Chemistry I

002

29/07/2022 08.30 AM – 11.30 AM

NESA | NATIONAL EXAMINATION AND SCHOOL INSPECTION AUTHORITY

ORDINARY LEVEL NATIONAL EXAMINATIONS, 2021-2022

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

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 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: This section **is compulsory**.   **(15 marks)**

4) **You do not need the periodic Table.**

5) Silent non-programmable calculators may be used.

6) Use only a **blue** or **black pen**.

SECTION A: Attempt all questions from this section. **(55 marks)**

1) a) A student entered a chemistry laboratory and found two solutions which were not labelled. One is known to be acidic and the other alkaline. He/she uses phenolphthalein indicator to test them. State the colour he/she observed:

    (i) In acidic solution. **(1 mark)**
    (ii) In basic solution. **(1 mark)**

    b) List any two rules and regulations that students must follow during an experiment in a chemistry laboratory. **(2 marks)**

2) Study the experimental setup below and answer the questions.

    a) Which type of method for mixture separation does the diagram show?
    (1 mark)
    b) State to which type of mixture the method above in (2 a) can be applied?
    (1 mark)
    c) State why liquid oil forms the upper layer. **(1 mark)**

    d) Give an example of other mixture that can be separated by the same separation technique. **(1 mark)**

3) Air can be liquefied by cooling it cooling it to about – 200˚C. The boiling point of oxygen is – 180˚C and the boiling point of nitrogen is – 196˚C.
    a) When warming liquid air, which substance will boil off first and why?
    (2 marks)
    b) Give one use of nitrogen. **(1 mark)**

    c) Give one industrial use of oxygen. **(1 mark)**

4) The number of protons, neutrons and electrons in particles W, X, Y and Z are shown in the table below.

Substance	Number of Protons	Number of Neutrons	Number of Electrons
W	9	9	10
X	11	11	11
Y	12	12	10
Z	16	17	16

a) Which one(s) of the particles is/are:
    i) A cation. **(1 mark)**
    ii) An anion. **(1 mark)**
    iii) Neutral. **(1 mark)**

b) Write the electronic configuration of X. **(1 mark)**

c) i) State the valency of X.   **(1 mark)**
   ii) Give a reason for your answer in c)(i).   **(1 mark)**

5) Sodium, Aluminium, Carbon and Sulphur can combine with oxygen to form oxides. Copy and complete the following table to show the formula and class (amphoteric, acidic, basic, neutral) of the oxide formed by each of these elements.
   (Na: Z = 11, Al: Z = 13, S: Z = 16, C: Z = 12, O: Z = 8)

Element	Formula of oxide	Class of oxide
Sodium		
Aluminium		
Sulphur		
Carbon		

6) Aluminium is a metal of group IIIa of the periodic table.
   a) Using Bohr model of representation of electrons on shells, draw the structure of Aluminium atom.   **(1 mark)**

   b) Write a balanced chemical equation of a reaction that takes place when aluminium reacts with chlorine.   **(2 marks)**
      Atomic numbers: Al (Z = 13), Cl (Z = 17)

   c) How many grams of Aluminium chloride could be produced from 34g of Aluminium and 39g of chlorine?   **(4 marks)**
      Relative mass: Al = 27, Cl = 35.5

7) Aluminium metal conducts electricity in both solid and molten states but aluminium chloride conducts electricity in molten state and not in solid state.
   a) Explain this statement.   **(2 marks)**

   b) Which particles are responsible for the conduction of electricity in:
      (i)   Aluminium?   **(1 mark)**
      (ii) Aluminium chloride?   **(1 mark)**

8) Compare the reactivity of the following atoms:
   a) Magnesium, Mg (Z = 12) and Calcium, Ca (Z = 20)   **(3 marks)**

   b) Sulphur, S (Z = 16) and chlorine, Cl (Z = 17)   **(3 marks)**

9) Magnesium reacts with chlorine to form magnesium chloride.
   (Atomic number: Mg = 12, Cl = 17)
   Using this reaction, explain how ionic compounds are formed. **(2 marks)**

10) The molecular formula of an organic substance X is C_4H_{10}.
    a) Write down the structural formulae of 2 isomers of substance X and give their chemical names.   **(2 marks)**

b) Write a balanced chemical equation for the reaction of X with chlorine.
(3 marks)

11) Five steps in an acid-base titration are shown below.

