



MAJLIS PEPERIKSAAN MALAYSIA



# LAPORAN PEPERIKSAAN STPM & MUET 2020

## Chemistry (962)



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# CHEMISTRY (962/1)

## OVERALL PERFORMANCE

The number of candidates for this subject was 4 605. The percentage of candidates who obtained a full pass was 63.35%.

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	10.50	8.53	10.98	9.49	11.60	8.31	11.97	4.42	6.90	3.21	14.10

## RESPONSES OF THE CANDIDATES

### SECTION A: Multiple-Choice Questions

#### Answer Keys

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

Generally, candidates from the big centres performed better than candidates from the smaller centres.

## Comments on the individual questions

### Question 16

This question asked about the electronic configuration of an atom.

In part (a)(i), many candidates were able to identify X. A few candidates made a mistake by writing the symbol of cobalt as CO.

In part (a)(ii), some candidates were able to state the principal quantum number of the removed electrons. Most candidates stated 4s as the answer, showing they did not apply the concept of the principal quantum number.

In part (a)(iii), some candidates were able to determine the number of unpaired electrons for  $X^{2+}$  by writing the valence electronic configuration of  $X^{2+}$  as  $4s^23d^5$  and they answered,  $X^{2+}$  has 5 unpaired electrons. Many candidates did not use the orbital diagram to show the electrons in 3d but they only wrote the valence electron configuration as  $3d^7$ .

In part (a)(iv), some candidates were able to state the number of valence electrons for  $X^{3+}$ . Most candidates answered the question as  $3d^6$  instead of 6.

In part (b)(i), many candidates were able to write the valence electronic configuration of Y, but some of them wrote the valence electronic configuration of Y as  $3d^94s^2$  instead of  $3d^{10}4s^1$ . A few candidates gave the electronic configuration of Cu.

In part (b)(ii), most candidates were able to identify Y as Cu. A few candidates made spelling mistakes such as “cupper” and “cuprum”.

### Question 17

In part (a), most candidates were able to explain about the shape of the curve given in the question. Many candidates were able to mention that the strength of intermolecular forces between propanone and trichloromethane is stronger than in the respective pure substances. Some candidates mentioned higher intermolecular forces or attractive forces instead of stronger intermolecular or attractive forces. They also used the term bond instead of intermolecular forces. Many candidates stated that the mixture is a non-ideal solution and has minimum vapour pressure or it shows a negative deviation from Raoult's law instead of the molecules in the mixture or solution have less tendency to escape into vapour phase or become vapour.

In part (b), majority of the candidates were able to give the correct deviation.

In part (c), most candidates were able to predict the changes in temperature when both substances are mixed.

In part (d), many candidates were unable to sketch the correct curve for the mixture of propanone and trichloromethane. Some candidates sketched the liquid-vapour composition, for example, two curves with azeotrope rather than the vapour composition curve. Some candidates failed to show the left boiling point-axis to be lower than the right boiling point-axis. Some candidates failed to label the x-axis as mole fraction of trichloromethane with the values 0 to 1.

In part (e), most candidates were unable to give a correct example of another mixture. Some candidates wrote “hydrochloric acid-water mixture” instead of “hydrogen chloride-water”. Some candidates wrote “ethanoic acid-water” or “ethanol-water” instead of “nitric acid-water”.

### Question 18

In part (a), many candidates were able to state the types of bonds present in ammonium nitrate but they did not state which atoms or ions form the suitable bonds. The ionic bonds formed between  $\text{NH}_4^+$  and  $\text{NO}_3^-$  were not mentioned. Covalent bonds were not differentiated from the coordinate bonds in  $\text{NH}_4^+$  and  $\text{NO}_3^-$ . Some candidates did not state the hydrogen bonding between N-H atoms in  $\text{NH}_4^+$  or between  $\text{NH}_4$  and  $\text{NO}_3$ . The candidates drew the hydrogen bonding with the H from  $\text{NH}_4^+$  joining with O from NO.

