CHEMISTRY (962/1)

OVERALL PERFORMANCE

The number of candidates for this subject was 3 918. The percentage of candidates who obtained a full pass was 46.95%.

The achievement of candidates according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	6.25	4.87	8.32	9.93	5.18	5.82	6.58	3.55	10.31	3.93	35.25

RESPONSES OF CANDIDATES

SECTION A: *Multiple-Choice*

Answer Keys

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

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 of 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 isotopes of chlorine. In part (*a*), many candidates were able to describe the isotopes of chlorine. Some of the common mistakes made by the candidates were did not give the number of electrons, used the term neutron number instead of number of neutrons, and some of them answered $^{35}_{17}Cl$ has 18 nucleons instead of 18 neutrons.

In part (*b*), many candidates were able to calculate the ratio of $^{35}_{17}Cl$ to $^{37}_{17}Cl$ by using the relative atomic mass of Cl. Some candidates only show the correct ratio of 35-Cl : 37-Cl is equal to 3 : 1 without showing how they obtained the ratio.

In part (*c*), most of the candidates were unable to identify the parent ions of $CHCl_2CF_2OCH$. Most of them gave fragment ions as the answer due to their failure to understand the term parent ion.

Question 17

The question asked about reaction kinetics to test the knowledge of candidates in the deduction of rate constant. Write the rate law for the reaction and write the overall equation from two-step mechanism.

In part (*a*), many candidates were able to write the overall balanced equation but did not state the physical states or phases.

In part (*b*), majority of the candidates were able to identify the intermediate. Some of the candidates gave the answer as chlorine gas or Cl without its physical state.

In part (*c*), majority of the candidates were able to write the rate law for the given reaction with explanation. Some candidates were able to write the rate law for the equation but fail to give explanation.

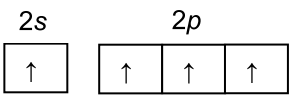
In part (*d*), most of the candidates were able to calculate the overall rate constant using the data given in the question. However, some candidates mistakenly wrote the symbol of the half-life as $T_{\frac{1}{2}}$ and did not round off the final answer as two significant figures.

Question 18

The question asked about the covalent bonding to test the candidates in the explanation of bonding in the molecule using the concept of hybridisation and overlapping orbitals, polarity of the molecule and their properties.

In part (*a*)(i), most candidates were able to draw either the Lewis structure or orbital overlapping of CCl_2F_2. Candidates were able to explain the formation of *sp*^{3} hybrid orbital of carbon which results in tetrahedral structure. Most candidates were also able to explain the formation of sigma bonds. The common mistakes made by the candidates in this part were as follows:

- Did not write the Lewis structure for the CCl_2F_2 molecule
- Did not give the excited state of the carbon atom as diagram below



- Did not state the geometry of CCl_2F_2 molecule
- Did not state the overlapping occured between the *sp*^{3} hybrid orbitals of carbon atom and the 2*p* orbital of fluorine atom and 3*p* orbital of chlorine atom respectively. Some candidates just mentioned orbital *p* for both Cl and F
- Did not state 4 sigma bonds are formed

In part (*a*)(ii), many candidates were unable to compare the electronegativity of carbon, fluorine and chlorine when explaining why the molecule is polar. Many thought that the molecule was non polar due to the canceling of dipole moment.

In part (*b*), most candidates were able to explain Na is a conductor due to it having mobile electrons. Most of them gave reason that solid NaCl contains no moving or mobile electrons instead of mobile ions. They also stated that Na has a metallic structure.

Question 19

The question asked about the states of matter that tested the ability of the candidates to explain the pressure and behavior of ideal gas using kinetic theory and to determine the mass by applying pV=nRT equation.

In part (*a*)(i), most candidates were able to state the conditions that enable gas to behave as an ideal gas with correct explanation.

In part (*a*)(ii), most candidates were unable to deduce the behaviour of gas based on the data provided. Candidates did not calculate either PV or PV/RT, thus failed to made deduction with proper explanation.

