9.0 233 – CHEMISTRY

9.1 Candidates' Performance

Over the years, Chemistry has been tested using two theory papers. Each of the theory papers is taken in 2 hours and is marked out of 80 marks. The practical paper tests on the manipulative skills. It is taken in 2¼ hours and is marked out of 40 marks.
The table below shows performance in Chemistry in 2008, 2009, 2010 and 2011.

Table 21: Candidates' overall performance for four years

Year	Paper	Candidature	Maximum Score	Mean Score	Standard Deviation
2008	1	**296,937**	80	18.28	14.78
	2		80	15.74	13.00
	3		40	11.46	5.42
	Overall		**200**	**45.48**	**31.78**
2009	1	**329,730**	80	12.49	9.50
	2		80	14.93	12.04
	3		40	10.86	4.55
	Overall		**200**	**38.23**	**24.53**
2010	1	**347,364**	80	18.78	14.48
	2		80	16.19	13.25
	3		40	14.87	5.60
	Overall		**200**	**49.79**	**31.57**
2011	1	**403,070**	80	18.43	14.86
	2		80	16.99	13.95
	3		40	11.91	6.30
	Overall		**200**	**47.31**	**33.51**

From the table it is to be observed that:

- The candidature increased from 347,364 in 2010 to 403,070 in 2011 an increase of 16%. The mean for 233/1 remained almost the same being 18.78 in 2010 and 18.43 in 2011.
- The mean for 233/2 had a slight improvement being 16.19 in 2010 and 16.99 in 2011.
- There was a drop in performance in the practical paper, 233/3 where the mean went down from 14.87 in 2010 to 11.91 in 2011. The drop in performance in the practical paper could probably be attributed to lack of facilities in the many schools coming up and also

due to lack of adequate exposure of candidates to various manipulative skills tested in the practical examination.

QUESTIONS WHICH WERE PERFORMED POORLY ARE BRIEFLY DISCUSSED BELOW

233/1

Question 9

State **two** reasons why hydrogen is **not** commonly used as a fuel. (2 marks)

In this question, candidates were required to state two reasons why hydrogen gas is not commonly used as a fuel.

Weakness

The candidates did not state aspects of hydrogen which make it not a suitable fuel. They instead said it is less dense than air, it does nto support combustion, it is inflammable.
They should have realized that there are some aspects associated with hydrogen which make it not a good fuel. Fuels are supposed to be:

(i) Cheap
(ii) Not pollute environment
(iii) Easily transportable
(iv) Have no complications when burning
(v) Easily available

They should have realized that hydrogen is not easily available. It is very expensive, unaffordable hence not commonly used. They should also have realized that burning of hydrogen is explosive and therefore should be avoided.
When teaching production of materials, the uses of such materials should be clearly brought out. Dangers associated with the materials should also come out.

Expected Responses

(i) It is explosive
(ii) It is very expensive

Question 10

During a class experiment, chlorine gas was bubbled into a solution of potassium iodide.

(a) State the observations made. (1 mark)

(b) Using an ionic equation, explain why the reaction is redox. (2 marks)

In this question, the candidates were expected to state the:

(a) Observation made when chlorine gas is passed through a solution containing iodide ions.
(b) Use an equation to show that when chlorine reacts with iodide ions the overall is redox.

Weakness

1. Candidates could not state accurately the observations made. Some stated that the solution was decolorized!
2. Average and below average candidates were not able to write the required redox equation.

The kind of response given in Part (1) clearly indicated that candidates had not performed this experiment or a demonstration had not been carried out. Potassium iodide is colourless hence one wonders why the candidates should state it is decolorized. Experimental approach should be used as much as possible in teaching. Theoretical approach should be avoided. The fact that the candidates could not write the required equations shows that the results of experiments are not thoroughly discussed. Observations made should be given a thorough discussion and where equations are involved, balanced equations with correct state symbols written. It is once more stated equations should be balanced and should have the correct symbols. All marks will be lost if equations are not balanced. Half of the marks will be lost if state symbols are wrong or are missing.

Expected Responses

(i) Brown solid deposited

(ii) $Cl_{2(g)} + 2I^{-}(aq) \rightarrow 2Cl^{-}(aq) + I_{2(s)}$

Question 14

Two organic compounds P and Q decolourise acidified potassium manganate (VII) solution; but only P reacts with sodium metal to give a colourless gas.
Which homologous series does compound P belong? Give a reason. (2 marks)

The candidates were required to study the reactions of two organic compounds with (i) Acidified potassium manganate (VII) and (ii) sodium metal. From the observations, they were supposed to deduce the homologous series of one of them.

