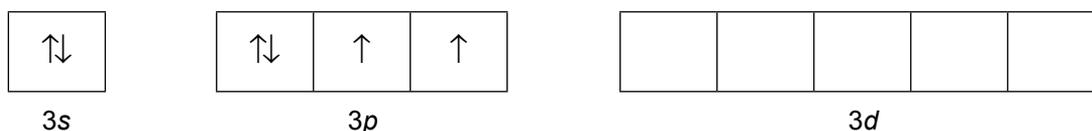
### Question 17

The question asked about covalent bonding to test the candidates in the filling of valence electron in orbital diagram, state the type of hybridisation, identify the strongest covalent bond in sulphuric acid, state the types of intermolecular forces in sulphuric acid and explain the reason why sulphuric acid is not suitable to be used as reducing agent.

In part (a), many candidates were able to complete the orbital diagram correctly but some candidates incorrectly wrote the excited state of O atom as follows:



They also incorrectly wrote the excited state of S atom as follows:



In part (b), majority of the candidates were able to state the type of hybridisation of O atom and S atom correctly but some candidates wrote the  $sp^3$  hybrid incorrectly such as  $sp_3$ ,  $SP^3$  or  $Sp_3$ .

In part (c), majority of the candidates were able to state the  $\text{S}=\text{O}$  as the strongest covalent bond in  $\text{H}_2\text{SO}_4$ . However, some candidates simply wrote double bond without stating between S and O atoms.

In part (d), most of the candidates were able to state hydrogen bond or van der Waals forces. However, many candidates wrongly spelled van der Waals as van der waals, Van der Waals or van der Walls.

In part (e), majority of the candidates were unable to give the reason for the unsuitability of  $\text{H}_2\text{SO}_4$  as a reducing agent.

## Question 18

This is a very popular question. The question asked about the electronic structure of atoms to test the candidates in the drawing of energy level diagram, arrangement of electrons in orbital according to Aufbau principle, Pauli exclusion principle and Hund's rule.

In part (a), many of the candidates were able to draw and label the energy level diagram correctly.

The common mistakes made by the candidates in this part were as follows:

- Labelled the axis as energy level
- Draw more than 5 energy levels
- Did not draw the energy levels converge as energy increases
- Gave less than and more than 4 electronic transitions
- Drew lines without arrows for the electronic transitions
- Did not indicate the shortest wavelength on the energy level diagram, instead the explanation was given in the text
- Failed to relate energy with wavelength, instead provided the relationship between frequency and wavelength or energy and frequency

In part (b), many candidates were able to explain the three rules to fill electrons into the orbitals of the sulphur atom. Some of the candidates did not write the electronic configuration of sulphur.

The common mistake made by the candidates in this part were as follows:

- For Aufbau principle, many of them used the term lower orbital instead of lowest energy orbital. Some candidates stated electrons were filled into orbitals from the lower energy without stating the sequence of increasing energy of orbitals  $1s < 2s < 2p < 3s < 3p < 4s < 3d < \dots$
- For Pauli exclusion principle, many candidates stated that each orbital have to be filled with two electrons with opposite spins. They did not use the term maximum with two electrons or with two electrons only.
- For Hund's rule, some candidates did not use the term degenerate for  $3p$  orbitals of sulphur. Hence, they did not use the orbital diagram to show the correct arrangement of electrons in the  $3p$  orbitals of sulphur.

In part (c), majority of the candidates were able to write valence electronic configuration of the elements and state the elements.

The common mistakes made by the candidates in this part were as follows:

- Gave the full electron configurations for the elements
- Wrote the valence electronic configuration of Ca as  $3p^6 4s^2$  or  $3s^2 3p^6 4s^2$  and Cr as  $3d^4 4s^2$
- Wrote other elements such as Fe and Cu or Mn and Ni instead of writing the elements that present in the same block from the given elements

## Question 19

The question asked about the states of matter that tested the ability of the candidates to calculate the total pressure exerted by the gaseous, explain the deviation of ideal gas at low temperature and high pressure, and drawing of the distribution of particle vs molecular speed.