In part (b), many candidates were unable to draw the Lewis structures accurately. Dots and crosses were mixed with lines to represent bonding electrons and charges, so the Lewis structure was drawn wrongly. However, most candidates were able to identify hybridisations, their shapes and the angle of the central atoms. The candidates made mistakes in spelling the shape, for example, planar as plannar, planer or planner and tetrahedral as tetrahydal.

In part (c), a few candidates were able to explain why ammonium nitrate is used as fertiliser by stating that ammonium nitrate is soluble in water. Many candidates failed to give the reason that ammonia nitrate has a high content of nitrogen. A few candidates explained in terms of high nitrogen or N atom or nitrate ion instead of nitrogen only. Some candidates made a mistake by stating the ammonium nitrate is acidic, so it can neutralise the basic soil or it is high in nutrient.

### Question 19

In part (a)(i), many candidates were unable to state the Dalton's law completely. Most of them failed to mention that the gases are non-reacting gases. Some candidates only stated the expression,

$$P_A = x_A \cdot P_T.$$

In part (a)(ii), most candidates were unable to calculate the partial pressure of  $\text{N}_2$  in the cylinder. Some candidates were able to determine the total number of moles by using  $PV = nRT$  equation to solve the question. However, many candidates failed to give the final answer correctly because of carelessness in substituting the correct numbers or giving the correct significant figures. They also failed to give the correct unit for the final answer.

In part (b), many candidates were unable to sketch the phase diagram. Most candidates sketched the diagram separately instead of comparing the curves on a single diagram. The common mistakes made by the candidates are as follows:

- Did not label the solid, liquid and gas phases in the phase diagram
- Did not label the curves correctly
- Labelled diagram phases as s, l and g
- Did not draw the freezing point line as a straight line
- Did not compare water and NaCl solution in one phase diagram but sketched two separate diagrams
- Drew the sublimation curve starting from the origin

Some candidates were able to explain the differences in vapour pressure, freezing point and boiling point between the solution and water correctly.

## Question 20

In part (a), most candidates were able to plot the graph with the correct curve. Some candidates did not give the unit for y-axis as  $\text{mol dm}^{-3}$  for  $[\text{NO}_2]$  and x-axis as s for time. A few candidates plotted different graphs which were  $1/[\text{NO}_2]$  against time or  $\ln[\text{NO}_2]$  against time. Majority of the candidates were unable to determine the initial rate and the rate of formation of  $\text{O}_2$  at 35 s from the graph. The candidates failed to relate the differential rate equation with the gradient of the graph. Tangents must be drawn at  $t = 0$  s and at  $t = 35$  s respectively to calculate the initial rate and the rate of formation of  $\text{O}_2$  at 35 s.

In part (b), many candidates were able to state that the rate of reaction is affected by three factors. The rate of reaction increases with the increase of the partial pressure of reactant, increase of temperature and addition of catalyst. However, some candidates mentioned that the rate of the reaction increases when there is an increase of particles per unit volume or an increase in concentration of reactant and an increase in kinetic energy, thus there is more effective collision and provides alternative pathway with lower activation energy.

# CHEMISTRY (962/2)

## OVERALL PERFORMANCE

The number of candidates for this subject was 4 461. The percentage of candidates who obtained a full pass was 63.48%.

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	3.73	6.40	4.92	10.98	13.00	12.46	13.14	3.13	4.07	6.17	21.99

## RESPONSES OF THE CANDIDATES

### SECTION A: Multiple-Choice Questions

#### Answer Keys

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

Generally, candidates from the big centres performed better than candidates from the smaller centres.

## Comments on the individual questions

### Question 16

This question asked about the elements of Period 3 of the Periodic Table and their chemical properties.

In part (a), many candidates were able to give the answer which is element Z has higher ionisation energy. Some candidates failed to give the correct reason. The wrong reasons given are Z has a greater number of valence electrons, Z has a smaller atomic radius or Z has half-filled *p* orbitals.

