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 Hours 30 Minutes *2009 February 16, Monday p.m.*

Instructions

1. This paper consists of **10** questions in sections A, B and C.
2. Answer **five (5)** questions, choosing at least **one (1)** question from each section.
3. All questions carry equal 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).

Constants: R = 0.0821 L atm mol^{-1} K^{-1} or 8.314 J mol^{-1} K^{-1}

Atomic masses: H = 1, C = 12, O = 16, Na = 23, S = 32, Ba = 137, Cl = 35.5

1 Faraday = 96,500 Coulombs

GMV = 22.4 dm^3

1 litre = 1 dm3 = 1000 cm^3

This paper consists of 6 printed pages.

SECTION A

Answer at least **one (1)** question from this section

1 (a) The reaction $SO_2Cl_{2(g)} \rightarrow SO_{2(g)} + Cl_{2(g)}$ is a first order gas reaction with rate constant $k = 2.2 \times 10^{-5}$ sec^{-1} at 320°C. What percentage of SO_2Cl_2 is decomposed on heating at 320°C for 90 minutes? **(05 marks)**

(b) At 289 K the following data were obtained for the reaction
$C_5H_5I + OH^- \rightarrow C_5H_5OH + I^-$

$[C_5H_5I]$(M)	$[OH^-]$(M)	Rate(Msec^{-1})
0.1	0.1	5.02×10^{-4}
0.1	0.1	2.51×10^{-4}
0.05	0.05	1.25×10^{-4}

(i) What is the order of reaction with respect to each reactant? **(04 marks)**

(ii) What is the rate constant at 289 K? **(03 marks)**

(iii) If at 333 K the rate constant for the reaction is 6.71 M^{-1} sec^{-1}, what is the activation energy of the reaction? **(04 marks)**

(iv) What is the rate constant at 305 K? **(04 marks)**

2 (a) What do you understand by:

(i) Electrodes.

(ii) Voltaic cell.

(iii) Salt bridge.

(iv) Cell notation. **(08 marks)**

(b) (i) For the electrochemical cell

$Zn_{(s)} | ZnSO_{4(aq)} \| CuSO_{4(aq)} | Cu_{(s)}$ sketch a labelled diagram of such a cell to show the essential features. **(05 marks)**

(ii) Write an expression for the e.m.f. of the cell in 2(b)(i) above, operating under standard conditions. **(01 mark)**

(iii) Calculate the e.m.f. of the cell in 2(b)(i) above if $[Cu^{2+}] = 1M$ and $[Zn^{2+}] = 0.01M$ at standard conditions. **(03 marks)**

(iv) Calculate the equilibrium constant for the electrochemical cell above. **(03 marks)**

3. (a) Explain briefly the following terms:

(i) Common ion effect

(ii) Buffer solution

(iii) Salt hydrolysis **(06 marks)**

(b) Calculate the pH of a buffer solution made by adding 3.40 g of sodium acetate to 500 cm^3 of 0.12 M acetic acid (assume the volume does not change on addition of sodium acetate) **(10 marks)**

(K_a for acetic acid = 1.8×10^{-5}).

(c) Hydrochloric acid of concentration 1×10^{-1} mol dm^{-3} has a pH of 1 but acetic acid of the same concentration has a pH of 2.87. What is the reason behind the difference in their pH? Justify your answer with the help of mathematical calculations. **(04 marks)**

4. (a) (i) Draw an energy diagram to show how solid aluminium chloride is formed from its elements under standard conditions. Indicate and name all energy changes in the diagram. **(08 marks)**

(ii) What is the name of the energy diagram you have shown in 4(a)(i) above? **(01 mark)**

(b) (i) State Hess's Law.

(ii) Calculate the C-Cl bond energy given that the enthalpy of formation of tetrachloromethane is -135.5 kJ mol^{-1} and the enthalpies of atomisation of graphite and chlorine are 715.0 kJ mol^{-1} and 121.1 kJ mol^{-1}, respectively. **(05 marks)**

(c) (i) Explain why copper (II), mercury (II) and lead (II) ions are precipitated as sulphides by bubbling H_2S gas through their aqueous solutions in acidic medium while zinc (II), nickel (II) and cobalt (II) ion do not form precipitates of their sulphides under such conditions. **(02 marks)**

(ii) The solubility product of $BaSO_4$ in water at 25 °C is 1×10^{-10} mol^2 dm^{-6}. Calculate the mass of the precipitate formed when 20 cm^3 of 0.01M $BaCl_2$ solution and 20 cm^3 of 0.01M Na_2SO_4 solution are mixed at 25 °C. **(04 marks)**

SECTION B

Answer at least **one (1)** question from this section.

5. (a) All the compounds listed below contain nitrogen element which is found in group V of the periodic table. **(03 marks)**

HNO_3, NO_2, $NaNO_3$, $NaNO_2$, HNO_2, NH_3

Which of those compounds contain nitrogen with the lowest oxidation state?

(b) With the help of balanced equations, explain how a nitrate can be converted to nitric acid. **(05 marks)**

(c) Complete and balance the following reaction equations.

