



P.O.BOX, 3817 KIGALI-TEL/FAX : 86871

NATIONAL EXAMINATION 2002/2003

SUBJECT: CHEMISTRY II

OPTION : MATHS - PHYSICS

DURATION: 3 HOURS

INSTRUCTIONS:

This paper consists of three Sections A, B and C.

Answer **ALL** questions in Section A.

Choose **THREE** questions from Section B.

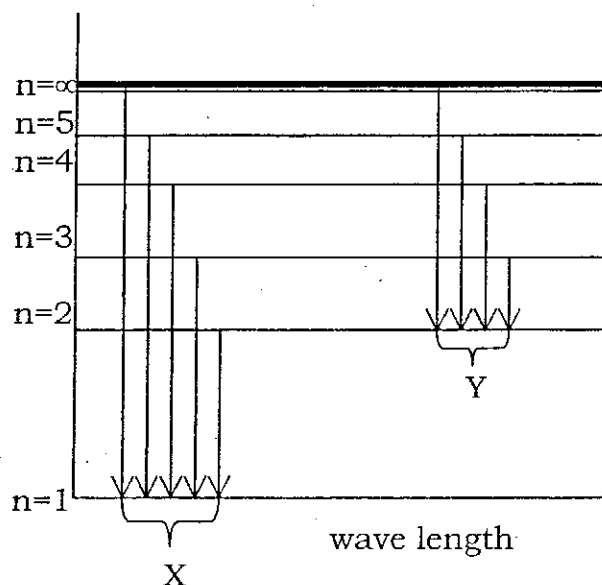
Choose **ONE** question in Section C.

Calculators may be used.

SECTION A: Answer ALL questions in this section.

1. (a) Explain the origin of line spectrum of Hydrogen atom. (2marks)

(b) The diagram below shows part of the series in the hydrogen spectrum.



(i) Identify spectral series X and Y. (1mark)

(ii) Which of the two series gives rise to visible spectrum? (1mark)

2. A thorium atom ${}_{90}^{231}\text{Th}$ disintegrates by emission of a beta particle to form an Isotope of protactinium (Pa) whereas a uranium atom ${}_{92}^{238}\text{U}$ disintegrates by emission of an alpha particle to form an Isotope of thorium atom.

(a) What are Isotopes? (2marks)

(b) Write balanced nuclear reactions showing the disintegration of Thorium and Uranium respectively. (2marks)

(c) Give one reason why radio Isotopes must be handled with care. (1mark)