In part (b), most candidates were able to give the correct element as they were able to relate the electrical conductivity of Y to Y being a metal and Y has delocalized electrons. A common mistake made was using Al as the answer and not the element Y given in the question.

In part (c), many candidates were able to write the chemical formula for each oxide formed. Some candidates were unable to answer this question because they have written the chemical equations of the reactions between the elements and oxygen instead of the chemical formulae of the oxides formed. The chemical formulae for the oxides of Y and Z are  $Y_2O_3$  and  $ZO_2$  or  $ZO_3$  respectively. Many candidates used Al and S to represent Y and Z in the chemical formulae.

### Question 17

This question asked about the properties of beryllium and magnesium.

In part (a)(i), most candidates were unable to name the complex ion correctly. They gave the answer as hexaaquamagnesium(II) ion instead of hexaaquamagnesium ion.

In part (a)(ii), most candidates were able to state the orbitals involved in the formation of the coordinate bonds between  $Mg^{2+}$  and water.

In part (b), most candidates were able to write the formula of beryllium ion in aqueous solution as  $[Be(H_2O)_4]^{2+}$  and explained their answers. The common mistakes made by the candidates were as follows:

- Wrote equation:  $Be(s) + 4H_2O(l) \rightarrow [Be(H_2O)_4]^{2+}(aq)$
- Wrote incorrect formula:  $[Be(H_2O)_4]^{2-}$  or  $[Be(H_2O)_6]^{2+}$

Many candidates explained their answer by stating that  $Be^{2+}$  has high polarising power and charge density instead of  $Be^{2+}$  has empty 2*s* and 2*p* orbitals.

In part (c)(i), many candidates were able to explain the difference in acid-base properties between magnesium oxide and beryllium oxide based on bonding.

In part (c)(ii), most candidates were able to write the chemical equations for the reactions between BeO and HCl as well as between BeO and NaOH(aq).

## Question 18

This question asked about the standard enthalpy of solution and thermochemistry.

In part (a)(i), majority of the candidates were unable to explain completely why the enthalpy of solution of NaCl,  $+3.9 \text{ kJ mol}^{-1}$  is an endothermic reaction. Some candidates just stated in general that the lattice energy is higher than the hydration energy without stating both energies are for NaCl. Most candidates were able to give the following two reasons:

Enthalpy of solution depends on the lattice energy and the hydration energy or

$$\Delta H_{\text{solution}} = -\Delta H_{\text{lattice}} + \Delta H_{\text{hydration}}$$

The hydration energy of NaCl is lower or less exothermic than the lattice energy of NaCl or the lattice energy of NaCl is higher/more exothermic than the hydration energy of NaCl.

The candidates also stated that both the enthalpies are dependent on the charge and size.

$$\Delta H_{\text{hydration}} \ \& \ \Delta H_{\text{lattice}} \propto \frac{\text{charge}}{\text{size}}$$

Some candidates stated that  $\text{Na}^+$  and  $\text{Cl}^-$  are small and not large in ionic size as expected in the answer.

In part (a)(ii), most candidates were able to state that fluoride ion is smaller in size and the hydration energy of  $\text{F}^-$  is higher or more exothermic than that of  $\text{Cl}^-$ . Some candidates stated that the lattice energy of NaF is higher than NaCl due to size, thus failed to explain why the standard enthalpy of solution of NaF is lower than that of NaCl.

In part (b)(i), most candidates were able to give the correct definition for the standard enthalpy of neutralisation for a reaction. However, a common mistake made by candidates is to define it as enthalpy change and not as heat released or liberated. Some candidates also did not mention about the 1 mole of hydrogen ions from acid, 1 mole of hydroxide ions from base and the reaction is under standard conditions.

