THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

CHEMISTRY

(For Non-Science Students)

(ii) Gas constant $R = 0.0821\ L\ atm\ mol^{-1}\ K^{-1}$

$R = 8.314\ JK^{-1}$

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SECTION A

Answer any FOUR questions from this section.

1. (a) Define the following terms:

   (i) Quantum orbital

   (ii) Quantum numbers

   (iii) Quantization of energy

   (iv) Wave particle duality of matter. (4 Marks)

   (b) Give the postulates of Bohr's atomic model. (3 Marks)

   (c) What are the shortcomings of Bohr's atomic model? (3 Marks)

2. (a) State

   (i) Raoults law

   (ii) Partition law. (2 Marks)

   (b) The ideality of a solution is approached when it is made more dilute. Explain. (2 Marks)

   (c) 10g of methanol give an ideal solution when mixed with 50g of ethanol.

   If the vapour pressures of methanol and ethanol at the same temperature are 6265Pa and 2933Pa, respectively, calculate:

   (i) the partial pressure exerted by each component in the mixture. (4 Marks)

   (ii) the composition of the vapour. (2 Marks)

3. (a) State

   (i) Boyles' law

   (ii) Charles' law

   (iii) Avogadro's law. (4½ Marks)

   (b) SO_2, used in the manufacture of sulphuric acid, is obtainable from sulphide ores:

   $$4FeS(s) + 11O_2(g) \rightarrow 2Fe_2O_3(s) + 8SO_2(g).$$

   Find the mass of oxygen in grams reacting when 75 liters of SO_2 is produced at 100°C and 1.04 atm. (5½ Marks)

4. (a) Explain why there is a constant pressure of carbon dioxide at a particular temperature over calcium carbonate undergoing thermal dissociation $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ and why a current of air is blown through a lime kiln during the production of quick lime, CaO. (3 Marks)

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(b) When one mole of ethanoic acid (acetic acid) is maintained at 25°C with one mole of ethanol, one-third of the ethanoic acid remains when equilibrium is attained.

How much would have remained if three quarters of one mole of ethanol had been used instead of one mole at the same temperature? (7 Marks)

5. The solubility product of lead (II) chloride, $PbCl_2$, has a value of 1.6×10^{-5} mol^3dm^{-9} at 298K.

Explain what is meant by this statement and calculate the solubility at 298K of lead chloride in:

(a) water (4 Marks)

(b) 0.1M lead(II) Nitrate, $Pb(NO_3)_2(aq)$ (2 Marks)

(c) 0.01M sodium chloride, $NaCl(aq)$ (2 Marks)

6. Given the number of electrons in the electron shells of the four atoms below, answer the question that follows:

P : 2,1

Q : 2,8,5

R : 2,8,13,2

S : 2,8,7

(a) For each element write its electronic configuration and classify it as S, P, d block element. (4 Marks)

(b) Which element or elements exhibit the following oxidation states?

(i) 1 (ii) 3 (iii) 7. (3 Marks)

(c) Consider the process

$M(g) + e = M^-(g)$

(i) State which element has largest magnitude of the energy change involved and whether, for this element, the process is exorthemic or endothermic. (2 Marks)

(ii) Explain briefly the reason for your answer to C(i). (1 Mark)

SECTION B

Answer any THREE (3) questions from this section.

7. Cobalt, Copper, Iron and Manganese are d-block elements.

(a) What is meant by the term 'd-block element'? (1 Mark)

(b) Write the electronic configurations of Cu, Fe^{2+} and Mn^{2+}. (2 Marks)

(c) Explain in terms of their electronic configurations why Fe^{2+} ions are readily oxidized to Fe^{3+} ions but Mn^{2+} ions are not readily oxidized to Mn^{3+} ions. (2 Marks)

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(d) (i) Give the formula of a compound or ion containing manganese in an oxidation state of +7. (1 Mark)

(ii) How do you account for the existence of the +7 oxidation state for manganese? (1 Mark)

(e) Cobalt forms a complex compound of formula $[Co(NH_3)_4 Cl_2]^+ Cl^-$.

(i) What is the oxidation state of cobalt in this compound? (1 Mark)

(ii) Give the name of the complex ion contained in this compound. (1 Mark)

(iii) How many moles of silver chloride would be immediately precipitated from one mole of this compound in aqueous solution by the addition of excess silver nitrate? (1 Mark)

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

(i) Action of steam on cobalt.

