8.0 CHEMISTRY (233)

This was the third time the subject was tested using the revised curriculum. The subject is tested using two theory and one practical paper. Each of the theory papers is taken in 2 hours while the practical paper is taken in 2¼ hours.

8.1 CANDIDATES' GENERAL PERFORMANCE

Performance in the years 2006, 2007 and 2008 was as shown in the table below:

Table 10: Candidates' Overall Performance in Chemistry in the years 2006, 2007 and 2008

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**
2008	1		80	18.28	14.78
	2		80	15.74	13.00
	3		40	11.46	5.42
	Overall	**296,937**	**200**	**45.48**	**31.78**

From the table it is to be observed that:

8.1.1 The overall candidature for the subject has continued to grow over the years. It increased from ***267,719*** in the year 2007 to ***296,937*** in the year 2008, a percentage increase of ***10.91%***.

8.1.2 The mean for ***paper 1 (233/1)*** dropped slightly from ***19.67*** in the year 2007 to ***18.28*** in the year 2008.

8.1.3 The mean for ***paper 2 (233/2)*** dropped from ***19.22*** in the year 2007 to ***15.74*** in the year 2008.

8.1.4 The mean for ***paper 3 (233/3)*** also dropped from ***11.87*** in the year 2007 to ***11.46*** in the year 2008.

8.1.5 The overall mean for the subject dropped from ***50.78*** in the year 2007 to ***45.48*** in the year 2008.

Questions which were poorly performed are discussed below.

8.2 PAPER 1 (233/1)

Question 3

Complete the following table by filling in the missing test and observations.

No.	Gas	Test	Observation
I	Chlorine	Put a moist red litmus paper into the gas	
II	Sulphur (IV) oxide		Paper turns green
III	Butene	Add a drop of bromine water	

The question required the candidates to state at least one test for chlorine and make observations that would arise as a result of the test for sulphur (IV) oxide when bromine water is added to butene.

Weaknesses

- Candidates were not able to state the observation made when a moist red litmus paper was dropped in chlorine. Some candidates stated it remained red, while others left the question unanswered. A majority stated that there was no observation.
- Candidates also failed to state one correct chemical test for sulphur (IV) oxide. Some stated the use of dichromate (VI) paper, while others stated the use of concentrated sulphuric acid.
- Candidates were not able to state the correct observation made when bromine water is added to butene. Some of the candidates who made a fair attempt did not use proper scientific language when describing the tests and the observations.

Expected Responses

i) The red litmus paper turns white/bleached.
ii) Put a filter paper dipped in acidified potassium dichromate (VI) into the gas.
iii) Bromine water is discoloured.

Advice to Teachers

The weaknesses stated above are likely to have occurred due to lack of adequate exposure to various practical activities stated in the syllabus. Schools are once more reminded that sciences being practical subjects should be approached through carefully planned experimental work. Students must be given the chemicals and equipment to carry out practicals themselves. Results of the practicals must be recorded immediately and using appropriate scientific language. The results should then be discussed fully.

The weaknesses noted could also have resulted from inadequate coverage of the syllabus. Students should have covered the syllabus before they sat for their mock examinations. This allows them to have enough time for thorough revision.

Question 16

Starting with copper metal, describe how a sample of crystals of copper (II) chloride may be prepared in the laboratory.

The candidates were expected to describe how crystals of ***copper (II) chloride*** could be prepared in the laboratory.

Weaknesses

Candidates were not able to give a logical description of the method used to prepare crystals. Others did not realize that the crystals could not be dried by the use of an oven because they could loose water of crystallization and thus become powdery. It has been stated earlier that questions which involve preparations of substances must be planned carefully. The question requires that all steps involved must be written logically starting with the ***correct*** first step. If the first step is incorrect the whole description is also incorrect and ***all*** the marks will be lost. The weaknesses stated above usually arise from lack of practical skills. Students should thus be exposed to as much practical work as possible.

Expected Responses

Heat the metal in the air to form copper (II) oxide. Add excess dilute hydrochloric acid to get copper (II) chloride. Concentrate the filtrate and leave to crystallize. Filter and dry the crystal at room temperature or between pieces of filter paper.