Step 1 – Slowly add the acid from a burette into a conical flask until the indicator becomes colourless.

Step 2 – Add thymolphthalein.

Step 3 – Use a volumetric pipette to add a fixed volume of alkali to a conical flask.

Step 4 – Read and record the initial volume of acid in the burette.

Step 5 – Read and record the final volume of acid in the burette.

a) Choose the letter that illustrates the correct sequencing of acid-base titration. **(1 mark)**
A) $2 \rightarrow 4 \rightarrow 1 \rightarrow 5 \rightarrow 3$
B) $3 \rightarrow 2 \rightarrow 4 \rightarrow 1 \rightarrow 5$
C) $3 \rightarrow 4 \rightarrow 1 \rightarrow 5 \rightarrow 2$
D) $4 \rightarrow 3 \rightarrow 1 \rightarrow 2 \rightarrow 5$

b) State the role of thymolphthalein in the titration process. **(1 mark)**

c) Why do we add the acid from a burette into a conical flask dropwise while approaching the end of the titration? **(1 mark)**

12) A senior three student passed 140 cm^3 of air over heated copper metal until there was no further change. The remaining volume of air was 115 cm^3.
a) State the main gas in the 115 cm^3 of the remaining air. **(1 mark)**

b) Why did the volume of air decreases? **(1 mark)**

c) Calculate the percentage by volume of oxygen in the 140 cm^3 of air.
(2 marks)
d) Is the air used polluted or not? Give a reason. **(2 marks)**

SECTION B: ATTEMPT ONLY THREE (3) QUESTIONS **(30 marks)**

13) In an experiment, ammonia gas was prepared by heating ammonium chloride (NH_4Cl) with Calcium hydroxide [$Ca(OH)_2$]. After drying, 120 cm³ of ammonia gas were collected at room temperature and pressure.

    a) Is Calcium hydroxide a base or an acid? Justify your answer. **(2 marks)**

    b) Ammonia gas is dried using calcium oxide and not concentrated sulphuric acid. Explain. **(2 marks)**

    c) Write a chemical equation of the reaction between Calcium hydroxide and ammonium chloride. **(2 marks)**

    d) Calculate the mass of ammonium chloride required to produce 120 cm³ of ammonia. (RAM: N = 14, H = 1, Cl = 35.5, molar gas volume = 22.4 dm³ per mole). **(2 marks)**

    e) The solubility of calcium chloride salt at 30°C is 40, what amount of water is required to make a saturates solution of 80g of solute? **(2 marks)**

14) a) Burning is one way of managing wastes. Discuss 3 negative impacts of this practice on the environment. **(3 marks)**

    b) Outline 3 dangers of materials that do not rot when dumped. **(3 marks)**

    c) **Reuse, Recycling, Disposal** and **Minimization** are the steps of effective waste management. Discuss these 4 steps. **(4 marks)**

15) Study the diagram below and answer the questions that follow:
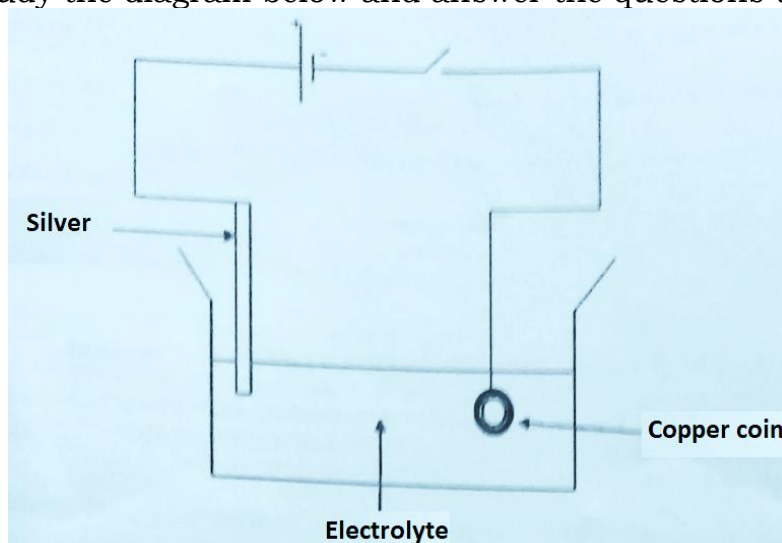
    a) Name a suitable electrolyte that could have been used. **(1 mark)**

    b) What name is given to the negative electrode. **(1 mark)**

c) Give an ionic equation for the reaction which occurred on the surface of the copper coin. **(2 marks)**

d) What happened to the mass of the silver electrode? Explain your answer. **(2 marks)**

e) State the name of particles responsible for conduction of electricity in:
   (i)   The electrolyte. **(1 mark)**
   (ii) The external wire connecting the electrodes. **(1 mark)**

f) The original mass of the copper coin used was **12.8 g**. Calculate the number of moles of copper in the coin. (Cu = 64) **(2 marks)**