In part (a), most candidates were able to calculate the total pressure in the flask by using  $PV=nRT$ .

The common mistakes made by the candidates in this part were as follows:

- Calculated the number of moles of nitrogen,  $\frac{125}{14.0}$  and the number of moles of krypton,  $\frac{1.75}{(83.8 \times 2)}$  wrongly
- Did not give the final answer in two significant figures

- Failed to give the reason for  $N_2$  as the gas that would exert greater partial pressure

In part (b), many candidates were unable to sketch and label the graph properly. The common mistakes made by the candidates in this part were as follows:

- Did not label the y-axis as number of particles, instead labelled it as number of molecules or fraction of molecules
- Did not draw the curves starting from the origin and labelled the graph correctly

In part (d), many candidates were unable to state the gas which deviates the most from the ideal gas behavior at low temperature and high pressure. They also were unable to relate the lower temperature with lower kinetic energy and high pressure with significant volume. Most candidates were not aware that krypton gas exists as monoatom. Hence, the candidates stated that the molecular size or intermolecular forces to describe the krypton gas.

## Question 20

The question asked about kinetics reaction to test the knowledge of candidates in calculation of half-life of first order reaction, application of Arrhenius equation in calculating activation energy and the role of catalyst in increasing reaction rate.

In part (a)(i), most of the candidates were able to calculate the half-life of  $H_2O_2$ . However, they did not round off the final answer in two significant figures. The candidates also did not write the chemical equation for the decomposition of  $H_2O_2$  and stated the order of the reaction.

In part (a)(ii), most of the candidates were able to calculate the activation energy of the decomposition of  $H_2O_2$ . However, the candidates did not round off the final answer in two significant figures. The candidates also did not convert the temperature from celcius to Kelvin. The candidates also did not change the equation from index form to logarithmic form.

In part (b)(i), many candidates were able to explain the role of  $I^-$  as the catalyst in the reaction by providing the pathway with lower activation energy. However, they failed to write the mechanism that showed the involvement of  $I^-$  in the reaction. Some candidates gave  $I^-$  as heterogeneous catalysts instead of homogenous catalyst.

In part (b)(ii), many candidates were able to state the amount of  $O_2$  as equal in the presence and absence of  $I^-$  but they did not explain precisely that catalyst increases the rate of the reaction only.

# CHEMISTRY (962/2)

## OVERALL PERFORMANCE

For Semester 2, 3 550 candidates sat for the examination for this subject and 61.68% 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	5.35	5.92	2.72	8.56	13.75	12.03	13.35	4.34	5.04	2.14	22.25

## RESPONSES OF CANDIDATES

### SECTION A: *Multiple-Choice*

#### *Answer Keys*

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

### SECTION B AND C: *Structured and Essay Questions*

#### *General comments*

The questions tested the basic and important concepts in Chemistry such as writing equations for enthalpy changes, constructing energy level or cycle diagrams calculating enthalpy change of reactions and writing half-cell and overall equations and equations for inorganic reactions. In general, candidates had moderate performance. The performance of candidate 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.

## Comments on the individual questions

### Question 16

The question asked about electrochemistry to test the ability of candidates to interpret the cell notation as well as write half-cell equations at anode and cathode. From that, they should have written the overall equation for the reaction with the correct symbol and phase for each species as well as identified the oxidising agent.

In part (a), most candidates were able to write the half-cell equations and the overall equations. They also were able to identify the oxidising agent in the reaction. However, some of the candidate did not write the states for each species, used reversible arrow and reduced  $\text{Sn}^{2+}$  to  $\text{Sn}^{4+}$ .

In part (b)(i), most candidates were able to calculate the electric charge correctly.

In part (b)(ii), many candidates were able to calculate the mass of Ba deposited and gave the final answer as two significant figures.

The common mistakes made by the candidates in this part were as follows:

- Did not divide the number of mole of electron by 2 to produce one mole of Ba
- Multiplied the number of mole with the proton number of Ba or relative molecular mass of  $\text{BaCl}_2$  instead of relative atomic mass of Ba

### Question 17

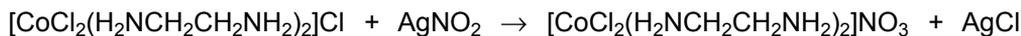
The question asked about transition elements to test the knowledge of candidates in physical and chemical properties of the complex compound.

