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: 2½ Hours **10 May 2001 a.m.**

Instructions

1. This paper consists of sections A, B and C.
2. Answer FOUR (4) questions from section A, THREE (3) questions from section B and THREE (3) questions from section C.
3. Read each question carefully before you start answering it.
4. Mathematical tables and calculators may be used.
5. Write your examination number on every page of your answer booklet.
6. For your calculations you may use the following.

   Atomic masses: H = 1, C = 12, N = 14, O = 16, S = 32,
   Gas constant R = 0.082 L atm mol $^{-1}K^{-1}$ or 8.314 JK^{-1}
   Planck's constant: 6.256×10^{-34} Js
   Velocity of light: 3×10^{8} ms^{-1}
   Reydberg`s constant: 1.09737×10^{3} cm^{-1}

SECTION A

Answer any FOUR (4) questions from this section.

1. (a) State the rules which govern the pairing of electrons in orbitals of an atom which is in ground state.

(3 marks)

(b) Give the name of a geometrical structure and one example of the molecule formed from the following hybridized atomic orbitals.

(i) sp^3 hybridized orbitals
(ii) sp^2 hybridized orbitals
(iii) d^2sp^3 hybridized orbitals.

(4½ marks)

(c) Calculate the energy associated with an electron moving in an orbital of principle quantum number n = 2.

(2½ marks)

2. (a) State

(i) Avogadro's law.
(ii) Dalton's law of partial pressure.

(2 marks)

(b) A 15.5 litre sample of 0.75 mole oxygen gas at a pressure of 1 atmosphere and a temperature of 25° C was completely converted to ozone (O_3) at the same temperature and pressure. What was the volume of ozone?

(4 marks)

(c) A mixture of helium and oxygen is used in diving tanks instead of nitrogen, which at elevated pressures a large quantity dissolves in blood producing an agonizing condition called "the bends".
For a particular dive 40 litres of oxygen at 25° C and 1.0 atmosphere was pumped along with 12 litres of helium at 25° C and 1.0 atmosphere into a tank with a volume of 5.0 litres. Calculate the partial pressure of each gas and the total pressure in the tank at 25° C.

(4 marks)

3. (a) State the law of mass action. (2 marks)

(b) Distinguish between equilibrium constant and reaction quotient. (2 marks)

(c) A 4 litre flask was filled with 2.0 moles of gaseous SO_2 and 2.0 moles of gaseous NO_2 and heated. After equilibrium was reached, it was found that 1.2 moles of gaseous NO was present. Assume that the reaction

$$SO_{2(g)} + NO_{2(g)} \rightleftharpoons SO_{3(g)} + NO_{(g)}$$

occurs under these conditions. Calculate the value of K_c and K_p for this reaction.

(6 marks)

4. (a) What is meant by

(i) oxidation state (ii) reducing agent (iii) oxidation (iv) reduction?

(3 marks)

(b) Which of the following equations represent redox reactions?

(i) $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$

(ii) $NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow NaHSO_{4(aq)} + H_2O_{(l)}$

(iii) $BaCl_{2(aq)} + H_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2HCl_{(aq)}$

(iv) $ClO^-_{3(aq)} + 3Zn_{(s)} + 6H^+_{(aq)} \rightarrow Cl^-_{(aq)} + 3Zn^{2+}_{(aq)} + 3H_2O_{(l)}$

(v) $2Cu^{2+}_{(aq)} + 4I^-_{(aq)} \rightarrow 2CuI_{(s)} + I_{2(aq)}$

(5 marks)

(c) Write a balanced equation for the reaction between

(i) acidified dichromate (VI) ions and sulphur dioxide solution.
(ii) manganate (VII) ions and iron (II) ions in acid solution.