Question 23

In a closed system, aqueous iron (III) chloride reacts with hydrogen sulphide gas as shown in the equation below.

$$2FeCl_{3(aq)} + H_2S_{(g)} \rightleftharpoons 2FeCl_{2(aq)} + 2HCl_{(aq)} + S_{(s)}$$

State and explain the observation that would be made if dilute hydrochloric acid is added to the system at equilibrium.

In this question, candidates were expected to state the observation that would be made when dilute hydrochloric acid was added to the mixture at equilibrium.

Weaknesses

Candidates failed to state the correct observation and therefore the explanation they gave was incorrect. The bright candidates were however able to score the two marks.

Candidates should have realized that when equilibrium is attained in a closed system, all the species would exist in the mixture. If one of the species is changed by increasing or decreasing its concentration, the position of the equilibrium would shift in order to nullify the effect of the change. In this case, the amount of dilute hydrochloric acid was increased, the system would thus respond by shifting in the direction in which hydrochloric acid is consumed. Thus the position shifts in the backward direction resulting to the increase of hydrogen sulphide and iron (III) chloride. This means the brown colour of the solution intensifies.

Expected Responses

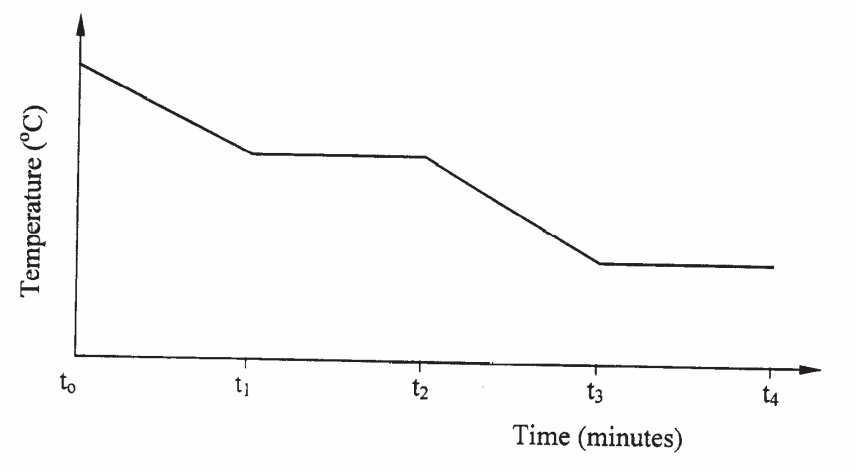
The brown colour of the mixture intensifies or increases while the green colour of the mixture fades. Iron (II) is oxidized to iron (III).

Advice to Teachers

Reactions involving poisonous gases (substances) are usually avoided. For students to understand the reactions of hydrogen sulphide, a carefully planned demonstration can be carried out either in an efficient fume cupboard or in the open. Theoretical teaching should be avoided. Enough time must be allowed to teach and revise all topics in the set syllabus if improvement is to be expected in chemistry.

Question 25

The graph below is a cooling curve of a substance from gaseous state to solid state.



Give the name of the:

(a) process taking place between t_0 and t_1;

(b) energy change that occurs between t_3 and t_4.

In this question, candidates were supposed to study the cooling curve of the substance from its gaseous state to solid state and then answer a few questions.

Weaknesses

Majority of the candidates were not able to state the process taking place between time t_0 and t_1. Most of them could not state the correct name of the energy change that occurs between t_3 and t_4. These weaknesses are likely to have resulted from lack of enough coverage of the topic ***"energy changes"***. It is therefore strongly advised that this topic should be given more time during teaching. Assignments should be administered immediately after tuition. Drilling during revision is a must if this topic is to be understood properly. Experiments on cooling curves should be conducted by students and results discussed.

In part (b) of the question, the candidates failed to give the correct name of the energy change between t_3 and t_4. Some of the wrong responses given by candidates were: ***"Physical change", "heat of freezing", "latent heat of solidification"*** and ***some even subtracted t_4 from t_3.*** This kind of weaknesses occur when candidates do not give themselves enough time to read and understand the question. Candidates are advised that they should read each question carefully, understand the demands of the question and give it its correct interpretation before they begin to write responses. Questions involving graphs and flowcharts demand a fair amount of time and intense concentration. Usually these questions are the easiest and yet they are the poorest performed just because enough time is not spent on them.