In part (*b*), many candidates were aware that pV=nRT equation is needed to calculate the number of moles of gas produced. However, the common mistakes made by the candidates in this part were as follows:

- Did not write the balance equation for the reaction
- Did not change the units of kPa and dm^3 to SI unit in the substitution of the gas equation
- Did not aware that the number of moles obtained is the number of moles of N_2
- Did not relate the number of moles of N_2 obtained to the number of moles of NaN_3 in the airbag

In part (*c*), most candidates were able to explain the observation of fullerene and diamond. The common mistakes made by the candidates in this part were as follows:

- Failed to state the giant covalent structure or strong covalent bonds in 3-dimensional network of diamond
- Failed to state the weak van der Waals forces in fullerene
- Wrong spelling of van der Waals for example, Var der Waals, van Der Waals, van Der waals and van der waals

Question 20

The question asked about solubility equilibria to test the knowledge in calculation of K_{sp} and apply the concept of solubility equilibria to describe industrial procedure for water softening.

In part (*a*)(i), majority of the candidates were able to write at the balanced equation and write expression of pOH and pH, and calculate the pOH and the pH. The common mistakes made by the candidates in this part were as follows:

- Did not put the physical states or reversible sign correctly in the solubility equation
- Failed to write the ratio of Mg^{2+} and OH^- produced
- Failed to calculate the concentration of OH^- produced
- Wrote the formula of pOH as $pOH=-lg[OH^-]$ instead of $pOH=-log[OH^-]$
- Did not write the formula $pH=14-pOH$ in their calculation
- Did not put the correct decimal places for the final answer of pH

In part (*a*)(ii), most of the candidates were able to calculate K_{sp} of $Mg(OH)_2$. The performance in this part is related to part (*a*)(i). Those who did well in (*a*)(i) could answer well in (*a*)(ii) and vice versa.

In part (*b*)(i), many candidates were unable to explain the concept of equilibria is used in the industrial process of water softening. Candidates were not aware that CO_3^{2-} is also present in hard water, hence they were unable to relate the common ion effect in the water softening process.

CHEMISTRY (962/2)

OVERALL PERFORMANCE

The number of candidates for this subject was 3 880. The percentage of candidates who obtained a full pass was 63.74%.

The achievement of candidates according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	5.80	5.88	7.89	8.25	11.08	12.24	12.60	5.98	2.84	5.70	21.75

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	B	**7**	A	**12**	B
3	A	**8**	A	**13**	D
4	C	**9**	A	**14**	D
5	B	**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 on concept of electrochemistry such as identify oxidation and reduction reaction from E° value, write cell notation and draw the electrochemical cell.

In part (*a*), most candidates were able to identify species that undergo oxidation.

In part (*b*)(i), most candidates were able to write redox equation for the reaction but some of them fail to write the balance equation and did not put the physical states for the species or wrongly assigned.

In part (*b*)(ii), many candidates calculated E°_{cell} but the answer did not include the positive sign and correct unit, V.

In part (*b*)(iii), most candidates were unable to write the complete cell diagram. They did not put inert electrode and the physical states of the species. The position of species for the cathode and anode also did not correct.

In part (*c*), most candidates were able to draw the electrochemical cells but they were unable to get full marks because the cell was not labelled cathode and anode, salt bridge and the electron flow in the diagram.

Question 17

The question asked about the general trend of boiling and melting point of elements in Period 3 of the Periodic Table and explain why elements have different melting points.

In part (*a*), many candidates were able to state the general trend of the melting and boiling point.

In part (*b*), most candidates were able to explain the reason of P, Cl and Ar have lower melting point and boiling point. Many of them explained P, Cl and Ar are simple covalent molecules instead of P and Cl are simple covalent molecules but Ar is monoatomic. The candidates also did not state van der Waals forces is a force between molecules/atoms respectively or these elements have weak intermolecular forces.

In part (*c*), many candidates were able to state the melting point and boiling point increases but did not relate the trend to the increasing metallic bond strength. However, they were able to state that the number of valence or delocalised electrons increases from Na to Al. Some candidates stated that it is due to ionic bond or covalent bond instead of metallic bond.

In part (*d*), many candidates were able to explain that Si has a giant covalent structure with strong covalent bond.

