ORDINARY LEVEL NATIONAL EXAMINATIONS, 2016

SUBJECT: CHEMISTRY I

DURATION : 3 HOURS

INSTRUCTIONS TO CANDIDATES:

1) Write your names and index number on the answer booklet as they appear on your registration form and **DO NOT** write your names and index number on additional answer sheets of paper if provided.

2) Do not open this question paper until you are told to do so.

3) This paper consists of three sections: **A, B and C**.
   - **SECTION A**: Attempt all questions. **(55 marks)**
   - **SECTION B**: Attempt any **THREE** questions **(30 marks)**
   - **SECTION C**: Attempt **ONLY ONE** question. **(15 marks)**

4) You do not need the Periodic Table.

5) Silent non-programmable calculators may be used.

6) Use only blue or black pen.
SECTION A: ATTEMPT ALL THE QUESTIONS. (55 MARKS)

1) Iron metal undergoes rusting when it is exposed to air for a long period of time.
   (a) Indicate names of 2 chemical substances that are necessary for causing rusting
   of iron, Fe. (2 marks)
   (b) Mention 2 means that are used to prevent rusting of objects which are made
   of iron (Fe) metal. (2 marks)

2) Water is used for various domestic purposes.
   a) State 2 natural sources of water. (2 marks)
   b) Briefly describe one method used to treat unclean drinking water to be ready
   for cooking food. (2 marks)

3) A student uses 100 cm³ of a 0.5 mol dm⁻³ sodium hydroxide solution to react with
   excess sulphuric acid.
   a) Calculate the number of moles of NaOH contained in 100 cm³ of solution. (2 marks)
   b) Calculate the mass of sodium sulphate crystals that are formed after
   evaporation of the resultant solution.
   Equation:
   \[ \text{H}_2\text{SO}_4(aq) + 2\text{NaOH(aq)} \rightarrow \text{Na}_2\text{SO}_4(aq) + 2\text{H}_2\text{O(aq)} \]
   (Atomic mass Na = 23, S = 32, O = 16, H = 1) (2 marks)

4) (a) When hydrated sodium sulphate crystals are heated gently, water is given off.
   State the name of the reagent used to test the presence of water and the
   expected observation for a positive test. (2 marks)
   (b) Pure oxygen for industrial use can be obtained from atmospheric air.
   State the percentage composition of oxygen gas by volume in air. (1 mark)

5) In the upper atmosphere, there is a layer of zone surrounding the earth.
   (a) Explain the importance of this layer in terms of human health. (2 marks)
   (b) State the type of chemical substances that destroy the ozone layer. (1 mark)

6) Calcium is a metal of group IIa of the periodic table.
   (a) Using Bohr model of the representation of electrons on shells, draw the
   structure of calcium atom. (2 marks)
   (b) Write a balanced equation of the reaction that takes place when calcium reacts
   with oxygen (O₂).
   (Atomic number of Ca = 20). (2 marks)

7) Sodium atom loses 1 electron and sulphur accepts 2 electrons to form ions.
   (a) Deduce the chemical formula of the compound formed between sodium and
   sulphur. (2 marks)
   (b) State one physical and one chemical property of the compound formed when
   sodium reacts with sulphur. (Atomic number: Na = 11, S = 16) (2 marks)

8) When calcium reacts with water, hydrogen gas is evolved and an alkaline solution
   is formed.
   a) State two observable changes that take place when calcium reacts with water. (2 marks)
   b) Write the equation of reaction between calcium and water; include state
   symbols. (2 marks)

9) Magnesium is an alkaline earth metal; copper is a transition element. State one
    difference between these two metals in terms of:
    a) Melting point. (1 mark)
    b) Density. (1 mark)
    c) Color. (1 mark)

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10) In an experiment, SO₂ gas was dissolved in a test tube of cold water; blue and red litmus papers were put in the resultant mixture.
   a) Indicate the litmus paper that changed color. (1 mark)
   b) Write down the chemical equation for the reaction which took place between SO₂ and H₂O. (2 marks)