Expected Responses

(a) Cooling.

(b) Latent heat of fusion.

8.3 PAPER 2 (233/2)

From the data collected, ***questions 4*** and ***5*** were best performed with an approximate mean score of ***60%*** while the ***questions 1*** and *7* were the poorest done with a mean score of ***29%*** and ***34%*** respectively. ***Questions 1*** and *7* are

discussed below.

Question 1

(a) Biogas is a mixture of mainly carbon(IV) oxide and methane.

(i) Give a reason why biogas can be used as a fuel.

(ii) Other than fractional distillation, describe a method that can be used to determine the percentage of methane in biogas.

(b) A sample of biogas contains 35.2% by mass of methane. A biogas cylinder contains 5.0 kg of the gas.

Calculate the:

(i) number of moles of methane in the cylinder. (Molar mass of methane = 16)

(ii) total volume of carbon(IV) oxide produced by the combustion of methane in the cylinder (Molar gas volume = 24.0 dm^{-3} at room temperature and pressure).

(c) Carbon(IV) oxide, methane, nitrogen(1) oxide and trichlorofluoromethane are green-house gases.

(i) State **one** effect of an increased level of these gases to the environment.

(ii) Give **one** source from which each of the following gases is released to the environment:

I Nitrogen(1) oxide.

II Trichlorofluoromethane.

Candidates were expected to state:

- Why biogas (mixture of methane and carbon (IV) oxide) is a fuel.
- Carry out a calculation involving the mole concept.
- Describe a method for obtaining methane from the mixture and determine its percentage.
- State the environmental effects of N_2O and CCl_3F.

Weaknesses

Candidates were able to state why biogas can be used as a fuel and they were also able to carry out the mole calculation quite well. They were however, not able to describe systematically a method that can be used to determine the percentage of methane in a sample of biogas. They were also not able to state the environmental effects of nitrogen (V) oxide and trichlorofluoromethane.

Once more, candidates are reminded that questions which involve descriptions of processes need careful planning. The start of the process is very important. If the starting is incorrect then the whole process is incorrect and ***all*** the four marks would be ***lost***. There was a drop in the performance of paper 2. It is strongly believed that the marks were lost in this area (Description of processes). It is important for candidates to plan, organize the steps sequentially then proceed to write their responses.

One of the emerging issues is pollution of the environment especially from industrial waste. Most of topics dealing

with industrial processes will have a sub-topic on effects of products and by products on the environment. Over 70% of the candidates were not able to state the correct pollution effects of N_2O and CCl_3F. Items in examinations can be set from ***any*** section of the syllabus. Therefore ***thorough*** coverage of the entire syllabus is critical. A clear relation on what is taught to real life happenings should be brought out strongly. Project work should also not be ignored.

Expected Responses

(a) (i) Biogas contains methane which combustible.

(ii) Pass a known volume of biogas (V_1) through aqueous NaOH, KOH or limewater. CO_2 will be absorbed. Collect all the gas that comes out in a gas syringe (V_2).

% of methane $\frac{V_2}{V_1} x100$

(b) (i) Moles of methane $= \frac{35.2x5x1000}{100x16}$

$=$ 110 moles

(ii) $CH_{4(g)} + 20_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(\ell)}$

Volume $=$ 110 x 24

$=$ 2640 dm^3

(c) (i) Global warming

(ii) I N_2O: ammonium fertilizers.

II CCl_3F: sprays, aerosols, propellants, refrigerators.

Advice to Teachers

Teachers should give candidates more practice in giving precise and logical descriptions of processes.

Question 7

(a) Define the standard enthalpy of formation of a substance.

(b) Use the thermochemical equations below to answer the questions that follow.