In part (b)(ii), most candidates were able to calculate the standard enthalpy of neutralisation based on the data given by using  $q = mc\Delta T$  followed by  $\Delta H = -q/n$ , where  $n = 0.025 \text{ mol}$  and  $\Delta H = -56.8 \text{ kJ mol}^{-1}$ . Most candidates wrote symbol of heat as  $Q$  instead of  $q$  in the equation  $Q = mc\Delta T$  and substituted the data incorrectly. For example,  $q = 25 \times 4.18 \times 31.8$  or  $q = 50 \times 4.18 \times 6.80$

For the final answer of the calculation, some candidates failed to put the negative sign for the enthalpy change. Some candidates answered with the wrong significant figure such as  $-56.84 \text{ kJ mol}^{-1}$ .

## Question 19

The question asked about electrolysis and the application of electrochemistry.

In part (a)(i), many candidates were able to calculate the  $E_{\text{cell}}^{\circ}$  by using the Nernst equation and the value of  $K_{\text{sp}}$  given. The candidates were expected to write the complete Nernst equation and substitute the value of  $E_{\text{cell}} = 0$  at equilibrium and value of  $n = 2$  in order to obtain the value of  $E_{\text{cell}}^{\circ}$ .

The candidates were also able to state the equation correctly using the equilibrium equation given as follows:

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.059}{n} \log [\text{Fe}^{2+}][\text{F}^-]^2 \text{ or } E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.059}{n} \log K_{\text{sp}}$$

The common mistakes made in the equation are as follows:

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} + \frac{0.059}{n} \log [\text{Fe}^{2+}][\text{F}^{-}]^2$$

$$E^{\circ}_{\text{cell}} = E_{\text{cell}} - \frac{0.059}{n} \log [\text{Fe}^{2+}][\text{F}^{-}]^2$$

$$\frac{E^{\circ}_{\text{cell}}}{E_{\text{cell}}} = E^{\circ}_{\text{cell}} - \frac{0.059}{n} \log \frac{[\text{reactant}]}{[\text{product}]}$$

Some candidates made mistakes when substituting the data into the equation, for example,  $E^{\circ}_{\text{cell}} = 0$  instead of  $E_{\text{cell}} = 0$  and  $n = 1$  instead of 2.

In part (a)(ii), many candidates were able to state the formula used to calculate the standard reduction potential,  $E^{\circ}_{\text{cell}}$  using  $E^{\circ}_{\text{cell}} = E^{\circ}_{\text{reduction}} + E^{\circ}_{\text{oxidation}}$  but failed to identify the anode (oxidation) and cathode (reduction) reaction correctly, hence resulted in obtaining a wrong value.

In part (a)(iii), many candidates were unable to differentiate the oxidising power of  $\text{Fe}^{2+}$  with that of  $\text{FeF}_2$ . This is because they did not answer correctly in (a)(ii), thus their performance in (a)(iii) was affected. The candidates made a mistake in stating that  $\text{FeF}_2$  has a stronger oxidising power than  $\text{Fe}^{2+}$  and their reason was the  $E_{\text{o}}$  value is positive or more positive.

In part (b), many candidates were able to state the observation of the electrolysis but did not explain the reasons why  $\text{Na}^{+}$  and  $\text{SO}_4^{2-}$  are not discharged at the cathode and the anode respectively. Some candidates were unable to differentiate between electrolytic cell and electrochemical cell.

The common mistake made by the candidates are as follows:

- Did not state all the species in the electrolyte before electrolysis
- Did not state the term reduction for the reaction at the cathode and oxidation for the reaction at the anode
- Failed to explain that  $\text{SO}_4^{2-}$  is not oxidised at the anode because the S in  $\text{SO}_4^{2-}$  is at its maximum oxidation state

## Question 20

The question asked about the reaction between halogens and hydrogen.

In part (a)(i), many candidates were able to state that the reactivity of halogens and hydrogen decrease down the group. They were able to relate the reactivity of halogen with the bond length of the H-X bond but not the size of the halogen. Some candidates mentioned that the size of the atom increases down the group correctly but failed to relate with decreasing oxidising strength or decreasing electronegativity in the answer.

