CHEMISTRY 2

1. GENERAL COMMENTS

The standard of the paper compares favourably with those of the previous years. On the whole, questions were concise and well-structured covering almost the entire syllabus of the subject.

Demands of the individual questions were well articulated and easy to comprehend by the candidates.

The standard should therefore be maintained to enable candidates study all the aspects of the general syllabus and avoid the unnecessary specialization in certain topics of their choice.

2. SUMMARY OF CANDIDATES' STRENGTHS

The major strengths of the candidates identified as far as this paper was concerned include:

(1) periodic chemistry including chemical bonding and naming of complex ions;
(2) oxidation/reduction reactions, calculation of e.m.f. of cells from given half equations and the knowledge of the Faraday's Laws;
(3) Stoichiometry and its application in determining percentage yield;
(4) calculations on solubility of salts and isotopic mass from the knowledge of relative atomic mass and percentage abundance;
(5) knowledge of radioactivity and its uses;
(6) dissociation of weak acids and bases in aqueous solution and the corresponding Ka and Kb expressions. Calculation of hydroxonium ion concentration;
(7) organic chemistry, isomerism, functional group identification and resonance in benzene.

3. SUMMARY OF WEAKNESSES

Despite the strengths mentioned and observed in several cases, some candidates were unable to present their answers in a systematic way. In such cases, the candidates were unable to score maximum marks. The major weaknesses identified in the candidates' responses to the tasks involved in the questions include:

(1) the physical property that would enhance the separation of a mixture of water and palm-oil;
(2) comparison of the rates of forward and backward reactions for a reversible reaction at time zero;
(3) organic functional group identified with ammonical $AgNO_{3(aq)}$;
(4) how molecules assume their shapes and dipole moments in molecules;
(5) why the C=C bond energy is larger but not twice as that of C-C and why the bond energy of Cl_2 is not the same as its bond dissociation energy.

4. SUGGESTED REMEDIES

(1) Early completion of the syllabus.

(2) Candidates should have a thorough grasp of the principles behind the answers they provide.

(3) Routine administration of exercises on the various topics treated.

(4) Encouragement of extra learning with self examination.

5. DETAILED COMMENTS

QUESTION 1

(a) State Faraday's second law of electrolysis.

(b) Separate the following redox reaction into balanced half equations:
$Cu + NO_3^- \rightarrow Cu^{2+} + NO + H_2O$.

(c) Calculate the e.m.f. of the cell formed by combining the following half-equations:

$SO_4^{2-} + 4H^+ + 2e^- \rightarrow SO_2 + 2H_2O$ $E^\theta = +0.17$ V

$Br_{2(g)} + 2e^- \rightarrow 2Br^-$ $E^\theta = +1.07$ V

(d) Explain briefly why sugar does not conduct electricity.

(e) State one use of each of the following processes in the chemistry industry:

(i) cracking;

(ii) hydrogenation of vegetable oil.

(f) State one:

(i) physical property that would enhance the separation of a mixture of palm-oil and water;

(ii) neutral oxide that is a colourless liquid at room temperature.

(g) In a reversible reaction, state how the rate of the forward reaction compares to that of the backward reaction.

(i) at time zero;

(ii) before equilibrium;

(iii) at equilibrium.

(h) Write a reaction equation to show the effect of heat on the following compound: $Pb(NO_3)_{2(s)}$.

(i) Draw the structural formulae of two isomers of C_3H_7OH.

(j) Consider the following carbon compounds: ethanol, ethane, butane

(i) Arrange them in increasing order of their boiling point.

(ii) Explain briefly your answer in j(i).

(a) The requirement of the question was recall of the Faraday's second Law of electrolysis.

Majority of the candidates were able to state the law. However, some few candidates used "mass of the substance" in place of "amount of substance".

(b) Almost all the candidates were able to separate the given redox reaction into balanced half equations.

(c) Calculation of the e.m.f. of a cell from given half equations can be done in two ways:

(i) Ecell = Ecathode – Eanode method

(ii) Identifying the oxidation and redox half equations from the Eo values given and summing them-up. About 40% of the candidates failed to add the positive sign to the calculated e.m.f. as +0.90 V

(d) Most of the candidates were able to say that the absence of ions in sugar is responsible for its inability to conduct electricity. However, they failed to add that it is a covalent compound / contain molecule.

(e) Almost all the candidates were able to give the use of cracking and hydrogenation of vegetable oil in the chemical industry.

But some candidates were confused with fractional distillation of crude oil to obtain its fractions and the breaking down of the large fractions / hydrocarbons by the process of cracking.

(f) (i) Just a few candidates were able to state the physical property that enhances the separation of a mixture of water and palm oil – Immiscibility

(ii) Majority of the candidates were able to state that "water" is the neutral oxide that is a colourless liquid at room temperature.

(g) Almost all the candidates were able to state how the rate of the forward reaction compares to that of the backward reaction (i) before equilibrium and (ii) at equilibrium for a reversible reaction.

(h) Most of the candidates were able to write the reaction equation to show the effect of heat on Pb $(NO_3)_{2(s)}$ as: $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

(i) Almost all the candidates were able to draw the structural formulae of the two isomers of C_3H_7OH. Some few could not as they saw the compound as not an alkanol.

(j) Majority of the candidates were able to arrange ethanol, ethane and butane in the correct order of increasing of their boiling points but could not explain or give the reasons for the answer.

The reason is that, ethane and butane belong to the same homologous series / are alkanes, but butane is heavier / contains stronger van der Waals forces. And that ethanol contains hydrogen bonds therefore has the highest boiling point.

QUESTION 2

(a) (i) Define *atomic radius*.

(ii) Explain briefly why the ratio of ionic radii $\frac{Na^+}{Mg^{2+}}$ is greater than 1.

(b) Consider the following equation:

$CH_3CH_2CH_2OH \rightarrow CH_3CH = CH_2 + H_2O$.

If 30.0 g of propan-1-ol produces 16.8 g of propene, calculate the percentage yield of propene.

[H = 1.0; C = 12.0; O = 16.0]

(c) What would be the final volume of a fixed mass of a gas if its initial pressure is halved and the absolute temperature doubled.

