

3.5 CHEMISTRY (233)

In 2014, chemistry (233) was tested using two theory papers , 233/1, 233/2 and a practical paper (233/3). The two theory papers are marked out of 80 marks each while the practical paper is marked out of 40 marks.

Table 13: Performance of Chemistry in the Years 2010, 2011, 2012, 2013 and 2014

Year	Paper	Candidature	Maximum Score	Mean Score	Standard Deviation
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
2012	1	427,190	80	22.36	14.17
	2	427,212	80	17.18	14.50
	3	427,167	40	16.34	6.73
	Overall	427,386	200	55.86	34.10
2013	1	439,787	80	16.68	13.89
	2	439,770	80	18.31	14.25
	3	439,765	40	14.67	5.68
	Overall	439,847	200	49.00	32.10
2014	1	476,582	80	25.44	15.79
	2		80	21.33	13.46
	3		40	17.57	6.19
	Overall		200	64.31	35.63

From the table it can be observed that:-

- (i) Performance in all the three papers went up.
- (ii) Paper 1 (233/1) went up from a mean of 16.68 in 2013 to 25.44 in 2014.
- (iii) Paper 2 (233/2) went up from a mean of 18.31 in 2013 to 21.33 in 2014.
- (iv) Paper 3 (233/3) went up from a mean of 14.67 in 2013 to 17.57 in 2014.
- (v) Overall performance in chemistry (233) went up from a mean score of 49.00 to 64.

The candidature for the subject has continued to increase. In 2014 it increased by 5%.

The improved performance could be attributed to improved quality of setting and more important to improved quality of marking.

Questions which were performed poorly discussed below.

3.5.1 Chemistry Paper 1 (233/1)

Question 2

When dilute hydrochloric acid was reacted with solid B, a colourless gas which extinguished a burning splint was produced. When an aqueous solution of solid B was tested with a blue litmus paper, the paper turned red/ pink.

- (a) Identify the anion present in solid B. (1 mark)
- (b) Write an ionic equation for the reaction between solid B and dilute hydrochloric acid. (1 mark)

The question required candidates to;

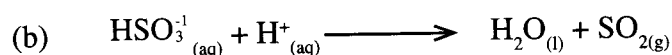
1 identify an ion present in a solution which turns a blue litmus paper pink.

2 write an ionic equation for the reaction which would occur when the named ion reacts with a dilute acid.

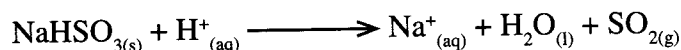
Weaknesses

Candidates could not correctly identify the ion present in the solution. They also could not write the correct ionic equation. Many other candidates identified the ions as either hydrogen carbonate or as carbonate. Solutions containing these ions have a PH of 8 and therefore cannot be acidic. The weaknesses shown indicate that the topic on acids and normal salts is not practically taught in schools. Teachers are advised to cover all topics fully. All topics can be tested any time.

Expected response



or



Question 4

Starting with zinc sulphate solution, describe how a sample of zinc oxide can be obtained.

(3 marks)

Candidates were expected give a brief and concise description on the preparation of Zinc oxide from a solution of Zinc sulphate.

Weaknesses

Candidates did not know the effect of heat on Zinc sulphate and also how to convert Zinc sulphate solution to another Zinc salt that can easily be decomposed to Zinc oxide. In order to obtain Zinc oxide, Zinc sulphate can be reacted with a soluble solution of a group one element for example Sodium carbonate. This way, Zinc carbonate is formed which can now be decomposed to form Zinc oxide. Expose candidates to numerous methods of preparation of salts. Concepts are best learnt if some kind of discovery is made in the process of teaching . All efforts should be made to avoid theoretical teaching.