In part (a), many candidates were able to state the oxidation state of cobalt correctly. Therefore, some candidates stated wrongly as  $3+$  or 3.

In part (b), most candidates were able to write the electronic configuration of the cobalt ion correctly. Some candidates wrote the electron configuration of the cobalt ion as  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4 4s^2$  instead of  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$ .

In part (c), many candidates were able to state the coordination number of the  $\text{Co}^{3+}$  in the complex as 6. In the explanation, many candidates were able to state  $\text{Cl}^-$  as a monodentate ligand and  $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$  as a bidentate ligand. However, there were some candidates who wrongly write  $\text{Cl}^-$  as Cl atom or  $\text{Cl}_2$ . Some of them only explained  $\text{Cl}^-$  as having one lone pair and  $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$  as having two lone pairs to be donated but did not state that each  $\text{Cl}^-$  forms one coordinate bond and each  $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$  forms two coordinate bonds with the central cobalt ion.

In part (d), many candidates were able to predict the number of AgCl moles formed. Most of them were unable to explain that 1 mol free  $\text{Cl}^-$  is released from the complex to react with the  $\text{Ag}^+$ . Most candidates were able to explain the formation of 1 mole of AgCl by giving the equation below.



### Question 18

The question asked about chemical energetics to test on construction of the Born-Haber cycle for strontium oxide, SrO and determination the second electron affinity of oxygen, X value using the correct equation from energy level diagram or enthalpy cycle. Candidates also required to calculate the standard enthalpy change of formation of  $\text{SrCO}_3$  from the standard enthalpy change of formation of SrO and  $\text{CO}_2$  and compared the relative stabilities of SrO and  $\text{SrCO}_3$ .

In part (a), most of the candidates were able to construct the Born-Haber cycle for SrO. Many of them were able to determine the value of X by using the correct equation.

The common mistakes made by the candidates in this part were as follows:

- Did not put the physical states for the species or wrongly assigned
- Stated the unit of  $X$  as kJ instead of  $\text{kJ mol}^{-1}$ .
- Halved the enthalpy change of atomisation of oxygen,  $+248/2 \text{ kJ mol}^{-1}$

In part (b), most candidates were able to explain the difference between the first electron affinity of oxygen and second electron affinity of oxygen,  $X$ , correctly. Many of them were unable to relate this to the attraction of the positive charge nucleus and the coming electron and the heat absorbed to overcome the repulsion between the electrons in the  $\text{O}^-(\text{g})$  with the second incoming electron.

In part (c), most candidates were able to calculate the enthalpy change of formation of  $\text{SrCO}_3$  as  $-1218 \text{ kJ mol}^{-1}$  using the formula or cycle or algebraic method. However, a few candidates wrongly gave the unit as kJ instead of  $\text{kJ mol}^{-1}$ .

In part (d), most candidates were able to compare the thermal stability of  $\text{SrO}$  and  $\text{SrCO}_3$  based on the value standard enthalpy of formation. They were also able to explain  $\text{SrCO}_3$  more stable due to the enthalpy change of formation of  $\text{SrCO}_3$  is more exothermic or more negative.

## Question 19

The question asked about Group 2 of the Periodic Table. The candidates were required to state the properties of the reaction of magnesium and barium with water. The candidates also required to explain about the solubility of magnesium sulphate and barium sulphate in water and explained the acid-base properties of hydroxides of Group 2 from Be to Ba.

