Rwanda National Chemistry II S6 Collection (2003 - 2023)

BIOLOGY-CHEMISTRY-GEOGRAPHY (BCG)

- MATHEMATICS-CHEMISTRY-BIOLOGY (MCB)

- PHYSICS-CHEMISTRY-BIOLOGY (PCB)

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Chemistry III

015

29/07/2021 08:30 AM – 10:00 AM

NESA NATIONAL EXAMINATION AND SCHOOL INSPECTION AUTHORITY

ADVANCED LEVEL NATIONAL EXAMINATIONS, 2020-2021

SUBJECT: CHEMISTRY III PRACTICAL EXAM

COMBINATIONS:

- BIOLOGY-CHEMISTRY-GEOGRAPHY **(BCG)**
- MATHEMATICS-CHEMISTRY-BIOLOGY **(MCB)**
- PHYSICS-CHEMISTRY-BIOLOGY **(PCB)**
- PHYSICS-CHEMISTRY-MATHEMATICS **(PCM)**

DURATION: 1 hour 30 minutes

Marks: /30

INSTRUCTIONS:

1) Write your name and index number on the answer booklet as written on your registration form, and **DO NOT** write your names and index number on additional answer sheets if provided.
2) Please read carefully before you start and make sure that you have all the apparatuses and chemicals that you may need.
3) This paper has one question.
4) Answer the question in this paper and record your answers in the spaces provided.
5) Non-programmable scientific calculators may be used.

BACK TITRATION: DETERMINATION OF PERCENTAGE PURITY OF Na_2SO_3 IMPURE SAMPLE

Titration of $Na_2S_2O_3.5H_2O$ (0.1 mole/litre) against iodine (I_2) liberated by oxidation of iodide ions by $K_2Cr_2O_7$ = 0.02 mole/litre.

PROCEDURE:

(i) Pour 100 ml of H_2SO_4 (1 mole/litre) solution in a beaker.

(ii) Add 100 ml of $K_2Cr_2O_7$, (0.02 mole/litre) to the H_2SO_4 acid solution in the beaker.

(iii) Add **0.3 g of** Na_2SO_3 **crystals** to the above 200 ml solution mixture of $K_2Cr_2O_7$ (0.02 mole/litre) and H_2SO_4 (1 mole/litre) then stir gently.

(iv) Label this 200 ml solution mixture of $K_2Cr_2O_7$ (0.02 mole/litre) and H_2SO_4 (1 mole/litre) solution containing 0.3 g of Na_2SO_3 crystals as **P**

(v) Measure 50 ml of solution **P** using a measuring cylinder and pour it in an empty conical flask or beaker then add in it 25 ml of KI (0.2 mole/litre) solution.
Call (label) this solution as **Q**.

(vi) Fill the burette with $Na_2S_2O_3.5H_2O$ (0.1 mole/litre) solution.

(vii) Titrate the $Na_2S_2O_3.5H_2O$ (0.1 mole/litre) into the red solution (Q) until the solution turns orange.

(viii) Add some drops (about a half dropper full) of starch solution in the orange **Q** solution of iodine in the conical flask to obtain a blue-black solution.

(ix) Continue the titration of $Na_2S_2O_3.5H_2O$ (0.1 mole/litre) in the blue-black iodine solution **Q** above until the black colour discharges (disappears).

(x) Record the volume of $Na_2S_2O_3.5H_2O$ used to reach equivalent point with **Q** in the table of results.

(xi) Repeat the experiment **procedures v) to xi) 2 times** to get consistent results.