Expected response

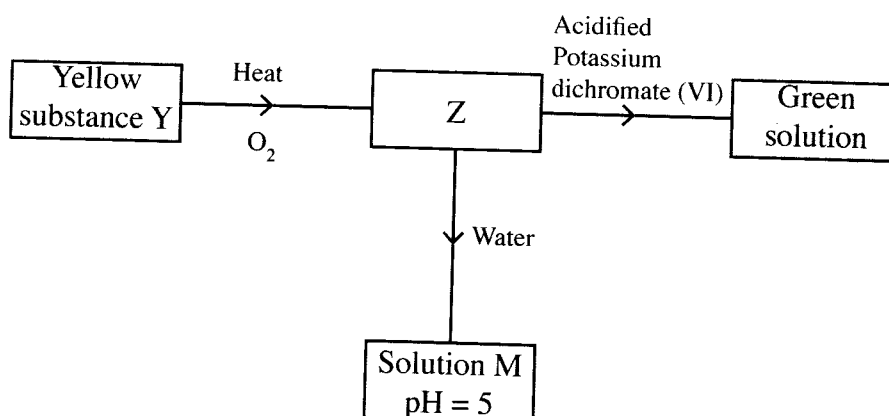
- Add soluble carbonate/Add soluble hydroxide.
- Filter out the zinc carbonate/filter the zinc hydroxide.
- Heat strongly the ZnCO_3 to decompose it to form ZnO /Heat strongly the Zn(OH)_2 to decompose it to form ZnO .

OR

- Heat to evaporate the water. (1)
- Heat ZnSO_4 solid to decompose (1) to form ZnO /yellow solid.

Question 11

Study the flow chart below and answer the questions that follow.



Identify Z and M.

(2 marks)

Z

M

In this question candidates were expected to identify products formed when Sulphur is burnt in Oxygen, the reducing properties of sulphur dioxide and the PH values of weak acids.

Weaknesses

Majority of the candidates confused sulphur with ZnO and PbO due to its yellow colour. Others had no idea about the PH value of the weak acid formed when Sulphur(IV)oxide is dissolved in water. Once more candidates demonstrated lack of exposure to practical work. It is important for schools to embrace the practical approach method in the teaching of all science oriented subjects.

Expected response

Z is SO_2 / sulphur (IV) oxide.

M is H_2SO_3 / sulphuric (IV) acid.

Question 14

When 20 cm³ of 1 M sodium hydroxide was mixed with 20 cm³ of 1 M hydrochloric acid, the temperature rose by 6.7 °C. Assuming the density of the solution is 1 g/cm³ and the specific heat capacity of the solution is 4.2 Jg⁻¹ k⁻¹;

- (a) calculate the molar heat of neutralisation; (2 marks)
- (b) when the experiment was repeated with 1 M ethanoic acid, the temperature change was found to be lower than that with 1 M hydrochloric acid. Explain. (1 mark)

Candidates were required to calculate the molar heat of neutralization between a strong acid and a strong base. They were also required to state why the molar heat of neutralization between a weak acid and a strong base is lower than that of strong acid with strong base.

Weaknesses

Many candidates did not know that the mass of the solution is the sum of the masses of the two solutions. Others had no idea about the difference in the molar heats of solution. Measurement of enthalpy changes is one of the easiest and cheapest topics to teach practically as it involves cheap and easily available chemicals and equipment. Students need to see, touch, hear etc during learning. Denying them this opportunity is unfair. There is need to embrace the 21st century approach where discovery is the norm. When experiments are used during learning the results should be thoroughly discussed.

Expected response

- (a) Total volume of solution = 40 cm³ / 40 g

$$\Delta H = 40 \times 6.7 \times 4.2$$

$$= 1125.6/1000$$

$$= 1.1256 \text{ KJ}$$

$$\text{Moles of acid } \frac{20}{1000} \times 1 = 0.02 \text{ moles}$$

$$0.02 \text{ moles} = 0.1256$$

$$1 \text{ mole} = \frac{1.1256}{0.02} \quad -56280 \text{ j/mol}$$

$$= -56.28 \text{ KJ / mol}$$

- (b) Some energy is used to ionise the weak acid first before it can neutralise. So not all energy is used in neutralisation.

3.5.2 Chemistry Paper 2 (233/2)

Questions in paper 2 are usually long and test in depth particular areas of the syllabus. They each have between 10 and 15 marks. Analysis of each question performance was carried out and questions 2 and 6 were found to have been poorly done. These two questions are briefly discussed below.

Question 2

- (a) The grid below represents part of the periodic table. Study it and answer the questions that follow. The letters are not the actual symbols of the elements.