In part (a), most candidates were unable to state the properties of the reaction between magnesium and barium with water. However, they did not specifically state the reactivity of magnesium with water that should be a slow reaction as well as the reaction of magnesium with steam produced magnesium oxide and hydrogen gas. The common mistakes made by the candidates in this part were as follows:

- Wrote the imbalanced chemical equation between magnesium with water and magnesium with steam
- Did not state the reason for the reactivity of the reaction between magnesium and barium
- Did not state slowly and vigorously when described the reaction between magnesium and barium with water respectively
- Wrote the equation between Ba and water as  $\text{Ba} + \text{H}_2\text{O} \rightarrow \text{BaO} + \text{H}_2$  instead of  $\text{Ba} + 2\text{H}_2\text{O} \rightarrow \text{Ba}(\text{OH})_2 + \text{H}_2$

In part (b), most of the candidates were able to explain about the solubility of magnesium sulphate and barium sulphate in water, which are the solubility of salt depends on the lattice energy and enthalpy of hydration and the cationic size of  $\text{Ba}^{2+}$  is larger than  $\text{Mg}^{2+}$ .

The common mistakes made by the candidates in this part were as follows:

- Stated the atomic size of Mg as smaller than Ba instead of ionic radius or cationic size of  $\text{Mg}^{2+}$  as smaller than  $\text{Ba}^{2+}$
- Compared the solubility of two salts which by stating the enthalpy hydration of  $\text{Mg}^{2+}$  as more exothermic than  $\text{Ba}^{2+}$  or vice versa and the presence of difference in lattice energy in both salts

In part (c), many candidates were able to state the acid-base properties of the Group 2 hydroxides correctly. However, some of them were able to write the balanced equations for the reaction between  $\text{Be}(\text{OH})_2$  with  $\text{H}^+$  and  $\text{OH}^-$  accurately. The candidates also stated hydroxides of Group 2 elements but stated Be as alkaline instead of basic.

## Question 20

The question asked about the tetrachloride of Group 14 of the Periodic Table and the silicates.

In part (a)(i), most of the candidates were unable to compare the reaction for each of the tetrachloride with water.

The common mistakes made by the candidates in this part were as follows:

- Wrote carbon has no empty  $d$  orbitals instead of carbon has no  $d$  orbitals
- Wrote  $\text{SiCl}_4$ ,  $\text{GeCl}_4$ ,  $\text{SnCl}_4$  and  $\text{PbCl}_4$  have empty  $d$  orbitals instead of Si, Ge, Sn and Pb have no  $d$  orbitals
- Did not write the equation for the hydrolysis involved
- Did not balance the hydrolysis equation
- Explained the hydrolysis of tetrachlorides using term nuclear charge and screening effect which were not relevant
- Did not mention that the Si, Ge, Sn and Pb could form dative bond or coordinate bond.

In part (b)(ii), most candidates were able to state the thermal stability of the tetrachlorides decreases when going down the group but they were unable to explain reasons correctly.

The common mistakes made by the candidates in this part were as follows:

- Wrote bond length of tetrachlorides increases instead of bond length between  $M$  and Cl or  $M$ -Cl increases
- Did not write the equations involved
- Did not write symbol,  $\Delta$ , at the arrow of the decomposition equations of  $\text{SnCl}_4$  and  $\text{PbCl}_4$  to indicate heat was required to decompose both  $\text{SnCl}_4$  and  $\text{PbCl}_4$
- Did not mention about the thermal stability of  $\text{CCl}_4$ ,  $\text{SiCl}_4$  and  $\text{GeCl}_4$  due to strong covalent bonds

In part (b), most of the candidates were unable to draw the structure of the sheet silicate correctly. A few candidates were able to draw the sheet silicate but failed to show the oxygen atoms at the end of the repeating units with two bonds. They were also unable to state the  $\text{SiO}_4^{4-}$  as the basic unit of the silicate. A few of the candidates wrongly stated that each  $\text{SiO}_4^{4-}$  unit shares 2 or 3 oxygen atoms instead of sharing 3 oxygen atoms. However, many candidates were able to give the correct examples for the sheet silicate such as mica or talc.

# CHEMISTRY (962/3)

## OVERALL PERFORMANCE

For Semester 3, 3 542 candidates sat for the examination for this subject and 55.03% 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	11.07	3.39	5.76	4.21	9.54	8.95	12.11	3.67	2.54	5.19	33.57

## RESPONSES OF CANDIDATES

### SECTION A: Multiple-Choice

#### Answer Keys

Question number	Key	Question number	Key	Question number	Key
1	A	6	C	11	D
2	B	7	C	12	C
3	A	8	D	13	D
4	B	9	C	14	A
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.