TABLE OF RESULTS (9 marks)

Experiment	1	**2**	**3**
Initial volume of FA3 ($Na_2S_2O_3.xH_2O$) (ml)			
Final volume of FA3 ($Na_2S_2O_3.xH_2O$) (ml)			
Volume of FA3 ($Na_2S_2O_3.xH_2O$) used(ml)			

Equations of the reactions:

$$Cr_2O_7^{2-}{}_{(aq)} + 3\ SO_3^{2-} + 8H^+ \rightarrow 2\ Cr_2(SO_4)_{3(aq)} + 4H_2O_{(l)}$$

$$Cr_2O_7^{2-}{}_{(aq)} + 6I^-{}_{(aq)} + 14H^+{}_{(aq)} \rightarrow 3I_{2\ (aq)} + 7\ H_2O_{(l)} + 2\ Cr^{3+}{}_{(aq)}$$

$$I_{2\ (aq)} + 2S_2O_3^{2-}{}_{(aq)} \rightarrow 2I^-{}_{(aq)} + S_4O_6^{2-}{}_{(aq)}$$

Questions:

a) Calculate the average volume of $S_2O_3^{2-}$ used in this titration. **(2 marks)**

b) Calculate the number of moles of $S_2O_3^{2-}$ used in the titrated volume.

(2 marks)

c) Calculate the number of moles of Iodine (I_2) that reacted with $S_2O_3^{2-}$ during titration. **(2 marks)**

d) Determine the number of moles of $Cr_2O_7^{2-}$ that reacted to produce the iodine (I_2) in 50 ml of solution Q. **(2 marks)**

e) Determine the number of moles of $Cr_2O_7^{2-}$ in the 200 ml of solution P. **(2 marks)**

f) Calculate the number of moles of $Cr_2O_7^{2-}$ (0.02 mole/litre) in the 100 ml of solution before adding **neither** 100ml H_2SO_4 (1 mole/litre) **nor** 0.3 g of Na_2SO_3 to it. **(2 marks)**

g) Calculate the number of moles of $Cr_2O_7^{2-}$ (0.02 mole/litre) that reacted with Na_2SO_3 in the 0.3 g impure sample to obtain solution P. **(2 marks)**

h) Determine the number of moles of Na_2SO_3 in 0.3 g impure sample. **(2 marks)**

i) Calculate the mass of Na_2SO_3 in the 0.3 g of impure Na_2SO_3 **(2 marks)**

j) Calculate the percentage composition of Na_2SO_3 in the 0.3g impure sample. **(3 marks)**

CHEMISTRY III

015

21/11/2019 8:30 AM – 10:00 AM

REB
Rwanda Education Board

ADVANCED LEVEL NATIONAL EXAMINATIONS, 2019

SUBJECT: CHEMISTRY

PAPER III: PRACTICAL

COMBINATIONS:

- **BIOLOGY-CHEMISTRY-GEOGRAPHY (BCG)**
- **MATHEMATICS-CHEMISTRY-BIOLOGY (MCB)**
- **PHYSICS-CHEMISTRY-BIOLOGY (PCB)**
- **PHYSICS-CHEMISTRY-MATHEMATICS (PCM)**

DURATION: 1 hour 30 minutes

INSTRUCTIONS:

1) Write your names and index number on the answer booklet as written on your registration form and **DO NOT** write your names and index number on additional answer sheets of paper if provided.
2) Please read carefully before you start and make sure that you have all the apparatus and chemicals that you may need.
3) This paper consists of **one question**.
4) Answer the question in this paper and record your answers in the spaces provided.
5) Non-programmable scientific calculators may be used.
6) Use only a **blue** or **black** pen.

PRACTICAL: IODOMETRY TITRATION.

(Reaction of ***thiosulphate ions*** *with* ***iodine*** *produced from the oxidation of* ***iodide ions*** *by* ***iodate ions*** *in HCl acid).*

PROCEDURE:

i) Pour 25 ml of **FA1** which is a 0.06mole/litre solution of KI (potassium iodide) in a conical flask/beaker at room temperature (25^0 C) using a 50 ml measuring cylinder.

ii) Add 10ml of a 0.2 mole/litre HCl (hydrochloric acid) solution to the KI solution in the conical flask/beaker to acidify it using the measuring cylinder.

iii) iii) Measure 25 ml of **FA2** which is a 0.01 mole/litre solution of KIO_3 (potassium iodate) using a pipette then add it to the acidified KI solution in the conical flask/beaker.