3. Given that the atomic numbers of boron, Fluorine, Hydrogen and Sulphur are 5, 9, 1 and 16 respectively,

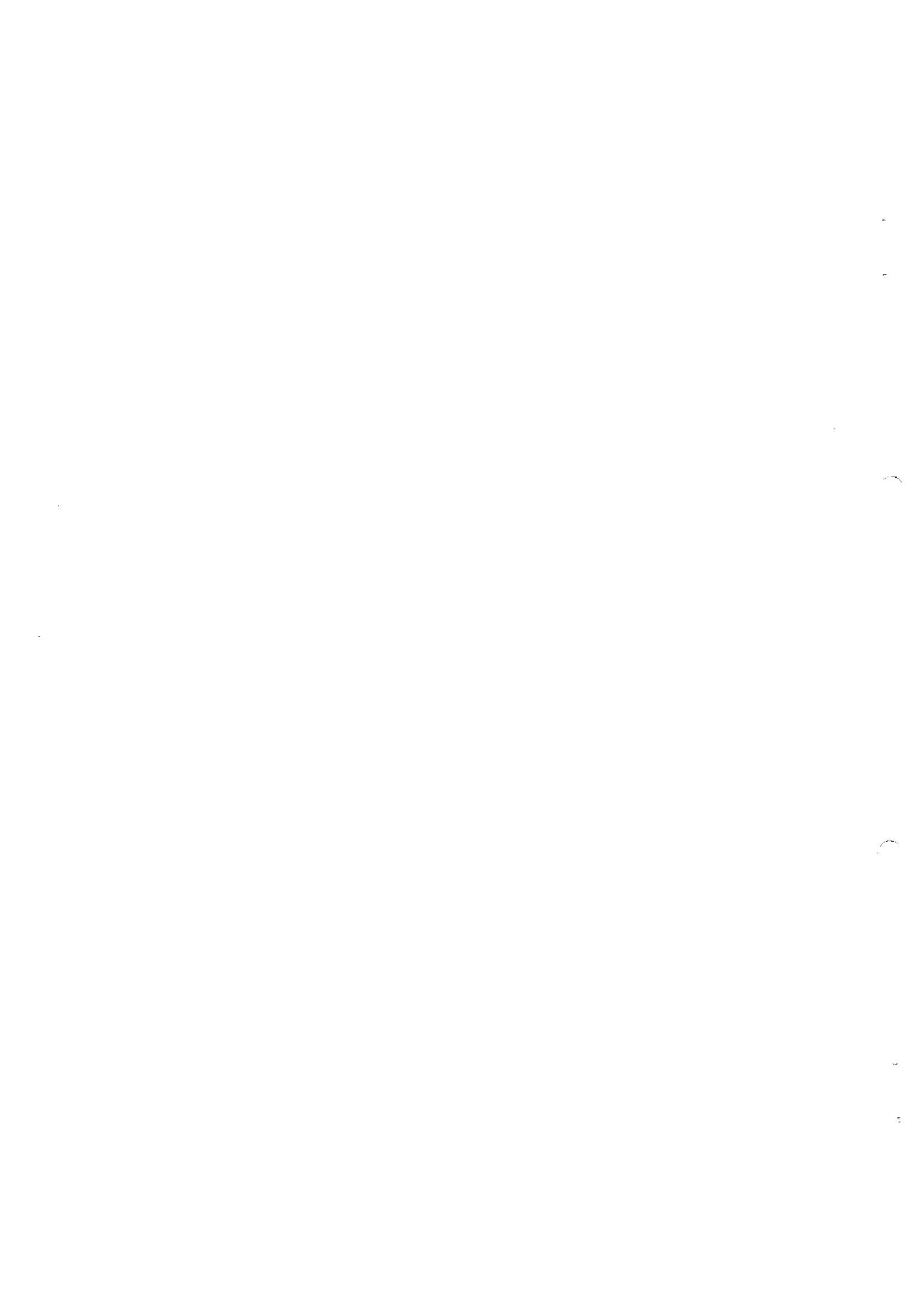
(a) Sketch and name the shapes of the following molecules.

(i) BF_3

(1mark)

(ii) H_2S

(1mark)



(b) Explain why BF_3 is considered a Lewis acid. (2marks)

4. The Ionisation energies (expressed in electron volts, (eV) of the elements in the first period of the periodic table are:
Li : 5.4, Be: 9.3, B: 8.3, C: 11.3, N: 14.5, O :13.6, F: 17.4
Ne: 21.6

(a) Give reasons for the general trend in Ionisation energy across the period. (2marks)

(b) Explain why Be has a higher Ionisation energy than B. (Atomic numbers of Be and B are 4 and 5 respectively). (2marks)

5. Study the table below and answer the questions that follow.

Bond	Bond dissociation energy (kJmol^{-1})
C - H	413
C - C	345
H - H	436

enthalpy of atomisation of carbon (C) is 721 kJmol^{-1} .

(a) Why is the bond dissociation energy for C - H bond greater than that of C - C bond? (2marks)

(b) Calculate the enthalpy of formation of cyclohexane. (3marks)

6. The table below contains a list of polymers.

(a) Complete the table. (3marks)

Type of polymer	Example of artificial polymer	One use
Polyalkene		
Polyester		
Polyamide		

2:7
2:5

(b) Draw the structures to show how two monomers are linked to form the polyamide named in (a) above. (1mark)

7. (a) Write the structural formula and name of the product of each of the following reactions.



(b) Write the mechanism of the reaction in a(ii) above. (2marks)

8. For each of the following reactions choose from A to E the most appropriate reaction type.

- A. nucleophilic addition
- B. Electrophilic addition
- C. nucleophilic substitution
- D. Electrophilic substitution
- E. Free radical substitution.

