8.0 CHEMISTRY (233)

Chemistry is tested using three papers. ***Paper 1 (233/1)***, a theory paper tests the entire syllabus. Each item carries a minimum of one mark and a maximum of three marks. ***Paper 2 (233/2)*** is also a theory paper and tests in-depth particular topics in the syllabus. Each question carries between 10 and 15 marks. Both are marked out of 80 marks and each is tested in 2 hours. ***Paper 3 (233/3)*** is a practical paper marked out of 40 marks. Questions in this paper can be set from any section of the syllabus and is taken in 2 ¼ hours.

8.1 CANDIDATES' GENERAL PERFORMANCE

The table below shows performance in Chemistry in the years 2006 and 2007.

Table 11: Candidates Overall Performance in Chemistry in the years 2006 and 2007

Year	Paper	Candidature	Maximum score	Mean Score	Standard Deviation
2006	1		80	20.79	14.95
	2		80	17.56	13.82
	3		40	11.48	5.10
	Overall	**236,831**	**200**	**49.82**	**32.00**
2007	1		80	19.67	15.26
	2		80	19.22	13.45
	3		40	11.87	4.95
	Overall	**267,719**	**200**	**50.78**	**31.00**

From the table above, it can be observed that:

8.1.1 There was an increase in candidature of ***30,888*** candidates, representing a percentage increase of approximately ***13%*** in the year 2007 when compared to the year 2006. This means that the subject is quite popular in most schools.

8.1.2 There was a slight drop in performance in ***paper 1 (233/1)*** where the mean score dropped from ***20.79*** in the year 2006 to ***19.67*** in the year 2007. Most of the questions in this paper were practical oriented and therefore candidates from schools without well equipped laboratories and where the practical approach may not have been used during teaching may have had difficulties in responding to them.

8.1.3 There was improvement in candidates' performance in ***paper 2 (233/2)*** where the mean score went up in the year 2007 to ***19.22*** compared to ***17.56*** in the year 2006.

8.1.4 Performance in ***paper 3 (233/3)*** improved slightly when compared to that of the year 2006.

8.1.5 Overall performance in the subject improved slightly by about 3%, from ***49.82*** in the year 2006 to ***50.78*** in the year 2007

Questions where candidates' performance was poor are discussed below.

8.2 PAPER 1 (233/1)

Question 6

In an experiment, a few drops of concentrated nitric (V) acid were added to aqueous iron (II) sulphate in a test-tube. Excess sodium hydroxide solution was then added to the mixture.

(a) State the observations that were made when:

(i) concentrated nitric (V) acid was added to the aqueous iron (II) sulphate.

(ii) excess sodium hydroxide was added to the mixture.

(b) Write an ionic equation for the reaction which occurred in (a)(ii) above.

In this question, candidates were required to state the observations made when concentrated nitric (V) acid was added to iron (II) sulphate solution and when excess Sodium hydroxide was added to iron (II) sulphate solution. Candidates were also expected to write an ionic equation for the reaction between iron (II) sulphate solution and sodium hydroxide.

Weaknesses

Candidates failed to state the observations made when concentrated nitric (V) acid was added to aqueous iron (II) sulphate. Some incorrect responses given by candidates included ***"yellow precipitate formed"***, ***"a clear solution is formed"***, ***"there was effervescence"***, and ***"a colorless gas with the smell of rotten eggs"***.

Candidates should have realized that concentrated nitric (V) acid is an oxidizing agent and thus would oxidize Fe^{2+} to Fe^{3+}. Presence of Fe^{3+} in solution would make the color of the solution either yellow or brown. Iron (II) sulphate is soluble and thus a precipitate would not be formed. They should have also recalled that Fe^{2+} and Fe^{3+} are colored ions and therefore a white precipitate would not have resulted. Candidates also lost marks because they did not state the correct color of the solutions.

Some candidates wrote incorrect equations, for example:

- $Na^{+}_{(aq)} + Fe^{2+}_{aq} + 2OH^{-}_{(aq)} \rightarrow Fe(OH)_2Na$
- $Fe^{2+}_{(aq)} + 2(OH)^{-}_{(aq)} \rightarrow Fe(OH)_{2(s)}$
- $FeSO_{4(aq)} + NaOH_{(aq)} \rightarrow Fe(OH)_3 + NaNO_3$

The wrong responses given are a clear indication that the reactions of $Fe^{2+}_{(aq)}$ with oxidizing agents and with NaOH are not known. These are simple reactions which every student is supposed to have performed. Chemistry becomes interesting if an investigatory approach is used during teaching.

