Chemistry (962)

OVERALL PERFORMANCE

The number of candidates for this subject was 8013. The percentage of candidates who obtained a full pass was 74.17%, with an increase of 1.93% compared to the result of the previous year.

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

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	6.96	7.24	8.63	10.63	12.53	13.64	14.54	5.95	4.60	4.87	10.41

RESPONSES OF CANDIDATES

PAPER 962/1 (MULTIPLE-CHOICE)

Keys

Question number	Key	Question number	Key	Question number	Key
1	**B**	18	**A**	35	**A**
2	**C**	19	**B**	36	**A**
3	**A**	20	**C**	37	**B**
4	**A**	21	**D**	38	**B**
5	**D**	22	**D**	39	**A**
6	**A**	23	**A**	40	**D**
7	**C**	24	**C**	41	**B**
8	**D**	25	**C**	42	**D**
9	**D**	26	**A**	43	**B**
10	**A**	27	**C**	44	**B**
11	**D**	28	**C**	45	**A**
12	**A**	29	**D**	46	**C**
13	**D**	30	**D**	47	**D**
14	**–**	31	**B**	48	**D**
15	**C**	32	**D**	49	**C**
16	**C**	33	**B**	50	**B**
17	**A**	34	**A**		

General comments

The mean score was 30.33 and there was a very good spread of scores with a standard deviation of 9.89. Questions 1, 22, 29, 32, 36, 42, 46, 47 and 48 were very difficult for the candidates as less than 30% of candidates obtained correct answers. For questions 4, 8, 10, 19, 23, 26, 27, 31, 37, 28 and 41, at least 60% of the candidates answered correctly.

PAPER 962/2 (STRUCTURE AND ESSAY)

General comments

This paper tested the candidates' knowledge and understanding of important aspects of the Chemistry in the STPM level. The overall standard achieved by candidates was better than that of last year. There were many candidates who answered all the questions, demonstrating sound knowledge and a good understanding of the chemistry examined in this paper. Overall, the answers given showed a continuing improvement in the quality of candidates' performance with most candidates being able to demonstrate some positive achievement with a mean of 35.87 and a standard deviation of 18.06.

Comments on the individual question

Question 1

In part (*a*)(i), most candidates were able to write the meaning of the term *isoelectronic*. However, some candidates were unable to mention the word elements, particles, spesies or ions that have the same number of electrons. Some candidates misunderstood the number of electrons as electron number. A significant number of candidates wrote they are having the same number of valence electrons.

In part (*a*)(ii), most candidates were able to identify Cl^- and S^{2-} ions as isoelectronic.

In part (*a*)(iii), many candidates correctly arranged the ions in order of increasing size, but failed to explain their answers correctly. Some candidates mention about nuclear charge instead of effective nuclear charge for the difference in sizes of the Cl^- and S^{2-} ions. They also did not compare the number of electrons in the inner shells of O^{2-}, Cl^- and S^{2-} ions.

In part (*b*)(i), most candidates were able to explain that the boiling point increases from Na to Al due to the presence of metallic bonding, but only good candidates could relate the strength of metallic bonds with the number of valence electrons involved in the formation of the metallic bonds.

In part (*b*)(ii), most candidates were able to state that Si has a giant covalent structure with strong covalent bonds between the atoms. A few candidates wrongly stated that Si has the highest melting point because of the stronger van der Waals forces between its atoms.

In part (*b*)(iii), almost all candidates could not answer this part correctly. A majority of the candidates just mentioned about Ar having the van der Waals forces between its atoms and failed to mention about similar magnitudes of the forces in both solid and liquid phases.

Question 2

In part (*a*)(i), most candidates were able to state the type of bonding present in lead(II) chloride as ionic bonding.

In part (*a*)(ii), most candidates were able to state the substance which conducts electricity as sodium or lead(II) chloride.

In part (*a*)(iii), most candidate were able to state that hydrogen bromide and methane are gaseous at room temperature and atmospheric pressure.

In part (*a*)(iv), most candidate were able to explain why methane and silicon dioxide showed a significant difference in boiling points. This is because methane is a simple covalent molecule with weak intermolecular van der Waals forces whereas silicon dioxide is a giant covalent molecule with strong covalent bonds between its atoms.

