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: 2:30 Hours **Monday, 13th February, 2012 p.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. Each question carries **ten (10)** marks.
4. Mathematical tables and non-programmable calculators may be used.
5. Cellular phones are **not** allowed in the examination room.
6. Write your **Examination Number** on every page of your answer booklet(s).
7. For calculations you may use the following constants:
   Gas constant, R = 8.31 $Jmol^{-1} K^{-1}$ or 0.0821 atm $mol^{-1} K^{-1} dm^3$
   GMV = 22.4 dm^3
   1litre = 1dm^3 = 1000 cm^3
   Temperature = 273 K
   Pressure = 760 mmHg
   Planck constant, h = 6.63 x 10^{-34}Js
   Velocity of light, c = 3.0 x 10^8 m/s
   Atomic masses: H = 1, C = 12, N = 14, O = 16, P = 31,
   S = 32, Cl = 35.5, K = 39, Mn = 55, Fe = 56.

SECTION A (40 marks)

Answer **four (4)** questions from this section.

1. (a) Define mass spectrometer. **(1 mark)**

(b) Given below are the naturally occurring isotopes of oxygen:

Element	Isotopic mass	Relative abundance %
Oxygen	$^{16}O = 15.995$	99.76
	$^{17}O = 16.999$	0.04
	$^{18}O = 17.969$	0.20

Calculate the relative atomic mass of oxygen. **(2 marks)**

(c) Write the products of the following changes:

(i) Alpha decay of $^{24}_{12}Mg$ and $^{8}_{4}Be$.

(ii) Beta decay of $^{14}_{6}C$ and $^{31}_{14}Si$. **(4 marks)**

(d) If the wavelength of the first line in the Balmer series in a hydrogen spectrum is 6863 $\overset{0}{A}$, calculate the wavelength of the first line in the Lyman series in the same spectrum. **(3 marks)**

2. The remains of an ancient fire in a cave in Africa shows a $^{14}_{6}C$ decay rate of 3.1 counts per minute per gram of carbon. Assuming that the decay rate of $^{14}_{6}C$ in a freshly cut wood is 13.6 count per minute per gram of carbon, calculate the age of the remains, given the half life of $^{14}_{6}C$ is 5730 years. **(10 marks)**

3. (a) Briefly explain the following terms:

(i) reversible reaction

(ii) rate constant. **(2 marks)**

(b) The reaction $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$, $-\Delta H$ kJ; attains its equilibrium at 47 °C. Study the reaction careful and then answer the following questions:

(i) State whether the reaction is endothermic or exothermic.

(ii) How will the yield of HI be affected if

- pressure is increased?
- temperature is increased?
- an inert gas is added?

(iii) Write the expression for the equilibrium constant in terms of partial pressures.

(iv) At 47 °C, analysis of an equilibrium mixture of the gases yielded the following results:

$P_{H_2} = 2.5 \times 10^{-1}$ atm., $P_{I_2} = 1.6 \times 10^{-1}$ atm. and $P_{HI} = 4.0 \times 10^{-1}$ atm.

Calculate the equilibrium constant for the reaction. **(8 marks)**

4. (a) State the following:
   (i) Boyle's law
   (ii) Charles' law
   (iii) Dalton's law of partial pressures. **(3 marks)**

   (b) A sample of PCl_5 weighing 2.69 g was placed in a 1.00 litre flask and completely vaporized at a temperature of 250 °C. The pressure observed at this temperature was 1 atmosphere. The possibility exists that some of the PCl_5 may have dissociated according to equation $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$. Calculate the partial pressures of PCl_5, PCl_3 and Cl_2 under the given experimental conditions. **(7 marks)**

5. (a) List four colligative properties of a solution. **(2 marks)**

   (b) Considering that heptane and octane are liquids that form an ideal solution, answer the following questions:
   (i) Give a mathematical expression for Raoult's vapour pressure law for a solution of two liquids and state each symbol used.
   (ii) Under what conditions will a mixture of two liquids behave as an ideal solution?
   (iii) Calculate the vapour pressure of a solution containing 50 g heptane (C_7H_{16}) and 38 g octane (C_8H_{18}) at 20 °C; given that the vapour pressures of heptane and octane at 20°C are 473.2 Pa and 139.8 Pa, respectively. **(8 marks)**