Expected Responses

(a)

(i) The color of the solution changed from ***pale green*** to ***yellow*** or ***brown.***

(ii) A brown precipitate is formed.

(b) $Fe^{3+}_{(aq)} + 3OH^{-}_{(aq)} \rightarrow Fe(OH)_{3(s)}$

Advice to Teachers

Teachers are advised to allow the students to carry out experiments and record their observations. Those observations should then be discussed in class. If ionic equations are required, it should be made very clear that only the species that participate in the reaction should be written. Equations should have correct state symbols and all formulae **MUST** be correct. Spectator ions should be left.

Question 10

The thermochemical equations for the formation of hydrogen peroxide under standard conditions are:

$$H_{2(g)} + O_{2(g)} \longrightarrow H_2O_{2(g)};\ \Delta H_f^{\theta} = -133 kJmol^{-1}$$
$$H_{2(g)} + O_{2(g)} \longrightarrow H_2O_{2(l)};\ \Delta H_f^{\theta} = -188\ kJmol^{-1}$$

Write the thermochemical equation for the molar heat of vaporisation of hydrogen peroxide.

Candidates were required to write a thermochemical equation for hydrogen peroxide when it changes from liquid state to gaseous state.

Weaknesses

Majority of candidates did not know the meaning of a ***themochemical equation***. Some of the equations were not balanced and lacked correct state symbols. The value of the energy change was also not included in the equations. The weaknesses stated above may have resulted from poor tuition on the topic concerning energy changes.

Expected Response

$$H_2O_{2(l)} \rightarrow H_2O_{2(g)} \Delta H_f^{\theta} = -55KjMol^{-1}$$

A thermochemical equation should have all the reactants and products, their correct state symbols and the valuc of cnergy that accompanies thc reaction

Advice to Teachers

Teachers are advised that terms used in thermochemistry, for example: thermochemical equation, Hess's law, heat of vaporization etc should be explained to students properly. Examples should be given and where possible, rigorous evaluation should be made at the end of the topic. This is not an easy topic and thus time must be spent on it and remedial tuition given to poor students.

Question 16

The table below shows the tests that were carried out on solid N and the observations made.

	Test	Observations
I	Solid N was heated	Solid N turned from white to yellow.
II	Dilute hydrochloric acid was added to solid N.	A colourless solution was formed.
III	To the colourless solution obtained in test II, excess sodium hydroxide solution was added.	A white precipitate was formed which dissolved to form a colourless solution.

Write the formula of the anion in:

(a) solid **N**
(b) the colourless solution formed in test III.

The candidates were expected to analyze the results of the tests performed on solid **N**, interpret the results and then give the anion present in solid N and in the colorless solution.

Weaknesses

- Candidates appear not to know the meaning of the term ***"anion"***. A good number of examinees gave the formulae of positively charged ions, for example: Zn^{2+}.
- Quite a large number of candidates could not identify the correct anion in solid **N** and in the colourless solution. Some wrong responses given by candidates are; OH^{-}, CO^{2}_{3}, N^{-2}, NO_3^{-} etc.
- Some of the candidates who identified the correct anions were not able to write the correct formulae, for example: $Zn(OH)_2$ $[Zn(OH)_2^{2-}]$ $[Zn(OH)_4Na]^{-}$.
- Candidates were expected to recall that when substances are heated some undergo permanent and others temporary changes. Oxides of zinc and lead undergo temporary changes when heated. Candidates' responses indicated that some had not heated these common substances before.

Expected Responses

a) O^{2-}

b) $[Zn(OH)_4]^{2-}$

Advice to Teachers

It is strongly recommended that all schools should have adequate facilities to use during teaching and for examination purposes. Terms should be explained properly and where possible illustrated by use of suitable examples. All parts of the syllabus will be examined whether in the theory or practical papers. Each section of the set syllabus should thus be given adequate coverage.

Question 18

Starting with sodium metal, describe how a sample of crystals of sodium hydrogen carbonate may be prepared.

Candidates were required to give a precise and logical description of how a sample of crystals of sodium hydrogen carbonate can be prepared starting with sodium metal.