Question 18

The question asked about chemical energetics to test the knowledge on construction of energy cycle and calculate the enthalpy of solution of *Y*Cl. Candidates also required to compare the solubility of two ionic solids in water. Candidates also needed to calculate the standard enthalpy of combustion of magnesium.

In part (*a*)(i), most candidates were able to draw energy cycle and label the hydration energy, lattice energy and enthalpy of solution on the diagram and then calculate the enthalpy of solution of *Y*Cl. Instead of using Hess' law, some candidates use the following expression to calculate ΔH_{sol} of *Y*Cl.

$$\begin{aligned}\Delta H_{\text{sol}} &= \Delta H_{\text{H.E}} - \Delta H_{\text{L.E}} \\ &= [(-473)+(-378)] - (-916) \\ &= +65\ \text{kJ mol}^{-1}\end{aligned}$$

However, some candidates were unable to answer correctly because of the cycle is not labelled correctly. They also did not put the physical states for the species or wrongly assigned on the cycle. They did not put positive sign for the enthalpy of solution of *Y*Cl and did not give the final answer in correct significant figures.

In part (*a*)(ii), many candidates were able to state that *X*Cl is soluble in water because its ΔH_{sol} is exothermic while *Y*Cl is insoluble because its ΔH_{sol} is endothermic. Most of the candidates gave the general explanation by relating the hydration and lattice energy. They were explaining the solubility of the ionic solids in water by using terms more soluble or higher solubility and that is not accepted.

In part (*b*)(i), most candidates were able to give the correct meaning of standard enthalpy of combustion.

In part (*b*)(ii), most candidates were able to write the thermochemical equation for the combustion of magnesium and calculate the standard enthalpy of combustion based on the data given by using this equation, $\Delta H = -q/n$, where n = (5.24/24.3)+16.0 = 0.130 mol and q = –78.3 kJ. The final answer is $\Delta H = -602$ kJ mol^{-1}. Many candidates fail to get full marks because of they did not put negative sign to indicate heat released. They also did not give the final answer in correct significant figures and did not write the physical states for the species or wrongly assigned in the thermochemical equation.

Question 19

The question asked about Group 14 of the Periodic Table. The candidates were required to explain the differences in melting points of carbon and lead. The candidates also required to explain the polarity of CCl_4 and the properties of silicon as semiconductor.

In part (*a*), only few candidates were able to explain the difference of melting point between carbon and lead by relating their structure, size and strength of bond correctly. Many candidates explained using general term, wrong name of structure and name of bonding between carbon atoms and lead atoms. Most candidates did not compare the strength of covalent bond and the metallic bond. The metallic bond in this situation is weaker than covalent bond because the atomic size of lead is large and lead only uses two valence electrons in bonding.

In part (*b*), some candidates were able to explain correctly the polarity of CCl_4 where they mentioned CCl_4 is non polar with tetrahedral shape in which carbon form 4 covalent bonds with chlorine atoms. C–Cl bond is polar but the dipole moment is cancelled due to the symmetrical shape of CCl_4. Many candidates were unable to state the C–Cl bond is polar because Cl is more electronegative than C and bond dipoles cancel out one another.

In part (*c*), many candidates were able to state the silicon is semimetal or metalloid, with small energy gap in between valence and conduction band where the electron is promoted from valence band to conduction band when heated and the conductivity of silicon can be increased by doping or increasing the temperature. However, majority of the candidates did not mention the process occur at high temperature and the electrons get excited from the valence band to the conduction band.

Question 20

The question asked about the properties of Group 17 of the Periodic Table. Candidates required to compare the volatility of group 17 elements down the group. Candidates also required to write the chemical equations and explain the reaction between sulphuric acid with magnesium chloride and magnesium bromine respectively. Candidates also need to describe the reactions of chlorine, bromine and iodine with hydrogen respectively.

In part (*a*), some of the candidates were able to relate the low volatility of halogen to the increase in the molecular size and van der Waals forces going down the group. Many candidates made mistakes by not giving specific terms to relate size and intermolecular forces.

In part (*b*), most candidates were able to identify the white fume as HCl while the reddish brown gas is Br_2 and concentrated H_2SO_4 is able to further oxidize HBr to Br_2. Only a few candidates managed to give the correct equations for the reaction taken place. Some candidates gave wrong explanation for the observation, equation given are not balanced and wrong formulae of products.