16) Study the diagram representing the preparation and collection of gas Q by decomposing hydrogen peroxide.
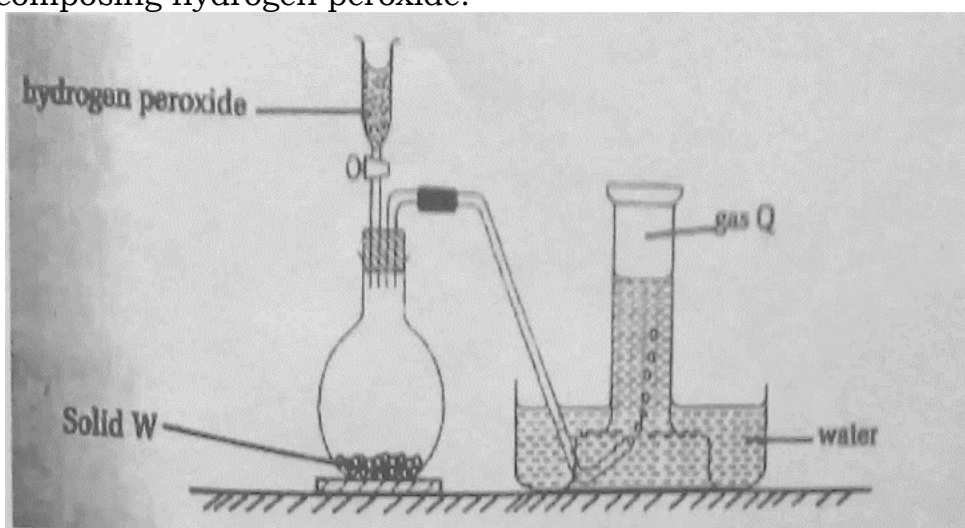
a) Identify W and Q. **(2 marks)**

b) Give the chemical equations of decomposition of hydrogen peroxide, including states of the reactants in the flask. **(2 marks)**

c) Write the chemical equation when:

   (i)   Burning Sulphur in gas Q. **(1 mark)**

   (ii) Burning magnesium in gas Q. **(1 mark)**

   (iii) The products in (c) (i) and (c) (ii) were dissolved separately in water and the resulting solution tested with litmus solution. Determine the colour change of litmus solution in each solution. **(2 marks)**

   (iv) Explain the reasons of that change in colour in (c) (iii) with a chemical equation. **(2 marks)**

SECTION C: THIS QUESTION IS COMPULSORY   (15 marks)

17) A sample of air was bubbled into two wash bottles containing soda lime and concentrated sulphuric acid respectively, and finely collected in a gas syringe.

    a) (i) State the role of soda lime in this experimental set up.   **(1 mark)**
       (ii) Suggest a reason for passing the air sample through concentrated sulphuric acid.   **(1 mark)**

    b) 80cm³ of the gas was collected in the syringe and it was passed over heated copper fillings in a combustion tube very many times until no further change occurred. On cooling to initial temperature, the volume of the gas did reduce to 63.2cm³.

       (i)   State what was observed in the combustion tube.   **(1 mark)**

       (ii)   What is the purpose of copper fillings?   **(1 mark)**

       (iii)   Calculate the volume change of the gas in the syringe.   **(1 mark)**

       (iv)   Determine the percentage change in the volume of the gas.
            (2 marks)

    c) What is the composition of residual gas in the syringe?   **(1 mark)**

    d) 20 grams of sulphur burn completely in air to form Sulfur Dioxide.

       (i)   Write the chemical equation of combustion reaction of Sulfur.
            (1 mark)
       (ii)   State the limiting reactant. Support your answer.   **(2 marks)**

       (iii)   Calculate the mass of SO_2 produced.   **(2 marks)**

       (iv)   Explain how dioxide produced by burning Sulfur, can pollute atmospheric air. (Equation not required).   **(2 marks)**