iv) Fill the burette (fixed on the retort stand) with the solution of **FA3** which is $Na_2S_2O_3.xH_2O$ (hydrated sodium thiosulphate) using a beaker and a filter funnel.

v) Titrate (add)12 ml of $Na_2S_2O_3.xH_2O$ solution in the resultant acidified red solution of KIO_3 and KI in the conical flask/beaker.

vi) Then put 5 drops of starch solution in the red solution of KIO_3 and KI in the conical flask/beaker.

vii) Continue the titration of $Na_2S_2O_3.xH_2O$ until the blue-black colour of starch disappears (solution becomes colourless).

viii) Record the volume of titrated (used) $Na_2S_2O_3.xH_2O$ solution in the table of results on page 3.

ix) Repeat the experiment **procedures i) to viii) 3 times** to get consistent results.

TABLE OF RESULTS **(12 marks)**

Experiment	**1**	**2**	**3**	**4**
Final volume of FA3 ($Na_2S_2O_3.xH_2O$) (ml)				
Initial volume of FA3 ($Na_2S_2O_3.xH_2O$) (ml)				
Volume of FA3 ($Na_2S_2O_3.xH_2O$) (ml)				

Equations of the reactions:

$$IO_3^-{}_{(aq)} + 5I^-{}_{(aq)} + 6H^+{}_{(aq)} \rightarrow 3I_{2\,(aq)} + 3\,H_2O_{\,(l)}$$

$$3I_{2\,(aq)} + 6S_2O_3^{2-}{}_{(aq)} \rightarrow 6I^-{}_{(aq)} + 3S_4O_6^{2-}{}_{(aq)}$$

Questions:

a) Calculate the average volume of $Na_2S_2O_3.xH_2O$ used. **(2 marks)**

b) Calculate the number of moles of IO_3^- in 25 ml of the solution. **(2 marks)**

c) Determine the number of moles of I_2 produced from the reaction. **(2 marks)**

d) Calculate the number of moles of $S_2O_3^{2-}$ that reacted with the I_2 (iodine) produced. **(2 marks)**

e) Calculate the molarity of $S_2O_3^{2-}$. **(2 marks)**

f) Determine the value of **x** (number of moles of water of crystallization) in the formula **if 12.4 g of $Na_2S_2O_3.xH_2O$ was dissolved to make 1 litre of solution.**

(Atomic mass: Na = 23, S=32, O=16, H=1) **(3marks)**

Chemistry III 015 17/11/2016 08.30am-11.30am

REB
Rwanda Education Board

ADVANCED LEVEL NATIONAL EXAMINATIONS, 2016

SUBJECT: CHEMISTRY

PAPER III: PRACTICAL CHEMISTRY

COMBINATIONS:
- **PHYSICS-CHEMISTRY-MATHEMATICS (PCM)**
- **PHYSICS-CHEMISTRY-BIOLOGY (PCB)**
- **MATHEMATICS-CHEMISTRY-BIOLOGY (MCB)**
- **BIOLOGY-CHEMISTRY-GEOGRAPHY (BCG)**

DURATION: 1Hour 30minutes

INSTRUCTIONS TO CANDIDATES:

1. Do not open this question paper until you are told to do so.
2. Write your names and index number as they appear on your registration form.
3. Please read carefully before you start and make sure that you have all the apparatus and chemicals that you may need.
4. This paper consists of **only one question**.
5. All answers must be written in the spaces provided in this question paper.
6. Non-programmable scientific calculators may be used.
7. Use only **blue** or **black** pen.

You are provided with the following:

- **FA_1**, which is a metal hydrogen sulphate solution, prepared by dissolving 3.4 g of $MHSO_4$ in distilled water to make 250 cm^3 of the solution.
- **FA_2**, which is a sodium hydroxide solution prepared by dissolving 1.0 g of NaOH in distilled water to make 250 cm^3 of the solution.

PROCEDURE.

i) Pipette 20 cm^3or 25 cm^3 of **FA_1** into a conical flask.
ii) Add 2 drops of phenolphthalein indicator.
iii) Titrate with **FA_2** from a burette.