11) State the reagent that you would use to differentiate between each of the pair of compounds and give the observable change for a positive test:
   a) Sulphur dioxide, SO₂ and hydrogen sulphide H₂S. (2 marks)
   b) Copper II nitrate Cu(NO₃)₂ and iron II nitrate Fe(NO₃)₂

12) Alkanes are members of a homologous series of saturated hydrocarbons with the general formula CₙH₂ₙ₊₂.
   a) Write the chemical equation of reaction for the combustion of an alkane with 4 carbon atoms. (2 marks)
   b) State 2 uses of hydrocarbon compounds. (2 marks)

13) Silicon dioxide has a similar structure to that of diamond. Suggest the reason why silicon dioxide:
   a) does not conduct electricity. (2 marks)
   b) is solid at 25°C. (2 marks)

14) A student added 3.0g of magnesium to an excess sulphuric acid solution of 0.5 mol dm⁻³ by concentration to react in a container.
   a) Calculate the number of moles contained in 3.0g of magnesium. (2 marks)
   b) Calculate the maximum volume of sulphuric acid that reacted with all he 3.0g of magnesium. (2 marks)

   (Atomic mass, Mg = 24).
   Equation of reaction: Mg(s) + H₂SO₄(aq) → MgSO₄(aq) + H₂(g)

15) (a) Write the chemical formula of 1 weak base. (1 mark)
    (b) Describe the difference between a strong acid and a weak acid. (2 marks)

SECTION B: ATTEMPT ANY THREE QUESTIONS ONLY. (30 MARKS)

16) A mixture of Zinc and Zinc oxide were reacted with excess sulphuric acid. 400 cm³ of hydrogen gas were produced (measured at room temperature and pressure).
   If the mixture had a mass of 2g and only Zinc reacted with the acid to produce H₂ has, determine:
   a) The number of moles of H₂ gas produced. (2 marks)
   b) The number of moles of Zn that reacted with the acid. (2 marks)
   c) The mass of zinc in the mixture. (2 marks)
   d) The mass of zinc oxide in the mixture. (2 marks)
   e) The percentage composition of Zinc oxide by mass in the mixture. (2 marks)

   Equation:
   Zn(s) + H₂SO₄(aq) → ZnSO₄(aq) + H₂(g)

   (Atomic mass: Zn = 65, O = 16; 1 mole of gas occupies 24000 cm³ at room temperature and pressure)
17. Copper II oxide, CuO can be reduced by hydrogen gas, H₂. Study the setup diagram below and answer the questions that follow:

- Write the equation of the reaction that takes place when copper II oxide reacts with hydrogen gas. (2 marks)
- State the observable color change when copper II oxide has completely been reduced by hydrogen. (2 marks)
- State the role of CaCl₂ in the tube. (1 mark)
- Zn reacts with dilute HCl to produce H₂.
  - i) Indicate 1 physical property of H₂ gas. (1 mark)
  - ii) Mention 1 test for H₂ gas and give the observation of the test. (2 marks)
- Copper II oxide can be reduced by carbon on heating. Write the equation of reaction between CuO and C. (2 marks)

18. The set-up apparatus below is for the preparation of ammonia gas in the laboratory.

- Nitric acid is used to prepare fertilizers.
  - i) Write a balanced equation of the reaction between HNO₃ and Ca(OH)₂. (2 marks)
  - ii) State 1 danger of using chemical fertilizers. (1 mark)
- Nitrogen gas from the atmosphere is absorbed by plants via root nodules to

Equation for the reaction:

\[ \text{Ca(OH)₂(s)} + 2\text{NH₄Cl(s)} \rightarrow 2\text{NH₃(g)} + 2\text{H₂O(g)} + \text{CaCl₂(s)} \]

- a) (i) State the role of calcium oxide [CaO] in the apparatus. (1 mark)
  - (ii) State the type of method used for the collection of the gas NH₃ in the setup. (1 mark)
  - (iii) Write a balanced equation of reaction between NH₃ and H₂SO₄. (2 marks)
  - (iv) State two uses of ammonia on a large scale. (2 marks)
form nitrate fertilizers. State the percentage composition of nitrogen gas in the atmosphere.

