THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL
ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/1

CHEMISTRY 1
(For Both School and Private Candidates)

Time: 2 Hours 30 Minutes   Tuesday 19th February 2008 a.m.

Instructions:

1. This paper consists of **fourteen (14)** questions in sections A, B and C

2. Answer **four (4)** questions from section A and **three (3)** questions from each of sections B and C.

3. Mathematical tables and non programmable calculators may be used.

4. Cellular phones are not allowed in the examination room.

5. Write your **Examination Number** on every page of your answer booklet(s)

6. For your calculations you may use the following constants:

     (i) R_H (Rydberg constant) $= 1.097 \times 10^7 \, m^{-1}$

     (ii)   Speed of light $C = 3.0 \times 10^8 \, m/s$

     (iii)   Planck's constant, $= 6.63 \times 10^{-34} \, J/S$

     (iv)   Molar gas constant $R = 8.314 \, Jmol^{-1} K^{-1}$ or $0.0821 \, atm \, mol^{-1} K^{-1} L$.

     (v)   Atomic masses: $H = 1$, $O = 16$, $S = 32$, $C = 12$, $Na = 23$,

This paper consists of 7 printed pages

1 (a) Define the following terms
   (i)   Radioactive decay
   (ii)   Radioactive isotope
   (iii) Radioactivity   (03 marks)

(b) A radioactive isotope of the element $^{226}_{88}Ra$ decays according to the following scheme

$$^{226}_{88}Ra \xrightarrow{\ 2\beta\text{ particles}\ } F \xrightarrow{\ \alpha\text{ particle}\ } G \xrightarrow{\ \beta\text{ particle}\ } H$$

Deduce the atomic number and mass of F, G and H   (03 marks)

(c) The mass number of two atoms X and Y with the same atomic number are 206 and 208, respectively. If X contains 124 neutrons in its nucleus, find the number of neutrons in the nucleus of Y. What is the atomic number of Y?   (04 marks)

2 (a) Write short notes on the following:
   (i)   Hydrogen bonding
   (ii)   Van der Waals forces
   (iii) VSEPR theory   (03 marks)

(b) Use the VSEPR theory to predict the molecular geometry of the following species:

   (i) ^9Cl (ii) SO_3 (iii) CS_2 (iv) SO_4^{2-} (04 marks)

(c) Explain why CO_2 is a non-polar molecule while SO_2 is polar despite the fact that both have the same empirical formula   (01 mark)

(e) Calculate the frequency of the second line in Brackett series. (02 marks)

3 (a) Define Raoult's Law of vapour pressure.   (01 mark)

(b) Heptane and octane form an ideal solution. Give a mathematical expression for Raoult's vapour pressure law for a solution containing heptane and octane   (02 marks)

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(c) (i) Under what circumstances will two liquid mixtures behave as an ideal solution? (Give three (3) conditions) **(03 marks)**

(ii) Calculate the vapour pressure of a solution containing 50 g of heptane (C_7H_{16}) and 38 g of octane (C_8H_{18}) at 20 °C. Vapour pressures of heptane and octane at 20 °C are 47.32 Pa and 139.8 Pa, respectively. **(04 marks)**

4. (a) Define the following terms:
(i) Le Chatelier's principle.
(ii) Reversible reaction
(iii) Law of mass action
(iv) Catalyst. **(04 marks)**

(b) Explain briefly how temperature affects the equilibrium reaction. **(02 marks)**

(c) In an experiment, 0.206 moles of hydrogen and 0.144 moles of iodine were heated (at 723 K) to equilibrium in the reaction

$$H_2 + I_2 \rightleftharpoons 2HI$$
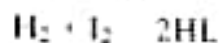
0.258 moles of hydrogen iodide was formed. Calculate the equilibrium constant of the reaction. **(04 marks)**

5. (a) The atomic nuclei of isotopic atoms X and Y contain the following.
X 9 neutrons and 8 protons
Y 20 neutrons and 19 protons

Write the
(i) Mass number of X and Y
(ii) Atomic number of X and Y
(iii) Electronic configurations of X and Y.
(iv) Groups and periods in the periodic table of elements to which X and Y belong
(v) Most probable oxidation states of X and Y.
(vi) Possible chemical formula for a compound formed between X and Y **(07 marks)**