(2 marks)

5. (a) Define the term transition metals. (1 mark)

(b) Write the electronic configurations of Cr^{3+} and Cu. (2 marks)

(c) Explain in terms of their electronic configurations, why Cr and Cu are said to violate Aufbau principle. (1 mark)

(d) (i) Give the formula of a compound or ion containing chromium in an oxidation state of +6. (1 mark)

(ii) Give the formula of the chromium complex dichlorobis (ethylenediamine) chromium (III) nitrate. (1 mark)

(iii) In (ii) above which ligand is anionic and neutral? (1 mark)

(e) Study the following complexes carefully.

$[Cr(H_2O)_5 Cl]Cl_2$ and $[Cr(H_2O)_4 Cl_2]Cl$

(i) What is the coordination number in the two complex compounds?
(ii) If one is blue-green and the other is green, assign these colours to an appropriate complex.
(iii) Give the IUPAC names of the compounds.

(3 marks)

6. (a) Distinguish between solubility and solubility product of a given solid substance.

(4 marks)

(b) A solution is prepared by mixing 150.0 ml of 1.00×10^{-2} M $Mg(NO_3)_2$ and 250.0 ml of 1.00×10^{-1} M NaF. Calculate the concentrations of Mg^{2+} and F^- at equilibrium with solid MgF_2. (Ksp = 6.4×10^{-9} mol^3 dm^{-9} at 298 K)

(6 marks)

SECTION B

Answer any THREE (3) questions from this section.

7. With the aid of balanced chemical equations where necessary, explain how pure copper is obtained from copper pyrites.

(10 marks)

8. (a) List the postulates which led to the derivation of the fundamental gas equation.

(2½ marks)

(b) Find the density of oxygen gas at 25° C and 0.987 atmospheres.

(3 marks)

(c) 280 cm^3 of nitrogen diffuse through a membrane in 70 seconds. How long will it take for 400 cm^3 of carbon dioxide to diffuse through the same membrane under the same conditions?

(4½ marks)

9. (a) Write short notes on the following terms.

(i) Diffusion (ii) Osmosis (iii) Osmotic pressure (iv) Effusion

(2 marks)

(b) (i) What is the difference between osmosis and diffusion?

(2 marks)

(ii) When 15 g of glucose, $C_6H_{12}O_6$ was dissolved in 50 g of solvent with a relative molecular mass of 180 g, the freezing point was depressed by 8.0° C. Using these data calculate the freezing point depression constant for the solvent.

(3 marks)

(c) An aqueous solution of cane sugar containing 19.15 g of sugar per dm^3 has osmotic pressure of 136,300 Nm^{-2} at 20° C. Calculate the relative molecular mass of cane sugar.

(3 marks)

10. (a) State Hund's rule of maximum multiplicity. (1 mark)

(b) What is the maximum number of electrons in an atom which has the following quantum numbers?

(i) $n = 2$, and $\ell = 1$.
(ii) $n = 2$, $\ell = 1$, $m_\ell = -1$ and $m_s = -½$. (2 marks)

(c) Elements X,Y and Z have the following electronic configurations.

X: $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$
Y: $1s^2$ $2s^2$ $2p^6$ $3s^2$
Z: $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^1$.

The first ionization energies of the three elements (not in the same order) are 0.42, 0.74 and 1.5 MJ/mole. The atomic radii are 1.60, 0.94 and 1.97 Å. Identify the three elements and match the appropriate ionization energy and atomic radius to each configuration.

(7 marks).

SECTION C

Answer any THREE (3) questions from this section.

11. (a) Explain briefly what is meant by the terms

(i) addition polymerisation (ii) condensation polymerisation.
Give one example in each case.

(3½ marks)

(b) Give three properties of nylon.

(1½ marks)

(c) Write a correct structural formula for each of the following compounds.