1. $C_2H_{6(g)} + \frac{7}{2}O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)}; \quad \Delta H_1 - 1560 kJmol^{-1}$

2. $C_{(graphite)} + O_{2(g)} \rightarrow CO_{2(g)}; \quad \Delta H_2 = -394 kJmol^{-1}$

3. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}, \quad \Delta H_3 = -286 kJmol^{-1}$

(i) Name **two** types of heat changes represented by ΔH_3.

(ii) Draw an energy level diagram for the reaction represented by equation 1.

(iii) Calculate the standard enthalpy of formation of ethane.

(iv) When a sample of ethane was burnt, the heat produced raised the temperature of 500g of water by 21.5K,. (Specific heat capacity of water = $4.2Jg^{-1}K^{-}$).

Calculate the:

I. heat change for the reaction.

II. mass of ethane that was burnt. (Relative formula mass of ethane = 30.)

The question required the candidates to:

- Define the standard enthalpy of formation of a substance.
- Interpret thermo chemical equations.
- Draw energy level diagrams and use the energy level diagram to calculate the enthalpy of formations of a substance (ethane).
- Carry out calculations involving the mole concept and energy.

Weaknesses

Average and above average candidates were able to give the correct definition of the standard enthalpy of formation. More than 60% of the candidates were not able to state two energy changes represented by the equation:

$$H_{2(g)} + \tfrac{1}{2}0_{2(g)} \rightarrow H_2O_{(g)}$$

If candidates spent some time on the equation, they should have realized that one mole of water is formed from its constituent elements, hydrogen and oxygen. Therefore one of the heat changes involved is heat of formation of water. They should also have realized that one mole of hydrogen gas is being burnt completely. Therefore, the other energy change is heat of combustion of hydrogen. It is important to think seriously about the requirements of a question before attempting it. The other weakness noticed was that the candidates could not link the moles of a substance to energy changes. Majority drew the correct energy level diagrams but they could not calculate the heat of formation of methane.

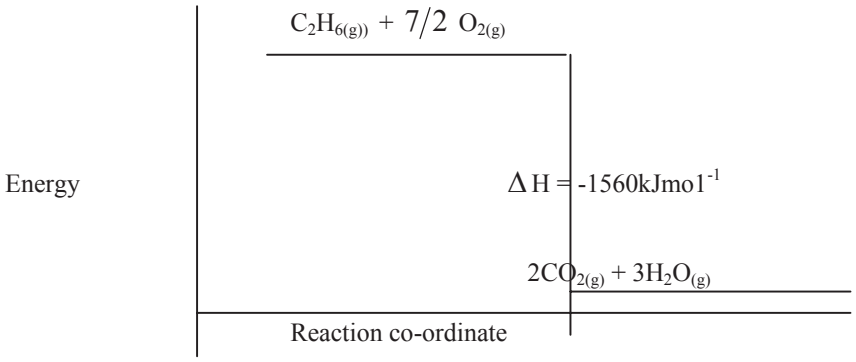
Expected Responses

(a) This is the heat change (ΔH) when one mole of a substance is formed from its constituent elements (under standard conditions).

(b) (i)

- Heat of combustion of hydrogen.
- Heat of formation of water.

(ii)



(iii) $2\,CO_{2(g)} + 3\,H_2O_{(g)} \rightarrow C_2H_{6(g)} + \frac{7}{2}O_{2(g)}; \quad \Delta H = -1560 kJmol^{-1}$

$2\,C_{(s)} + 2\,O_{2(g)} \rightarrow 2\,CO_{2(g)}; \quad \Delta H = 788\ kJmol^{-1}$

$3\,H_{2(g)} + \frac{3}{2}O_2 \rightarrow 3\,H_2O_{(g)}; \quad \Delta H = 858\ kJmol^{-1}$

$2\,C_{(s)} + 3\,H_{2(g)} \rightarrow C_2H_{6(g)}; \quad \Delta H = 86\ kJmol^{-1}$

(iv) I Heat change $= \frac{500x21.5x4.2}{100}$

$= 45.15$ kJ

II No. of Moles of ethane

$= \frac{45.15}{1560}$

$= 0.0289423$

$\therefore$ Mass of ethane $= 0.0289423 \times 30$

$= 0.87$ g

Advice to Teachers

As was noticed in ***paper 1 (233/1)***, the topic on energy changes is not properly understood. More time should be allocated to its teaching. Methods of approach should also be re-designed so that students can be allowed to carry out experiments on heat changes. Heats of displacement, solution etc are quite easy to determine. Students should be allowed to determine them. More examples on calculations involving energy changes should be given to students for practice.