(b) The energy of the electron in a hydrogen atom when it is in the ground state is given by

$$E_1 = -2.178 \times 10 \left(\frac{1}{n_1^2} \right) \text{ Joules}$$

The energy of the same electron if it occupies a higher energy level (n =2) is given by

$$E_2 = 2.178 \times 10 \left(\frac{1^2}{n_2^2} \right) \text{ Joules}$$

Calculate the energy, in joules, and the wavenumber, in metres, of the light which must be absorbed by a hydrogen atom to excite its electron from $n = 1$ to $n = 2$. **(03 marks)**

6. (a) What do you understand by the following terms?
   (i) Mole   (ii) Mole fraction   (iii) molarity
   (iv) Molality   (v) Normality   **(05 marks)**

   (b) Sulphuric acid solution containing 571.6 g of H_2SO_4 per dm^3 of solution at 20 °C has a density of 1.3294 g/ml. Calculate the
   (i) Molarity of sulphuric acid
   (ii) Percentage by mass of H_2SO_4
   (iii) Mole fractions of the solution components. **(05 marks)**

SECTION B (30 marks)

Answer **three (3)** questions from this section.

7. (a) Give three (3) reasons to support hydrogen being grouped in group seven together with halogens in the periodic table **(02 marks)**

   (b) Give four (4) diagonal similarities between aluminium and beryllium. **(02 marks)**

   (c) Explain the following chemical phenomena using equations or other illustrations whenever possible

   (i) Aluminium chloride is a good Lewis acid

   (ii) Concentrated nitric acid renders aluminium passive

   (iii) The relative molecular mass of aluminium chloride in the vapour state is twice the expected value **(06 marks)**

8. (a) Write balanced chemical equations for the following reactions

   (i) Excess carbon dioxide is bubbled in sodium hydroxide solution.
   (ii) Excess sulphuric acid is added to sodium sulphate solution

   (iii) A white precipitate is observed when sodium sulphate solution is added to barium chloride solution in the presence of hydrochloric acid **(06 marks)**

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(b)   (i)   What is the difference between hydrolysis and hydration?

         (ii)   Give two (2) supporting reaction equations to show clearly the contrast between hydrolysis and hydration   **(03 marks)**

(c)   Elements in group I and group II are normally extracted by electrolysis of their fused chlorides Explain why?   **(01 mark)**

9.   (a)   What do you understand by the following terms:

         (i)   Mole

         (ii)   Avogadro's constant.   **(02 marks)**

(b) SO_2 is used in the manufacture of sulphuric acid and it is obtained from sulphide ores

$$4FeS_{2(s)} + 11O_{2(g)} \rightarrow 2Fe_2O_{3(s)} + 8SO_2(g)$$
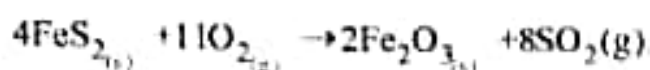
         Find the mass of oxygen, in grams, reacting when 75 l of SO_2 is produced at 100 °C and 1.04 atm   **(04 marks)**

(c)   A mixture of 5.0 g of sodium carbonate and sodium bicarbonate is heated. The loss in mass is 0.31 g Calculate the percentage by mass of sodium carbonate in the mixture   **(04 marks)**

10.   (a)   With two (2) examples in each case, explain the terms:

         (i)   Cationic complexes

         (ii)   Anionic complexes

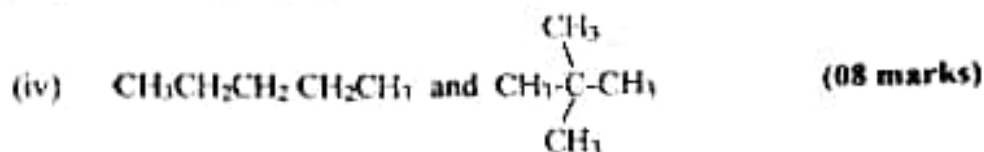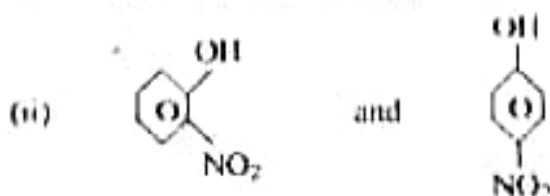   (iii)   Neutral complexes.   **(04½ marks)**

(b)   (i)   Give all the isomers of $CoCl_3.6NH_3$.

