2411/302
INORGANIC CHEMISTRY
Oct./Nov. 2006
TIME: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

# DIPLOMA IN ANALYTICAL CHEMISTRY

INORGANIC CHEMISTRY

**3 hours**

**INSTRUCTIONS TO CANDIDATES:**

*You should have the following for this examination:*

*Answer booklet*
*Scientific calculator*

*This paper consists of **TWO** sections; **A** and **B***
*Answer **ALL** questions in section **A** and any **THREE** questions from section **B**.*
*Each question in Section **A** carries **4** marks while each question in Section **B** carries **20** marks.*

**This paper consist of 4 printed pages**

**Candidates should check the question paper to ensure that all the pages are printed as indicated and no questions are missing.**

## SECTION A

1. Give the experimental evidence of the electric nature of matter. (4 marks)

2. A student gave the electronic configuration of element x (atomic No.12) as $1s^2 2s^2 2p^6 2d^2$.

   (a) State what letters s, p and d represent. ($1^1/_2$ marks)

   (b) Comment on the configuration given by the student. ($2^1/_2$ marks)

3. Use the data given below to answer questions which follow:

| ELEMENT | IONIZATION ENERGY | | | |
|---|---|---|---|---|
| | 1st | 2nd | 3rd | 4th |
| A | 738 | 1450 | 7730 | 10550 |
| B | 495 | 4563 | 6912 | 9540 |
| C | 800 | 2427 | 3658 | 25024 |

   Determine:

   (a) the element forming a covalent chloride (1 mark)

   (b) the element whose common oxidation state is +2 (1 mark)

   (c) the element forming an ionic univalent bromide (1 mark)

   (d) the element with the largest atom (assume elements are in same period) (1 mark)

4. (a) Arrange the following bonds in order of increasing ionic character:
   N-H; F-H; B-H; C-H and S-H. (1 mark)

   (b) Justify the order given in (a) above (3 marks)

5. Explain the following observations:

   (a) Melting point of diamond is much higher than that of silicon, despite their structural similarities. (2 marks)

   (b) The tendency to form catenated compounds in group $\overline{\text{IV}}$ B decreases as the atomic number increases. (2 marks)

6. (a) Reactions of oxygen ($0_2$) at 25°C are often slower than those of ozone ($0_3$). Explain this observation. ($1^1/_2$ marks)

   (b) Determine which of the oxides $Cr_2O_3$ and $Cr\ O_3$ is more acidic. ($2^1/_2$ marks)

7. Oxygen is a gas but sulphur is a solid at room temperature. Suggest reasons for this occurrence. (4 marks)

8. (a) Arrange the following acids in order of increasing acid strength:

$HClO_4$; HClO; $HClO_3$; $HClO_2$ (2 marks)

(b) Explain the order in (a) above. (2 marks)

9. Give reasons for the following observations:

(a) Fluorine reactions are much faster than those of the other halogens. (2 marks)

(b) HF boils at 20°C while Hcl boils at -85°C. (2 marks)

10. Name and state the principle and the rule used to determine the electronic configuration of an atom of a given element. (4 marks)

## SECTION B

11. (a) Some substances are radioactive but many are not.

(i) Define the term "radioactivity" (2 marks)
(ii) State the cause of radioactivity (2 marks)
(iii) Differentiate α-emitters from β-emitters. (6 marks)

(b) Explain the origin of gamma radiation. (4 marks)

(c) Many radionuclides are artificially synthesized by neutron bombardment.

(i) Name the type of decay expected of such nuclei. (1 mark)

(ii) Explain the response in (c) (i) above. (2 marks)

(d) Complete the nuclear equation below and identify X and Y.

$$X + {}^{31}_{15}P \rightarrow {}^{32}_{15}P \rightarrow {}^{32}_{16}S + Y$$

(3 marks)

12. Bromine exists naturally as $^{79}Br$ and $^{81}Br$ and has relative atomic mass of 79.904.

(a) Determine the relative isotopic abundance in a natural sample of bromine. ($5^1/_2$ marks)

(b) Sketch a mass spectrum for $CH_3Br$. ($6^1/_2$ marks)

(c) State the applications of mass spectroscopy. (6 marks)

(d) Most mass spectra have very weak peaks at $^m/_e$ 28 and 32 with height ratio 4:1. Account for this observation (2 marks)

13. (a) Sketch and name the shapes of the following molecules:

(i) $Becl_2$ (ii) $BF_3$ (iii) $NH_3$ (iv) $CLF_3$ (7 marks)

(b) (i) State the determinant of the shapes of simple covalent molecules.

(ii) Suggest the shape of a water molecule

(iii) Explain the shape suggested in b (ii) above. (5 marks)

(c) A solid mixture is suspected to contain elements X,Y and Z which are $\alpha$, $\beta$ and $\gamma$ emitters respectively. Describe how presence of the elements in the mixture may be confirmed. (8 marks)

14. (a) (i) State how Moseley's work affected Mendeleev's version of the periodic table. (5 marks)

(ii) Illustrate the answer in (a) (i) above graphically. (4 marks)

(b) Tellirium (atomic mass 127.60) is in group VI while iodine (atomic mass 126.90) is in group VII of the modern periodic table.

(i) State the order of these elements in Mendeleev's table. (1 mark)

(ii) Account for the difference, if any in the two periodic table versions. (3 marks)

(c) $FeCl_{3(s)}$ exists but $FeI_3$ does not. Give reasons for this observation. (4 marks)

(d) Calculate the energy required to ionize a hydrogen atom.

($h=6.625 \times 10^{-34} JS$; $C=3.0 \times 10^{8} MS^{-1}$; $R_H = 109766\ cm^{-1}$) (3 marks)

15. (a) The atomic numbers of noble gases are 2,10,18,36,54 and 86. Use this information to predict three properties of elements X,Y and Z of atomic numbers 15,85 and 87 respectively. (15 marks)

(b) Explain the following observations

(i) Many transition metal compounds are coloured. (3 marks)

(ii) The atomic radius changes little between scandium and zinc. (2 marks)