In part (a)(ii), majority of the candidates were able to arrange the ascending order of acid strength and explained the effects of bond length and bond strength based on the degree of dissociation of the acids. Only a few of the candidates explained the strength of the acids in terms of the stability of the conjugate base, which is, the more stable the conjugate base, the stronger the acid.

In part (b), many candidates were able to state the reagent as  $\text{AgNO}_3$  solution, but many of them did not state the term aqueous. Most candidates were able to write the chemical equation and mention the white precipitate for  $\text{AgCl}$  and yellow precipitate for  $\text{AgI}$  using  $\text{AgNO}_3$ .

# CHEMISTRY (962/3)

## OVERALL PERFORMANCE

The number of candidates for this subject was 4 570. The percentage of candidates who obtained a full pass was 54.57%.

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	9.07	3.02	7.36	3.05	11.43	8.35	11.89	5.59	7.64	4.85	27.74

## RESPONSES OF THE CANDIDATES

### SECTION A: Multiple-Choice Questions

#### Answer Keys

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

Generally, candidates from the big centres performed much better than candidates from the smaller centres.

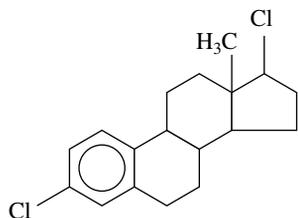
## Comments on the individual questions

### Question 16

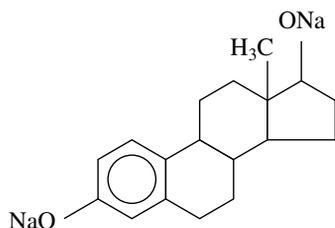
In part (a), most candidates were able to name the functional group of the estradiol. Some candidates gave incorrect answers such as hydroxy and aromatic compound as functional group instead of the hydroxyl group.

In part (b), majority of the candidates were able to give the structural formulae of the products formed when estradiol reacts with the stated reagents. Some candidates made mistakes in their answers such as:

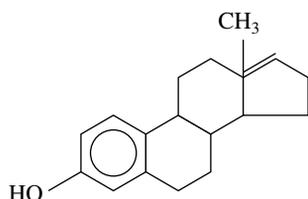
- (i) both OH groups become Cl



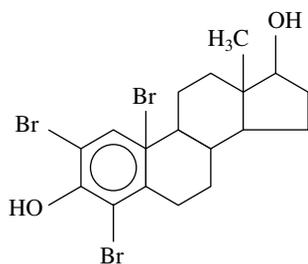
- (ii) both OH groups become ONa



- (iii) gave sulphonic acid or product with the double bond in the wrong position



- (iv) gave tribrominated product



In part (c), majority of the candidates were unable to state the correct type of reactions that occurred in (b)(iii) and (b)(iv). Most candidates wrote dehydration for the reaction occurred in (b)(iii) instead of the elimination reaction. For the reaction occurred in (b)(iv), most candidates wrote bromination or electrophilic substitution instead of electrophilic aromatic substitution reaction.

### Question 17

This question tested the understanding of optical isomer, IUPAC nomenclature and the reaction of carbonyl compounds.

In part (a)(i), most candidates were able to draw the structural formulae of two isomeric carbonyl compounds and name their IUPAC nomenclature. However, a few candidates made mistakes by writing the IUPAC name of an alcohol as 1-propanol or 1-propanal instead of propanal.

In part (a)(ii), most candidates were able to give a propanal which is a more reactive isomer towards nucleophilic addition reaction.

In part (a)(iii), most candidates were able to give a propanone as the product of the oxidation of secondary alcohol.

In part (b)(i), majority of the candidates were able to state the correct number of chiral carbon in the fructose.

In part (b)(ii), majority of the candidates were able to write the correct structural formula of the product formed when fructose reacts with  $\text{LiAlH}_4$  in dry ether followed by hydrolysis.