         (ii)   Addition of excess of silver nitrate solution to an aqueous solution containing 0.01 M of $CoCl_3.6NH_3$ leads to an immediate precipitate of 0.03 M of silver chloride What is the structure of $CoCl_3.6NH_3$?

                                                  (02½ marks)

(c)   With the help of equations explain what happens when

         (i)   an acid is added to a chromate (VI)

         (ii)   a base is added to a dichromate (VI)   **(03 marks)**

SECTION C (30 marks)

Answer three (3) questions from this section

11. (a) Write the structural formular for the following compounds
    (i) 2. 3 - dibromopentane
    (ii) 3. 3 - dimethylheptane
    (iii) 3. 3 - dichlorobutan – 1.3 – diene   (02 marks)
    (iv) 1. 4 – hexadiene

    (b) Write an equation for the reaction of propylene with each of the following
    (i) Hydrogen bromide in presence of Peroxide.
    (ii) H_2O, H^+
    (iii) Hot Conc. alkaline $KMnO_4$ followed by acidification
    (iv) Cl_2, uv light
    (v) Br_2 /CCl_4 solution.   (08 marks)

12. (a) For each of the following pairs of alcohols suggest one observable distinguishing test

    (i) $CH_3 CH_2 CH_2 – OH$ and CH_3CH_2OH

    (ii) $CH_3 – \overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}} – OH$ and 2-methylpropan-1-ol   (03 marks)

    (b) (i) Which alcohol will be made if pentan 3 – one is reacted with $LiAlH_4$?

    (ii) What will be the products of the following reaction?

    Pent – 2 – ene $\xrightarrow[H_2O]{Conc\ H_2SO_4}$ (03 marks)

    (c) An alcohol B reacts with conc. H_2SO_4 at 170°C to form an alkene Q. Q reacts with ozone, zinc dust and water to give propanone and ethanal

    (i) Deduce the structural formulae of Q and B
    (ii) Give balanced equations for the formation of all compounds mentioned   (04 marks)

13. (a) You are provided with the following pairs of organic compounds. Which compounds has higher boiling point in each pair? Give reasons for your choice

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(i) CH_3CH_2OH and CH_3OCH_3

(ii)

and

(iii) $CH_3CH_2CH_2CH_3$ and $CH_3CH_2CH_2CH_2CH_3$

(iv) $CH_3CH_2CH_2CH_2CH_3$ and $CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3$ **(08 marks)**

(b)   Arrange the following compounds A, B and C in order of increasing acidic strength, and give reasons for your order

A   B   C   **(02 marks)**
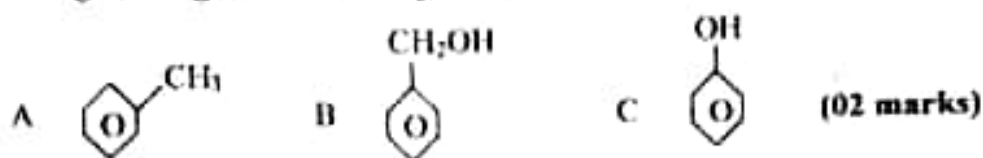
14   (a)   With the help of chemical equations, explain the following observations.

(i)   Nitration of methylbenzene gives ortho and para nitromethylbenzene

(ii)   Addition of methyl group to nitrobenzene gives meta nitromethylbenzene   **(05 marks)**

(b)   Give the systematic IUPAC names of each of the following compounds:

(i) $CHCl_3$

(ii) $CH_3C-\underset{\underset{CH_2}{|}}{CH}-\overset{\overset{CH_3}{|}}{CH}-CH_3$

(iii) $CH_3CH_2CH_2\underset{\underset{CH_3}{|}}{CH}-C=C\overset{\diagup CH_3}{\diagdown H}$ with H

(iv)

(v)   **(05 marks)**