(i) 2 - bromo - 2,5 - dimethylhexane

(ii) 3 - ethyl - 6 - methyloctane

(iii) 2, 4, 4 - trimethylpent - 1- ene

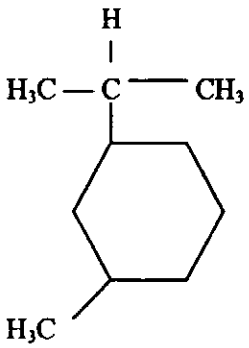
(iv) 4 - methylhydroxybenzene

(v) 2, 2 - dichloro - 5, 6 - diethylnonane

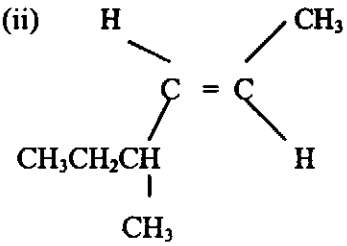
(5 marks)

12. (a) Give the systematic IUPAC name for each of the following compounds:

(i)

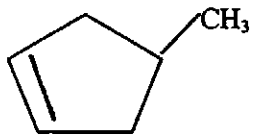


(ii)



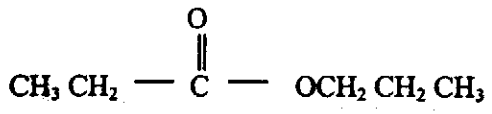
(iii) $CH_3CH_2-CH(Cl)-CH(CH=CH_2)-CH_2CH_3$

(iv)



(v) $CH_3CH(CH_3)CH_2CHO$

(vi)



(3 marks)

(b) Study the following organic reactions carefully and answer the questions which follow.

(i) $A + O_3 \xrightarrow[H_2O]{Zn} B(C_2H_4O) + C(C_4H_8O)$

(ii) $B \xrightarrow{KMnO_4} D$

(iii) $2B + \text{cold } NaOH \rightarrow E(C_4H_8O_2)$

(iv) $D + SOCl_2 \rightarrow F + HCl_{(g)} + SO_{2(g)}$

(v) $C_6H_5 - CH_3 + F \xrightarrow{AlCl_3} CH_3CO - C_6H_4 - CH_3$

(vi) $CH_3CO - C_6H_4 - CH_3 + \text{conc. } HCl \xrightarrow{Zn/Hg} G$

Name the type of reactions (i), (ii), (iii), (iv), (v) and (vi). (3½ marks)

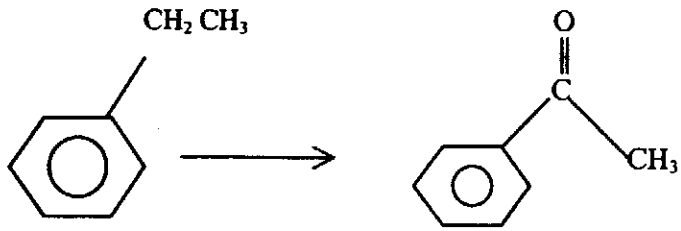
(c) Write the systematic IUPAC names and structures of compounds A, B, C, D, E, F and G given in question 12 (b). (3½ marks)

13. (a) With the help of chemical equations show clearly how the following conversions can be achieved (NOT MORE THAN 4 STEPS).

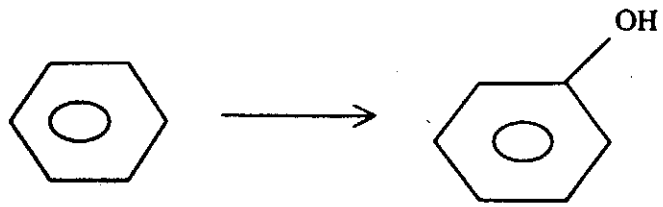
(i) $CH_3\ CH_2\ Cl \rightarrow CH_3\ COOH$

(ii) $CH_3\ CH_2\ C \equiv CH \rightarrow CH_3\ CH_2\ \underset{\displaystyle Cl}{\underset{|}{CH}}\ CH_3$