A				B		C		
	D			E		F	G	
H								

- (i) Select the most reactive metal. Explain. (2 marks)
- (ii) Select an element that can form an ion with a charge of 3^- . (1 mark)
- (iii) Select an alkaline earth metal. (1 mark)
- (iv) Which group 1 element has the highest first ionization energy? Explain. (2 marks)
- (v) Element A combines with chlorine to form a chloride of A. State the most likely pH value of a solution of a chloride of A. Explain. (2 marks)
- (b) (i) Explain why molten calcium chloride and magnesium chloride conduct electricity while carbon tetrachloride and silicon tetrachloride do not. (2 marks)
- (ii) Under the same conditions, gaseous neon was found to diffuse faster than gaseous fluorine. Explain this observation. (F = 19.0; Ne = 20.0) (2 marks)

In this question candidates were required to study the part of the periodic table given and

- 1 Select an ion whose charge is 3 minus
- 2 Pick an alkaline metal
- 3 State a group 1 element with the highest ionization energy
- 4 State properties of the chlorides of group 1 elements
- 5 Explain conduction in molten ionic and non conduction in covalent compounds
- 6 Explain difference in rates of diffusion between mono atomic and diatomic gases.

Weaknesses

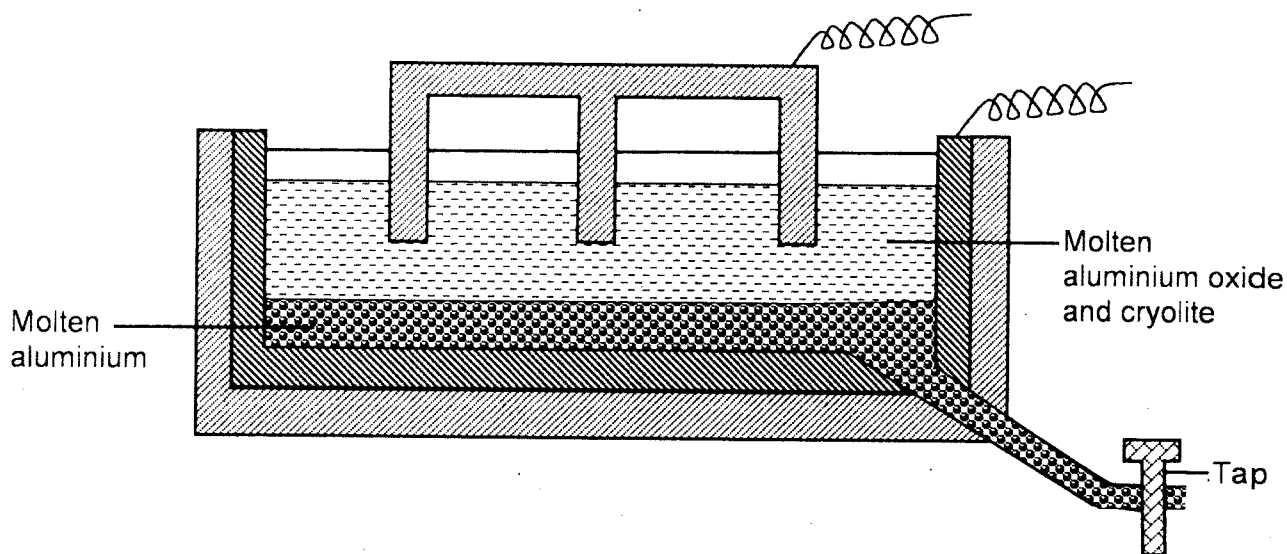
Candidates were not able to select accurately an ion with a charge of minus 3, an alkaline earth metal and an element with the highest ionization energy. They could also not explain why conduction occurs in molten Calcium chloride and not in carbon tetrachloride. These weaknesses can only indicate that candidates did not take time to read, understand and interpret the tasks before they began to write their responses. It can also indicate that the topics on chemical families, structure and bonding and the periodic table were not fully covered. It should be stressed that all topics in the syllabus can be tested any time and therefore all should be given adequate coverage and be finalized in good time so that candidates have enough time to revise before they sit for their exams. After each topic is covered, evaluation should be undertaken and remedial teaching provided where necessary.