Weaknesses

Candidates did not give a precise description of the procedure followed in order to prepare a sample of sodium hydrogen carbonate. Some did not realize that sodium is a highly reactive metal hence it could not be reacted with dilute acids. Other candidates got confused and described the Solvay process. Candidates were required to realize that sodium is a group 1 metal and therefore very highly reactive especially with acids. Those who gave an explanation involving use of dilute acids did not even know that the reaction is explosive. These weaknesses could have been caused by poor tuition especially where experiments are not conducted. The candidates who described the Solvay process perhaps did not read the question carefully. As has been suggested in previous editions of this report, candidates should read each question thoroughly, interpret it correctly and plan on how to proceed from the beginning to the end.

Expected Responses

Heat sodium metal in air to form sodium oxide. Dissolve the oxide in water to form sodium hydroxide. Bubble excess carbon (IV) oxide to form sodium hydrogen carbonate. Warm the solution to obtain a concentrated mixture. Cool the solution for the crystals to form. Filter and dry the crystals between pieces of papers. It should be noted that these crystals cannot be dried by use of an oven at high temperatures because sodium hydrogen carbonate would decompose.

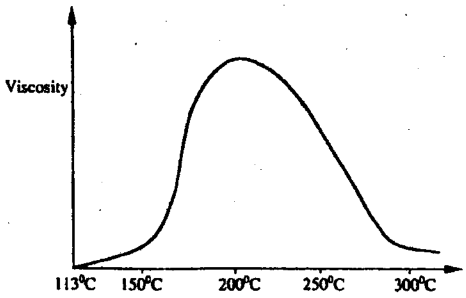
Advice to Teachers

Teachers are advised to carry out well planned reactions of these metals with water. Precautions to be observed should be stressed. Comparison of the reactivity of these metals with water and acids should be discussed quite well. Students should therefore be able to know the reasons why the metals should never be reacted with acids.

Candidates are also reminded that questions on procedures need to be logically planned. If one does **NOT** start the procedure correctly, then everything would be wrong, and all the marks would be lost. One should therefore plan on the steps involved and then arrange the steps logically. They should also state why each mentioned step is necessary.

Question 30

Below is a sketch of a graph showing the change in viscosity (Ease of flow) with temperature when solid sulphur is heated.



Describe what happens to the sulphur molecules when sulphur is heated from 150°C to about 200°C.

In this question, candidates were expected to describe the changes that occur to sulphur molecules when the solid is heated from 150°C to 200°C.

Weaknesses

Candidates did not relate the increase in viscosity to the changes occurring to the molecules of sulphur. Some candidates wrote ***"the viscosity increases as the temperature increases"***. No mention was made of the changes to the molecules of sulphur as was required by the question.

The type of responses given by candidates, for example: ***"sulphur combines with oxygen to form sulphur (IV) dioxide"*** show that the candidates did not quite understand the question. They just attempted to reproduce information in some text books. Questions in science may not be that direct hence patience is necessary when reading each question. Candidates should make sure they have fully understood the problem before they begin to give answers. Deeper and clear understanding of the concept being tested is necessary. Enough time should therefore be allowed for each question in order to read and understand the question so as to plan on how to give a short and precise response to it.

The responses stated above could have resulted from poor discussion of the observations made when sulphur is heated. An attempt should be made to give clear explanations for the changes observed when sulphur is heated from room temperature to boiling. This way, students will understand why it melts and flows easily but as the temperature increases it does not flow easily. On further heating, it flows quite easily as shown by the viscosity decreasing.

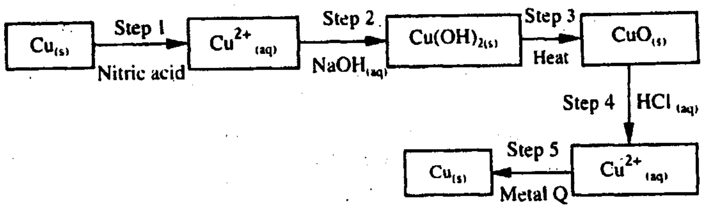
Expected Responses

The S_8 rings in sulphur are broken down to form S_8 chains. These chains entangle (join together) to form huge molecules of sulphur which do not flow easily.

8.3 PAPER 2 (233/2)

Question 3

The flow chart below shows a sequence of chemical reactions starting with copper. Study it and answer the questions that follow.



