Chemistry (962)

OVERALL PERFORMANCE

The number of candidates for this subject was 7857. The percentage of candidates who obtained a full pass was 74.11%, decrease of 0.06% compared to the results 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	6.57	7.06	9.71	10.62	13.74	11.75	14.66	4.55	6.89	4.45	10.00

RESPONSES OF CANDIDATES

PAPER 962/1 (MULTIPLE-CHOICE)

Keys

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

General comments

The mean score was 28.26 and there was a very good spread of scores with a standard deviation of 9.29. Questions 8, 21, 37, and 40 were very difficult for candidates as less than 30% of them obtained correct answers. Questions 1, 2, 24, and 26 were easy to candidates because 70% to 80% of them could answer the questions. The rest of the questions were of average difficulty to candidates.

PAPER 962/2 (STRUCTURE AND ESSAY)

General comments

This paper tested the candidates' knowledge and understanding of the important aspects of Chemistry in the STPM level. The overall standard achieved by candidates was about the same as last year. There were many candidates who answered all the questions which are not required of them, although it demonstrated sound knowledge and a good understanding of the chemistry examined in this paper. The achievement of the candidates is at a mean of 43.29 and standard deviation of 21.85.

Comments on the individual question

Question 1

In part (*a*), many candidates were not able to determine Δv. They also showed poor ability in plotting the graph. Among the mistakes made by the candidates were mixing up the axes, mislabelling or not labelling the axes and not using a scale that is easy to read. Many candidates did not know the expression for calculating the ionisation energy of hydrogen atom. Instead of ΔE, a few of them wrote ΔH as the symbol for the ionisation energy.

In part (*b*)(i), some candidates could not draw a simple orbital overlapping diagram for the hydrogen molecule. For part (*b*)(ii), many candidates gave the answer as single/simple/hydrogen bond instead of sigma bond. They used *p* orbital to form the sigma bond in hydrogen.

Question 2

In part (*a*), some candidates could explain the trend in the acid-base properties of the oxides that is from basic to acidic because the oxide changes from ionic to covalent across the period. Some candidates gave the answer as acidic to basic and they did mention the oxides became more covalent, but did not explain that the oxides changes from metallic to non-metallic across Period 3.

In part (*b*), many candidates correctly explained that an amphoteric compound is one that is able to react with both acids and alkalis/bases. A few candidates used the term soluble or dissolve instead of react. However, many could not write balanced equations to show the amphoteric behaviour of Al_2O_3.

In part (*c*), candidates could not explain clearly that aluminium in aluminium chloride has an empty orbital which enables it to accept a lone pair of electrons. An example for the aluminium chloride complex formed should be given such as $AlCl_4$ or $H_3N \rightarrow AlCl_3$.

In part (*d*), candidates could draw clearly the dimer Al_3Cl_6 which shows the dative bonds.

In part (*e*), candidates must reason out that boron trifluoride is a simple covalent molecule whereas aluminium trifluoride is an ionic compound when they explained why boron trifluoride is volatile whereas aluminium trifluoride has a high melting point. Instead, many candidates explained that the type of bond formed in BF_3 molecule is covalent bond and in AlF_3 molecule is ionic bond.

Question 3

In part (*a*), many candidates could write a balanced equation for the reaction between chlorine and water, and identify the active ingredient HOCl which has the bleaching properties. However, many candidates found that the calculation part quite challenging. As many candidates were weak in the mole concept, they could not relate that the number of moles of NaOH is twice that of chloride solution. Some of candidates gave the wrong significant figures for the numerical answer, example 0.2 dm^3.

In part (*b*), candidates did not specify that silicon is stable in the +4 oxidation state whereas lead is stable in the +2 oxidation state due to the inert pair effect in lead. Some candidates also could not explain that the thermal stability of silicon(IV) chloride is greater than lead(II) chloride because silicon has a smaller radius compared to lead.