Weaknesses

- Candidates seem not to have understood the task.
- Majority chose the wrong homologous series e.g. alkenes, alkanoic acid
- Others did not attempt the question.
- Those who chose the wrong homologous series gave the wrong reasons hence lost all the marks.

- These type of weaknesses could result from candidates not taking enough time to read and understand the task and therefore give the response suitable for the task. The weakness could also result from the poor coverage of the syllabus and also not allowing themselves enough time for revision and also candidates not being given enough exposure in relevant experimental work.

Candidates are advised to take time to read, understand the task before beginning to give responses. Syllabus coverage is a must because questions will be set from any section of the syllabus. Each end of the chapter or topic tasks should be set and marked. Results from such tests should be thoroughly discussed to get feedback. Topics or areas found not to have been properly understood should be re-visited. Individuals who still will not have understood the topics should be given remedial teaching in order to bring them to the same level with others. Candidates and teachers should allow themselves enough time for revision among themselves and with teachers.

Organic substances which decolorize acidified potassium manganate (VII) are alkanols, alkenes and alkynes therefore **P** and **Q** could have been any of these. Out of the three only alkanols react with sodium metal.

Practical work is really crucial in order to get a clear understanding of these homologous series and therefore distinguish them.

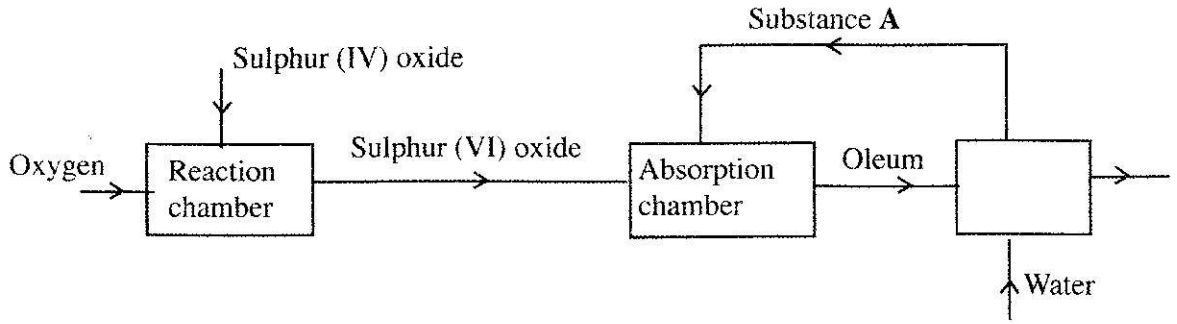
Expected Response

Alkanol because these will decolorize acidified potassium manganate (VII) and also react with sodium metal to produce hydrogen gas.

9.2 Paper 233/2

Question 1

The flow chart below shows some of the processes involved in large scale production of sulphuric (VI) acid. Use it to answer the questions that follow.



(a) Describe how oxygen is obtained from air on a large scale. (3 marks)

(b) (i) Name substance **A**. (1 mark)

.....

(ii) Write an equation for the process that takes place in the absorption chamber. (1 mark)

(c) Vanadium (V) oxide is a commonly used catalyst in the contact process.

(i) Name another catalyst which can be used for this process. (1 mark)

In this question, candidates were required to:

(i) Read and understand a flow chart on industrial production of Sulphuric (VI) acid.
(ii) Describe a logical procedure of preparing oxygen from air.
(iii) Recall processes involved in the production of sulphuric (VI) acid on industrial scale.
(iv) Name some reactions of sulphuric (VI) acid.
(v) State the uses of sulphuric (VI) acid.

Weaknesses:

1. The main weakness on this question was the candidate's failure to describe a logical concise procedure of obtaining oxygen from air in large scale.
2. Lack of clear understanding of the processes involved in industrial production of sulphuric (VI) acid.
3. Some could not recall the properties (chemical) of concentrated sulphuric (VI) acid.
4. Just a few could not name the uses of the acid.

It has been said previously that procedures in carrying out processes should be approached with care. Candidates should plan on how to start a process and how to proceed to the end. Procedure should be stepwise and following one another logically. If one of the steps is wrong or is missing then the procedure breaks down and no marks are awarded afterwards. If the first step

is wrong all the marks will be lost. Candidates should therefore take time to read and understand the question plan and then proceed to give the response.

Other candidates do not take time to read and understand a flow chart, if this happens they cannot give correct responses on any questions based on the flow chart. Understanding the chart is therefore very important when teaching preparations of materials properties of the products should be brought out clearly. The properties should be tied to some of the uses of materials. Some of the properties of concentrated sulphric (VI) acid are:

(i) Dehydration

(ii) Displacement of HCL, HNO_3 concentrated sulphuric (VI) acid can only be used as a Dehydrating agent because it can remove chemically combined water from other compounds e.g hydrated copper (II) sulphate. It can also be used to prepare HCl because it is less volatile. General uses of substances should be emphasized as one of the objectives of learning Chemistry is to produce materials which can be used to improve our standards of living. Students should be told why they should spent time and resources in learning chemistry. We need chemistry today, in future in all our lives.