(d) (i) Identify the class of organic compound that could be detected using each of the following reagents:

(α) Biuret reagent;

(β) Ammoniacal silver trioxonitrate (v) solution;

(γ) Bromine in tetrachloromethane.

(ii) State what is observed in each of the cases stated in (d)(i).

(e) (i) Under what condition does water react with sodium?

(ii) Name the products formed when water reacts with sodium.

(a) (i) Majority of the candidates were able to define atomic radius. Some candidates defined it in terms of two atoms in a covalent bond rather than identical/same atoms in the covalent bond.

(ii) Candidates were able to explain why the ratio of ionic radii Na+/Mg^{2+} >1

(b) Vast majority of the candidates were able to do this single application on stoichiometry.

(c) Again, majority of the candidates were able to use the general gas equation to deduce the final volume of a gas whose initial pressure was halved, and its absolute temperature doubled.

(d) Majority of the candidates were able to identify the class of organic compounds that could be detected using

1. Buiret reagent
2. Bromine in tetrachloromethane; and what would be observed.

3. However, they could not do same for ammoniacal silver trioxonitrate (V) solution.

The response should have been "Terminal alkyne" and the observation, "white precipitate".

(e) Most of the candidates were able to state the condition under which water reacts with sodium and named the products formed.

QUESTION 3

(a) Consider the following table and use it to answer the questions that follow.

Elements	Atomic number	Mass number
A	**10**	**20**
B	**12**	**24**
C	**17**	**35**
D	**20**	**40**
E	**25**	**50**

(i) Which of the elements:
- **(α) is an alkaline earth metal;**
- **(β) belongs to group VII;**
- **(γ) belongs to the d-block of the periodic table;**
- **(δ) would readily form an ion with a double positive charge?**

(ii) How many electrons are there in D?

(iii) What type of bond would exist between D and C when they combine?

(iv) Write the formula of the compound formed when B combines with C.

(v) State the element which is inert.

(vi) Select the element which has a catalytic property.

(b) Consider the following reaction equation:

$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ heat

(i) What type of reaction does the equation illustrate?

(ii) Give a reason for the answer stated in (b)(i).

(iii) What would be observed if
- **(α) water is sprinkled on CaO?**
- **(β) excess water is added to CaO?**

(iv) Write a balanced chemical equation for the reaction in (b)(iii)(β).

(c) (i) The heat of solution for NH_4Cl is +15.1 kJ mol^{-1}. State with reason the effect of increase in temperature on the solubility of NH_4Cl.

(ii) If a salt of mass 5.10 g dissolves in distilled water of volume 7.70 cm^3 at 50°C, determine the solubility of the salt in mol dm^{-3} at the stated temperature.

[Mr of salt = 165.5]

(a) This question was answered by all the candidates and they performed very well. This suggests that the candidates are well vested in periodic chemistry.

(b) Almost all the candidates were able to state the type of reaction illustrated by the equation:

$CaCO_{3(s)} \longrightarrow CaO_{(s)} + CO_{2(g)}$ as heat

Decomposition:

But they could not give a reason for the answer as well as state what would be observed if

1. water is sprinkled on CaO;
2. excess water is added to CaO.

In the first case, the CaO cracks with hissing sound and breaks up into powder.

In the second case, the CaO dissolves / forms a milky suspension and the container becomes warm.

The candidates were able to write balanced equation for the reaction of CaO with water.

(c) The majority of the candidates were able to state the effect of increase in temperature on the solubility of NH_4Cl whose heat of solution was given as +15.1kJ mol^{-1}.

Candidates were able to determine the solubility of salt from information on its mass, molar mass and volume.

QUESTION 4

(a) Explain briefly how molecules assume their shapes.

(b) (i) State the difference between polar covalent bond and coordinate covalent bond.

(ii) Illustrate dipole moment in each of the following molecules:

(α) NF_3;

(β) CO_2;

(γ) H_2O.

(c) (i) Define each of the following terms:

(α) natural radioactivity;

(β) nuclear fusion;

(ii) State one difference between natural radioactivity and artificial radioactivity.

(iii) Give two uses of nuclear fusion.

(d) The equilibrium constant for the reaction $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ at a certain temperature is 6.0. Calculate the equilibrium concentration of HI at that

temperature when the equilibrium concentration of H_2 and I_2 are 0.2 mol dm^{-3} and 0.3 mol dm^{-3} respectively.

(e) (i) Explain briefly why the C ═ C bond energy is larger but not twice as large as the C — C bond energy.

(ii) Give the IUPAC name of each of the following complex ions:

(α) $[Cu(NH_3)_4]^{2+}$;

(β) $[Fe(CN_6]^{4-}$.

(a) Only a few of the candidates were able to explain how molecules assume their shapes. The requirement was that "Pairs of electrons around a central atom repel each other thereby arranging themselves as far apart as possible to minimize any repulsion.

(b) (i) Majority of the candidates were able to state the difference between polar covalent bond and coordinate covalent bond.

(ii) Just a handful of the candidates were able to illustrate dipole moment in NF_3, CO_2 and H_2O. This could be due to the fact that they don't know what dipole moment is.

This is separation of partial charges in covalent compounds with the more electronegative atom attaining the partial negative charge.

(c) This question on nuclear chemistry was well answered by the candidates. They were able to define natural radioactivity, nuclear fusion and stated the difference between natural radioactivity and artificial radioactivity. They were also able to give the uses of nuclear fusion.

(d) From the data on the equilibrium reaction:
$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$, the candidates were able to determine the equilibrium concentration of HI.

(e) A few of the candidates were able to answer this question correctly.

(i) They could not explain why the C —C bond energy is larger but not as twice as large as the C C bond energy.

They failed to recognize that one of the bonds in C═ C is pi and the other sigma and that the sigma bond is stronger than the pi-bond.

(ii) Most of the candidates could not name the following complex ions:

$[Cu(NH_3)_4]^{2+}$ - tetra ammine copper (II) ion

$[Fe(CN)_6]]^{4-}$ - hexacyano ferrate (II) ion

QUESTION 5

(a) $NaHCO_3$ acts both as a weak acid and a weak base in aqueous solution.