In part (*c*), a few candidates were able to describe the reactivity of the reaction of chlorine, bromine and iodine with hydrogen. However, there were candidates gave the correct answers, which is Cl_2 reacts vigorously in the presence of sunlight or ultraviolet light or slowly in the dark, Br_2 reacts in the presence of a catalyst and heated or at high temperature (T is 2000 °C or more 2000 °C), while I_2 reacts very slowly or partially or reversibly with heating (T is 3000 °C or more 3000 °C) in the presence of a catalyst (Pt, Ni, Pd).

CHEMISTRY (962/3)

OVERALL PERFORMANCE

The number of candidates for this subject was 3 851. The percentage of candidates who obtained a full pass was 44.47%.

The achievement of candidates according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	6.41	4.73	5.06	5.32	7.19	9.61	6.15	5.56	5.09	3.53	41.39

RESPONSES OF CANDIDATES

SECTION A: ***Multiple-Choice***

Answer Keys

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

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 and 17. The answers for 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 and wrote the synthetic pathway in schematic form. However, many candidates showed a general weakness in IUPAC naming of compound, writing mechanism and writing 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 about haloalkene.

In part (*a*), many candidates were unable to state the type of reaction correctly. Some candidates wrote nucleophilic addition, nucleophilic substitution, elimination as the answer instead of unimolecular nucleophilic substitution or S_N1. Some of them wrote S_N1 wrongly such as SN1.

In part (*b*), most candidates were unable to write the IUPAC nomenclatures of simple alkyl halide. However, some candidates named the alkyl halide as 2-methyl-2-bromoalkane or 1,1-methylbromoalkane.

In part (*c*), most candidates were able to draw the structural formula of *X*. Most of them drew alcohol instead of ether as product. A few candidates stated the symbol [O] in the oxidation equations which was not accepted.

In part (*d*)(i), most candidates were unable to give the reason why dry ether is used in the formation of Grignard reagent.

In part (*d*)(ii), most candidates were able to identify the reagent and condition for the formation of 2-butanol from respective Grignard reagent. Some candidates wrote alcohol in step 1 and strong acid in step 2.

In part (*d*)(iii), many candidates were able to give the usage of chloroalkane as refrigerants, aerosol propellants, solvents or pesticide. However, there were candidates that gave medicine as the answer.

Question 17

The question tested about carboxylic acids and their derivatives.

In part (*a*), most candidates were able to draw the correct structural formulae for methyl butanoate.

In part (*b*)(i), most candidates were able to identify *P as* butanoic acid and *Q* as methanol.

In part (*b*)(ii), many candidates were able to name the product formed. Some candidates gave wrong spelling, for example buthanyl chloride, buthanoyl chloride, buthyl chloride.

In part (*c*)(i), majority of the candidates were able to state the compound. Many candidates gave ethanamine or $CH_3CH_2NH_2$ as the answer. Some of them stated ethanamide instead of ethanamine.

In part (*c*)(ii), many candidates were able to write the chemical equation of an acid chloride (butanoyl chloride) with amine (ethanamine) to form *N*-butylbutanamide. Some of the candidates wrote butanoic acid, instead of butanoyl chloride that reacted with amine to form an amide.

In part (*d*), many candidates were able to compare the solubility of methyl butanoate and *P*. However, they failed to give correct reason why *P* is more soluble than methyl butanoate. Majority of candidates gave the reason *P* forms hydrogen bonds whereas methyl butanoate forms hydrogen bond. Therefore, methyl butanoate is insoluble in water.

Question 18

The question tested the application of free radical substitution reaction in alkanes to alkyl part of the alkene.

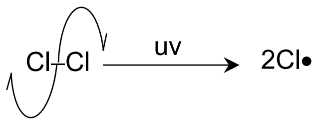
In part (*a*), most candidates were able to draw the structures of *P*, *Q* and *R* correctly based on the information given in the question but not *S* and *T*. Some candidates were able to draw structures of *S* and *T* as alkanes, but *S* as methylcyclopropane and *T* as cyclobutane. Many candidates were unable to extract the information that *S* gives a monochlorinated product upon chlorination.