Reaction	Reaction type
$\text{CH}_2=\text{CH}_2 + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br}$	
$\text{C}_6\text{H}_6 + \text{Br}_2 \xrightarrow{\text{AlBr}_3} \text{C}_6\text{H}_5\text{Br} + \text{HBr}$	
$\text{CH}_3\text{CHO} + \text{HCN} \xrightarrow{\text{KCN}} \text{CH}_3 - \overset{\text{H}}{\underset{\text{CN}}{\text{C}}} - \text{OH}$	
$\text{CH}_4 + \text{Cl}_2 \xrightarrow{\text{light}} \text{CH}_3\text{Cl} + \text{HCl}$	
$\text{C}_6\text{H}_6 + \text{Cl}_2 \xrightarrow{\text{light}} \text{C}_6\text{H}_6\text{Cl}_6$	

(2½marks)

9. Aluminium is extracted from its purified ore by electrolysis.

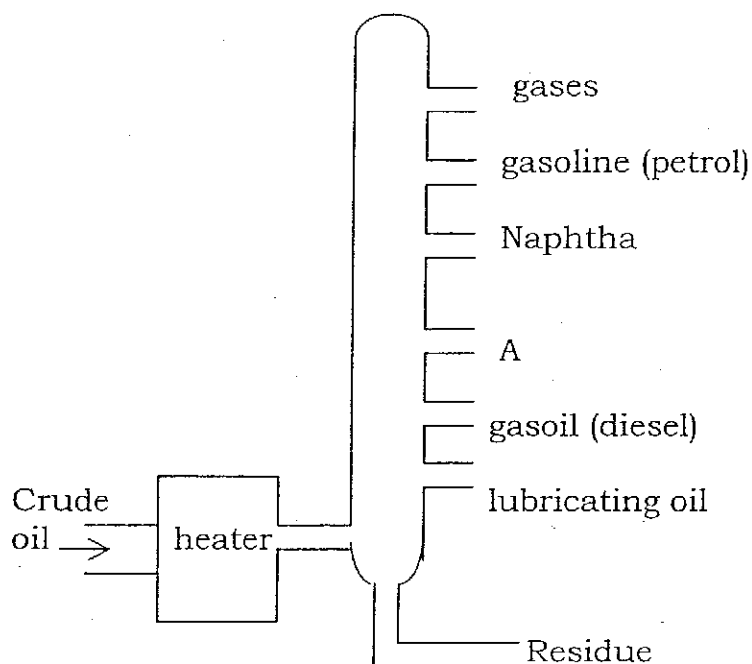
(a) Give one essential condition for this electrolysis. (1mark)

(b) Write the equations for the reactions occurring at each electrode. (2marks)

(c) Explain why Aluminium is more expensive to extract than Iron.

(2marks)

10. The simplified diagram below represents the Industrial fractional distillation of crude oil.



(a) Identify fraction A.

(1mark)

(b) What property of the fractions allows them to be separated in the column?

(1mark)

(c) Write an equation for a possible cracking reaction of the alkane $C_{16}H_{34}$, given that the products include ethane and propane in molar ratio 2:1 and only one other product.

(2marks)

11. 2-hydroxy propanoic acid (lactic) $CH_3CH(OH)COOH$ is found in sour milk.

(a) Why does the acid show optical Isomerism?

(1mark)

(b) Show the structural relationship between the two optical Isomers.

(2marks)

(c) How can the two isomers be distinguished?

(1mark)

12. The standard enthalpy of combustion of methanol is $-238.9 \text{ kJ mol}^{-1}$ and the standard enthalpies of formation of Carbon dioxide and water are $-393.7 \text{ kJ mol}^{-1}$ and $-285.9 \text{ kJ mol}^{-1}$ respectively.

(a) Calculate the enthalpy of formation of methanol. **(3marks)**

(b) Explain why the calculated value may not be the same as the experimentally determined value. **(2½marks)**

13. Write an equation for the reaction between 2-bromo-3 methyl butane and dilute aqueous sodium hydroxide. Name the type of reaction taking place and outline the mechanism of the reaction. **(4marks)**

SECTION B: Choose only 3 questions.