(i) Write the:

(α) K_a expression for $NaHCO_{3(aq)}$;

(β) K_b expression for $NaHCO_{3(aq)}$.

(ii) Calculate the $[H_3O^+]$ for 0.100 mol dm^{-3} aqueous solution of $NaHCO_3$ at 25°C.

[K_a at 25°C = 4.7×10^{-11}]

(b) Chlorine has two isotopes. The isotopic mass and percentage abundance of the heavier isotope are 36.98 and 24.95% respectively.

(i) Calculate the isotopic mass of the lighter isotope.

(ii) Sketch the mass spectrum of chlorine.

(c) (i) The standard enthalpy of combustion of ethanol is -1368 kJ mol^{-1}. Explain briefly this statement.

(ii) Explain briefly why the bond energy of chlorine is not the same as its bond dissociation energy.

(iii) List two factors that favour ionic bond formation.

(d) Benzene contains six carbon atoms and six hydrogen atoms:

(i) Draw two stable structures of benzene to show how these atoms are arranged.

(ii) State the concept behind these structures;

(iii) State one industrial source of benzene;

(iv) State one use of benzene.

Most candidates avoided this question.

(a) Majority of the candidates who attempted this question could not answer it well.

(i) The demand of the question was the expressions for the K_a and K_b for $NaHCO_3$ in aqueous solution.

The candidates were expected to write the dissociation equations for $NaHCO_3$ as a weak acid and as a weak base before coming up with the K_a and K_b expressions.

i.e. $NaHCO_{3(aq)} \rightarrow Na^+_{(aq)} + HCO_3^-$

As an acid: $HCO_3^- + H_2O \rightleftharpoons CO_3^{2-} + H_3O^+$

$\therefore K_a = \frac{[CO_3^{2-}][H_3O^+]}{[HCO_3^-]}$

As a base: $HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$

$K_b = \frac{[H_2CO_3][OH^-]}{[HCO_3^-]}$

(ii) Most candidates were able to calculate the $[H_3O^+]$ from information on K_a and concentration of $NaHCO_3$.

(b) All the candidates were able to calculate the isotopic mass of the lighter isotope but could not sketch the spectrum of chlorine.

(c) (i)&(ii) Majority of the candidates could not answer these questions. This could be due to the fact that they do not understand the knowledge of Energy and energy changes.

(iii) Factors that favour ionic bond formation was expected to be easy, but candidates could not list them.

The expected answers are:

(i) it means that when 1 mole of ethanol in its normal physical state at 298 K and 1 atm pressure is completely burnt in air/oxygen, 1368 kJ of heat is given out.

(ii) bond energy is the energy needed to break one mole of Cl – Cl bond to form 2 moles of gaseous chlorine atoms while dissociation energy is the energy needed to break Cl – CL bonds to form 1 mole of gaseous chlorine atoms.

OR

bond energy is the ΔH for the reaction

$$Cl_{2(g)} \rightarrow 2Cl_{(g)}$$

While dissociation is the ΔH for the reaction

$$\frac{1}{2} Cl_{2(g)} \rightarrow Cl_{(g)}$$

(iii)
- low ionization energy of the metal atom
- high electron affinity of the non-metal atom
- low polarizing power of the cation
- low polarizability of the anion

(d) Vast majority of the candidates were able to answer this question. The only problem was the industrial source of benzene which they could not state as “Coaltar”.

CHEMISTRY 3

1. GENERAL COMMENTS

The standard of the paper was comparable to the previous year.

The performance of the candidates however, was lower than that of the previous year.

2. SUMMARY OF CANDIDATES' STRENGTHS

(1) Candidates could draw table of burette readings to 2 decimal places as required.
(2) Candidates understood the concept of mole ratio.
(3) Cations and anions were identified correctly by most of the candidates.
(4) Improvement in the use of concordant titres for averaging.

3. SUMMARY OF WEAKNESSES

(1) Significant figures still pose a challenge. Most of the candidates could not leave their answers to the right significant figures.
(2) Some candidates could not attach the correct units to the values calculated.
(3) Organic Qualitative Analysis question (Alt. A Question 2) was not well understood.
(4) Candidates could not attach correct states to the species in equations.
(5) Most candidates could not answer the question 3 in all the three alternatives.
(6) Difficulty in identification of colours of precipitates, residues and solution.

4. SUGGESTED REMEDIES

(1) Teachers should find time to take the students through practical exercises and usual laboratory activities.
(2) Students should be encouraged to practice more questions on practical work.
(3) Students should be taken through the key points in:
- preparation of table of titre values;
- writing of test, observation and inference for qualitative analysis.

5. DETAILED COMMENTS

ALTERNATIVE A

QUESTION 1

A is a solution containing 5.00 g of HNO_3 in 500 cm^3 of solution.
B is a solution of NaOH of unknown concentration.

(a) Put A into the burette and titrate it with 20.0 cm^3 or 25.0 cm^3 portions of B using methyl orange as indicator.
Repeat the titration to obtain concordant titre values.
Tabulate your results and calculate the average volume of acid used.
Equation of the reaction is:

$HNO_{3(aq)} + NaOH_{(aq)} \rightarrow NaNO_{3(aq)} + H_2O_{(l)}$

(b) From your results and the information provided, calculate the:

(i) concentration of A in mol dm^{-3};

(ii) concentration of B in mol dm^{-3};

(iii) concentration of B in g dm^{-3}.

(iv) Mass of $NaNO_3$ formed, if 250 cm^3 of NaOH were neutralized.
[Molar mass of: NaOH = 40 g mol^{-1}; $NaNO_3$ = 85 g mol^{-1}]

QUESTION 2

C is an organic compound. Carry out the following exercises on C.
Record your observations and identify any gas(es) evolved.
State the conclusions you draw from the results of each test.

(a) Put about 10 drops of C on a watch glass and ignite it using a burning splint.

(b) (i) Put about 1 cm^3 of C in a test tube and add about 1 cm^3 of distilled water. Shake the test tube.

(ii) Put about 1 cm^3 of C in a test tube and add about 2 cm^3 of acidified $K_2Cr_2O_7$ solution. Warm the mixture gently and leave to stand for 5 minutes.

