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

132/2 **CHEMISTRY 2**

(For Both School and Private Candidates)

Time: 2:30 Hours **Tuesday, 15th February 2011 a.m.**

INSTRUCTIONS

1. This paper consists of **ten (10)** questions in sections A, B and C.
2. Answer **five (5)** questions choosing at least **one (1)** question from each section.
3. Each question carries **twenty (20)** 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 J mol^{-1} K^{-1} or 0.082 atm mol^{-1} K^{-1} dm^3
   GMV = 22.4 dm^3
   1 litre = 1dm^3 = 1000 cm^3
   1 faraday = 95,500 coulombs
   Velocity of light, C = 3.0 x 10^8 m/s
   Atomic masses: H = 1, C = 12, N = 14, O = 16, Na = 23,
   S = 32, Cl = 35.5, K = 39, Cr = 52.

This paper consists of 5 printed pages.

SECTION A

1. (a) Using the Brønsted – Lowry theory, define
   (i) an acid
   (ii) a base. **(2 marks)**

   (b) Predict and explain whether the following salts will be acidic, basic or neutral:
   (i) $CuSO_4$
   (ii) NaCN
   (iii) NH_4Cl
   (iv) $NaNO_3$. **(8 marks)**

   (c) Calculate the equilibrium constant of the reaction between cobalt and nickel from the following redox potentials at 25 °C:
   $Ni^{2+}_{(aq)}/Ni_{(s)}$ $E^{\theta} = -0.250$ V
   $Co^{2+}_{(aq)}/Co_{(s}$ $E^{\theta} = -0.277$ V. **(10 marks)**

2. (a) What is a half life of a reaction? **(2 marks)**

   (b) Consider the following reaction:
   $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$.
   If the rate constant, K at 317 °C and 427 °C is 1.4×10^{-3} $dm^3mol^{-1}s^{-1}$ and 6.4×10^{-2} $dm^3mol^{-1}s^{-1}$ respectively, what is the activation energy E_a for the reaction? **(6 marks)**

   (c) The reaction between compounds Y and Z is represented as
   $Z_{(g)} + 3Y_{(g)} \rightarrow ZY_{3(g)}$
   The reaction produced the following experimental results shown in the following table:

Experiment	Initial concentration of Z ($moldm^{-3}$)	Initial concentration of Y($moldm^{-3}$)	Initial rate of formation of ZY_3 ($moldm^{-3}$ min^{-1})
1	0.100	0.100	0.00200
2	0.100	0.200	0.00798
3	0.100	0.300	0.01805
4	0.200	0.100	0.00399
5	0.300	0.100	0.00601

   Using the results in the table calculate the order of reaction with respect to
   (i) Y (ii) Z (iii) overall reaction. **(8 marks)**

   (d) (i) Find the rate constant for the reaction in (c) above.
   (ii) Find the units for the rate constant. **(4 marks)**

3. (a) The dissociation constants, K_b for NaF and NH_3 in water are 1.56×10^{-11} and 1.77×10^{-15} respectively. Find the pH of
   (i) 0.01 M solution of NaF
   (ii) 0.10 M solution of NH_3. **(15 marks)**

(b) The solubility product, K_{sp} for CaF_2 is 4.0×10^{-11}. Calculate the solubility of CaF_2 in 0.025M NaF solution. **(5 marks)**

4. (a) Define the following:
   (i) Hess' law
   (ii) Standard enthalpy of formation
   (iii) Standard enthalpy of neutralization. **(3 marks)**

(b) Below is the Born Haber cycle for the formation of magnesium chloride.

$$Mg^{2+}_{(g)} + 2e^- + 2Cl(g) \xrightarrow{\Delta H^\theta_5 = 2(-364\ kJmol^{-1})} Mg^{2+}_{(g)} + 2Cl^-$$

$$\uparrow \Delta H^\theta_4 = +242\ kJmol^{-1}$$

$$Mg^{2+}_{(g)} + 2e^- + Cl_{2(g)}$$

$$\uparrow \Delta H^\theta_3 = 1448\ kJmol^{-1}$$

$$Mg^{+}_{(g)} + e^- + Cl_{2(g)}$$

$$\uparrow \Delta H^\theta_2 = +736\ kJmol^{-1}$$

$$Mg_{(g)} + Cl_{2(g)}$$

$$\uparrow \Delta H^\theta_1 = 146\ kJmol^{-1}$$

$$Mg_{(s)} + Cl_{2(g)} \xrightarrow{\Delta H^\theta_f = -658\ kJmol^{-1}} MgCl_{2(s)}$$

ΔH^θ_6

(i) Name the enthalpy changes corresponding to the following symbols:
ΔH^θ_1, ΔH^θ_2, ΔH^θ_3, ΔH^θ_4, ΔH^θ_5 and ΔH^θ_6

(ii) Calculate the value of ΔH^θ_6. **(14 marks)**

(c) The standard enthalpy changes of formation of MgCl and $MgCl_3$ are -110 $kJmol^{-1}$ and +4000 $kJmol^{-1}$ respectively. How do you compare the energetic stabilities of $MgCl_{(s)}$, $MgCl_{2(s)}$ and $MgCl_{3(s)}$ with respect to their constituent elements? **(3 marks)**