(a) In step 1, excess 3M nitric (V) acid was added to 0.5g of copper powder.

(i) State **two** observations which were made when the reaction was in progress.

(ii) Explain why dilute hydrochloric acid cannot be used in step 1.

(iii) I Write the equation for the reaction that took place in step 1.

II Calculate the volume of 3M nitric (V) acid that was needed to react completely with 0.5g of copper powder. (Cu=63.5).

(b) Give the names of the types of reactions that took place in steps 4 and 5.

Step 4

Step 5

(c) Apart from the good conductivity of electricity, state **two** other properties that make it possible for copper to be extensively used in the electrical industry.

The candidates were required to study and understand the reactions given in the flow chart starting with copper powder and then:

- State the observations made when 3M nitric (V) acid was reacted with copper powder.

- Compare the reactions of 3M nitric (V) acid with copper powder with dilute hydrochloric acid hence explain why there is a difference.
- Write the equation for the reaction between copper and nitric (V) acid and use the equation to calculate the volume of acid required to react completely with 0.5g of copper powder.
- Identify neutralization and displacement reactions in the flow chart.
- State properties of copper metal associated with its use in the electrical industry.

Weaknesses

The following weaknesses were noted in the candidates' responses:

- Many candidates did not realize that 3M nitric (V) acid is concentrated enough to act as an oxidizing agent and that dilute hydrochloric acid is not. Some candidates stated that hydrogen gas was produced.
- Some candidates did not quite understand the question thus giving the incorrect responses, for example: "***copper is below hydrogen in the activity series hence it could not displace hydrogen***". This was not required.
- Candidates did not know how the equation for the reaction between concentrated nitric (V) acid and copper is written. They could not also use it correctly to calculate the volume of 3M nitric (V) acid used during the reaction.
- A few candidates could not identity the correct type of reaction in steps 4 and 5 in the flow chart while others could not name the properties of copper used in the electrical industry.

Candidates were supposed to realize that 3M nitric (V) acid is an oxidizing agent and would thus oxidize copper to copper nitrate while it is reduced to nitrogen (IV) oxide. Consequently, they should have given the colour for copper nitrate which is blue and that for nitrogen (IV) oxide which is brown. They should have also realized that dilute hydrochloric acid not being an oxidizing agent could not react with copper metal.

Expected Responses

(a) (i) Brown gas;
Blue solution.

(ii) Dilute hydrochloric acid is not an oxidizing agent and therefore has no effect on copper.

(iii) I $Cu_{(s)} + 4HNO_{3(aq)} \rightarrow (Cu(NO_3)_{2(aq0} + 2NO_{2(g)} + 2H_2O_{(l)}$

II Moles of Cu $= \frac{0.5}{63.5} = 0.007874$

Moles of HNO_3 $=$ 4 x 0.007874

$=$ 0.03149

Volume of HNO_3 $= \frac{0.03149x1000}{3}$

$=$ 10.5 cm^3

(b)

- Step 4: neutralization;
- Step 5: displacement.

(c)

- It does not corrode easily, that is, it is unreactive.
- It is ductile.
- Has high melting point.

Advice to Teachers

Equations involving concentrated nitric (V) acid are not often tested. Teachers and students may have perhaps not concentrated on this topic. Teachers and students are advised not to ignore any section of the syllabus if they do not want to be caught unawares. Balancing of equations is not an easy task for the average and below average students. Enough practice should therefore be given in writing equations for different types of reactions, for example: Redox, Precipitation, displacement, acid/base, acid/metal, acid/carbonate etc. It should be emphasized that where an equation is required for a calculation, it ***MUST*** be balanced. Time should be taken to ensure equations are balanced.

Question 4

(a) Methanol is manufactured from carbon (IV) oxide and hydrogen gas according to the equation:

$$CO_{2(g)} + 3H_{2(g)} \rightleftharpoons CH_3OH_{(g)} + H_2O_{(g)}$$

The reaction is carried out in the presence of a chromium catalyst at 700K and 30kPa. Under these conditions, an equilibrium is reached when 2% of the carbon (IV) oxide is converted to methanol.

(i) How does the rate of the forward reaction compare with that of the reverse reaction when 2% of the carbon (IV) oxide is converted to methanol?