(c) Put few crystals of specimen D in a test tube and add about 2 cm^3 of C followed by about 2 cm^3 of 10% $NaOH_{(aq)}$. Shake the test tube vigorously.

(d) State the class of compounds to which C belongs.

QUESTION 3

(a) A zinc salt, E, when heated strongly, produced a brown gas with pungent smell, a colourless gas which rekindled a glowing splint and a residue which was allowed to cool.

(i) Identify the salt E;

(ii) Write an equation for the decomposition of E;

(iii) State what would be observed when the residue was allowed to cool.

(b) Describe how 250 cm^3 of 0.2 mol dm^{-3} H_2SO_4 could be prepared from 150 cm^3 of a 1.0 mol dm^{-3} stock of the acid.

(c) State the effect of aqueous solution of $Al_2(SO_4)_3$ on litmus paper.

QUESTION 1

(b) (i) Conc. of A in mol dm^{-3}

Many of the candidates were able to calculate the mass concentration of the acid (HNO_3) before dividing by the molar mass.

(ii) Conc. of B in mol dm^{-3}

Performance was good except that almost all the candidates missed the mark for correct evaluation to 3 significant figures.

(iii) Conc. of B in gdm^{-3}

This was quite well handled.

(iv) Mass of $NaNO_3$ formed

Performance here was average. Many of the candidates were able to find moles of NaOH in 250 cm^3 of solution then proceeded to use the equation:
i.e. 1 mole of NaOH ≡ 1 mole of $NaNO_3$.

Candidates were expected to convert molar concentration to amount of substance in 250 cm^3. Most of them could not do this.

QUESTION 2

The concept of oxidizing and reducing agents was not well understood. The iodoform test was not properly done.

The following observations were, however, made.

(c)

Test	Observation	Inference
D(s) + C + $NaOH_{(aq)}$ + shaking vigorously	Yellow precipitate forms with antiseptic smell	Iodoform produced

- Some candidates stated yellow solution instead of yellow ppt.
- Many also did not get the antiseptic smell.
- Almost all the candidates who made correct observation gave the inference as ethanol / secondary alkanol instead of Iodoform produced.

The expected solution is:

	TEST	OBSERVATION	INFERENCE
(a)	C on a watch Glass + burning splint	Burns with a non-smoky flame	Saturated hydrocarbon may be present
(b)(i)	C + distilled water + shaking	One-layer forms / C dissolves	C is soluble
(ii)	C + acidified $K_2Cr_2O_{7(aq)}$ + Warm and leave to stand for 5 minutes	Orange solution turns green	Primary or Secondary alcohol present
(c)	$D_{(s)}$ + C + $NaOH_{(aq)}$ + shaking vigorously	Yellow precipitate forms with antiseptic smell	Iodoform produced

QUESTION 3

Candidates handled parts (a) and (c) quite well.

Description of dilution of solutions was not well understood.

(b) Many candidates knew they must use the dilution law but messed up with the simple calculation. In the procedure, some also missed the marks for not using pipette / burette and for not stating volume of the volumetric flask.

The expected answer is:

(b) Using the law of dilution

$C_1V_1 = C_2V_2$

$\therefore V_1 = \frac{C_2V_2}{C_1}$

$= \frac{0.2 \times 250}{1.0} = \frac{0.2 \times 250}{1.0}$

$= 50\ cm^3$

Procedure: 50 cm^3 of the stock solution is pipetted into a 250 cm^3 volumetric flask. The flask is topped up to the mark with distilled water. Flask is stoppered and shaken to obtain a uniform solution.

ALTERNATIVE B

QUESTION 1

E is a solution containing 5.99 g of HNO_3 per dm^3.

F is a solution containing 13.0 g of $Na_2CO_3.yH_2O$ per dm^3.

(a) **Put E into the burette and titrate it against 20.0 cm^3 or 25.0cm^3 portions of F using methyl orange as indicator.**

Repeat the titration to obtain concordant titre values.

Tabulate your results and calculate the average volume of E used.

The equation for the reaction is:

$$2HNO_{3(aq)} + Na_2CO_3.yH_2O \rightarrow 2NaNO_{3(aq)} + (y+1)\ H2O_{(l)} + CO_{2(g)}$$

(b) **From your results and the information provided, calculate the:**

(i) **concentration of E in mol dm^{-3};**

(ii) **concentration of F in mol dm^{-3};**

(iii) **concentration of F in g dm^{-3}.**

(iv) **percentage of water of crystallization in $Na_2CO_3.yH_2O$.**

[H = 1.0; C = 12.0; O = 16.0; Na = 23.0]

QUESTION 2

G is a mixture of two salts, one of which is a sodium salt. Carry out the following exercises on G.

Record your observations and identify any gas(es) evolved.

State the conclusions you draw from the results of each test.

(a) **Put G into a beaker and add about 10 cm^3 of distilled water. Stir the mixture and filter. Keep both the filtrate and residue. Test the filtrate with litmus paper.**

(b) **To about 2 cm^3 of the filtrate add dilute HCl followed by few drops of $BaCl_{(aq)}$.**

(c) **(i)** **Place about half of the residue from (a) in a boiling tube and add about 10 cm^3 of dilute HNO_3.**

(ii) **To about 2 cm^3 portions of the clear solution from (c)(i), add dilute NaOH in drops and then in excess.**

(iii) **To another 2 cm^3 portions of the solution, add dilute HCl.**

QUESTION 3

(a) **(i)** **Describe briefly how copper (II) tetraoxosulphate (VI) solution could be converted to zinc tetraoxosulphate (VI) solution in the laboratory.**

(ii) **Write a chemical equation for the reaction in (i).**

(b) **State what would be observed when hydrogen gas is passed over heated copper (II) oxide.**

QUESTION 1

Candidates were expected to work out for the value of y in $NaCO_3.yH_2O$. Calculating the value of y was not properly done.