Questions:

a) Record your results in the table below.

	Titration 1	**Titration 2**	**Titration 3**
Final burette readings (cm^3)			
Initial burette readings (cm^3)			
Volume of **FA_2** (cm^3)			

(6marks)

b) Volume of the pipette used : ..... **(1mark)**

c) Titre values used for calculating average volume of **FA_2**: **(1mark)**

d) Average value of **FA_2** used : **(1mark)**

e) Calculate the molarity of **FA_2** solution : **(2marks)**

Ar (Na= 23. O= 16, H= 1)

f) Complete the reaction equation below: **(2marks)**

$MHSO_4$ (aq)+ NaOH (aq) →

g) From the equation of the reaction, determine the mole ratio

of MHSO4: NaOH is: **(1mark)**

h) Calculate the number of moles of sodium hydroxide that reacted: **(1mark)**

i) Calculate the number of moles of $MHSO_4$ that reacted with sodium hydroxide: **(2marks)**

j) Calculate the number of moles of $MHSO_4$ in 1000 cm^3: **(2marks)**

k) Calculate the molarity of the solution **FA_1**: **(1mark)**

l) Calculate the mass of $MHSO_4$ present in 1 dm^3 of solution **FA_1**: **(2marks)**

m) Given that $\boldsymbol{n}\ (number\ of\ moles) = \frac{\boldsymbol{m}(mass)}{\boldsymbol{Mm}(molar\ mass)}$ **(3marks)**

and relative atomic mass (Ar) of: S = 32, O= 16, H= 1.

Calculate the relative atomic mass of the metal M:

Chemistry III

015

19 Nov. 2015 08.30AM - 10.00AM

REB
Rwanda Education Board

ADVANCED LEVEL NATIONAL EXAMINATIONS, 2015

SUBJECT: CHEMISTRY

PAPER III: CHEMISTRY PRACTICAL

COMBINATIONS: - BIOLOGY-CHEMISTRY-GEOGRAPHY (BCG)
- MATHEMATICS-CHEMISTRY-BIOLOGY (MCB)
- PHYSICS-CHEMISTRY-BIOLOGY (PCB)
- PHYSICS-CHEMISTRY-MATHEMATICS (PCM)

DURATION: 3 HOURS

INSTRUCTIONS:

1. Write your names and index number on the answer booklet **cover** provided as written on your registration form and **DO NOT** write your names and index number on this questionnaire which serves also as answer booklet.
2. Do not open this question paper until you are told to do so.
3. This paper consists of one question which is compulsory. **(25marks)**
4. **All** answers should be written in the spaces provided on this question paper.
5. **Please read carefully before you start and make sure that you have all apparatus and chemicals that you need.**
6. **You do not need the Periodic Table.**
7. Silent non-programmable calculators may be used.

YOU ARE PROVIDED WITH THE FOLLOWING:

- **FA_1** which is a solution of a carboxylic acid with the formula $HOOC(CH_2)nCOOH$. FA_1 contains 1.55 g of the acid per 250 cm^3 of the solution.
- **FA_2** which is a solution of NaOH. FA_2 contains 1g of NaOH per 250 cm^3 of the solution.
  (Atomic mass: C= 12, O= 16, H=1, Na=23)

PROCEDURE

1. Pipette 25 cm^3 of **FA_1** into a conical flask and add 3 drops of phenolphthalein indicator.
2. Titrate **FA_1** solution with **FA_2** from a burette.
3. Record your results in the table below : **(3marks)**

Volume of the pipette used: .....