(ii) Explain how each of the following would affect the yield of methanol:

I reduction in pressure

II using a more efficient catalyst.

(iii) If the reaction is carried out at 500K and 30 kPa, the percentage of carbon (IV) oxide converted to methanol is higher than 2%.

I. What is the sign of ΔH for the reaction? Give a reason.

II Explain why in practice the reaction is carried out at 700K but NOT at 500K.

(b) Hydrogen peroxide decomposes according to the following equation:

$2H_2O_2\,(aq) \rightarrow 2H_2O(l) + O_2(g)$

In an experiment, the rate of decomposition of hydrogen peroxide was found to be 6.0×10^{-8} mol dm^{-3} S^{-1}.

(i) Calculate the number of moles per dm^3 of hydrogen peroxide that had decomposed within the first 2 minutes.

(ii) In another experiment, the rate of decomposition was found to be 1.8×10^{-7} mol dm^{-3}S^{-1}. The difference in the two rates could have been caused by addition of a catalyst. State, giving reasons, one other factor that may have caused the difference in the two rates of decomposition.

This question was purely on application of knowledge on equilibria. It required the candidates to understand the equation and then use their acquired knowledge to:

- State how the rates of the forward and backward reactions compare.
- Explain the effect of reduction of pressure and use of a more efficient catalyst on the yield of product (yield of ammonia).
- Give the sign of the heat of reaction ΔH and explain why the reaction is carried out at 700K rather than 500K.
- Use the equation for decomposition of hydrogen peroxide to calculate the amount of hydrogen peroxide that would decompose in a given time and state other factors which could increase its rate of decomposition.

Weaknesses

Candidates of above average ability were able to score most of the marks allocated to the question. However, those of average and below average abilities could not:

- State how the rates compared.
- Explain the effect of reduction of pressure and use of a more efficient catalyst on the yield of ammonia.
- Give the sign of ΔH.
- Explain why the reaction in practice is carried out at 700K rather than 500K.

Questions in paper 2 (233/2) are supposed to test in-depth knowledge on some particular topics. Candidates seemed not to have mastered the content in ***rates of reaction, factors that affect systems in equilibrium*** etc. Candidates should have known that systems come to a state of (balance) equilibrium when the rates of forward and backward reactions are the same. Looking at the equation, it is clear that there are 4 moles of the reactants against 2 moles of the product. By the ***le Chatelier's principle***, if the pressure is reduced, the system will adjust itself in order to reduce the effect. It can only do this by shifting the position of the equilibrium in the direction in which more moles are produced and in this case towards the left. This has the effect of reducing the yield of ammonia.

Catalysts are substances that only affect the rates at which equilibrium is established. A more efficient catalyst can only reduce the time for a reaction to come to an end and ***NOT*** the yield of ammonia. The yield of methanol is more at lower temperature of 500K than 700K. By le Chatelier's principle, when temperature is reduced, the system shifts in the direction in which heat energy is evolved. Reactions in which energy is evolved are exothermic and therefore the sign of ΔH is negative. Reactions can be quite slow at low temperatures and thus a lot of time is lost before a reasonable amount of product is realized. This particular reaction is carried out at 700K rather than 500k so that more yield of methanol can be realized within a shorter time.

Expected Responses

(a) (i) The rate of the forward reaction is the same as that of the backward reaction.

(ii) I Reduction of pressure shifts the equilibrium to the left hence the yield of ammonia is lower.

II The yield remains the same. Catalysts only change the rate of attainment of equilibrium and **NOT** the amounts of species present in the equilibrium mixture.

(iii) I ΔH is (-ve) when the temperature is lowered, the system shifts in the direction in which heat is evolved.

II At 500K, the rate of reaction is lower than at 700K.

(b) (i) I Time = 2 x 60

= 120 sec.

No. of molsdm^{-3} = $6 \times 120 \times 10^{-8}$

= 7.2×10^{-6} molsdm^{-3}

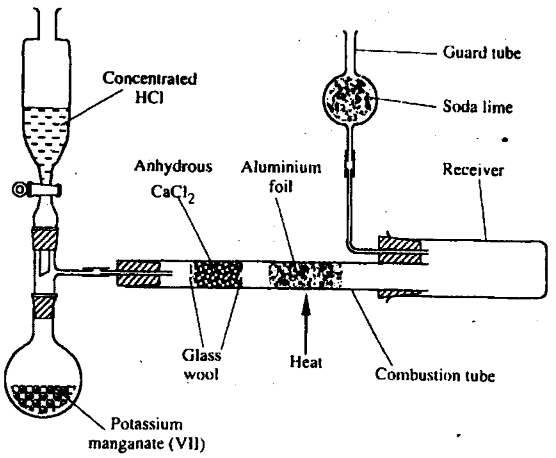
II Heating or warming increases kinetic energy, therefore frequency of high energy collisions increase hence the rate of reaction.