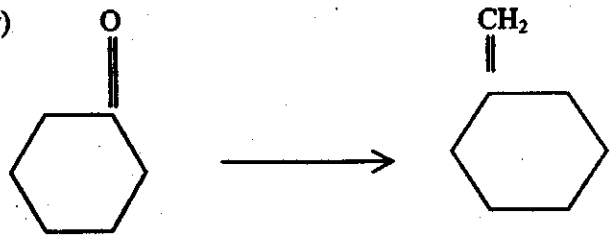
(iii)



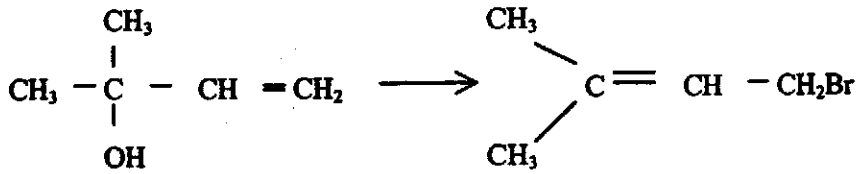
(iv)



(v)



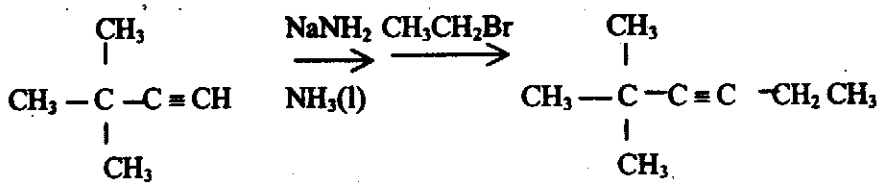
(vi)



(6 marks)

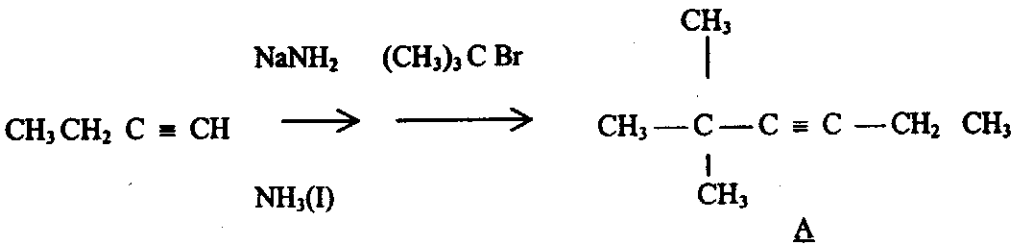
(b) Two alternative routes to compound A are given below. Which route is likely to be more successful? Explain.

Route I:



A

Route II:



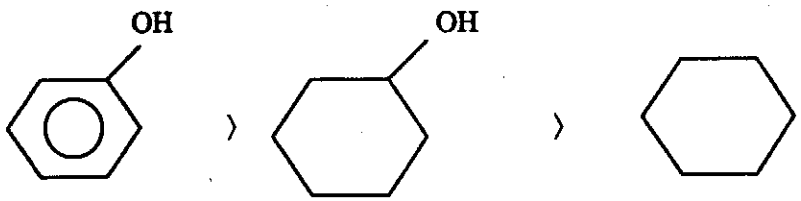
A

(4 marks)

14. (a) Explain each of the following observations.

(i) The fishy odour of a solution of dimethylamine in water is lost when an equimolar amount of hydrochloric acid is added.

(ii) The acidity of phenol, cyclohexane and cyclohexanol follows the trend:



(iii) When water is carefully added to benzoyl chloride a white precipitate is formed, but on addition of excess sodium hydroxide a clear solution is obtained.

(4 marks)

(b) An alkyl bromide X contains 35.04 % carbon, 6.56 % hydrogen and 58.40 % bromine. Treatment of X with a mixture of ethanol and potassium hydroxide yields compound Y. Oxidation of Y gives propanone, carbon dioxide and water. Y also reacts with hydrobromic acid to give Z, which is isomeric to X.
Using this information, suggest structures for X, Y and Z.

(6 marks)