Final burette readings (cm^3)			
Initial burette readings (cm^3)			
Volume FA_2 (cm^3)			

The average volume of FA_2 used = **(2marks)**

a) Complete the equation below: **(1mark)**

$HOOC(CH_2)nCOOH\ (aq) + Na(OH)(aq) \longrightarrow$

b) Moles of NaOH in 1g = **(2marks)**

c) Molarity of the solution FA_2 = **(2marks)**

d) Moles of NaOH that reacted = **(2marks)**

e) The mole ratio of $HOOC(CH_2)nCOOH$: NaOH = **(2marks)**

f) Moles of $HOOC(CH_2)nCOOH$ that reacted = **(2marks)**

g) The molarity of FA_1 = **(2marks)**

h) Molar mass of $HOOC(CH_2)nCOOH$ = **(2marks)**

i) From the molar mass of $HOOC(CH_2)nCOOH$, calculate n: **(2marks)**

j) Therefore the structure formula of the acid is: **(1mark)**

k) The names (IUPAC and usual names) of the acid are: **(2marks)**

CHEMISTRY III

015

06/11/2014 08.30AM - 10.00AM

Code : .....

Surname : .....

Other : .....

REB
Rwanda Education Board

ADVANCED LEVEL NATIONAL EXAMINATIONS, 2014

SUBJECT: CHEMISTRY PAPER III

COMBINATIONS: - BIOLOGY - CHEMISTRY - GEOGRAPHY (BCG)

- MATHEMATICS - CHEMISTRY - BIOLOGY (MCB)

- PHYSICS - CHEMISTRY - BIOLOGY (PCB)

- PHYSICS - CHEMISTRY - MATHEMATICS (PCM)

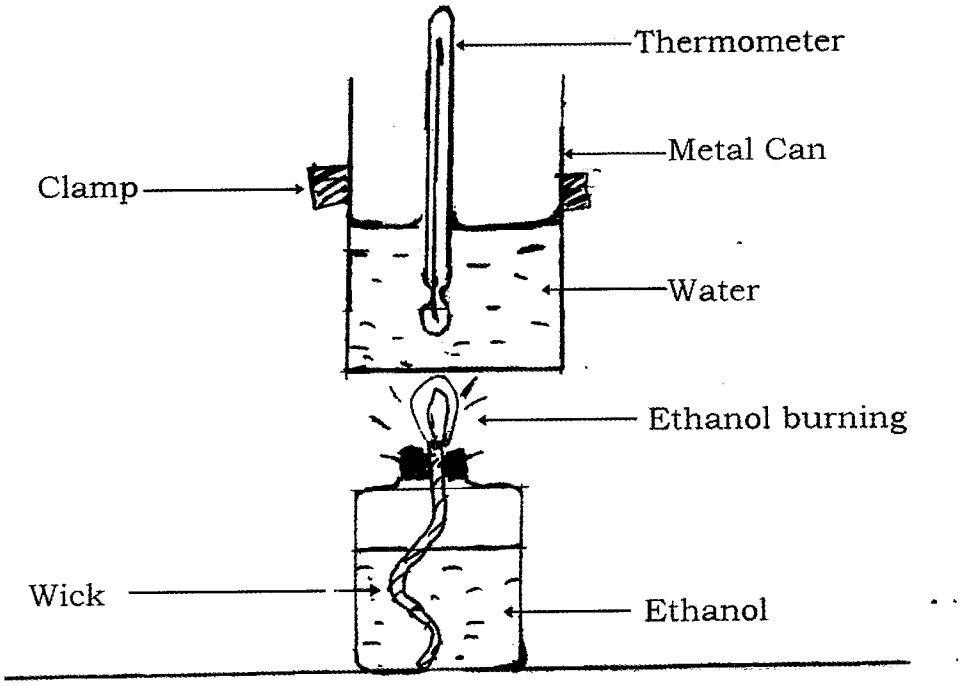
DURATION: 1 HOUR 30 MINUTES

INSTRUCTIONS:

1. Do not open this question paper until you are told to do so.
2. Write your names and index number in the space provided as written on your registration form, and **DO NOT** write your names and index number on additional answer sheets of paper if provided.
3. This paper consists of two questions which are compulsory.
4. All answers should be written in the spaces provided in this question paper
5. Please show all the working in cases which involve calculations.
6. Non-programmable scientific calculators may be used.