In part (*b*)(i), a majority of candidates did not know how to draw the Lewis structure of SO_3^{2-} ions. A common error made by the candidates was to show the number of lone pair electrons exceeding the octet configuration of the sulphur atom.

In part (*b*)(ii), most candidates were able to state the shape of the sulphite ion as trigonal pyramidal.

In part (*b*)(iii), some candidates just explained the existence of a lone pair electrons in SO_3^{2-} ions, but not in SO_3 molecule, and they did not explain the effects of the lone pair electrons on the bond angle. The presence of the lone pair electrons causes the repulsion between the lone pair electrons and the bonding pair of electrons to be greater, and hence, causes the O–S–O bond angle to become smaller.

In part (*b*)(iv), majority of candidates were able to state the effect of acid rain on the environment such as removing nutrients from the soil.

Question 3

In part (*a*)(i), most candidates failed to write the equation for the thermal decomposition reaction of $Ba(NO_3)_2$ as

$$2Ba(NO_3)_2 \rightarrow 2BaO + 4NO_2 + O_2$$

In part (*a*)(ii), many candidates failed to get any marks for this section as they only compared the size of atoms but not cations. In explaining the thermal stability of barium nitrate as compared to magnesium nitrate, candidates should emphasise the difference in ionic size of Ba^{2+} ion which is larger than that of Mg^{2+} ion, and thus, the polarising power of Ba^{2+} ion is weaker than that of Mg^{2+} ion.

Part (*a*)(iii), was poorly answered. Most candidates were unable to state the observation when barium oxide dissolves in water and does not give the approximate value of the pH of the solution formed which should be at least 12 or greater. Many candidates did not state that magnesium oxide dissolve sparingly in water and the pH of the solution formed should be between 8 to11.

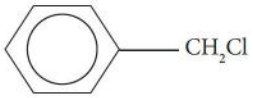
In part (*a*)(iv), many candidates were able to arrange the reactivity of organic halides in order of increasing reactivity as CH_3Cl, CH_3Br and CH_3I. Some candidates lost marks for explaining the bond length of CH_3Cl, CH_3Br or CH_3I instead C–Cl, C–Br, or C–Cl and the sizes of CH_3Cl, CH_3Br or CH_3I instead of Cl, Br or I.

Question 4

In part (*a*)(i), a majority of candidates could not write the structural formulae of compounds *A* to *F* correctly. There were candidates who obtained the compounds with the correct functional groups but with the wrong number of CH_2 group or double bond in the middle of the compounds. Some candidates gave the formula of the organic compounds of *B*, *C*, *D* and F with only one of the functional group (at one side) changing correctly while the functional group on other side remains the same.

In part (*a*)(ii), many candidates lost a mark when they were not careful when they wrote the functional group of the polymer. They either lost one of the oxygen atom or they add one or two more of the CH_2 group.

In part (*b*)(i), many candidates were able to write the structure of *J* as shown below.



In part (*b*)(ii), a few candidates were able to state the reagent and reaction condition for Step I, but almost all candidates failed to state the reaction condition for Step II that is "excess". A majority of candidates gave the answer as "heat".

In part (*b*)(iii), although some candidates were able to state the reagent for the chemical test correctly as HNO_2, but they failed to state the reaction condition that is 0 °C to 5 °C or < 5 °C.

Question 5

In part (*a*), many candidates knew how to write the correct electronic configuration of *L* as $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$. Some candidates explained how each of the orbital *s*, *p* and *d* was filled by explaining the filling of orbital 3*d* and 4*s*. Very few candidates mentioned about the maximum number of electrons to be filled in the *s*, *p* and *d* orbitals as 2, 6 and 10 respectively. Generally, the rules and principles used to fill up electrons into the orbital were mentioned correctly, but were not explained accurately. In the Aufbau principle, the candidates usually stated *lower* energy orbital is filled first instead of *lowest* energy orbital is filled first. However, in Hund's rule, the term *degenerate* orbital was often left out. Common mistakes made by candidates were in the spelling of the word Aufbau and a few candidates substituted the word exclusion in Pauli's Exclusion Principle with words like exclusive, excursion, repulsive and others.