The expected response is:

(b) (i) Conc. of **E** in mol dm^{-3}

Molar mass of HNO_3 = 1 + 14 + 48

= 63 g mol^{-1}

Conc. of **E** = $\frac{5.99}{63}$

= 0.0951 mol dm^{-3}

(ii) Conc. of **F** in mol dm^{-3}

$\frac{C_E V_E}{C_F V_F} = \frac{2}{1}$

$C_F = \frac{C_E V_E}{2V_F}$

$= \frac{0.0951 \times V_E}{2 \times 20/25}$

= Say ***a*** mol dm^{-3}

(iii) Conc. of **F** in gdm^{-3}

Molar mass of Na_2CO_3 = (2x23) + 12 + (16x3)

= 106 g mol^{-1}

Conc. of **F** in g dm^{-3}

= ***a*** x 106

= Say ***b*** g mol^{-1}

(iv) % of water of crystallization

Mass of water = (13.0 – b)

= Say **C** (g)

Percentage of water in $Na_2CO_3.yH_2O$

$= \frac{C}{13.0} \times 100$

= Say **X** %

QUESTION 2

Performance was average. The major issue was the incorrect way of using tests performed. Most of the candidates kept on adding, not stating whether they were adding to filtrate or residue (though correct observations were made).

Confirmatory test for Pb^{2+} using dil HCl could not be done.

QUESTION 3

(i) Candidates were to describe how to replace Cu in $CuSO_4$ using Zn. Most of the candidates answered the question without stating the appropriate laboratory instrument to use.

They failed to state the condition under which the reaction will be quickened and what would happen to the $CuSO_4$.

(ii) Majority of the candidates stated that hydrogen gas will be evolved instead of stating the colour change from black to brown.

ALTERNATIVE C

QUESTION 1

G is 0.045 mol dm^{-3} H_2SO_4

H was prepared by dissolving a sample of NH_4Cl in excess of 0.092 mol dm^{-3} NaOH solution.

(a) **Put G into the burette and titrate it against 20.0 cm^3 or 25.0 cm^3 portions of H using methyl orange as indicator.**
Repeat the titration to obtain concordant titre values.
Tabulate your results and calculate the average volume of G used.
The equations for the reactions are:
(i) **$NaOH + NH_4Cl \rightarrow NaCl + NH_3 + H_2O$**
(ii) **$2NaOH + H_2SO_y$ $Na_2SO_4 + 2H_2O$**

(b) **From your results and the information provided, calculate the:**
(i) **concentration of NaOH in H in mol dm^{-3};**
(ii) **amount of NaOH that reacted with NH_4Cl;**
(iii) **amount of NH_4Cl added;**
(iv) **masss of NH_4Cl added;**
(v) **volume of NH_3 evolve.**
[H = 1.0; N = 14.0; O = 16.0; Na = 23.0; Cl = 35.5; Vm = 22.4 dm^3]

QUESTION 2

J is a mixture of two salts. Carry out the following exercises on J.
Record your observations and identify any gas(es) evolved.
State the conclusions you draw from the result of each test.

(a) **Put all of J into a boiling tube and add about 10 cm^3 of distilled water. Stir the mixture thoroughly and filter. Keep both the filtrate and the residue.**

(b) **(i)** **To about 2 cm^3 portion of the filtrate, add $NH_{3(aq)}$ in drops and then in excess.**

(ii) **To another 2 cm^3 portion of the filtrate, add $BaCl_{2(aq)}$ and then add dilute HCl.**

(c) **Divide the residue into two portions.**

(i) **Heat the first portion strongly in a boiling tube.**

(ii) **Add dilute HCl to the second portion in a test tube.**

QUESTION 3

(a) **Give one example of each of the following substances:**

(i) **a gas that turns dump red litmus paper blue;**

(ii) **a compound of calcium used to neutralize soil acidity.**

(iii) **a gas other than oxygen that can relight a glowing plant.**

(b) **State what would be observed, when;**

(i) **sodium hydroxide pellets are exposed to the atmosphere for some time;**

(ii) **ethene is passed through bromine water.**

(c) **Explain briefly why when carbon (IV) oxide is bubbled through lime water, it turns milky, but the milkiness disappears when the gas is bubbled for a long time.**

QUESTION 1

(b)(ii) Candidates were to find the amount of alkali consumed in a back-titration exercise.

Most of them used mol dm^{-3} instead of mol.

Amount of NaOH used by NH_4Cl

It appeared many of the candidates were not conversant with the back-titration concept. They missed the mark. As a result, it affected performance for b(iii), b(iv) and b(v). Teachers must endeavour to take students through all the relevant practical topics.

QUESTION 2

White gelatinous precipitate and white chalky, precipitate were not understood by the candidates. Some of them did not know the difference.

Again, Effervescence was missing in most of their answers hence those candidates lost the mark allocated to the observation.

- In the Test column, many of the candidates did not indicate whether they were adding reagents to filtrate or residue.
- In b(i) many stated 'white ppt' as the observation instead of 'white gelatinous ppt'.
- In b(ii) many gave the inference CO_2 from CO_3^{2-} without evidence of having performed the chemical test i.e. colour gas turns limewater milky

QUESTION 3

Test for CO_2 using limited lime water and bubbling in excess could not be explained.

The expected response is:

(a) (i) NH_3

(ii) CaO / $Ca(OH)_2$ / $CaCO_3$

(iii) N_2O

(b) (i) the pellets dissolves to form a solution

(ii) Bromine water changes from brown to colourless

(c) The lime water turns milky because of the formation of insoluble $CaCO_3$ and the milkiness disappears due to the formation of soluble $Ca(HCO_3)_2$

CROP HUSBANDRY AND HORTICULTURE 2

1. GENERAL COMMENTS

The standard of the paper in terms of both level of difficulty and syllabus coverage compares favourably with those of previous years. However, candidates' performance was generally lower than last year.