Expected Responses:

(a) Purity to remove dust, bubble the air through Conc. NaOH or KOH to remove CO_2. Reduce the temperature to −25°C to remove water as ice. Compress the remaining air to liquefy it. Subject the liquefied air to fractional distillation n to obtain Oxygen at −183°C.

(b) (i) 98% Con.H_2SO4

(ii) $SO_{3(g)} + H_2SO_{4(l)} \rightarrow H_2S_2O_2$

(c) (i) Platinum or Platinized asbestos.

(ii) It is cheap and not easily poisoned.

(d) They turn from blue to white and form a powder. Conc. Sulphuric (VI) acid dehydrates hydrated copper (II) sulpate crystals forming anhydrous copper (II) sulphate.

(e) H_2SO4 is less volatile

(f) - Manufacture of ammonium sulphate fertilizers.
- Cleaning metals pickling
Any commercial use.

Question 4

(a) When excess calcium metal was added to 50 cm^3 of 2 M aqueous copper (II) nitrate in a beaker, a brown solid and bubbles of gas were observed.

(i) Write **two** equations for the reactions which occurred in the beaker. (2 marks)

(ii) Explain why it is **not** advisable to use sodium metal for this reaction. (2 marks)

(b) Calculate the mass of calcium metal which reacted with copper (II) nitrate solution. (Relative atomic mass of Ca = 40) (2 marks)

(c) The resulting mixture in (a) above was filtered and aqueous sodium hydroxide added to the filtrate dropwise until in excess. What observations were made? (1 mark)

(d) (i) Starting with calcium oxide, describe how a solid sample of calcium carbonate can be prepared. (3 marks)

(ii) Name **one** use of calcium carbonate. (1 mark)

In this question, candidates were expected to:

(i) Write two equations to show the reaction of calcium metal with dilute copper (II) nitrate.

(ii) Give a reason why sodium metal cannot be used for the same experiment.

(b) Carry out molar calculation for the reaction between copper (II) nitrate and calcium metal.

(c) State the observations made when aqueous sodium hydroxide is added to a solution containing calcium hydroxide.

(d) Give a logical and concise description of the preparation of $CaCO_3$ starting with CaO and the commercial uses of $CaCO_3$.

Weaknesses

- Candidates could not write equations for reaction between calcium and a solution of copper (II) nitrate.
- Some could not give reasons why sodium metal should not be reacted with aqueous copper II nitrate.
- Majority of candidates could not give logical description of the procedure to prepare calcium carbonate.
- Only a few candidates were able to give to uses of calcium carbonate.

It is possible that during teaching on displacement it is not clearly brought out that there are more than one reaction when a more reactive metal is used. When calcium is put in the aqueous mixture, it will react with both the water and also displace the copper ions. When carrying out the experiment one notices some bubbles of gas. The formation of the gas should be properly explained. They also see a brown deposit its origin should also be explained.

The bubbles will be as a result of reaction between Calcium and water while the brown deposit will be due to the copper atoms generated. Experimental approach with precise discussion of observations should be made. Once more when describing processes, the various steps must be included and should follow one another logically. No step should be left out or not placed at its right position.

- The fact that few candidates gave the right use of calcium carbonate shows that uses of materials are not emphasized. More often than not candidates ask themselves why should I learn this and that is it of any benefit for now and in the future? Uses and therefore the benefits of the knowledge and skills acquired in learning Chemistry should be emphasised hence arousing curiosity and encouraging further learning.

Expected Responses

4 (a) (i) $Ca_{(s)} + Cu(NO_3)_{(aq)} \rightarrow Ca(NO_2)_{(aq)} + Cu_{(s)}$

$Ca_{(s)} + 2H_2O_{(l)} \rightarrow Ca(OH)_{2(aq)} + H_{2(g)}$

(ii) Sodium metal is more reactive than Calcium. Reaction between Sodium and aqueous copper (II) nitrate would be explosive.

(b) $Ca_{(g)} + Cu(NO_3)_2 \rightarrow Ca(NO_3)_{2(aq)} + Cu_{(s)}$

Moles of $Cu(NO_3)_2 \rightarrow \frac{50x2}{1000} = 0.1$

Moles of Ca = 0.1

Mass of Ca = 0.1 x 40 = 4g

(c) A white precipitate is formed which is insoluble in excess.

(d) (i) Add dilute nitric (√) acid to calcium oxide to form calcium nitrate. Add sodium carbonate to form insoluble calcium carbonate. Filter the calcium carbonate wash it with distilled water dry it between pieces of filter paper.