Expected response

- (a) (i) K - Has largest atomic radius / it most readily loses its outermost electron.
- (ii) B / N
- (iii) D / Mg
- (iv) A ⁽¹⁾ It has the smallest/smaller atomic radius/ its outermost electron is more/most strongly held by nucleus. ⁽¹⁾
- (v) P^H is seven (7). The chlorides of group 1 elements are neutral salts.
- (b) (i) Both CaCl₂ and MgCl₂ have mobile ions in molten state ⁽¹⁾ while both CCl₄ and SiCl₄ are molecular compounds with no mobile ions ⁽¹⁾.
- (ii) Neon has molar mass of 20 while Fluorine has a molar mass of 38 (1). Therefore Neon diffuses faster. ⁽¹⁾ Since it has a lower molecular mass the faster the rate of diffusion.

Question 6

The diagram below represents a set up of an electrolytic cell that can be used in the production of aluminium.



- (a) On the diagram, label the anode. (1 mark)
- (b) Write the equation for the reaction at the anode. (1 mark)
- (c) Give a reason why the electrolytic process is not carried out below 950°C . (1 mark)
- (d) Give a reason why the production of aluminium is not carried out using reduction process. (1 mark)
- (e) Give **two** reasons why only the aluminium ions are discharged. (2 marks)
- (f) State **two** properties of duralumin that makes it suitable for use in aircraft industry. (2 marks)
- (g) Name **two** environmental effects caused by extraction of aluminium. (2 marks)

The question required candidates to demonstrate understanding of the processes involved in the industrial production of Aluminium. Writing of equations, stating uses of alloys of aluminium and stating the problems associated with large production of Aluminium.

Weaknesses

Candidates did not;

1 Know the anode on the diagram

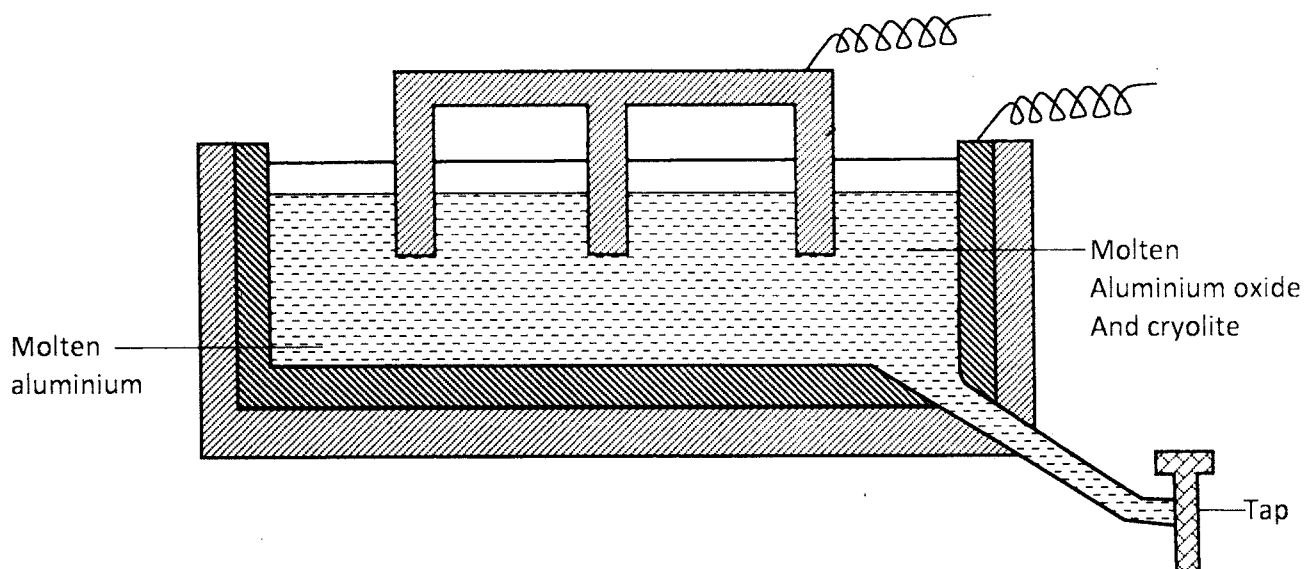
2 Write equations

3 Know the properties of duralumin

4 Know the problems caused by large scale production of Aluminium.

Chemistry is about production of materials. Students should be taught in detail the processes involved in the large scale production of common metals, fertilizers, detergents etc. This way they see the usefulness of studying chemistry which in turn leads to better understanding hence better performance in the subject. Reasons for each of the processes should be thoroughly articulated. Uses of the material produced should also be articulated. Problems associated with large scale production of goods must well known so that human beings can be able to take care of the themselves. Finally schools should organize trips to industrial plants so that they can see, touch, feel and thus get first hand experience in large scale production.