2. SUMMARY OF CANDIDATES' STRENGTHS

The Chief Examiner commended candidates for the following features noticed in their scripts:

(1) Most candidates obeyed the rubrics of the paper including answering one question only on a page

(2) Good number of candidates exhibited adequate knowledge of the characteristic features of a fertile soil, importance of rainfall to the growth and yield of crops and effects of pests in crop production

(3) Some candidates satisfactorily discussed cultural methods of controlling pests in crop production

3. SUMMARY OF CANDIDATES' WEAKNESSES

The Chief Examiner noticed the following weaknesses in the scripts of candidates:

(1) Several candidates could not spell technical terms and scientific words correctly

(2) Most of the candidates could not adequately explain the following horticultural terms; hybridization, relay cropping, succession cropping and organic farming

(3) Candidates' knowledge of Quality and Safety Standards in food industry is poor

4. SUGGESTED REMEDIES

The Chief Examiner made the following suggestions meant to remedy the weaknesses of candidates:

(1) Teachers should periodically use question and answer to drill students on scientific words and technical terms

(2) Concerted efforts should be made by students to cover the entire syllabus especially in the area of Horticultural terms and Quality and Safety Standards in food industry

(3) Candidates should cultivate the habit of articulating their views correctly and concisely using good language

5. DETAILED COMMENTS

QUESTION 1

(a) **State four characteristics of a fertile soil used in crop production.**

(b) **Explain three ways in which soil organic matter is important in crop production.**

(c) **Discuss five ways in which rainfall influences the growth and yield of crops.**

A great majority of the candidates attempted this question and exhibited fairly good familiarity and ideas about characteristics of a fertile soil and importance of soil organic matter in crop production.

(a) Generally, candidates did not find much difficulties in stating characteristics of a fertile soil in crop production. Their correct answers included adequate nutrients, good soil structure and good texture

(b) Majority of candidates enumerated correct importance of soil organic matter in crop production but most of them could not explain its effects on the soil

It is, therefore, useful for the candidates to note that presence of organic matter adds nutrients to the soil; increases the number and activities of soil micro and macro-organisms; leading to decomposition and recycling of nutrients thereby increasing soil fertility.

(c) Even though most of the candidates listed ways in which rainfall influences the growth and yield of crops, they could not discuss the listed points satisfactorily.

The correct ways in which rainfall influence the growth and yield of crops include the following:

- provides water for good plant growth and development;
- provides needed water to dissolve plant nutrients in the soil;
- provides needed water to facilitate nutrients uptake and transportation;
- provides water which is necessary for photosynthesis;
- heavy rainfall may cause soil erosion and low crop yield;

QUESTION 2

(a) **Explain the term hybridization as used in crop production.**
(b) **Give two advantages of hybridization in crop production.**
(c) **Discuss three advantages of vegetative propagation.**
(d) **Give two precautions to be taken when performing each of the following activities in vegetable production.**
   (i) **transplanting;**
   (ii) **staking.**

Many candidates attempted this question, but general performance was poor because they could not explain the stated term and precautionary measures in carrying out some cultural methods.

(a) Candidates generally failed to explain the term hybridization. It should be noted that, it is the process of crop improvement where two separate individuals of desirable characteristics are crossed to produce progenies that combine the characteristics of both parents.

(b) Most of the candidates could not, satisfactorily, outline the advantages of hybridization in crop production.

The correct advantages include:

- creates genetic variations;
- results in hybrid vigour;
- results in yield improvement in crops.

(c) This sub-question was fairly well answered. Their correct advantages of vegetative propagation include:

- produces genetically true-to-type plants;
- it does not require pollination agent;
- productions of crops are relatively fast;
- enables seedless plants to be propagated.

(d) This sub-question was generally badly answered as candidates failed, in most cases, to give precautions to be taken in performing transplanting and staking activities in vegetable production.

Expected answers include the following:

Transplanting:

- seedlings should be watered copiously at least an hour before they are removed to reduce root damage;
- seedlings should be uprooted carefully with ball of soil to avoid root damage;
- always transplant young and healthy seedlings to ensure survival;
- transplanting should be done in the evening or early in the morning;
- water copiously immediately after transplanting.

Staking:

- stakes should be strong enough to provide the needed support for the plant to be staked;
- train plants or seedlings gently onto the stake
- stake at the appropriate state of growth.

QUESTION 3

(a) Explain each of the following terms as used in crop production:

(i) relay cropping;

(ii) phased planting;

(iii) succession cropping.

(b) Give six ways in which weeds are of importance to a vegetable farmer.

(c) Discuss two ways by which spear grass could be controlled in a yam farm.

(d) Mention four examples of hedging plants.

This was another popular question and candidates' performance in it was only average.

(a) Most of the candidates could not explain the stated farming systems.

An explanation of the terms are as follows:

(i) Relay cropping

It is the growing of two or more crops on the same plot of land such that part of their life cycle occur simultaneously or overlaps.

(ii) Phased planting

It refers to the growing of two or more crops on the same farm or field by arranging planting dates systematically to ensure continuous sequence of growth and harvesting.

(iii) Succession cropping

It is a system of multiple cropping where two or more crops are grown on the same farm or field within a year with one crop planted after the harvest of a preceding one.

(b) This sub-question was well answered by candidates who correctly gave ways in which weeds are of importance to a vegetable farmer.

However, ways such as the following were rarely given:

- weeds increase cost of production of crops;
- weeds cause a decline in crop yield by competing with crops for water, nutrients, sunlight and space;
- weeds act as alternative host to pests and diseases of crops;
- some weeds are medicinal.

(c) This sub-question on ways in which spear grass could be controlled in a yam farm was badly answered.

Candidates should note that spear grass could be controlled by:

- ploughing and harrowing during dry season;
- use of systemic herbicides;
- embarking on good crop rotation.

(d) Most of the candidates gave correct examples of hedging plants.
Their correct answers include:

- Blue duranta
- Ice plant
- Hibiscus
- Croton
- pride of Barbados
- Lantana
- Blue plumbago
- Thumbegia
- Milkbush
- Bougainvillea

Candidates' difficulty in giving examples of hedging plants was wrong spellings of names which caused them valuable marks.

QUESTION 4

(a) (i) What is organic farming?

(ii) Mention five benefits of consuming food produced through organic farming.

(b) Discuss four effects of poor-quality vegetables on the health of consumers.

(c) Mention five ways for ensuring quality and safety standards in the pineapple industry.

This question was attempted by only a few candidates and general performance was poor. Perhaps the topics "Organic farming, Quality and Safety Standard in food industry" are not properly taught in schools.