In part (*c*), many candidates correctly stated that the shape of silicon(IV) chloride as tetrahedral. However, a few of them made spelling error such as thetrahydral or gave a wrong answer as square planar.

Answer: (*a*)(iii) 200 cm^3 or 0.200 dm^3

Question 4

In part (*a*), many candidates could state some of the functional groups present in the aspirin molecules which are the carboxyl, ester and phenyl groups, and identify *X* and *Y* as 2-hydroxybenzoic acid and ethanoic acid respectively. However, many candidates made the mistake of naming *X* as 2-hydroxylbenzoic acid.

In part (*b*), candidates could not state the Markonikov's rule precisely that it involved the addition of a compound to a carbon-carbon double bond, where the more electropositive atom is added to the carbon with a greater number of hydrogen atoms. However, they could write the structure of all the possible alkenes such as $CH_3CH{=}C(CH_3)CH_2CH_2CH_3$, $CH_3CH_2(CH_3)CH{=}CHCH_2CH_3$ and $CH_2{=}C(C_2H_5)CH_2CH_2CH_3$. Many candidates wrote 6 carbons instead of 7, and some of them gave the *cis* and *trans* isomers. The mechanism involved is an electrophilic addition, but not an electrophile addition.

Question 5

This question was very popular.

In part (*a*), candidates should state that isotopes are atoms with the same number of protons but different number of neutrons or same proton number but different nucleon number. The calculation on the relative atomic mass of naturally occurring argon was an easy question which should be rounded up to 1 significant figure.

In part (*b*), candidates could define proton number, but they had difficulty in defining nucleon number which is the total number of protons and neutrons in the nucleus of an atom. Generally, candidates could state the proton number, nucleon number and number of electrons and neutrons in ^{12}C and ^{13}C. Many candidates could calculate the percentage abundance of ^{12}C and ^{13}C to the correct number of significant figures.

In part (*c*), many candidates could not draw a correct Lewis structure for CO such as C≡O: and state that carbon undergoes *sp* hybridisation. The bond length would be the same for ^{12}CO and ^{13}CO as both carbon atoms have the same number of protons and electrons, and hence, the effective nuclear charges of both atoms are the same.

Lewis structure: $:C \leftleftarrows\!\!\equiv O:$

Generally, candidates showed poor understanding of a simple term such as the number of neutrons in an atom which is not a neutron number.

Answer: (*a*)(ii) 40; (*b*)(iii) 98.89% and 1.11%

Question 6

In part (*a*), some candidates could draw the set-up of apparatus to determine the $E°$ value of $Sn^{4+}(aq)/Sn^{2+}(aq)$ electrode, but they did not label it accurately and completely such as stating platinum as the electrode of the cell, 1 atm as the pressure of $H_2(g)$ and 25°C as the temperature.

The overall equation for the reaction should be $Sn^{4+} + H_2 \rightarrow Sn^{2+} + 2H^+$ and the e.m.f. of the cell is +0.15 – 0.00 = +0.15 V.

This was a challenging question and candidates should be able to use the Nernst equation, i.e.

$$E = E° - \frac{0.0592}{2} \log \frac{[Sn^{2+}][H^+]^2}{[Sn^{4+}]P_{H_2}}.$$

At equilibrium, E_{cell} = 0 V, and from the pH value of 0.5, candidates could calculate the concentration of hydrogen ion, $[H^+]$, as 0.316 mol dm^{-3}.

By substituting the values obtained into the Nernst equation as follows:

$$0 = +0.15 - \frac{0.0592}{2} \log \frac{(1.0)(0.316)^2}{(1.0)P_{H_2}},$$

candidates then should be able to calculate the pressure of the hydrogen gas,

$$P_{H_2} = 8.6 \times 10^{-3} \text{ atm or } 8.6 \times 10^2 \text{ Pa}.$$

In part (*b*), candidates should know that in industrial areas, the air is acidic due to pollution. The white coating shows that the compound formed must be a tin compound as copper(II) compound would be black or some other colour due to present of CuS compound.
The equation of the reaction is $Sn + 2H^+ \rightarrow Sn^{2+} + H_2$, and the e.m.f. of the cell is

$$E_{cell} = 0.00 - (-0.14) = +0.14 \text{ V}.$$

As the value of E_{cell} is positive, the reaction is spontaneous and tin reacts with the H^+ ions in humid air to produce Sn^{2+} salts.