### SECTION B AND C: Structured and Essay Questions

#### General comments

Candidates did fairly well in questions 16, 17 and 18. The answers to explanatory questions were not arranged systematically leading to incomplete answers given by the candidates. Most of the candidates were only able to answer parts of the question and not the whole question. Some of the candidates were able to plan their answers coherently and systematically. Majority of the candidates acquired good skill in writing structural formula of organic molecules. However, many candidates showed a general weakness in IUPAC naming of compound, writing mechanism and write proper chemical equation with reagents and reaction condition. Most of the candidates did not follow the question requirements correctly.

## Comments on the individual questions

### Question 16

The question tested the understanding of candidates in identifying and naming the structure of the products of catalytic cracking of long chain hydrocarbon, understanding the structural isomerism and write the equations for the oxidation of alkene.

In part (a), many candidates were able to draw the structural formulae of Y and Z. However, a few candidates drew the structures as vice versa whereby the structure could not be exchangeable.

In part (b), most candidates were able to write the IUPAC nomenclatures of Y and Z. However, some candidates wrote the name of the structure  $(\text{CH}_3)_2\text{C}=\text{CH}_2$  as 2-methylprop-1-ene.

In part (c)(i), many candidates were able to write the reaction equation by giving aldehyde as product. A few candidates stated the symbol [O] in the oxidation equations which was not accepted.

In part (c)(ii), most candidates were able to write the reaction equation correctly.

In part (d), most candidates were able to draw the structure of cyclobutane as W.

### Question 17

The question tested the deduction of structural formula of Q, S and T through the chemical reaction of nucleophilic addition reaction of aldehyde, esterification between carboxylic acid and ethanol and oxidation of aldehyde. This question also required candidates to identify the reagent used to convert alcohol to acyl chloride and aldehyde to alcohol, wrote the function of  $^- \text{CN}$  and suggest chemical test to differentiate aldehyde and ketone.

In part (a), most candidates were able to draw the correct structural formulae for Q, S and T. However, some candidates drew the structure of Q as  $\text{CH}_3\text{CH}_2\text{CH}(\text{CN})(\text{ONa})$  or  $\text{CH}_3\text{CH}_2\text{C}=\text{O}(\text{CN})$  instead of  $\text{CH}_3\text{CH}_2\text{CH}(\text{CN})(\text{OH})$ .

In part (b), most candidates were able to give reagent P and R. Many candidates were unable to state the reagent R, they wrote (1)  $\text{LiAlH}_4$  followed by hydrolysis, or (1)  $\text{LiAlH}_4$  as the reagent and (2), a reducing agents such as  $\text{H}_2/\text{Ni}$ , Na in ethanol instead of  $\text{H}^+/\text{H}_2\text{O}$  or  $\text{HCl}(\text{aq})$  or  $\text{H}_2\text{SO}_4(\text{aq})$  for hydrolysis.

In part (c), most candidates were able to state the function of  $^- \text{CN}$ . Some of them stated the function of  $^- \text{CN}$  as attacking species instead of nucleophile. Many candidates wrong spell the nucleophile such as neuclophile or nucleophilic.

In part (d), majority of the candidates were able to suggest a chemical test correctly. The candidates were able to state the suitable chemical test such as silver mirror test/Tollens' reagent/Fehling solution/Schiff reagent. Some of them give wrong spelling for Tollens' reagent.

### Question 18

The question tested the identification of compounds, understanding in nucleophilic substitution mechanism, identify major product of the dehydration reaction, write all the equations for the chemical reaction involved and suggest a chemical test to differentiate haloalkane and alkene.

In part (a)(i), most candidates were able to draw the structure of R, S, T and U correctly based on the information given in the question with interchangeable structural formula of T and U. A few candidates were unable to draw the correct structure of R because they did not understand the statement rate of hydrolysis was independent of the concentration of  $\text{OH}^-$  that implied the reaction was a first order reaction and thus compound R was a tertiary haloalkane. As a result, the candidates made a mistake by giving secondary alkyl halide or primary alkyl halide for R, thus the structural formulae of S, T and U were all wrong.