(a) (i) A lot of candidates could not clearly explain the term "Organic farming". It is, therefore, useful for candidates to note that organic farming is a practice of farming that avoids the use of agro-chemicals but encourage the use of botanicals or manure from living organisms or use of biological control.

(ii) Again, only a few candidates were able to mention the benefits of food produced from organic farming.

Their correct responses include:

- food tastes better;
- quality of fruits and vegetables produced are nutritionally superior to those grown conventionally;
- food produced organically have longer shelf life;

- food generally do not pose health problems.

(b) This sub-question was fairly well answered by few of the candidates who correctly stated the effects of poor-quality vegetables on health of consumers.

Most of them, however, could not adequately explain the stated effects.
Obvious effects such as the following were, however, hardly stated.

- cancer of lungs and throats as a result of chemical contamination of vegetables;
- chemicals contamination of vegetables may lead to hormonal imbalance causing infertility.

(c) Majority of the candidates were not able to mention and discuss ways of ensuring quality and safety standards in pineapple industry satisfactorily.

Expected answers include the following:

- strict adherence to time lapse between application of chemicals, harvest and use of the crop;
- ensure cleanliness in packaging, handling and transportation;
- apply correct dosage of chemicals;
- practice organic farming;
- clean harvested produce before packaging and storage;
- harvest produce at the appropriate stage of ripening.

QUESTION 5

(a) **Explain six effects of pests in crop production.**
(b) **Discuss three cultural methods of controlling pests in crop production.**
(c) **Mention two ways in which soil living organisms is important in vegetable farming.**

The performance of candidates on this question was generally good.

(a) Candidates were generally able to explain the effects of pests in crop production well and scored full marks in most cases.

However, few of the effects which were hardly mentioned include:

- defoliation of leaves of crop plants;
- injection of toxins into fruits leading to secondary infection;
- attack young shoots and leaves making them susceptible to fungal attack.

(b) Most of the candidates correctly enumerated cultural methods of controlling pests in crop production.

Their correct answers include:

- to practice crop rotation;
- ploughing and harrowing to overturn the soil to expose pathogens in the soil
- timing of planting to avoid pests and pathogens.

(c) Candidates' performance on this sub-question was only fair as most of them were able to mention the importance of soil living organisms in vegetable farming.

Their correct importance include:

- decomposed organic matter and mix them with soil leading to increase soil fertility;
- convert atmospheric nitrogen unto nitrogenous compound in the soil to be used by plants.

QUESTION 6

(a) Discuss the production of tomato under the following headings:

(i) soil requirement;
(ii) land preparation;
(iii) varieties;
(iv) transplanting;
(v) uses.

(b) List four actors involved in the tomato enterprise in West Africa.

Many candidates attempted this question and performed fairly well on it.

(a) Generally, candidates did not find much difficulties in discussing the production of tomato under the following headings: soil requirement, land preparation, varieties, transplanting and uses.

Their correct responses include the following:

Soil requirement

Fertile soil i.e., well aerated, deep, well drained and loamy soils, neutral pH and rich in minerals soil.

Land preparation

Slash with cutlass, fell trees, remove stumps and burn, plough and harrow field, prepare ridges to allow for good growth, dig planting holes of planting distance of 60 cm x 60 cm.

Varieties

Roma V.F, Laurano, Raki, Rasta, Ronita Owusu Bio

Transplanting

- seedlings are transplanted when they are about 3 to 4 weeks old;
- transplanted at a spacing of 60 cm within rows and 60 cm to 75 cm between rows
- transplanting is done early in the morning or late in the afternoon
- water seedlings before and after transplanting

Uses

- food in the form of paste or tomato puree,
- food in the form of stew;
- food in the form of soup.

(b) Candidates appeared to have a fairly good knowledge of actors involved in the tomato enterprise in West Africa.

The actors involved include:

- tractor operators;
- farmers;
- country buyers;
- processors
- wholesalers;
- middle men / women;
- retailers;
- market queens.

CROP HUSBANDRY AND HORTICULTURE 3

1. GENERAL COMMENTS

The standard of the paper in terms of both level of difficulty and syllabus coverage compares favourably with those of previous years.

However, candidates' performance is generally lower than last year.

2. SUMMARY OF CANDIDATES' STRENGTHS

The Chief Examiner observed the following as some of the strengths of candidates:

(1) Most of the candidates worked according to the rubrics of the paper.

(2) A good number of candidates exhibited fairly good knowledge about the operation carried out on budded citrus seedling and reasons for carrying out budding.

(3) Majority of the candidates were able to correctly identify a pair of secateurs and garden line.

3. SUMMARY OF CANDIDATES' WEAKNESSES

The Chief Examiner identified the following as weaknesses exhibited by candidates:

(1) Several candidates lacked understanding and correct uses of horticultural terminologies

(2) Majority of the candidates could not state factors affecting success of budding of citrus seedlings

(3) Some candidates could not state satisfactorily disadvantages of using clay pot for propagating ornamental plants

4. SUGGESTED REMEDIES

The Chief Examiner recommended the following remedies:

(1) Scientific words and horticultural terminologies should be carefully taught

(2) Concerted efforts should be made by students to cover the entire syllabus especially in the area of budding and grafting

(3) Practical lessons should be organized more frequently, supervised and discussed

5. DETAILED COMMENTS

QUESTION 1

(a) **Outline the steps involved in preparing specimen A for planting.**

(b) **Name four varieties of the crop from which specimen A was obtained.**

(c) **Mention three factors which could promote the disease condition of specimen B.**

(d) **Name four planting materials used for propagating specimen B.**

Many candidates attempted this question but failed to answer it satisfactorily.

(a) Most of the candidates answered this sub-question well but their responses did not follow the sequential order.

The correct steps involved in preparing pineapple sucker for planting involved:

- trim the dead vegetative materials;
- treat in appropriate chemicals;
- sun dry for about seven days;
- leave in upright position for about 18 – 24 hours before planting.

(b) Candidates readily provided varieties of pineapple (Specimen A). Their correct responses include:

- Sugar leaf;
- Red Spanish;
- Abakka;
- Queen;
- MD Two;
- Cayenne.