Answer: (*a*)(iii) 8.6×10^2 Pa or 0.86 kPa

Question 7

In part (*a*), candidates had to compare the electrical conductivity of titanium with that of germanium. They had to compare the two elements and not the trends. Few candidates explained in terms of the number of delocalised electrons. Many candidates were not able to explain why the conductivity of titanium decreases with temperature and some of them mentioned that it increases because more electrons were promoted into the conduction band. Many candidates failed to mention that Ge is a semiconductor and some thought it is a non-conductor.

In part (*b*), candidates had forgotten that silicon dioxide is just a component of glass. Therefore, when alkalis are stored in a glass container, the reaction is between the alkali and silicon dioxide, not glass. Many candidates did not explain that SiO_2 is a giant molecule, and most of them used the term compound instead of molecule. They also did not explain that the Si–O covalent bond was a strong bond, but they explained it in terms of the weak van der Waals. Many candidates could explain the reaction with alkali, but did not mention that salt and water were formed.

Question 8

This was quite a popular question and some candidates answered it quite well.

In part (*a*), candidates had to compare the thermal stability of magnesium carbonate with that of barium carbonate. Then, they had to compare the size, charge density and polarising power of the Mg^{2+} and Ba^{2+} ions. For example, the ionic radius of Mg^{2+} is longer than Ba^{2+}. Some candidates wrongly stated that the radius of Mg < Ba.

In part (*b*), candidates had to explain how the solubility of Group 2 sulphates changed. This is a trend and therefore all the discussion must be based on trend. For example, the ionic radius and hydration energy of cations increase as follows: $Be^{2+} < Mg^{2+} < Ca^{2+} < Ba^{2+}$.

Question 9

In part (*a*), very few candidates could answer this part well. The 2-aminoethanoic acid could form zwitterions and therefore, there would be a strong ionic bond between them. This causes the melting point to be higher. As for ethanoic acid, it forms dimers in solid state with weak van der Waals' forces between the dimers. Thus, its melting point is lowered. However, most candidates gave the explanation in terms of the formation of hydrogen bonds.

In part (*b*), some candidates used HCN instead of NaCN as the reagent, and the product formed after hydrolysis is an amino acid instead of a salt. Many candidates could only write part of the reaction scheme which should be as follows:

$$ClCH_2NH_2 \xrightarrow{KCN} N{\equiv}CCH_2NH_2 \xrightarrow{H_2O/H^+} HOOCCH_2\overset{+}{N}H_3 \xrightarrow{OH^-} HOOCCH_2NH_2$$

Some candidates gave the wrong answer such as:

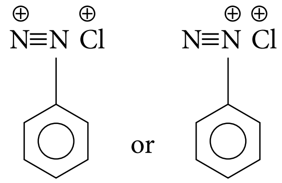
$$H_2N - CH_2 - Cl \xrightarrow{KCN} H_2N - CH_2 - CN \xrightarrow{H^+/H_2O} H_2N - CH_2 - COOH$$

In part (*c*), many candidates could correctly identify the amino acids formed when the polypeptide was hydrolysed, but they had to name the reagent used which is hydrochloric acid or sulphuric acid.

Question 10

In part (*a*), many candidates could identify *W* as a tertiary alcohol, and drew the structural formula of *W*. Candidates were also required to identify the acidic characteristic of alcohol which was displayed by the reaction between sodium metal and *W* which releases hydrogen gas. Many candidates did not explain that *W* is acidic, and most of them mentioned it as having an –OH group. Many candidates were not able to use Grignard reagent in the synthesis of *W* and some used Mg instead of dry ether.