14. Write equations to show how each of the following conversions can be carried out. In each step indicate the reagents and the conditions of the reactions.

(a) C_6H_6 to $\text{C}_6\text{H}_5\text{NH}_2$. **(4marks)**

(b) $\text{CH}_3\text{CH}_2\text{OH}$ to $\begin{array}{cc} \text{CH}_2 & \text{CH}_2 \\ | & | \\ \text{Br} & \text{Br} \end{array}$ **(3marks)**

(c) CH_3COOH to $\text{CH}_3\text{CH}_2\text{Cl}$. **(3marks)**

15. (a) State and explain the trend in oxidising ability of the elements down group VII of the periodic table. **(3marks)**

(b) With the help of relevant equations, explain how an aqueous solution of chlorine can be used to distinguish NaBr and NaI solutions. **(3marks)**

(c) Show how chlorine reacts with the following

(i) H_2O
(ii) FeCl_2
(iii) NaOH **(4marks)**

16. (a) State two factors on which the value of Lattice energy depends and explain how the stated factors affect the value of Lattice energy. **(3marks)**



(b) Given that:

Lattice energy of rubidium chloride (RbCl)	= -665 KJmol ⁻¹
Dissociation energy of chlorine gas molecules	= 226 KJmol ⁻¹
Enthalpy of atomisation of rubidium metal	= 84 KJmol ⁻¹
Ionisation energy of rubidium	= 397 KJmol ⁻¹
Enthalpy of formation of RbCl	= -439 KJmol ⁻¹

Draw a Born Haber cycle for the formation of RbCl and hence calculate the electron affinity of chlorine atom.

(7marks)

17. Manganese is a typical transition metal but zinc is not yet it is also a d-block element.

(a) State five characteristics of a typical transitional metal.

(5marks)

(b) Explain why zinc doesn't show some of the characteristics. Stated in 17(a) above. (Atomic number of zinc = 30)

(3marks)

(c) Given that atomic numbers of Mn and zinc are 25 and 30 respectively. Write the electronic configurations of Mn²⁺ and Zn²⁺.

(2marks)

18. A sample of boron contains 20% mass of ¹⁰B and 80% by mass of ¹¹B.

(a) Calculate the relative atomic mass of boron in this sample.

(3marks)

(b) Boron is in group III of the periodic table but shows different properties from those of other elements in the group III.

(i) State three properties of boron that are not shown by other elements of group III.

(3marks)

(ii) Explain why Boron shows such differences in properties.

(2marks)

(iii) Explain why BCl₃ forms a dative bond with NH₃.

(2marks)

SECTION C: Answer ONE question.

19. Name the reagents (chemical tests) that could be used to distinguish each of the following pairs of compounds. In each case state the observations that would be made and write relevant equations.

(a) $\text{CH}_3\text{CH}_2\text{OH}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

(b) $\text{CH}_3\text{CH}_2\text{Cl}$ and $\text{C}_6\text{H}_5\text{CH}_2\text{Cl}$

(c) $\text{C}_6\text{H}_5\text{COOH}$ and $\text{C}_6\text{H}_5\text{OH}$

(d) Na_2CO_3 and NaCl . Solutions

(e) $\text{Pb}(\text{NO}_3)_2$ and $\text{Ba}(\text{NO}_3)_2$ Solutions

(3marks each)

20. You are supplied with distilled water, dilute hydrochloric acid, solid samples of sodium carbonate, zinc metal and magnesium sulphate. Using no other chemicals, describe with the help of chemical equations how you could prepare solid samples of zinc carbonate and magnesium chloride.

(15marks)

21. (a) With the help of a well labelled diagram, describe an experiment to determine the enthalpy of displacement between zinc powder and copper sulphate solution.

(10marks)

(b) When excess zinc was added to 100cm^3 of 0.25m copper sulphate solution, the temperature of the solution rose by 12.9°C .

Given that the specific heat capacity and density of the solution are $4.2\text{Jg}^{-1}\text{K}^{-1}$ and 1.0g cm^{-3} respectively, calculate the enthalpy change for the displacement reaction.

(5marks)

10

11

12

13