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   *2009 February, 13 Friday a.m.*

INSTRUCTIONS

1. This paper consists of **14** questions in 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. **All** questions carry equal marks.

4. Mathematical tables and nonprogrammable 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.

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

$H = 1$, $O = 16$, $C = 12$, $Be = 9$, $Si = 28$, $Al = 27$,
$Na = 23$, $Cl = 35.5$, $Pb = 207$, $N = 14$
$R = 0.082$ atm. $mol^{-1}K^{-1}$ L or $R = 8.31$ $Jmol^{-1} K^{-1}$
1 litre = 1 dm^3 = 1000 cm^3
GMV at s.t.p. = 22.4 dm^3
Std temperature = 273 K
Std pressure = 760 mm Hg

This paper consists of   8   printed pages.

SECTION A

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

1. (a) An electron in a hydrogen atom finds itself in the fourth energy level, (n = 4).

   (i) Write down a list of orbitals (subshells) that it might be in.

   (ii) What are the values of ℓ for this energy level (n = 4)?

   (2 marks)

   (b) Radio isotope $^{12}C_6$ is a β-emitter with a half life of 5568 years.

   (i) Define the term half life.

   (ii) What is the **atomic number, atomic mass** and **name** of the **new atom** that is formed as a result of this change?

   (3 marks)

   (c) Identify the following elements:

   (i) $^{9}_{4}X$ (ii) $^{28}_{14}X$ (iii) $^{27}_{13}X$ **(3 marks)**

   (d) From which energy level do transitions in the hydrogen atom with the following spectral series arise?

   (i) the first line in the Lyman series.

   (ii) the second line in the Balmer series.   **(2 marks)**

2. (a) Give the meaning of the following:

   (i) Osmotic pressure of a solution

   (ii) Van't Hoff's factor, (i).   **(3 marks)**

   (b) Derive an expression relating the Van't Hoff factor, i with the degree of dissociation, ($\propto$) of a molecule.   **(3 marks)**

   (c) 3.42 g of sodium chloride were dissolved in 100 g of water. If the atmospheric pressure of this solution at 60 °C was 22680 mm Hg, calculate the percentage dissociation of the sodium chloride.   **(4 marks)**

3. (a) Define the following:

   (1 mark)

(b) Ethanol-water mixture is said to give a positive deviation from ideal behaviour. What factors contribute to this positive deviation from ideal behaviour? **(2 marks)**

(c) (i) Sketch a temperature-composition curve for water-ethanol mixture from the following data:

Atmospheric pressure = 1 atmosphere

Boiling point of pure water = 100 °C

Boiling point of pure ethanol = 78.4 °C

Boiling point of azeotropic mixture = 78.15 °C

Composition of azeotropic mixture = 95.6 % by mass of ethanol.

(2 marks)

(ii) It is possible to separate water-ethanol mixture into pure water but not into pure ethanol. Explain. **(3 marks)**

(iii) Sketch a vapour pressure – composition curve for water – ethanol mixture.

(2 marks)

4. (a) Name the following complexes according to the IUPAC rules.

(i) $[Ni (H_2NCH_2CH_2NH_2)_2Cl_2]$.

(ii) $[Cr (H_2O)_4Cl_2]Cl.$

(iii) $K_2 [Co (NO_2)_4]$.

(iv) $[Pt Cl_6]^{2-}$. **(4 marks)**

(b) The compound $[Co(NH_3)_5Cl]SO_4$ is isomeric with $[Co (NH_3)_5SO_4]Cl$

(i) What ions will these two isomers yield in their aqueous solutions?

(ii) Give one positive chemical test for each isomer.

(iii) What is the oxidation and co ordination numbers of the central atom in the two isomers? **(3 marks)**

(c) Explain why there is an increase in the maximum oxidation number from scandium to manganese while there is a decrease of maximum oxidation number from manganese to zinc? **(3 marks)**

5. (a) (i) What is a hydrogen bond?

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(ii)   In the following list of compounds, identify those which form strong hydrogen bonding and those which form weak hydrogen bonding.

Bifluoride ion HF_2^-, water (H_2O), 2-nitrophenc $\left[\bigcirc \substack{OH \\ NO_2} \right]$
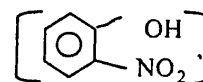
hydrogen fluoride (HF), Hydrated hydroxyl ion $(H_3O_2)^-$. **(6 marks)**

(b)   Classify the following compounds under:
Inorganic covalent hydrides, ionic hydrides and complex hydrides.