In part (*b*), majority of the candidates were unable to write the equation for the formation of *U* and *V*. Candidates were unable to identify or relate the alkyl part of an alkene that undergoes free radical substitution. Thus, they did not write the correct reaction equation with correct reagent and reaction conditions. Most candidates explained the formation of major product according to Markonikov's rule and the reaction occurred via electrophilic addition reaction instead of via free radical substitution reaction.

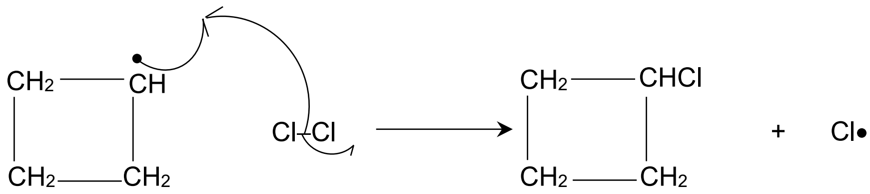
In part (*c*), most candidates were unable to give the reason why *S* produces one monochlorinated product which was due to equivalent hydrogens or hydrogen in the same environment.

In part (*d*), most candidates were unable to draw the reaction mechanism for the formation of *W*, for example free radical substitution mechanism. The common mistakes made by the candidates in this part were as follows:

- Did not use the curly arrows when writing mechanism
- Used full headed arrows instead of single headed arrows which is used for free radical substitution mechanism as shown below



For formation of bond, the single headed arrow should be used in writing the mechanism as below



- Did not state ultraviolet or uv light in the initiation step
- Gave the wrong intermediates, for example carbocations instead of free radicals
- Mentioned wrongly that both free radicals and carbonium ions formed in the same mechanism

Question 19

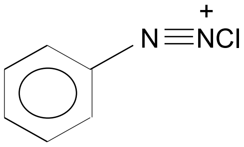
The question tested about hydroxyl compounds and amines.

In part (*a*), most candidates were unable to write the correct synthetic pathway for the formation of butanol from propene. Most candidates were able to write the correct intermediate, $CH_3CH_2CH_2X$, and the reactions proceeded from $CH_3CH_2CH_2X$ onwards. Candidates answered the preparation of butanol from propene starting from oxidation of propene, ozonolysis of propene and reaction of propene with bromine water. The reaction of HBr in the presence peroxide was not taught in some schools, even though the reaction alkene with H*X* is in the syllabus. For the reduction of intermediate $CH_3CH_2CH_2COOH$ to butanol, many candidates wrote $LiAlH_4$ and H^+ /H_2O together instead of two separate steps i.e. (i) $LiAlH_4$ as the first step and (ii) H^+/H_2O. Both steps can be written on the arrow. Candidates answered the synthetic pathway in stepwise reactions or individual reactions. Some candidates wrote the synthetic pathway from butanol to propene.

In part (*b*), most candidates were able to draw the structural formulae of *X*, *Y* and *Z.* Candidates also able to write the equations for the formation of diazonium salt and formation of azo dye.

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

- Put the positive sign on the wrong nitrogen for structural formula of *Y* such as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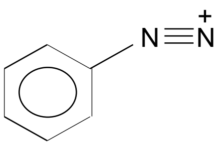
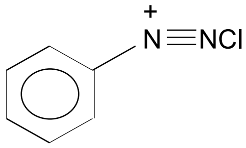

or

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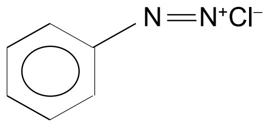
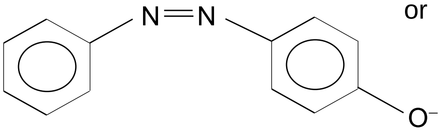


- Gave the wrong structural formula of *Z* such as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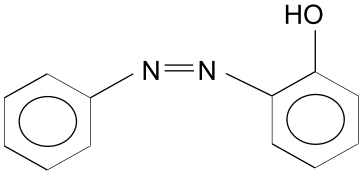
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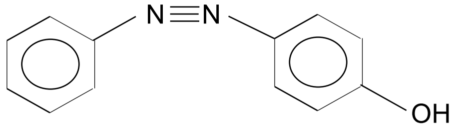