Advice to Teachers

Teachers should ensure that a deeper understanding of each topic is realized. The reasons for the use of particular conditions in industrial processes should be brought out very clearly. A visit to the manufacturing industries may assist a lot.

Question 7

The diagram below shows the set up used in an experiment to prepare chlorine gas and react it with aluminium foil. Study it and answer the questions that follow.



(a) In the experiment, concentrated hydrochloric acid and potassium manganate (VII) were used to prepare chlorine gas. State **two** precautions that should be taken in carrying out this experiment.

(b) Write the formula of another compound that could be used instead of potassium manganate (VII).

(c) Explain why it is necessary to allow the acid to drip slowly onto potassium manganate (VII) before the aluminium foil is heated.

(d) State the property of the product formed in the combustion tube that makes it possible for it to be collected in the receiver.

(e) When 1.08g of aluminium foil were heated in a stream of chlorine gas, the mass of the product formed was 3.47g.

Calculate the:

(i) maximum mass of the product formed if chlorine was in excess; (Al=27; Cl=35.5)

(ii) percentage yield of the product formed.

(f) Phosphorus trichloride is a liquid at room temperature. What modification should be made to the set up if it is to be used to prepare phosphorus trichloride?

The question required the candidates to state:

- The precautions that should be taken in carrying out experiments involving the use of concentrated acids and chlorine gas.
- Precautions to be taken in order to obtain a pure sample of the desired product ($AlCl_3$).
- The properties of aluminium chloride.
- It also required the candidates to calculate the mass of the product and its percentage yield.
- In addition, it also required the candidates to show how the set up of apparatus could be changed in order to collect a product initially formed in gaseous state but required in liquid state.

Weaknesses

- Many candidates were able to state the use of a fume cupboard but failed to mention the precaution to be taken in handling concentrated acids.
- Another set of candidates were not able to state why it is necessary to allow the acid to drip on to the potassium manganate (VII) before heating the aluminum foil.
- Candidates of average and below average abilities were not able to calculate the percentage yield while others could not state the necessary modifications for the set up to be used to collect a liquid product.

Candidates should have realized that concentrated hydrochloric acid is corrosive and produces harmful fumes. Chlorine is also a poisonous gas. They should therefore have mentioned the use of gloves in handling concentrated acid and carrying out the experiment in a fume cupboard in order to avoid poisoning by toxic fumes from hydrochloric acid and chlorine gas. Candidates were also required to realize that the apparatus contained oxygen at the beginning and this had to be removed so that the oxygen does not react with heated aluminium to form aluminium oxide.

Masses of products are usually different when a limited amount of one reactant is used. The mass is lower than when an excess is used. The use of excess chlorine gas converted all the 1.08g of aluminium and the product was expected to be more than 3.47g. The candidates who failed in this question may perhaps not have performed experiments involving the use of concentrated acids and the production of poisonous gases.

Expected Responses

(a)

- Use a fume cupboard;
- Use safety goggles;
- Wear gloves.

(b) MnO_2, $K_2Cr_2O_7$, PbO_2

(c) To displace air from the apparatus.
Heated aluminium may react with oxygen to form an impurity (AL_2O_3)

(d) Sublimes

(e) (i) $2Al_{(s)} + 3Cl_{2(g)} \rightarrow 2AlCl_{3(s)}$

R.F.M. of $AlCl_3$	=	133.5
54g of Al	=	267g of $AlCl_3$
1.08g of Al	=	$\frac{267x1.08}{54}$
	=	5.34 (g)

This is the mass of the $AlCl_3$ that would be formed if excess chlorine gas is used.

(ii) % yield $= \frac{3.47}{5.34}x100$

$= 65\%$

(f) Replace the receiver with a flask dipped in ice-cold water.