6. (a) Briefly explain the following terms:
   (i) Miscible liquids.
   (ii) Immiscible liquids.
   (iii) Partially miscible liquids.
   (iv) Partition law. **(4 marks)**

   (b) 10 grams of compound Q were dissolved in one litre of distilled water. When one litre of the solution formed was shaken with 100 cm^3 of ethoxyethane, 6 grams of compound Q were extracted. Calculate the amount of Q extracted from the solution residue after further shaking with 100 cm^3 of ethoxyethane. Assume that the molecular state of the solute is the same in ethoxyethane and in water. **(6 marks)**

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SECTION B (30 marks)

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

7. (a) Explain the following laboratory observations.
   (i) When potassium permanganate is used in volumetric analysis it is acidified by using dilute sulphuric acid but not dilute hydrochloric acid or nitric acid.
   (ii) Aqueous sodium hydroxide absorbs carbon dioxide readily but it is never used to test the gas. **(4 marks)**

   (b) 0.50 g of hydrated iron (II) sulphate was dissolved in sulphuric acid and titrated against 0.1 M aqueous potassium permanganate. Calculate the volume of potassium permanganate required to complete the titration. **(6 marks)**

8. Explain briefly the following facts:
   (a) Nitric acid can be stored in aluminium tanks but not sulphuric acid or sodium hydroxide. **(2 marks)**
   (b) Galvanized iron sheets rust less rapidly than tinned iron sheets. **(2 marks)**
   (c) Hydrogen gas can be used to reduce copper oxide but not zinc oxide. **(2 marks)**
   (d) Sodium carbonate can not precipitate lead carbonate from aqueous solution of lead ions. **(2 marks)**
   (e) Calcium phosphate is soluble in dilute HCl but calcium sulphate is insoluble in dilute HCl. **(2 marks)**

9. (a) Briefly explain the term diagonal relationship. **(3 marks)**
   (b) Describe four similarities of lithium and magnesium. **(4 marks)**
   (c) Describe the differences between graphite and diamond basing on the following properties:
   (i) Hardness.
   (ii) Electrical and thermal conductivity.
   (iii) Lubricating qualities. **(3 marks)**

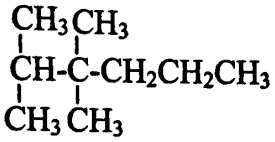
10. Element X which exists in gaseous form is more reactive than Y which exists in liquid form, but hydride of Y is a stronger acid than that of X. X does not disproportionates in water, while Y does. Although Y is not reactive as X it disproportionates in the cold and dilute or even in the hot and concentrated alkali while X does not. Both X and Y are the most electronegative elements in their respective periods. The reactive element X shows only negative oxidation state while Y shows negative and positive oxidation states. Basing on the given information:
   (a) Identify X and Y. **(1 mark)**
   (b) Explain why X exists in gaseous form while Y is in liquid form. **(2 marks)**

   (c) Give the equations of the reactions of X and Y with water, hot and concentrated alkali as well as cold and dilute alkali. **(3 marks)**
   (d) Explain why X shows only negative oxidation state while Y shows both negative and positive oxidation states. **(2 marks)**
   (e) Which one will displace the other in an aqueous solution of its salt? Explain why. **(2 marks)**

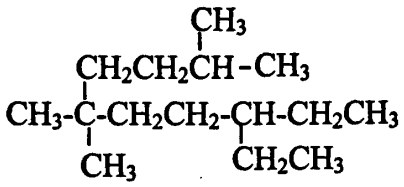
SECTION C (30 marks)

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

11. (a) Name the following organic compounds according to IUPAC rules.

(i)


(ii) $CH_3CH{=}CHCH{=}CHCH_2CH_3$

(iii)


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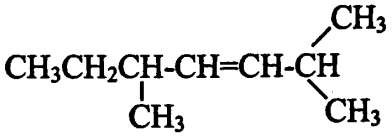

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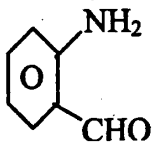

(5 marks)

(b) Write the structural formulae of the following:

(i) Cyclo octa 1,3,5,7-tetraene.
(ii) 2,2 dimethyl 3,4 diethylheptane.
(iii) 2-hydroxyl benzoic acid.
(iv) Butane 1,2,3,triol.
(v) Phenylethanone.