Expected response



- (a) On the diagram
- (b) $2\text{O}^{2-}_{(l)} \longrightarrow \text{O}_{2(g)} + 4e$
- (c) Below $950\text{ }^{\circ}\text{C}$, the electrolyte is not in molten state.
- (d) Aluminium is more reactive than carbon (coke) therefore the reduction process is not possible / carbon / carbon (II) oxide / coke cannot reduce Al_2O_3 .
- (e) - Aluminium is less reactive than Sodium \therefore It is preferentially discharged.
 - Al^{3+} ions are in higher concentration than Na^+ .
- (g) - Global warming due to production of CO_2 / F_2 pollution.
 - Creation of gullies during excavation.
- (f) - Light
 - Strong

3.5.3 Chemistry Paper 3 (233/3)

Chemistry (233/3) is a practical paper which tests candidates ability to manipulate apparatus, make accurate records, interpret data/information and make logical conclusions. The paper of 2014, had three questions. Question 1 was on quantitative analysis while questions 2 and 3 were on qualitative analysis. Question 1 and question 3 were performed quite well. Question 2 on inorganic chemistry was performed poorly and is briefly discussed below.

Question 2

You are provided with substance **P**. Carry out the tests below and write your observations and inferences in the spaces provided.

- (a) Describe the appearance of substance **P**. (1 mark)
- (b) Place about one-third of substance **P** in a dry test-tube and heat it strongly.

Observations	Inferences
(1 mark)	(1 mark)

- (c) Place the remaining amount of substance **P** in a boiling tube. Add about 10 cm³ of distilled water and shake well. **Retain** the mixture for tests in (d) below.

Observations	Inferences
(1 mark)	(1 mark)

- (d) Use about 2 cm³ portions of the mixture obtained in (c) for tests (i) to (iii) below.

- (i) Add two to three drops of aqueous barium nitrate to the mixture.

Observations	Inferences
(1 mark)	(2 marks)

(ii) Add five drops of dilute nitric(V) acid to the mixture.

Observations	Inferences
(1 mark)	(1 mark)

(iii) Add to the mixture, aqueous sodium hydroxide dropwise until in excess.

Observations	Inferences
(1 mark)	(1 mark)

(e) Give the formula of the cation and anion present in substance P.

Cation: ($\frac{1}{2}$ mark)

Anion: ($\frac{1}{2}$ mark)

The question required the candidates to;

- 1 Select apparatus that can be used to heat strongly small quantities of substances;
- 2 Reagents that can be used to carryout specified reactions;
- 3 Record results /observations;
- 4 Make interpretations of the results;
- 5 Draw conclusions from the results.

Weaknesses

- 1 Candidates did not make accurate observations and if they did, the results were not recorded in the spaces provided.
- 2 Interpretations made were inaccurate leading to inaccurate conclusions.

Candidates should plan how to proceed with the experiments. Candidates are being advised to make a habit of reading and making accurate planning before they begin to do any of the tasks. Any observation made should be recorded immediately and using scientific language. The fact that they did not score means that they had little or no exposure to practical work. Candidates must be given enough practice in qualitative and quantitative analysis before they can sit for examinations.

Expected response

(a) White crystalline substance.

(b) **Observations**

Colourless liquid condenses on the cool parts of T-Tube leaving behind a white solid

(c) Solid dissolves to form colourless solution.

(d) (i) White Ppt formed

(ii) No effervescence or no bubbles

(iii) White Ppt

(e) Cation

anion

Inferences

Hydrated salt or salt contains water of crystallisation

P is soluble in water

No coloured ions

SO_4^{2-} , SO_3^{2-} or CO_3^{2-} present

SO_4^{2-} , present or SO_3^{2-} or CO_3^{2-} absent

Mg^{2+} present

Mg^{2+} or Magnesium ions

SO_4^{2-} or Sulphate ions

CONCLUSION

Chemistry should be taught practically. Enquiry based approach to teaching and learning is the norm worldwide and Kenya should not be left behind. School heads are requested to ensure that adequate facilities are provided in schools. It is very unfair for some candidates to see some of the common apparatus for the first time during examinations.