SECTION B

5. (a) Study the following cathode processes:
   (i) $Ag^+_{(aq)} + e^- \rightarrow Ag_{(s)}$
   (ii) $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$
   What interpretations can you make from the two processes?
   (3 marks)

(b) Whereas metals are deposited at the cathode electrode, non metals are liberated at the anode electrode. Explain this electrolylitic phenomenon. **(3 marks)**

(c) Explain why H^+ ions cannot exist in solution. **(4 marks)**

(d) A metal of relative atomic mass 27 is deposited by electrolytic decomposition of its solution. If 0.176 g of the metal is deposited on the cathode when a current of 0.15 amperes flow for 3½ hours, what is the charge on the cation of this metal? **(10 marks)**

6. (a) Describe the four main features of a coordination compound. **(4 marks)**

(b) (i) Differentiate between coordination number and coordination geometry.
(ii) Use sketch diagrams to differentiate the orientation of the 3d atomic orbitals in space. **(7 marks)**

(c) Draw the geometrical structures of the following complexes:
(i) $Ni(CN)_5^{3-}$
(ii) $CuCl_2$. **(3 marks)**

(d) Show that
(i) hexaaquatitanium (III) ion is a paramagnetic complex **(3 marks)**
(ii) hexaaminecobalt (III) ion is a diamagnetic complex. **(3 marks)**

7. (a) Define the following terms:
(i) Buffer solution
(ii) Standard solution
(iii) Molarity. **(3 marks)**

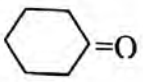
(b) A standard solution is made by dissolving 1.185 g of potassium dichromate (VI) and making it up to 250 cm^3 solution. This solution is used to find the concentration of sodium thiosulphate solution. A 25 cm^3 of the oxidant was acidified and added to an excess of potassium iodide to liberate iodine according to the equation;
$Cr_2O_7^{2-} + 6I^- + 14H^+ \rightarrow 3I_2 + 2Cr^{3+} + 7H_2O$.
When the solution was titrated against sodium thiosulphate, 20 cm^3 were required. Find the concentration of sodium thiosulphate. **(8 marks)**

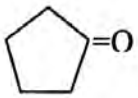
(c) A chemist desired to prepare one litre of a solution buffered at pH 9.0. How many grams of ammonium chloride have to be added to one litre of 0.20 M NH_3 to make such a buffer? (given the pK_b value of ammonia is 4.74 in the equation). **(9 marks)**

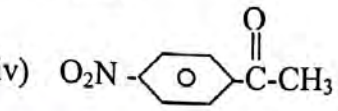
SECTION C

8. (a) Name the following compounds according to IUPAC system;

(i) $CH_3\text{-}\overset{\overset{O}{\|}}{C}\text{-}CH_2.Br$

(ii) 

(iii) 

(iv) 

(10 marks)

(b) Write the products for the following reactions:
(i) $CH_3CH_2CH_2CH_2Br + NaOH_{(aq)}$
(ii) $C_6H_5CH_2Cl + H_2O$
(iii) $CH_3CH_2CH_2Br + NaSH$
(iv) $CH_3CH_2Br + Na^+C^- \equiv C\text{-}CH_3$
(v) $CH_3CH_2CH_2Br + Na^+O^-CH_2CH_3$. **(10 marks)**

9. (a) An unknown compound **C** ($C_8H_{10}O$) is insoluble in water. Compound **C** reacts with excess HI to give acidic compound **D** (C_6H_6O) and ethyl iodide. Give the structural formulae of compounds **C** and **D** and the equation of the reaction. **(4 marks)**

(b) Show the mechanism of each of the following reactions:
(i) Friedel – Craft acylation to form acetophenone.
(ii) Formation of nitronium ion when concentrated nitric acid and concentrated sulphuric acid react together.
(iii) Reaction between methylmagnesium bromide and carbondioxide to form ethanoic acid.
(iv) Stabilization of phenoxide ion by mesomerism. **(16 marks)**

10. (a) Write the structural formula for each of the following compounds:
(i) 2,4–dichloro–1–hexanol
(ii) 1,2–dimethoxyethane
(iii) 2-chlorobutanal
(iv) Cyclobutanone. **(4 marks)**

(b) Indicate the monomers and the polymerization method which are likely used in making each of the following commercial polymers.

(i) $$- CH(C_6H_5) - CH_2 - CH(C_6H_5) - CH_2 - CH(C_6H_5) - CH_2 - CH(C_6H_5) - CH_2 -$$

(ii) $- CF_2 - CF_2 - CF_2 - CF_2 - CF_2 - CF_2 -$

(iii) $- NH(CH_2)_5CONH(CH_2)_5CONH(CH_2)_5CO -$ **(6 marks)**

(c) Describe the reaction which takes place during vulcanization of raw rubber. What changes in physical properties accompany this process? What would happen if the proportion of s ulphur used in vulcanization is very large? **(10 marks)**