- Did not put temperature when writing the equation for the formation of *Y*
- Wrote phenol instead of phenoxide ion or phenol in NaOH in the formation of *Z*
- Did not put ^{-}OH or NaOH(aq) in the equation for the formation of *Z*
- Wrote the reaction produces compound *Z* as nucleophilic addition/nucleophilic substitution/electrophilic aromatic substitution instead of coupling reaction

Question 20

The question tested about carbonyl compound that involves ketone and aldehyde.

In part (*a*), most candidates were able to identify compounds *A*, *B* and *C*. Many of them gave wrong ketone *A*, thus gave wrong structural formulae of *B* and *A* as aldehyde.

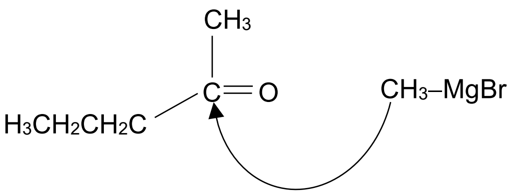
In part (*b*), many candidates were able to state the reagent and condition for the elimination and ozonolysis reactions. Most of them stated H_2SO_4, heat, instead of H_2SO_4, 170 – 180 ^{o}C for elimination reaction. For ozonolysis, many candidates gave reagent as O_3 in CCl_4, O_3 in CH_2Cl_2 and O_3 in acid, and the condition is hydrolysis.

In part (*c*), majority of the candidates were unable to write the mechanism for the formation of *B*. Candidates failed to use arrows when writing the mechanism. They were unable to identify the nucleophilic part of the Grignard reagent and did not show the formation of product using curly arrows.

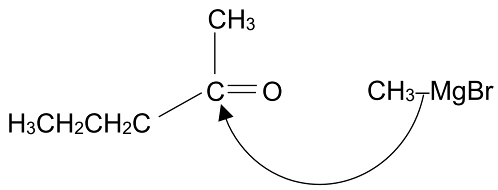
The common mistakes made by the candidates in this part were as follows:

- Did not recognise the nucleophilic part of the Grignard reagent
- Drew arrow started from C atom of Grignard reagent to the C atom of carbonyl

  group as shown in the structure below



The correct arrow as shown in the structure below



- Alkoxide ion and $^{+}MgBr$ were not written together in the intermediate
- Stated H^+ as the species to accept electron instead of H_3O^+

In part (*d*), majority of candidates were able to give correct pair of Grignard reagent and ketone which are $CH_3CH_2CH_2MgBr$ and CH_3COCH_3. However, some candidates gave CH_3CH_2MgBr and $CH_2CH_2COCH_3$ as the answer.

In part (*e*), most candidates were able to suggest a chemical test to differentiate propanal from propanone. However, they make mistakenly gave the wrong spelling for the name of reagent. They wrote Tollen's reagent instead of Tollens' reagent and Felling's test instead of Fehling test. They also wrote the negative observation as no observable reaction and no reaction instead of no observable change.

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), most candidates were unable to name *P* as a 250 ml volumetric flask.

In part (*a*)(ii), some candidates were unable to explain why the beaker and the glass rod were rinsed thoroughly and all the rising water then, should be poured into the 250 ml volumetric flask.

In part (*b*)(i), majority of the candidates were able to determine the number of electrons transferred in the reaction given.

In part (*b*)(ii), majority of the candidates were unable to give the reason for the need of freshly prepared I_2 solution in the titration.

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

In part (*c*), most candidates made mistakes in this part where they gave a value of the I_2 volume with only one decimal place rather than two decimal places as shown in the table. For example, volume of I_2 solution used in cm^3 was given as 23.8 instead of 23.80 in the table.

In part (*d*), most of the candidates were able to calculate the average titre.

$$Average\ titre = \left(\frac{23.80 + 23.60 + 23.60}{3}\right) = 23.67$$

In parts (*e*) and (*f*), generally, 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 and the mass of ascorbic acid, $C_6H_8O_6$, in (*e*) and (*f*).