Advice to Teachers

Students should be exposed to various types of experiments during teaching. Reasons for taking precautions should also be explained very well. Where it may not be possible to carry out experiments individually, a well designed demonstration should be undertaken. In all cases, theoretical teaching should be avoided.

8.4 PAPER 3 (233/3)

This is a practical paper where candidates are tested on manipulative skills, ability to obtain accurate results (data) and the use of the results (data) to make correct scientific conclusions.

In question 1, candidates were able to make accurate use of volumetric flasks, pipette fillers, burettes, pipettes etc. This was evidenced by the results recorded during titration. Titration as a skill is thus well mastered. Reading and plotting of graphs have been a problem in the previous years, but this is no longer the case. Temperatures recorded were quite accurate and candidates were able to present good graphs. Candidates however need to improve on calculations based on the results obtained.

In this paper, ***Question 2*** was poorly done and is discussed below.

Question 2

You are provided with solid E. Carry out the tests below. Write your observations and inferences in the spaces provided.

(a) **Place one half of solid E in a clean dry test-tube and heat it strongly. Test any gases produced with blue and red litmus papers.**

(b) Place the other half of solid **E** in a boiling tube. Add about 10 cm^3 of distilled water and shake until **all** the solid dissolves. (Use the solution for tests (i), (ii), (iii) and (iv).)

(i) Place two or three drops of the solution in a test-tube. Add 3 cm^3 of distilled water. Add two drops of universal indicator to the mixture obtained and then determine the P^H of the mixture.

(ii) **To about 1 cm^3 of the solution in a test-tube, add aqueous ammonia drop-wise until in excess.**

(iii) **To 2 cm^3 of the solution in a test-tube, add three or four drops of solution G (aqueous potassium iodide.)**

(iv) **To about 1 cm^3 of the solution in a test-tube, add four or five drops of barium nitrate solution. Shake the mixture then add about 1 cm^3 of dilute nitric acid and allow the mixture to stand for about 2 minutes.**

Candidates were expected to select appropriate apparatus and chemicals, follow the instructions 'strictly in carrying out the tests', plan on how best to carry out the tests in order to obtain accurate results, record the results/observations using acceptable scientific language and use the results to make accurate conclusions.

Weaknesses

Many candidates seemed not to have followed instructions and therefore they recorded wrong results /observations which led to wrong conclusions. Others appear to have made the correct observations but lacked the correct scientific language to communicate the results.

There is a need to decide on the precautions to take in order to obtain accurate results. If the observations are wrong, the conclusion(s) will also be wrong and all the marks will be lost. Apparatus must be clean. Results must be written as soon as they are made and proper language must be used to communicate the results. If a precipitate is formed, the color must be given, for example: ***white precipitate, yellow precipitate, etc.*** If on addition of reactants a clear solution is formed, its color must also be given. The color of the mixture before and after the reaction must also be given, for example: color of the solution changes from orange to green. Conclusions must also be communicated properly. If a cation is suspected to be present, its correct formula must be given and **not** the name in words.

Expected Responses

		Observations	*Inferences*
(a)		Colorless liquid formed on cool parts of test tube	Hydrated salt
		Blue litmus paper turns red Solid turns reddish brown	Acidic gas formed
(b)	(i)	Reddish brown solution formed pH 1,2 or 3	Strongly acidic solution
	(ii)	Brown precipitate Insoluble in excess	Fe^{3+}
	(iii)	Brown/black solid formed	Iodide ions oxidized to iodine
	(iv)	White precipitate settles at the bottom	SO_4^{2-} present

Advice to Teachers

Teachers should ensure that students are exposed to many types of practicals in qualitative analysis. Language used to communicate the observations and results must be checked after each experiment. Confidence must be built in the students before they sit for examinations and this can only happen with constant practice.

8.5 CONCLUSION

Teaching of chemistry as a science subject should be approached by use of investigatory methods. Experiments should be performed in all topics that demand them. The results should be carefully analyzed. Discussions of the results and clear explanations should be given after every experiment. This calls for all schools to have well equipped laboratories and well trained personnel in terms of teachers and laboratory assistants. All topics should be allowed enough time for adequate coverage. A deliberate attempt should be made to show students the usefulness of the subject in everyday life. Visits to manufacturing industries could assist in this end. It is hoped that with well planned teaching of the subject, performance in future examinations is going to be enhanced.