### Question 18

In part (a)(i), most candidates were able to draw the correct structural formulae of *P* and *Q* but failed to give the correct class of both compounds.

In part (a)(ii), majority of the candidates were unable to show the delocalisation of electrons in compound *Q*. They failed to draw the delocalisation of electrons using Kekule structure and also the correct arrow to show the resonance structures.

In part (b)(i), most candidates were able to deduce the structure of *R* and thus gave the correct structural formula of *R*. Many candidates were unable to draw the 3-dimensional structures of the optical isomers of *R*. Some candidates were unable to draw the mirror image correctly. Most candidates were able to write the equation for the reaction between *R* and alkaline iodine solution correctly.

In part (b)(ii), majority of the candidates were able to state the reagent and reaction condition for the synthesis of *R* starting from the chosen alkene. A few candidates listed the reactants, reagents and reaction conditions instead of writing the scheme of synthesis of *R* starting from the chosen alkene. This happened probably because the candidates did not understand the term *synthesis*. Some candidates made a mistake by writing the reaction of the alkene with  $\text{HCl}$  or  $\text{HBr}$  followed by the reaction with  $\text{NaOH}$ , which favours the formation of elimination product. They also did not write the complete reagent and condition such as the acid without water or dilute for the acid and did not write heat as the reaction condition.

### Question 19

In part (a), most candidates were able to draw the structural formulae of compounds *M* and *N* correctly.

In part (b), many candidates were unable to write the free radical mechanism for the formation of 3-bromo-2,2-dimethylbutane. Most candidates either wrote the equations without arrows or used the wrong arrow and failed to draw the curly half-headed arrow to show electrons movements. Some candidates gave the wrong termination step even though it was already given in the question.

The candidates should use the correct arrows to write the free radical mechanism of the reaction. Most candidates were able to state the reaction conditions but failed to explain the need for the conditions. For example, the candidates did not state that bromine molecules absorb energy to undergo homolytic fission and form free radicals. They also made a mistake by stating sunlight instead of ultraviolet light as the condition of the reaction.

In part (c), most candidates were able to name electrophilic addition reaction as the reaction mechanism for the formation of 3-bromo-2,2-dimethylbutane from compound *N* and wrote the electrophilic addition mechanism with correct arrows. However, some candidates did not draw the arrows to show the movement of electrons.

In part (d), most candidates were able to name the type of polymerisation and draw the structure of polymer *P*. A few candidates made a mistake by naming the type of polymerisation as an additional polymerisation instead of addition polymerisation. The answer cannot be accepted as this is not the correct term in Chemistry.

### Question 20

In part (a), most candidates were able to write the structural formulae of the first homologue of aliphatic carboxylic acids, esters, acyl chlorides and amides. Some candidates incorrectly gave the second homologue of all aliphatics. The majority of the candidates were unable to arrange the compounds according to their reactivity. The common mistake made by the candidates was stating the aliphatic ester as the least reactive compound compared to others.

In part (b)(i), most candidates were able to identify compounds *X* and *Y* but many of them drew the structure of *X* as a neutral molecule or compound *X* with a positive charge on H such as  $\text{NH}_3^+$ . The positive charge symbol should be on *N*.

In part (b)(ii), most candidates were able to write all the chemical equations involved. The common mistake made by the candidates was writing the reagent and condition on the arrow.

In part (b)(iii), many candidates were able to suggest the structure of compound *X* at isoelectric point, and the common mistake made was writing a positive charge on H such as  $\text{NH}_3^+$ . The positive charge symbol should be on *N*.