(5 marks)

SECTION C (30 marks)

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

11. (a) Name the following organic compounds according to IUPAC rules.

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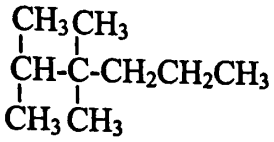
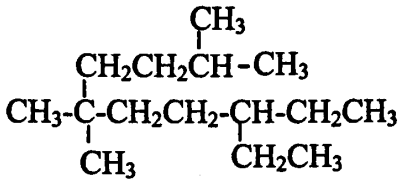
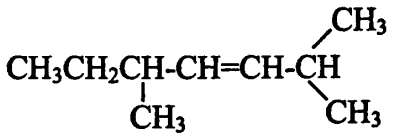
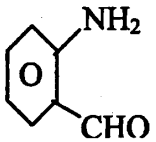


(ii) $CH_3CH{=}CHCH{=}CHCH_2CH_3$

(iii)


(iv)


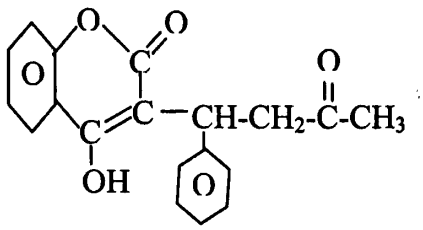
(v)


(5 marks)

(b) Write the structural formulae of the following:

(i) Cyclo octa 1,3,5,7-tetraene.
(ii) 2,2 dimethyl 3,4 diethylheptane.
(iii) 2-hydroxyl benzoic acid.
(iv) Butane 1,2,3,triol.
(v) Phenylethanone. **(5 marks)**

12. The following is a full structural formula of a certain organic molecule **P**. Study the structure and then answer the questions that follow:



(a) If the molecule gives a positive iodoform test,
(i) what are the reagents and conditions for the test?
(ii) show on the formula which part of the molecule **P** gives the tri-iodomethane. **(4 marks)**

(b) Indicate on the formula the part of the molecule which will react with 2,4-dinitrophenylhdrazine. **(2 marks)**

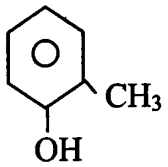
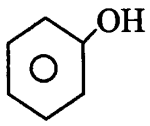
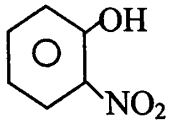
(c) Explain whether **P** would give a positive reaction with $[Ag(NH_3)_2]^+$. **(2 marks)**

(d) If molecule **P** reacts with aqueous sodium hydroxide then
(i) name the group in **P** which is attacked by sodium hydroxide.
(ii) draw the structure of the product formed by the reaction. **(2 marks)**

13. (a) Write the reaction steps to show how to convert the following organic compounds:
(i) Benzophenone to diphenyl methane.
(ii) Toluene to benzyl alcohol.
(iii) Acetone to propyne.
(iv) Propanal to 1-phenyl-1-propanol. **(6 marks)**

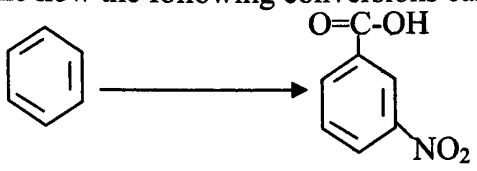
(b) Distinguish the following compounds:
(i) Phenol from chlorobenzene.
(ii) Acetone from propyne. **(4 marks)**

14. (a) You are given the following compounds:

A = CH_3CH_2OH **B** =  **C** =  **D** = 

Arange the given compounds in order of
(i) increasing acidity
(ii) increasing basic strength. **(2 marks)**

(b) Outline how the following conversions can be achieved in not more than four steps;

(i) 

(ii) $CH_3CH=CHCH_3 \longrightarrow CH_3\underset{OH}{C}H\text{-}CH_3$ **(4 marks)**

(c) Substance **A** is represented by a molecular formula $C_5H_{12}O$. **A** undergoes oxidation with acidified potassium permanganate to give compound **B** which forms a crystalline derivative with 2,4-dinitrophenyl hydrazine, but does not react with a mixture of iodine and sodium hydroxide.

(i) Write down the structural formulae of compounds **A** and **B**.

(ii) Show by means of an equation, how **B** reacts with 2,4-dinitrophenyl hydrazine.

(4 marks)