In part (*b*), most candidates were able to answer this part correctly. They stated that *L* is a good conductor, but failed to state that it is a transition metal; silicon is a metalloid, but failed to state that it is a semiconductor. Most candidates did not explain correctly the difference in the energy gap between the valence band and the conduction band in silicon and compound *L*. They failed to explain the effect of the increasing temperature on the electrical conductivity of both elements.

Question 6

In part (*a*), most candidates were able to answer this part correctly. However, quite a number of candidates lost their marks for excluding [HCl] from the rate equation. Many candidates did not know that HCl plays a very important role in the reaction and should be considered in the rate of reaction.

Part (*b*) and (*d*) were generally well answered. Those candidates who were penalised usually failed to give the answer to the correct significant figures and unit.

In part (*c*), most of the candidates were able to answer this part correctly by stating HCl as a catalyst and it lowers the activation energy so that the rate of reaction increases.

Answers: (*b*) 0.021 $mol^{-1}\ dm^3\ s^{-1}$; (*d*) 0.70

Question 7

In part (*a*), most of the candidates who answered this question were unable to answer this part correctly. Very few candidates managed to write the equation

$$Ag^+ + X^- \rightarrow AgX.$$

Some candidates calculated the number of moles of $AgNO_3$ without relating it to the number of moles of X^-. There were a number of candidates who were penalised when they failed to give the answer to the

correct significant figures. A few candidates were able to deduce the correct identity of the halide ion and the formula of PX_3, but they failed to write the equation of the reaction.

In part (*b*), a majority of the candidates who answered this question were able to deduce the relative strength of halogens as oxidising agents, but some candidates failed to relate the oxidising power to the positive value of standard reduction potentials. Some candidates lost marks for giving the oxidising power of atoms not molecules of Cl_2, Br_2, and I_2. Most candidates failed to explain the increase in the relative strength of halogens as oxidising agents going down Group 17 is due to the increase in atomic size, decrease in electronegativity and increase in screening effect.

In part (*c*), very few candidates stated that the electrolysis reaction at the anode produces chlorine gas while at the cathode produces hydroxide ion. The chlorine gas diffuses into the cathode and undergoes disproportionation reaction with the hydroxide ion to produce M which is NaOCl. Only good candidates were able to give the correct equation as follows:

$$Cl_2 + 2OH^- \rightarrow Cl^- + ClO^- + H_2O$$

Question 8

Part (*a*) was poorly answered by a majority of the candidates. They knew that the oxides are CO and CO_2 which have neutral and acidic properties respectively. However, they failed to state that CO is insoluble in water while CO_2 is soluble in water to form H_2CO_3, which is a weak acid.

In part (*b*), a few candidates were able to define the term catenation correctly. A majority of the candidates were unable to explain why carbon has a higher tendency to catenate as compared to lead. Most candidates explained the different strength of C–C bond with C–O bond and the bond strength of Pb–Pb bond with Pb–O bond without comparing the bond strength of C–C bond with Pb–Pb bond.

In part (*c*), most candidates knew that Sn and Pb are able to form complex ions because they have an empty *d* orbital, but very few candidates could mention that Sn and Pb are able to accept lone pair electrons from Cl^- or a ligand to form octahedral complex. In addition, most candidates knew that carbon cannot form a complex because it has no *d* orbital, but a common mistake made by candidates was stating that carbon has no empty *d* orbital.

Question 9

In part (*a*)(i), most candidates could not get full marks for this part. A majority of the candidates failed to relate the quantitative data given in the question to deduce the structural formula of *R* which is a dibasic acid with formula molecule, $C_6H_{10}O_4$. As a result, they failed to write the structural formulae of compound *P* and *Q*.

In part (*a*)(ii), most candidates were able to give the right answer as dehydrohalogenation or elimination reaction.

In part (*a*)(iii), most candidates were able to state one industrial use of compound *R*.

In part (*b*)(i), most candidates were not able to give the correct reagents and reaction conditions for the conversion of benzene and propene to phenol and propanone respectively in the three steps reactions. A majority of the candidates were not able to state two economic importance of the process such as the availability of raw materials from petroleum industry and the usefulness of the side products produce as a solvent. Most candidates stated the economic importance as cheap and starting material easily available or reactants can be recycled.