In part (b)(iv), some candidates were able to write the reaction scheme correctly. Many candidates wrote the reaction scheme using chemical equations in order to get compound *X* from ethylbenzene instead of the reaction scheme or synthetic pathway as stated in the question. The common mistake made was writing the reaction scheme for the preparation of compound *X* from ethylbenzene as follows:

- i. Oxidising ethylbenzene in the first step, thus the reaction proceeds at meta position.
- ii. Nitrating ethylbenzene at a higher temperature or just gave the symbol of heat,  $\Delta$  and also failed to mention concentrated nitric acid and concentrated sulphuric acid as the reagent.
- iii. Reducing nitro group before oxidizing phenyl- $\text{CH}_2\text{CH}_3$  to phenyl-COOH, for example from 2-nitroethylbenzene to 2-aminoethylbenzene.

## PAPER 962/5 (WRITTEN PRACTICAL TEST)

### General comments

The questions in general were good quality.

### Comments on the individual questions

#### Question 1

In part (a)(i), most candidates were unable to state how to prepare a solution of KA2, NaOH, even when the volume and mass of NaOH were given in the question. Some candidates explained the procedure to perform a titration which is an incorrect answer. Actually, in the preparation of a standard solution, the solid NaOH is weighed and transferred into a 250 cm<sup>3</sup> volumetric flask. Next, distilled water is added to first dissolve the solid NaOH and then filled up to the calibration mark of the volumetric flask. Finally, the solution is mixed thoroughly by shaking the volumetric flask.

In part(a)(ii), most candidates were unable to calculate the concentration of NaOH.

In part (b)(i) and (b)(ii), majority of the candidates were able to calculate the volume and the average volume of NaOH used in the titration. However, a few candidates failed to differentiate between the rough and accurate readings obtained from the titration and could not write the correct significant figure for the readings. The rough reading for the volume of KA2 was included as data to calculate the average volume of KA2, NaOH.

In part (b)(iii), most candidates were unable to write a balanced ionic equation for the reaction.

In part (b)(iv) and (b)(v), most candidates were unable to calculate the concentration of hydrated ethanedioic, thus they could not calculate the mass of hydrated ethanedioic in KA1.

In part (c)(i), many candidates were able to state the volume of KA3 but some of them made the same mistakes as in (b)(ii).

In part (c)(ii), most candidates failed to explain that heating is required to accelerate the reactions during the titration.

In part (c)(iii), most candidates were unable to calculate the concentration and the mass of C<sub>2</sub>O<sub>4</sub><sup>2-</sup> of KA1.

In part (c)(iv), most candidates failed to determine the mass of Na<sub>2</sub>C<sub>2</sub>O<sub>4</sub>.

In part (d), most candidates were unable to calculate the mass percentage of Na<sub>2</sub>C<sub>2</sub>O<sub>4</sub> in KA1.

$$\% \text{ sodium ethanedioate} = \left( \frac{2.85}{2.85 + 4.30} \right) \times 100 = 39.9\% \sim 40\%$$

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

#### Question 2

In part (a)(i) and (a)(ii), most candidates were able to calculate the temperature change and write the expression to calculate the heat change of the reactions.

In part (a)(iii), most candidates were unable to calculate the heat change of both reactions. Most of them used the expression below.

$$\text{Heat change (Q @ q)} = mc\Delta T @ mc\theta$$

Most candidates obtained the wrong answers because they wrote mass of solids in (a)(i) instead of the mass of water, which is  $1.0 \text{ g cm}^{-3} \times 50.0 \text{ cm}^3$  to calculate the heat change of the reaction in both experiments.

In part (b), some candidates were able to calculate the enthalpy of solution for anhydrous  $\text{CuSO}_4$  and  $\text{CuCO}_4 \cdot 5\text{H}_2\text{O}$  by calculating the number moles of anhydrous  $\text{CuSO}_4$  and  $\text{CuCO}_4 \cdot 5\text{H}_2\text{O}$  using the molar mass,  $M_{\text{rCuSO}_4} = 159.6 \text{ g mol}^{-1}$  and  $M_{\text{rCuCO}_4 \cdot 5\text{H}_2\text{O}} = 249.6 \text{ g mol}^{-1}$ . Some candidates were able to give the correct unit,  $\text{kJ mol}^{-1}$ , for the enthalpy of solution for both compounds.