(ii) Manufacture of cement.
Manufacture of sodium carbonate.

9.3 Paper 233/3

Paper 3 is a practical paper. The practical is set mainly on quantitative analysis, thermochemistry or rates of reactions. The practical paper of 2011 was set on quantitative analysis and qualitative analysis.

Question 1 on quantitative analysis involved titrations, and molar calculations. The question on molar calculations was performed fairly well while the titrations were well done. The questions where candidates had problems were questions number 2 and 3. Both of them were on qualitative analysis. Question 2 is briefly discussed below:

Question 2

(a) You are provided with solid **D**. Carry out the following tests and write your observations and inferences in the spaces provided.

(i) Place about one half of solid **D** in a test-tube and heat it strongly. Test any gases produced with both red and blue litmus papers.

Observations	**Inferences**

(ii) Place the rest of solid **D** in a boiling tube. Add about $10cm^3$ of distilled water. Shake well.

(b) You are provided with solution **E**. Carry out the following tests and write your observations and inferences in the spaces provided.
Divide solution **E** into **two** portions.

(i) To one portion of solution **E** in a test-tube, add 3 drops of barium nitrate. **Retain the mixture for use in test (ii) below**.

Observations	**Inferences**

(ii) To the mixture obtained in (i) above, add about 5 cm^3 of 2M nitric (V) acid.

Observations	**Inferences**

(iii) To portion two of solution **E** in a test-tube, add 2 drops of acidified potassium dichromate (VI) and warm the mixture.

(i) In this question, candidates were required to heat a sample of ferrous ammonium sulphate strongly and test gases with both blue and red litmus papers.

(ii) Make a solution of ferrous ammonium sulphate and test portions of the solution with hydrogen peroxide, barium nitrate, nitric (V) acid and with acidified potassium manganate (VII)

Weaknesses

Candidates failed to:

- Write the correct observations when reagents named above were used.
- Describe observations using standard acceptable scientific language.
- Write the accurate symbols of the ions present in the test sample.

Over the years it has been emphasized that candidates should plan how to carry out experiments. Apparatus **must** always be clean. When they are asked to use litmus paper, they should wet them and place them appropriately so that when the gas is produced it can come into contact with them. Some candidates will heat a solid and when the gas is completely gone that is when they start testing for it! In our case the solid should have been placed at the bottom of the test-tube (Dry). The litmus papers should have been held at the mouth of the test tube and solid heated. In addition to testing the gas with litmus papers, one should check for colour of the gas. Changes undergone by the solid, smell of the gas etc. All these observations should be written in the appropriate spaces immediately and using the scientific language.

Candidates are strongly reminded that when observations are wrong, or they are not reported using acceptable standard scientific language **NO** marks will be awarded. More importantly when the observations are wrong then the inferences will also be wrong and no marks will be awarded.

Practicals are also designed such that there is flow of information from the beginning of the experiment to the end.

In our case when the solution is tested using aqueous barium nitrate and a white precipitate is formed,the only conclusion would be: a sulphate SO_4^{2-} a sulphite SO_3^{2-} or a carbonate, CO_3^{2-} could be present. This experiment is followed immediately with another one using nitric (v) acid. The use of nitric (VI) acid is meant to show if CO_3^{2-} or SO_3^{2-} are present. If they are present the white precipitate would dissolve and a gas is formed. If the precipitate does not dissolve then a sulphate is present.
In our case the white precipitate dissolved and therefore only SO_3^{2-} or CO_3^{2-} could be present.
The test is followed immediately by one using acidified potassium dichromate (VI). This should distinguish between SO_3^{2-} and CO_3^{2-}. If SO_3^{2-} (A reducing agent) is present, it will reduce ion Cr^{6+} (orange) to Cr^{3+} (green). In our case the solution changed from orange to green therefore SO_3^{2-} was present.

When reporting the presence of ions correct symbols should be used. The correct symbol for sulphite ion is So_3^{2-} and not SO_3^{2-}. When symbols are not correctly written, no marks will be awarded.

Expected Responses

Observations	**Inferences**
Gas turns red litmus Paper blue	NH_4^+ present
- Gas turns blue litmus paper red - Brown solid is formed - Colourless liquid condenses on the cool parts of the test-tube - Gas with pungent/irritating smell	
(ii) Yellow/Brown solution is formed	Fe^{3+} formed
(b) (i) White precipitate is formed.	CO_3^{2-}, SO_3^{2-} or SO_4^{2-} present.
(ii) I White precipitate is dissolves	SO_3^{2-} or CO_3^{2-}
- Effervescence occurs - The colour changes from orange to green	SO_3^{2-} present.