(ii) Action of dil. HCl on CoO.

(iii) Action of carbon monoxide on cobalt. (5 Marks)

(b) 2.5×10^{-3} mole of a compound with the formula $Cr(NH_3)_5 Cl_3$ was dissolved in water and immediately titrated with 0.1M silver nitrate solution. $50.0cm^3$ were required for complete precipitation of the free chloride ion present.

(i) Deduce the ionic formula of the compound.

(ii) Draw the structure of the complex ion present and name it. (5 Marks)

9. (a) Outline five ways in which hydrogen

(i) resembles the alkali metals

(ii) resembles the halogens. (5 Marks)

(b) Give two reasons for the placement of hydrogen in its most suitable group and period on the periodic table. (1 Mark)

(c) Write short notes on

(i) hydrogen bonding

(ii) ortho and para hydrogen. (4 Marks)

10. Explain the following chemical phenomena using equations where possible.

(a) Aluminium oxide is amphoteric. (2 Marks)

(b) Aqueous solutions of aluminium salts are acidic. (2 Marks)

(c) Water has exceptionally high boiling point compared to the hydrides of its other group members.

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(d) Magnesium chloride cannot be prepared by heating the hydrated crystals to eliminate water. (2 Marks)

(e) Hydrogen fluoride is a liquid at room temperature while the other hydrogen halides are gaseous. (2 Marks)

SECTION C

Answer any THREE (3) questions from this section.

11. (a) Write a structural formula for each of the following compounds:

(i) 3 – Methy-1-hexene or 3-Methylhexene

(ii) Methylcyclopentane

(iii) 3, 5-Dimethylcyclopentene

(iv) 3 – Bromo – 3 – ethyl – 1,5-heptadiene

(v) 3 – Methyl – 1 – pentyne (5 Marks)

(b) Consider four compounds with nearly the same molecular weights: 1, 2 – dimethoxyethane, ethyl n-propyl ether, hexane, and 1 – propanol.

(i) Which would you expect to have the highest boiling point?

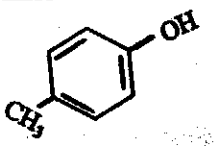
(ii) Which would be most soluble in water? Explain the reasons for your choices. (5 Marks)

12. (a) Arrange the following compounds in order of increasing acidity and explain the reasons for your choices.

(i) Phenol

(ii) p-chlorophenol

(iii) Cyclohexanol

(iv) p-cresol, 

(5 Marks)

(b) Indicate how the following mixtures could be separated WITHOUT the use of distillation.

(i) benzene and phenol

(ii) phenol and 1 - hexanol

(iii) 1 – prapanol and 1 – heptanol. (5 Marks)

13. (a) Give equations that illustrate a good method to synthesize each of the following acids.

(i) butanoic acid from 1 - butanol

(ii) butanoic acid from n-propyl alcohol (two ways)

(iii) p-chlorobenzoic acid from p – chlorotoluene.

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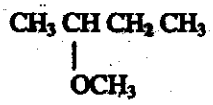
(b) Give equations for two different combinations of reagents that might be used to synthesize methyl sec-butyl ether by the Williamson method. Which combination would be preferred?



Methyl sec-butyl ether. (6 Marks)

14. (a) Compound A, which has an unbranched carbon chain, reacts with methylmagnesium bromide to give, after hydrolysis, compound B. Chromic acid oxidation of B gives C ($C_5H_{10}O$) which gives a crystalline product with 2, 4 – dinitrophenyl hydrazine and a positive iodoform test.

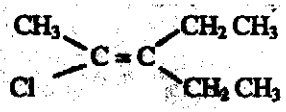
(i) Give the formulas of A – C and equations for all reactions mentioned.

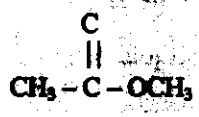
(ii) Give the formula of a possible isomer of A that would give the same results as A in the above transformations. (5 Marks)

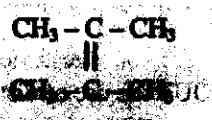
(b) Give the systematic IUPAC names for each of the following compounds:

(i) $CH_3CH_2 - O - CH_3$

(ii) $- CH_2CH_2 - OH$

(iii) 

(iv) 

(v) 

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