However, some candidates lost marks due to wrong spellings of varieties of pineapple.

(c) Candidates' performance in this question was generally below average.

Candidates should note that the factors which promote the disease condition of specimen B (a tuber of yam with rot) include the following:

- poor harvesting or injury during harvesting;
- bruises during packaging or storage;
- poor handling during transportation;
- when planted in soils infested by nematodes;
- when exposed to humid conditions;
- when stored in closed environment or in poor ventilated environment.

(d) Most candidates correctly stated the planting materials of Specimen B (tuber of yam with rot).

Expected planting materials include:

- yam seed;
- pieces of vine;
- true setts or setts;
- mini setts or microsetts;
- tissue culture.

QUESTION 2

(a) (i) Name the operation that was carried out on specimen C.

(ii) Give three reasons for carrying-out the operation on specimen C.

(iii) State three factors which could affect the success of the operation carried out on specimen C.

(b) State four horticultural uses of specimen D.

(c) Mention four methods of using specimen E to establish a lawn.

Performance of candidates on this question was poor. This raises the issue of whether grafting and budding are being properly taught in schools.

(a) (i) The operation carried out on specimen C (a budded citrus seedling) was correctly named by some candidates as budding or grafting.

(ii) A lot of candidates could not adequately state the reasons for carrying out budding.

Reasons that most of them did not state include the following:

- to prevent diseases or control soil borne diseases;
- early maturity of fruits / precosity;
- two varieties of fruits on one plant;
- to control height;
- to produce fruits that are true-to-type.

(iii) Most of the candidates were not able to state correctly factors affecting success of budding or grafting operation.

Candidates should however, note that factors affecting success of budding or grafting operation include the following:

- joint must be protected from drying;
- scion and stock should be about the same size in diameter;
- using budding tape to wrap the union firmly;
- avoid wetting cut surfaces;
- cambium matching the cambium of the stock;
- water or irrigate regularly.

(b) Candidates had some knowledge of the horticultural uses of specimen D (Rose plant). However, most of them could not give the required number of uses.

Other horticultural uses include:

- as specimen plant;
- as cut flower;
- as a hedging plant;
- means of showing affection / love;
- beautify the environment.

(c) This sub-question was well answered by most of the candidates. The expected methods of establishing specimen E (Love/Tafo grass) include:

- sprigging;
- sodding;
- plugging;
- seeding.

QUESTION 3

(a) (i) Mention two uses of specimen F.

(ii) State three ways of maintaining specimen F.

(b) State three uses of specimen G.

(c) (i) Give three disadvantages of using specimen H as pot for propagating ornamental plants.

(ii) Mention two management practices that should be carried out on specimen H before using it for propagation of ornamental plants.

This question was well answered by most candidates.

(a) (i) Most of the candidates correctly stated the uses of Specimen F (a pair of secateurs) as indicated below:

- for trimming leaves, roots, flowers etc
- for cutting budwood;
- for preparing leaf cutting;
- for preparing stem cuttings.

(ii) Candidates appeared to lack adequate knowledge of how to maintain a pair of secateurs.

Maintenance practices hardly mentioned include:

- replace spring when weak or loose;
- tighten bolt and nut when necessary;
- sharpen metal parts or blades.

(b) Majority of candidates gave correct uses of specimen G (Garden line). Their correct responses include the following:

- for making straight lines;
- for lining up beds;
- for measuring plots;
- for pegging plots.

(c) (i) Candidates appeared to lack adequate knowledge of the disadvantages of using clay pot (Specimen H) for propagating ornamental plants.

The expected disadvantages include:

- pots breaks when roots of plants expand or when pot falls down
- heavy to handle or difficult to transport
- toxic salts tend to build up when used for a long period
- encourages growth of algae.

(ii) Most of the candidates correctly stated management practices carried out on clay pot (Specimen H) before it could be used for propagating ornamental plants.

The correct management practices are:

- wash well before use;
- soak in water overnight before use;
- crocking the pot before filling with soil.

(iii) Candidates correctly provided examples of containers which could be used in place of clay pot in propagation of ornamental plants.

Examples given are outlined below:

- plastic pots
- fibre grass pots
- metal pots
- bamboo
- calabash
- seed tray
- polythene bags
- concrete pot

QUESTION 4

(a) (i) Mention two fungal diseases of crop from which specimen J was obtained.

(ii) State four uses of the crop from which specimen J was obtained.

(iii) Mention three varieties of crop from which specimen J was obtained.

(b) (i) Give the soil and rainfall requirements of crop from which specimen K was obtained.

(ii) Name two products that could be obtained from processing specimen K.

(a) Majority of the candidates performed well in this sub-question as they correctly provided the fungal diseases, uses and varieties of specimen J (oil palm fruits).

(i) Fungal diseases of specimen J (oil palm fruits)

- Anthracnose
- Cercospora
- Fusarium wilt
- *Phytophthora palmivora*

(ii) Uses of crop from which oil palm fruit was obtained

- cosmetics
- kernel oil for cooking
- palm oil for polish, lubricant, margarine
- leaves for making brooms and roofing materials
- palm fronds for making baskets
- oil for making soap

(iii) Varieties of crop from which oil palm was obtained

- Microcarya
- Dura
- Tenera
- Pisifera

Some candidates, however, lost marks either due to wrong spellings of technical words or did not follow the basic rules for writing scientific names

(b) Although these sub-questions were fairly well answered, a few could not identify specimen K as cocoa pod, therefore had their responses wrong.

Their correct responses are given below:

(i) Rainfall and soil requirements for cultivation of specimen K (cocoa pod).

Rainfall and soil requirements for the crop from which specimen K (cocoa pod) was obtained were outlined below:

Rainfall is between 1,000 – 3,000 mm per annum averaging 1,500 mm annually, fairly distributed throughout.

Soil should be deep, well drained, clay loam, rich in mineral nutrients and slightly acidic to slightly alkaline.

(ii) Products derived from processing specimen K (Cocoa pod) are listed below

- chocolate
- cocoa butter
- alcoholic beverages
- cosmetic