In part (*b*), many candidates could draw the structural formulae of *X* and *Y*. Some candidates made mistake in drawing the structure of *Y* as follows:



The reagent and condition used in step II were Sn with concentrated HCl, while in step III were excess CH_3Cl and heat. For part (iii), the IUPAC name of compound *Z* should be N,N-dimethylbenzenamine, but many candidates gave the answer as N,N-dimethylphenylamine. Majority of the candidates could name the reaction that was involved in step V which was a coupling reaction or an electrophilic substitution reaction.

PAPER 962/4 (WRITTEN PRACTICAL TEST)

General comments

Generally, the candidates had problem in handling numbers especially giving the answer in the correct significant figures. They were weak in calculating concentrations in acid-base titrations. They failed to realise that the stoichiometric coefficients in a chemical equation are related to the number of moles of each substance. Most candidates had very little understanding about the concept of partition coefficient of a substance between two immiscible solvents, and with simple neutralisation reaction involving NH_3 with aqueous HCl to produce NH_4Cl. The candidates also had little knowledge about electrolysis in terms of the preferred reactions that occurred at the anode and cathode for certain electrolyte, the relationship between the current and the charge in coulomb, the number of moles of electrons and number of moles of substances that is reduced or oxidised.

Comments on the individual question

Question 1

In part (*a*)(i), instead of giving the right answer as pipette or burette, many candidates gave answers as conical flask, measuring cylinder, glass test tube, filter funnel and dropper.

In part (*a*)(ii), a few candidates gave the right answer as to ensure the completion of the (redox) reaction. Most of them think sulphuric acid acts as a catalyst/indicator/dehydrating agent, to stabilise the solution, to provide acidic medium/H^+, to neutralise/acidify the sodium nitrite solution, to make the sodium nitrite crystals soluble.

In part (*a*)(iii), not many candidates could give the reason as to why the solution turns pink or purple.

In part (*b*)(i), very few candidates could give the final or initial readings in the reverse order. Many candidates completed the table by giving values not in two decimal places. They also could not read the burette's reading correctly.

In part (*b*)(ii), almost all candidates calculated the average titre value using all three titre values instead of using the last two values.

For part (*c*)(i), (*c*)(ii), (*c*)(iii), and (*c*)(iv), very few candidates could answer correctly.

Question 2

In part (*a*)(i), not many candidates gave the right answer for the function of the rheostat.

In part (*a*)(ii), even though, the candidates were asked to choose between anode and cathode, but many of them name a specific metal such as Zn and a non-metal such as graphite to be the electrodes.

In part (*b*)(i), a few candidates entered the final and initial readings of the burette in the given table wrongly. Many of them completed the table by giving the values not in one decimal place. Most candidates could not read the gas syringe correctly.

In part (*b*)(ii), some candidates stated the gas as Cl_2 or SO_2 instead of H_2.

Only a few candidates calculated correctly part (*c*)(i), (*c*)(ii) and (*c*)(iii).

Question 3

In part (*a*)(i), many candidates gave the answer other than separating funnel or stopped reagent bottle.

In part (*a*)(ii), majority of candidates only mentioned "shake vigorously" without saying that the flask, funnel or bottle were closed tightly by holding the stopper.

In part (*a*)(iii), a few candidates realised that water and trichloromethane were immiscible, and that ammonia molecules were distributed unevenly in each solvent.

In part (*b*)(i), some candidates gave phenolphthalein instead of methyl red/orange as the indicator.

In part (*b*)(ii), almost none of the candidates mentioned about "using pipette filler" and "close the pipette tip with a finger" while pouring out the trichloromethane layer.

In part (*b*)(iii) and (*b*)(iv), not many candidates calculated the concentrations of ammonia correctly since they did not understand what was happening in the process.

In part (*b*)(v), a number of candidates calculated the partition coefficient of ammonia between water and trichloromethane in the reverse order.