8.4 PAPER 3 (233/3)

This is a practical paper testing mainly on quantitative and qualitative analysis. Skills required in quantitative analysis have been mastered by the majority of candidates. Results from titrations, records of time, temperature, plotting of graphs, etc were done quite well in 2008. It is hoped that this trend continues.

Questions 2 and 3

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

(a) Place **all** of solid **D** in a clean dry test-tube and heat it strongly until no further change occurs. Test any gases produced with both blue and red litmus papers. Allow the residue to cool and use it for test (b).

Observations	**Inferences**

(b) Add about $10cm^3$ of 2M hydrochloric acid to the residue and shake for about three minutes. **Keep the mixture for test (c).**

Observations	Inferences

(c) (i) Place about $1cm^3$ of the mixture in a test-tube and add aqueous ammonia dropwise until in excess.

Observations	Inferences

(ii) To the rest of the mixture, add **all** of solid **E** provided and shake the mixture well.

Observations	Inferences

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

(a) Place about one third of solid **F** on a **metallic** spatula and burn it using a Bunsen burner.

Observations	Inferences

(b) Place the remaining of solid **F** in a test-tube. Add about $6cm^3$ of distilled water and shake the mixture well. **(Retain the mixture for use in test (c).**

Observations	Inferences

(c) (i) To about $2cm^3$ of the mixture, add a small amount of solid sodium hydrogen carbonate.

Observations	Inferences

(ii) To about $1cm^3$ of the mixture, add $1cm^3$ of acidified potassium dichromate (VI) and warm.

Observations	Inferences

(iii) To about $2cm^3$ of the mixture, add two drops of acidified potassium manganate (VII).

Observations	Inferences

The two questions were on qualitative analysis.

Weaknesses

Candidates recorded wrong results or observations. Candidates need to know that they can only earn marks if the observation is correct and correct scientific language is used to describe that observation. It should be known that if the observation is ***Wrong*** or ***Correct*** scientific language is ***not*** used, then all the marks will be lost.

Expected Responses

Observations	*Inferences*
2. (a) ▪ Green solid turned black. ▪ Colourless liquid condenses on cool part of test-tube. ▪ Blue litmus paper turned pink. ▪ Red litmus paper remains the same.	▪ Solid d is hydrated or Contains water of crystallization. ▪ Acidic gas is produced.
(b) ▪ No effervescence. ▪ Black solid reacts to form a green Solution.	▪ Black solid is basic. ▪ Coloured ion present i.e Fe^{2+}orCu^{2+}
(c) (i) ▪ Blue precipitate formed. ▪ Re-dissolves in excess to form a deep blue/Royal blue solution. (ii) ▪ Effervescence occurs ▪ Brown solid deposited. ▪ Colourless formed. ▪ Green solution turns. ▪ Test-tube gets warm.	Cu^{2+} present (1) E is a metal more reactive than copper ***Or*** E displaces Copper or E reduces Cu^{2+} to Cu
3. (a) Yellow smoky flames/sooty flame. (b) Dissolves to form a colourless solution. (c) (i) ▪ Effervescence occurs. ▪ Colourless gas given out. (ii) Orange/Yellow colour persists. (iii) $KMnO_4(aq)$ is decoloursied.	F is along chain hydrocarbon or an unsaturated organic compound. It is probably a soluble salt or Polar organic compound. Compound is acidic (1) – COOH or H^+ or H_3O_+ Absence of Hydroxyl group C= C or –C≡C- present

Advice to Teachers

Students should be given more practice in carrying out experiments. Correct descriptions of results should be emphasized and correct inferences must be given. It is totally unfair to the candidates to deny them use of apparatus during teaching only for them to see them during examinations. It makes them panic. Build confidence in the students by exposing them to various types of experiments throughout the four year course.