In part (a)(ii), majority of the candidates were unable to write the  $S_N1$  mechanism correctly. In writing the mechanism, most candidates wrote the formula of hydroxide ion as  $OH^-$  instead of  $^-OH$ . The candidates also drew the arrow from H atom instead of O atom of  $OH^-$  to the carbocation.

In part (a)(iii), most candidates were unable to state that the rate of reaction was independent of  $^-OH$  due to the  $^-OH$  did not take part in the slow step. Many candidates state  $S_N1$  as the answer.

In part (b), most candidates were able to identify the major product by explaining the correct reason. The common mistake in this part was by giving incorrect spelling for Saytzeff rule.

In part (c), most candidates were able to write the chemical equations involved in the reaction. Some candidates did not state the required condition specifically in the dehydration reaction as  $180^\circ C$ . Some candidates were unable to write two separate equations for the dehydration of *S*. The common mistake was candidates could not differentiate between reagents and reaction conditions.

In part (d), majority of the candidates were able to suggest a chemical test to differentiate *R* and *T*. Many of the candidates made a mistake by writing the reagent of the test as bromine gas in  $CCl_4$  or bromine water in  $CCl_4$  instead of bromine in inert solvent.

### Question 19

The question tested the knowledge of inductive effect in determination of the strength of acidity of the organic compounds and electrophilic aromatic substitution mechanism. Candidates also need to compare the reactivity of propanoyl chloride and chloropropane and write the equations for the chemical reactions involved.

In part (a)(i), most candidates were unable to arrange the order of acidity because they stated that both  $-NO_2$  and  $-OH$  groups were electron withdrawing groups with  $-NO_2$  being a stronger. Some candidates were able to arrange the acidity of *Z*, *X*, *Y* in correct sequence and were able to attribute it to the effect of electron withdrawing group,  $-NO_2$  and electron donating group,  $-OH$  on the bond strength of O-H in  $COOH$ .

In part (a)(ii), most candidates were unable to state the reaction condition correctly. Some of the candidates wrote concentrated  $H_2SO_4$  without concentrated  $HNO_3$  at temperature  $<55^\circ C$ . The candidates also stated heat or reflux instead of  $55^\circ C$ . As a result, the candidates were unable to write the electrophilic aromatic substitution mechanism. Most candidates wrote positive charge on O instead of the positive charge on N as  $^+NO_2$ .

While writing the electrophilic aromatic substitution reaction mechanism, the common mistakes made by the candidates in this part were as follows:

- Did not show at least 2 resonance structures for arenium ion
- Did not use kekulé structure in the reaction mechanism scheme
- Wrote the arrows with wrong directions such as the arrow points from pi bond to O atom instead of pi bond to N atom in  $^+NO_2$

In part (b)(i), majority of the candidates were unable to give the reason why the rate of hydrolysis of propanoyl chloride was higher than that of chloropropane. Only a few of candidates were able to explain that the oxygen atom in the  $-C=O$  group withdrew electron from carbonyl carbon in propanoyl chloride causing the carbonyl carbon acquiring a greater partial positive charge, thus a weak nucleophile would hydrolyse propanoyl chloride easily. While the C-Cl bond in chloropropane was less polar and it required a strong nucleophile for reaction to take place. Some candidates wrote propanoyl chloride was polar.

In part (b)(ii), most candidates were able to write the chemical equations and know that  $NaOH(aq)$  is required to hydrolyse  $CH_3CH_2CH_2Cl$ . Some candidates write the chemical equation used the wrong reagent which is  $NaOH(aq)$  instead of  $H_2O$  for the hydrolysis of  $CH_3CH_2COCl$ .

## Question 20

The question tested the deduction of the structure of tertiary amine, understanding the reaction of the amine with acid, esterification between tripeptide and ethanol, and identify the amino acid formed from hydrolysis of the tripeptide.