(i) NaH, KH, CaH_2 (ii) H_2O, H_2S, NH_3, HCl

(iii)   Li(Al H_4)   . **(4 marks)**

6.   The solubility product of lead (II) chloride Pb Cl_2, has a value of
1.6×10^{-5} Mol^3 dm^{-9} at 298 K.

(a)   Explain what is meant by this statement.   **(2 marks)**

(b)   Calculate the solubility in water of lead (II) chloride at 298 K.   **(4 marks)**

(c)   Calculate the solubility of the above compound in a 0.1 M solution of lead (II) nitrate at the same conditions.   **(4 marks)**

SECTION B

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

7.   Explain in ionic terms, the following facts with the help of a chemical equation where necessary.

(a)   Silver chloride is almost insoluble in water but passes readily into solution when excess ammonia is added.   **(2 marks)**

(b)   Iodine is readily soluble in a concentrated solution of potassium iodide but only sparingly soluble in water.   **(2 marks)**

(c)   Lead (II) chloride is more soluble in concentrated hydrochloric acid than in water.   **(2 marks)**

(d)   The addition of potassium cyanide solution to a solution of silver nitrate gives a white precipitate which then dissolves in excess of potassium cyanide solution.   **(2 marks)**

(e)   When ammonia solution is added slowly to an aqueous solution of copper (II) sulphate a pale blue precipitate is formed which dissolves in excess of ammonia to form a deep blue solution.   **(2 marks)**

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8. (a) Use the information in table 1 to explain the statements below:

Element	Na	Mg	Al	Si	P	S	Cl
Atomic radius (nm)	0.156	0.136	0.125	0.117	0.110	0.104	0.099
Ionic radius (nm)	0.095	0.065	0.500	X	X	0.184	0.181
1st Ionization Energy	492	743	579	591	1061	1003	1254

Table 1

(i) The ionic radii of Na^+, Mg^{2+} and Al^{3+} are less than their respective atomic radii whereas the ionic radii of Cl^- and S^{2-} are greater than their respective atomic radii.

(2 marks)

(ii) The first ionisation energies show a general increase from sodium to chlorine.

(2 marks)

(b) Identify from the following paramagnetic and diamagnetic species: Na, Mg, Cl^- and Ca^{2+}.

(6 marks)

9. (a) Define the term hybridisation.

(1 mark)

(b) By applying the knowledge of hybridisation explain the following:

(i) A carbon atom has got only two unpaired electrons yet, it can form four covalent bonds with chlorine atoms to form a carbon tetrachloride molecule.

(ii) Beryllium has a pair of electrons in its outermost shell but it can form a beryllium molecule by means of sharing electrons with two chlorine atoms to form a beryllium chloride molecule. (3 marks)

(b) Give explanations to the following observations:

(i) Anhydrous aluminium chloride does not conduct electricity but its aqueous solution does.

(ii) An aqueous solution of aluminium chloride turns blue litmus red.

(iii) A white precipitate tend to be formed which dissolves when carbon dioxide is bubbled till excess through calcium hydroxide solution.

(6 marks)

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10. (a) Account for the following:

(i) Strontium in period 5 group 2 has lower ionisation energy than bromine in period 4 group 7.

(ii) Phosphorus in period 3 group 5 has more non-metallic character than gallium period 4 group 3.

(iii) The atomic radius of strontium in group 2 is larger than that of Mg in group 2.

(iv) Bromine has more electron affinity than iodine although they belong to same group.

(4 marks)

(b) With reasons arrange the following species in order of increasing size.

K^+, Ar, S^{2-}, Cl^- and Ca^{2+}.
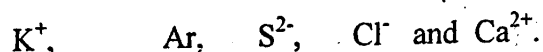
(6 marks)

SECTION C

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

11. (a) Give the IUPAC names for the following organic compounds:

(i) $CH_3 - CH_2 - C(CH_3)_2 - CO(NH_2)$

(ii) $CH_3 - CH(CH_3) - (CH_2)_4 - CO(OC_2H_5)$

(iii) $(C_6H_5 - CO) - O - (CO - C_3H_7)$

(iv) $C_6H_5 - COCl$.