19) The table below shows some symbols of elements of the periodic table. Study the table and answer the questions that follow:

<table>
<thead>
<tr>
<th>Element symbol</th>
<th>Group of element</th>
<th>Period of element</th>
<th>Atomic number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li</td>
<td>I</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>VI</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Ca</td>
<td>II</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Cl</td>
<td>VII</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Al</td>
<td>III</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>N</td>
<td>V</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

a) Write the electronic configuration of the oxygen atom (O). (1 mark)

b) Write a chemical equation that represents the ionization (ion formation) of Li. (2 marks)

c) Deduce the formula of the compound formed by the reaction of Al and Cl. (2 marks)

d) State 2 physical properties of a compound formed between N and O. (2 marks)

e) Indicate 1 important use of compounds formed between N and O. (2 marks)

f) Give 2 reasons to suggest why Al is the best of the above elements at being used as electric cables. (2 marks)

20) (a) Draw a well labeled diagram for the preparation of chlorine gas in the laboratory. (3 marks)

(b) A red litmus paper is placed in chlorine gas for 5 minutes, state 2 observable changes on the red litmus paper during the exposure in chlorine gas. (2 marks)

(c) Chlorine gas dissolves in cold water.
   i) Write a chemical equation of the reaction that takes place between Cl₂ and H₂O. (2 marks)
   ii) State 1 use of chlorine. (1 mark)

SECTION C: ATTEMPT ONLY ONE QUESTION. (15 MARKS)

21) Graphite and diamond are allotropes of carbon with different physical properties.

a) Write 1 physical property of:
   i) Graphite. (1 mark)
   ii) Diamond. (1 mark)

b) Write a chemical equation of the reaction between carbon (C) and iron oxide (Fe₂O₃) (2 marks)

c) State 1 use of:
   i) Graphite
   ii) Diamond

d) Carbon reacts with oxygen during combustion according to the equation:
   \[ \text{C}(s) + \text{O}_2(g) \rightarrow \text{CO}_2(g) \]
   In insufficient oxygen, the reaction shown below takes place:
   \[ 2\text{C}(s) + \text{O}_2(g) \rightarrow 2\text{CO}_2(g) \]
i) Mention 2 important uses of CO₂ in nature.
ii) State 1 important use and 1 danger of CO gas.

c) Carbon dioxide [CO₂] causes global warming. Describe 2 means of reducing CO₂ from the atmosphere.

f) Marble rock that is formed of carbohydrates can be degraded by acid rain.
   i) Write the equation of reaction between calcium carbonate, CaCO₃, and hydrochloric acid, HCl.
   ii) Temporary hard water contains hydrogen carbonates, HCO₃⁻. Indicate 1 means that is used to soften (eliminate) HCO₃⁻ from hard water.

22) (a) Describe the term "electrolyte" substance.
   (b) Write the chemical formula of 1 electrolyte substance.
   (c) Study the diagram below and answer the questions that follow:

   ![Diagram of an electrochemical cell]

   i) Write the chemical equation of the reaction that takes place at the "anode" and at the "cathode".
   ii) Describe a simple test for gas B and the observation for this test.

d) When carbon electrodes are replaced with copper electrodes using copper sulphate solution [CuSO₄] instead of H₂SO₄; the following reactions take place:

   Anode: Cuₙ(s) → Cu²⁺(aq) + 2e⁻

   Cathode: Cu²⁺(aq) + 2e⁻ → Cuₙ(s)

   i) Indicate 1 observable change in the mixture when the reaction is almost complete.
   ii) State 2 important applications of electrolysis on a large scale.

e) Zinc metal is put in a solution of copper sulphate. The following reaction takes place:

   Zn(s) + CuSO₄(aq) → Cu(s) + ZnSO₄(aq)

   i) If Zn and Cu metals are connected in an electrochemical cell; which of the two metals can act as the "anode"?
   ii) Indicate a reagent substance that can be used to distinguish ZnSO₄(aq) solution and CuSO₄ solution and the observable change when the reagent reacts in each case.

END

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