(i) $NH_3(g) + O_2(g) \longrightarrow$

(ii) $NO(g) + O_2(g) \longrightarrow$

(iii) $NO_2(g) + H_2O(l) + O_2(g) \longrightarrow$

(iv) $NH_4Cl(s) \xrightarrow{\Delta}$ **(12 marks)**

6. **(a)** What is a transition element? **(02 marks)**

(b) Given an element with atomic number 26.

(i) Write its electronic configuration in terms of atomic orbitals.

(ii) List down the stable ions of the element with atomic number 26 that are found in nature.

(iii) Write the electronic configuration of the stable ions in 6. (b) (ii) in terms of atomic orbitals.

(08 marks)

(c) Explain briefly **five (5)** major properties of transition elements. **(10 marks)**

7. (a) Using chemical equations, explain the following observations.

(i) Lead (II) chloride is soluble in concentrated HCl.

(ii) The aluminium hydroxide precipitate is soluble in excess sodium hydroxide.

(iii) Addition of ammonia solution to aqueous copper II sulphate gives a pale blue precipitate initially and deep blue solution when more ammonia solution is used.

(iv) Zinc oxide is amphoteric.

(v) Aqueous aluminium nitrate turns blue litmus red. **(10 marks)**

(b) Give IUPAC name of the following complexes.

(i) $[Cr(H_2O)_4Cl_2]Cl.2H_2O$

(ii) $[Co(en)_3Cl_3]$

(iii) $[Ag(CN)_2]$

(iv) $[Fe(H_2N-CH_2-CH_2-NH_2)_3]^{2+}$

(v) $[PtCl_4(en)]$

(10 marks)

SECTION C

Answer at least one (1) question from this section.

8. (a) Account for the following:

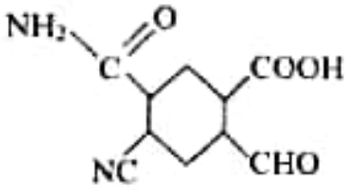
(i) In most cases benzene is very resistant to electrophilic addition reaction.

(ii) Amino group directs to ortho and para-positions on benzene ring, although it is a deactivator.

(iii) Methylamine is more basic than ammonia.

(09 marks)

(b) Given the structure of compound K.



Write down the chemical equations for the reaction between compound K and

(i) aqueous sulphuric acid

(ii) phosphorus pentachloride

(iii) ethanol

(iv) potassium permanganate

(v) sodium borate ($NaBH_4$).

(11 marks)

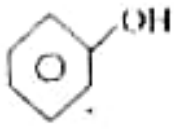
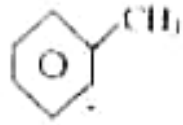
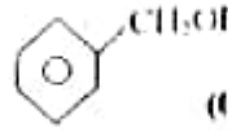
9. (a) An organic compound $A(C_5H_{10}O)$ containing carbonyl group was reduced with $LiAlH_4$ to give compound B. B was dehydrated with concentrated sulphuric acid to give product C of molecular formula C_5H_8. Ozonolysis of C followed by hydrolysis gave ethanal and compound D of molecular formula C_3H_6O. D gives positive iodoform reaction.

(i) Identify A, B, C and D compounds. Give their structural formula and IUPAC names

(ii) Give equations for all reactions.

(12 marks)

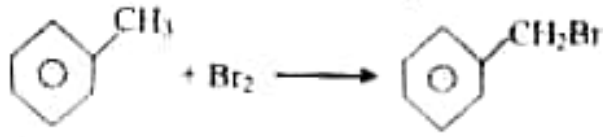
(b) Arrange the following compounds in order of increasing acidity and give reasons for your order

(04 marks)

(c) Identify briefly the condition necessary for the following reactions.

(i) 

(ii) 

(04 marks)

10. (a) Write short notes on

(i) additional polymerisation.

(ii) condensation polymerization.

(06 marks)

(b) (i) Give structural formulae of hexane–1,6–dioic acid and 1,6–diaminohexane.

(ii) Explain why the pair of molecules in 10(b)(i) is suitable for polymerisation.

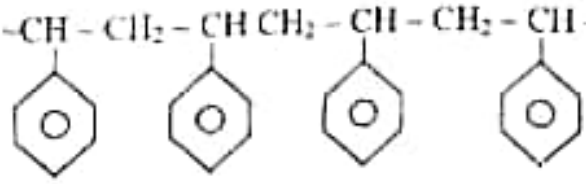
(iii) Give the structural formula of the polymer which might be formed by the pair of molecules in 10(b)(i).

(iv) What is the repeating unit of the polymer formed in 10(b)(iii)?

(08 marks)

(c) Indicate the monomer and polymerisation method which is likely to be used in making each of the following commercial polymers.

(i) $-CF_2-CF_2-CF_2-CF_2-CF_2-CF_2-$

(ii) 

(iii) $-NH-(CH_2)_5-CO-NH-(CH_2)_5-CO-NH(CH_2)_5-CO-$

(06 marks)