In part (c), most candidates were unable to determine the enthalpy of the reaction. By using Hess's Law, the correct answer is as follows:

$$\Delta H_r = \Delta H_1 - \Delta H_2 = -62.3 - (+11.0) = -73.3 \text{ kJ mol}^{-1}$$

In part (d)(i) and (d)(ii), majority of the candidates were unable to write the equations for both reactions because they failed to sketch the cycle involving the chemical equations of aqueous copper(II) sulphate solutions from both anhydrous  $\text{CuSO}_4$  and  $\text{CuCO}_4 \cdot 5\text{H}_2\text{O}$  reagent as the starting materials.

In part (e), most candidates were unable to draw an energy cycle diagram by giving the balanced chemical reaction equations with the correct phases.

### Question 3

In part (a), most candidates were able to complete the table by giving the correct mass of para red which is 1.55 g.

In part (b), some candidates were unable to write the correct molecular formula of para red although its molecular structure is already given in the question. The number of carbon and hydrogen atoms was answered wrongly and the correct answer is  $\text{C}_{16}\text{H}_{11}\text{N}_3\text{O}_3$ .

In part (c), most candidates were unable to calculate the maximum mass of para red synthesised in the experiment because the number of moles of para red was wrongly calculated. By using the relative molecular mass of para red, then its maximum mass formed could be determined as shown below.

$$\text{Maximum mass of para red} = \left( \frac{1.00}{138.0} \right) \times 293 = 2.12 \text{ g}$$

In part (d), the percentage of para red could be determined by using the mass of para red calculated in (c). Unfortunately, most candidates failed to obtain the mark as the answer in (c) was wrongly calculated.

$$\% \text{ para red produced} = \left( \frac{1.55}{2.12} \right) \times 100 = 73.1\%$$

In part (e), only a few candidates were able to state the reason for the temperature to be maintained below 5°C in *Stage I*, that is to prevent the decomposition of 4-nitrobenzenediozonium chloride.

In part (f)(i), most candidates were unable to give the correct answer. In *Stage II*, an alkaline solution of 2-naphtol is used instead of its aqueous solution because it is used to dissolve the 2-naphtol and to obtain the soluble sodium salt.

In part (f)(ii), a few candidates were able to state the reaction mechanism involved in the synthesis of para red which is electrophilic substitution reaction.

In part (f)(iii), water is used instead of propanone to rinse the precipitate of para red because para red is insoluble in water but dissolves easily in propanone. Unfortunately, most candidates were not able to give the correct reason.

In part (g), majority of the candidates failed to answer the question correctly. In order to ensure purity of the para red obtained in this experiment, the melting point of the para red has to be determined.

In part (h), most candidates were unable to state that Buchner funnel is the suitable apparatus to filter the para red formed in *Stage II*.

# LAPORAN PEPERIKSAAN STPM & MUET 2020



**SASBADI SDN. BHD.** 198501006847

(Anak syarikat milik penuh Sasbadi Holdings Berhad 201201038178)

Lot 12, Jalan Teknologi 3/4, Taman Sains Selangor 1,  
Kota Damansara, 47810 Petaling Jaya, Selangor Darul Ehsan.

Tel: +603-6145 1188 Faks: +603-6145 1199

Laman web: [www.sasbadisb.com](http://www.sasbadisb.com) E-mel: [enquiry@sasbadi.com](mailto:enquiry@sasbadi.com)



**MAJLIS PEPERIKSAAN MALAYSIA**

Persiaran 1, Bandar Baru Selayang,  
68100 Batu Caves, Selangor Darul Ehsan.

Tel: +603-6126 1600 Faks: +603-6136 1488

Laman web: [www.mpm.edu.my](http://www.mpm.edu.my) E-mel: [ppa@mpm.edu.my](mailto:ppa@mpm.edu.my)