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 ascorbic acid, $C_6H_8O_6$, which is supposed to be 25 cm^3 which was pipetted in the conical flask for the titration.

In parts (*g*) and (*h*), majority of candidates mistakenly used the value calculated in part (*f*) as the mass and then calculated wrongly the percentage of unoxidised ascorbic acid in the tablet.

Question 2

In part (*a*), majority of the candidates were unable to name rheostat as the apparatus used to maintain a steady electric current of 1.00 A in the experiment, involving the electrolysis of dilute sulphuric acid.

In part (*b*) and (*c*), most candidates were unable to give the correct reason why H_2SO_4 was used as an electrolyte which is to increase the electrical conductivity of the solution, and oxygen gas as the gas produced at the anode in the experiment.

In part (*d*), majority of the candidates wrongly stated the Faraday's first law of electrolysis. Supposedly they should mention that the amount of a substance produced during electrolysis is directly proportional to the quantity of electricity.

In part (*e*), most candidates were able to determine the electrical charge, *Q*, used in the experiment by using *Q* = *It* = (1.00) x (20.0 minute x 60 second) = 1200 C.

Some candidates wrongly calculated the value of *Q* because the time was calculated in minutes.

In part (*f*), majority of the candidates were unable to determine the number of electrons that carries the electrical charges, Q because they multiply the value calculated in (*e*) with 1.60×10^{-19} C.
The correct answer, no. of electrons = $\frac{1200C}{1.60 \times 10^{-19}} = 7.50 \times 10^{21}$ e

In part (*g*), majority of the candidates were unable to answer parts (*g*), (*h*) and (*i*) because they mistakenly wrote the half-equation reaction at the anode. The half-equation for the oxidation reaction of water occurred at the anode, involving production of oxygen gas as given below.

$$2H_2O \rightarrow O_2 + 4e + 4H^+$$

Volume of O_2 gas collected = 40.25 – 2.00 = 38.25 cm^3;

Therefore, moles of O_2 = $\frac{38.25\ cm^3}{24400\ cm^3} \times 1\ mol = 1.57 \times 10^{-3} mol$

From the equation, 1 mol $O_2 \equiv 4\ e^-$;

Therefore, the required number of electrons to produce the gas collected,

$$= \frac{1.57 \times 10^{-3}}{1\ mol\ O_2} = 6.28 \times 10^{-3} e$$

In part (*j*), the Avogadro's number, L = $\frac{\text{Number of electrons}}{\text{Number of moles}} = \frac{7.50\times10^{21}}{6.28\times10^{-3}} = 1.19 \times 10^{24}$.

In part (*k*), some candidates were able to answer this part by stating there is no effect of doubling H_2SO_4 concentration on the volume of gas released. The quantity of O_2 produced depends on the value of *Q*.

Question 3

In part (*a*), most candidates were unable to identify gases *A*, *B* and *C*. Gas *A* is hydrogen gas, gas *B* is ammonia and gas *C* is carbon dioxide.

In part (*b*), some candidates were unable to write the correct observations that could be seen at *P*, *Q* and *R.* Compound *Y* was an aldehyde which reacted with 2,4 dinitrophenylhydrazine to produce white precipitate. *Q*, Cu_2O was red precipitate when aldehyde, *Y*, reacted with Fehling's solution. Compound *Z* was butanoic acid, therefore, the litmus solution turned red.

In part (*c*), some candidates were able to correctly state the functional groups in *X*, *Y* and *Z*.

In part (*d*), most of the candidates were able to give two possible structural formulae of *X* which are alcohols.

In part (*e*), most candidates were able to state one physical properties of *S* which is ester, either fruity smell or insoluble in water.

In part (*f*), most candidates were able to state one precautionary step when using Na in the experiment, either using a small portion or chip of sodium, or by using a pair of tongs to hold the sodium.

In part (*g*), majority of the candidates were unable to state the reagent and observation for one simple test that confirms gas *D* which was butene.

Therefore, bromine water or acidified $KMnO_4$ could be used as the reagent. And the observation was either orange to colourless or purple to colourless.