(2 marks)

(b) Study the following reaction:

Ethanol $\xrightarrow{A}$ Ethanoic acid $\xrightarrow{B}$ Ethanoyl chloride

Ethanoyl chloride $\xrightarrow{C}$ Ethylamine

$\xrightarrow{D}$ C_2H_5
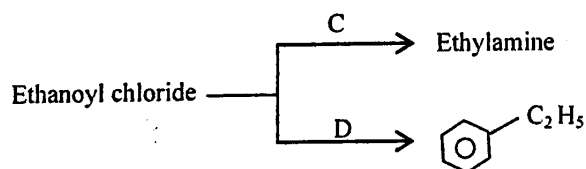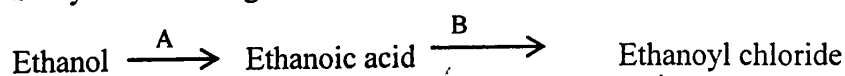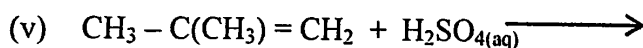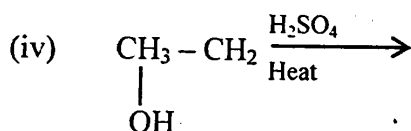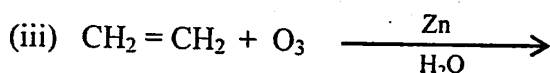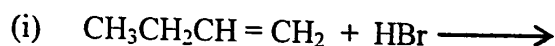
Give the names of reagents A, B, C and D.

(4 marks)

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(c) What type of reagents attack the benzene ring to form substitution products of benzene.

(d) Give the attacking reagents which are involved in the:

(i) nitration of benzene   (ii) alkylation of benzene   (iii) acylation of benzene.

(4 marks)

12. (a) Define the following:

(i) Elimination reaction

(ii) Addition reaction

(iii) Organic substitution reaction

(iv) Nucleophilic substitution reaction

(v) Homologous series.

(5 marks)

(b) Complete the following reactions:

(i) $CH_3CH_2CH = CH_2 + HBr \longrightarrow$

(ii) $CH_2 = CH_2 + KmnO_4 \longrightarrow$

(iii) $CH_2 = CH_2 + O_3 \xrightarrow[H_2O]{Zn}$

(iv) $CH_3 - CH_2 \underset{OH}{|} \xrightarrow[Heat]{H_2SO_4}$

(v) $CH_3 - C(CH_3) = CH_2 + H_2SO_{4(aq)} \longrightarrow$

(5 marks)

13. (a) Give the chemicals and conditions, if any which can be used to prepare aldehydes by using the following processes:
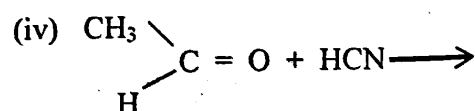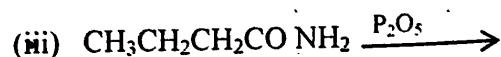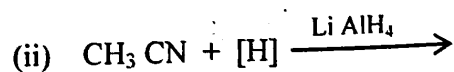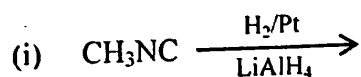
(i) Dehydrogenation

(ii) Catalytic hydrogenation.

(3 marks)

(b) Why do aldehydes

(i) behave like polar compounds

(ii) have lower boiling points than alcohols of comparable relative molecular masses?

(2 marks)

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(c) Complete the following chemical reactions:

(i) $CH_3NC \xrightarrow[\text{LiAlH}_4]{\text{H}_2/\text{Pt}}$

(ii) $CH_3CN + [H] \xrightarrow{\text{Li AlH}_4}$

(iii) $CH_3CH_2CH_2CONH_2 \xrightarrow{\text{P}_2\text{O}_5}$

(iv) $\begin{matrix} CH_3 \searrow \\ \quad\quad C = O + HCN \longrightarrow \\ H \nearrow \end{matrix}$

(v) $CH_3CHO \xrightarrow[\text{Ni}]{\text{H}_2}$

(5 marks)

14. (a) Give the names of four alcohols represented by the molecular formula C_4H_9OH and write their structural formulae. (2 marks)

(b) Give the products of oxidation of the alcohols in 14.(a) above when acidified potassium dichromate solution was used as an oxidizing agent. (4 marks)

(c) A substance X has a molecular formula $C_5H_{10}O$. What deductions can you make for substance X from each of the following facts:-

(i) X reacts with sodium metal to give hydrogen gas with the formation of compound C_5H_9ONa. (2 marks)

(ii) On treatment of X with chromium (VI) oxide it forms compound C_5H_8O. The compound C_5H_8O does not reduce ammoniacal silver nitrate solution but it forms a crystalline derivative with 2, 4 dinitrophenylhydrazine. (2 marks)