In part (*b*)(ii), a few candidates stated that phenol is used to make dettol.

Question 10

In part (*a*), most candidates were able to write the structural formulae of compounds *U*, *V*, *W*, *X*, *Y* and *Z*.

In part (*b*)(i), most candidates knew that urea is a base but a majority of the candidates did not know that compound *Y* is a neutral compound. Good candidates were able to write the equation to prove that urea is a basic compound as shown below.

$$H_2NCONH_2 + H_2O \rightleftharpoons H_2NCONH_3^+ + OH^-$$

In part (*b*)(ii), most candidates were able to state that urea is more soluble in water than compound *Y* (CH_3CONH_2). The candidates were aware that solubility is due to hydrogen bond, but only good candidates were able to state that urea is a polar molecule. The candidates also lost a mark when they drew the structure of urea forming less than three hydrogen bonds with water molecule.

PAPER 962/4 (WRITTEN PRACTICAL TEST)

General comments

In general, the candidates performed quite well in all three questions. All the answers given were straightforward or partly structured. Greater familiarity with experimental techniques would be of benefit to all candidates.

Comments on the individual question

Question 1

In part (*a*), many candidates were unable to suggest a suitable flask that can be used to prepare the standard solution of sodium hydroxide which is a 250 cm^3 volumetric flask.

In part (*b*), only better candidates managed to answer this part correctly.

In part (*c*)(i), instead of stating *pipette* being used to transfer a standard solution of sodium hydroxide into a titration flask, most candidates mentioned burette, sucker, conical flask, or boiling tube. Only better candidates were able to explain that the remaining solution left at the tip of the apparatus can be transferred into the titration flask by touching the tip of the pipette to the side or bottom of the titration flask.

In part (*c*)(ii), many candidates were unable to write the equation for the common acid-base reaction as follows:

$$C_nH_{2n+1}COOH + NaOH \rightarrow C_nH_{2n+1}COONa + H_2O$$

They failed to realise that the organic acid *G* comprises of $C_nH_{2n+1}COO^-$ and H^+ whereas NaOH contains Na^+ and OH^- and changing the partners will lead to the products.

In part (c)(iii), only good candidates were able to answer this part correctly. The candidates did not realise that this is a simple acid-base reaction and the stoichiometric coefficients of the reactants is 1.

In part (*c*)(iv), only a few candidates were able to think that they need to know the molecular weight of the acid *G* first in order to know the value of *n* in $C_nH_{2n+1}COOH$. Most candidates gave the identity of acid *G* by guessing without showing all the working either by formulae or names such as butanoic acid, propanoic acid, carboxylic acid, $C_5H_{11}COOH$, sodium chloride, ethanoic acid and others. Acid *G* is an ethanoic acid, CH_3COOH.

Answers: (*b*) 5.0 g; (*c*)(iii) 0.40 mol dm^{-3}.

Question 2

In part (*a*)(i), only a few candidates were able to give a suitable aqueous solution of *J* as copper(II) sulphate or copper(II) nitrate or copper(II) chloride.

In part (*a*)(ii), good candidates were able to state that *K* is the anode while *L* is the cathode.

In part (*a*)(iii), only a few candidates were able to deduce that the mass of the electrode labelled *K* decreases.

In part (*b*)(i), very few candidates were able to state why the cathode should be washed with propanone that is to remove the electrolyte or to clean it.

Part (*b*)(ii) was generally well answered by most candidates. They knew that the concentration of Cu^{2+} aqueous solution remains the same or unchanged.

In part (*c*)(i), majority of the candidates were able to answer this part correctly. The candidates were able to calculate the quantity of electricity using the formula $Q = It$.

In part (*c*)(ii), although the question asked the candidates to plot a graph of the mass of copper deposited against the quantity of electricity, there were a few candidates who plotted the graph wrongly.

In part (*c*)(iii), most candidates were able to deduce the relationship between the quantity of electricity against the mass of copper deposited as $m \propto Q$.

Question 3

This question enabled many candidates to get relatively higher marks. The candidates were able to get the correct answers to all parts of the question by referring to the information given in the tables.