In part (a)(i), only a few candidates were able to deduce  $X$  and explain that  $X$  was an aromatic compound due to the ratio of C: H  $\approx$  1:1. Most of the candidates were unable to deduce the structure of  $X$ . Most candidates gave the structural formula of  $X$  as a tertiary aliphatic amine with a benzyl group ( $-\text{CH}_2\text{C}_6\text{H}_5$ ) as the substituent. In general, many of them did not understand the meaning of tertiary amine. Some candidates defined tertiary amine as atom N attached to three C atoms.

In part (a)(ii), most candidates stated that  $X$  was a base instead of a Lewis base and did not explain its role in the reaction with hydrochloric acid. The candidates did not mention N atom in  $X$  donated a lone pair electrons to  $\text{H}^+$ . Although the candidates were able to write the equation for the acid-base reaction correctly but they gave incorrect structural formula for the quaternary ammonium salt formed.

In part (b)(i), many candidates were able to state that ethanol reacted with tripeptide to form ester but they did not mention the requirement of an acid catalyst in the reaction. Some candidates wrote carboxylic acid group instead of carboxyl group,  $-\text{COOH}$ , in the tripeptide that undergoes condensation reaction with the hydroxyl group,  $-\text{OH}$ , of ethanol. In writing the chemical equation, the candidates did not write the reversible arrows.

In part (b)(ii), majority of the candidates were able to determine the structures of amino acids obtained upon the completion of hydrolysis of the tripeptide. However, they were unable to write the IUPAC name of all amino acids formed as 2-aminoethanoic acid and 2-amino-2-phenylethanoic acid.

In part (b)(iii), most candidates were able to draw the structural formulae of another tripeptides correctly.

## PAPER 962/5 (WRITTEN PRACTICAL TEST)

### General comments

In general, the performance of the candidates was moderate. Knowledge of mole concept, stoichiometry and balancing redox chemical reaction was crucial in problem solving of redox titration. The weaknesses in calculating molarity and converting molarity to mass of compound based on the stoichiometric ratio obtained from the balanced equation of the redox reaction. Obviously, some candidates were unable to interpret the stopwatch reading and unable to plot the graph by giving the appropriate scale for x-axis and y-axis even when the title of the graph has been given in the question.

### Comments on the individual questions

#### Question 1

In part (a)(i) and (a)(ii), some candidates were unable to calculate the average titre value because the rough reading was included as a datum in the calculation.

In part (a)(iii), most of the candidates wrongly stated the pink changed to colourless instead of colourless to pink because of the pink colour signals the endpoint of the redox titration in the presence of excess oxidising agent potassium manganate(VII) or potassium permanganate. In this case, no indicator was used in the redox titration.

In part (a)(iv), majority of the candidates were unable to write a balanced equation for the redox titration.

In part (a)(v), most candidates were unable to calculate the concentration of  $\text{KMnO}_4$  solution because they were wrongly calculated in part (a)(iv).

In part (b), most of the candidates were unable to calculate the percentage purity of  $(\text{NH}_4)_2\text{SO}_4 \cdot \text{Fe}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$ .

$$\% \text{ purity} = \frac{5.36}{6.95} \times 100 = 77.1\%$$

Generally, some candidates were unable to show their understanding, knowledge and application of mole concept in problem solving of redox titrimetry.

## Question 2

In part (a), some candidates were unable to give the correct time taken for *Experiment 3*.

In part (b), most of the candidates were able to plot the graph as required. Nevertheless, a few candidates were quite confused in getting the correct scale of  $y$ -axis because of the values of  $\frac{1}{t}$  decreasing as the temperature increased.

In part (c), most candidates were unable to determine the order of the reaction and calculate the rate constant because the rate constant was wrongly calculated when the candidate failed to obtain the straight line from the graph.

In part (g), most of the candidates were able to calculate the required volume of  $X^{2+}$  solution by using  $M_1V_1 = M_2V_2$ .

In part (d), (e), (f) and (h), some candidates were able to answer correctly these questions as they fully understand the theoretical part of the experiment set-up.

## Question 3

In this question, most candidates were able to answer correctly but in part (c), all candidates were unable to give the correct answer regarding how to complete the diagram.

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