1. The enthalpy change of combustion of ethanol (C_2H_5OH) was determined in a chemistry laboratory using the method described below :

- Ethanol from a small burner was used to heat water in a metal can.
- The change in temperature of water as well as the mass of ethanol burnt were determined.
- The set up of the experiment is shown in the diagram below:



The following results were obtained:
Mass of water in a metal can = 500g
Initial temperature of water = 22^0 C
Final temperature of water = 30^0C
Initial mass of the burner + ethanol before burning = 250. 95g
Final mass of burner + ethanol after burning = 250.00g
Assume that the specific heat capacity of water =$4.2Jg^{-1}K^{-1}$

(a) Calculate the heat absorbed by water in the metal can. **(2marks)**
Use the equation: Heat = m x c x ΔT
Where m = mass of water
c = Specific heat capacity of water
ΔT = Temperature change

(b) Calculate the mass of ethanol burnt. **(1mark)**

(c) Calculate the amount in moles of ethanol burnt. **(2marks)**
(Atomic masses : C=12, O= 16, H =1)

(d) Ethanol burns in air/oxygen to form water and carbon dioxide.
Write a balanced chemical equation for the combustion of ethanol. **(2marks)**

(e) Calculate the enthalpy change of combustion per mole of ethanol. **(2marks)**

(f) State one source of error in this experiment. **(1mark)**

2. A student decided to find out the percentage of calcium carbonate in a rock using the method described below:
   - 3.0g of the rock were mixed with $25cm^3$ of 2mol dm^{-3} hydrochloric acid (2M HCl). The acid was in excess to ensure that all the calcium carbonate reacted. The impurities did not react .
   - The whole mixture containing excess acid was titrated by adding 2mol dm^{-3} of sodium hydroxide (2M NaOH) solution from a burette using phenolphthalein indicator.
   - The experiment was repeated 4 times using similar quantities of the rock. Volume of the acidic mixture = $25cm^3$.

Final burette readings (cm^3)	16.50	31.70	15.60	30.90
Initial burette readings (cm^3)	0.00	16.50	0.50	15.60
Volume of 2mol dm^{-3} NaOH(cm^3)				

(a) Complete the above table and calculate the average volume of 2mol dm^{-3} NaOH (2M NaOH) used. (Show the values used to calculate the average volume of NaOH).

(3marks)

(b) Calculate the amount in moles of NaOH used to react with the excess HCl.

(1mark)

(c) Calculate the amount in moles of excess HCl. **(1mark)**

(d) Calculate the amount in moles of the original HCl which was mixed with the rock.

(1mark)

(e) Calculate the amount in moles of HCl which reacted with the calcium carbonate in the rock.

(1mark)

(f) Write a balanced chemical equation for the reaction between calcium carbonate and HCl. **(2marks)**

(g) Use the mole ratio in the equation of part (f) to calculate the amount in moles of Calcium carbonate in the rock. **(2marks)**

(h) Calculate the molar mass (relative molecular mass) of calcium carbonate and hence the mass in grams of Calcium Carbonate in the rock. **(2marks)**

Molar mass of $CaCO_3$ =

Mass of $CaCO_3$ in the rock = ... g

(Atomic masses : Ca =40, C=12, O = 16)

(i) Calculate the percentage of $CaCO_3$ in the rock using the formula:

$$\% \text{ of } CaCO_3 = \frac{mass\ of\ CaCO_3}{mass\ of\ the\ rock} \times 100$$

(Give your answer to one decimal place) **(2marks)**

REPUBLIC OF RWANDA

Chemistry III

015

08 Nov. 2013 08.30am - 11.30am

RWANDA EDUCATION BOARD

ADVANCED LEVEL NATIONAL EXAMINATIONS 2013

SUBJECT: CHEMISTRY

PAPER III: CHEMISTRY PRACTICAL

COMBINATIONS:- BIOLOGY-CHEMISTRY-GEOGRAPHY (BCG)

- MATHEMATICS-CHEMISTRY-BIOLOGY (MCB)

- PHYSICS-CHEMISTRY-BIOLOGY (PCB)

- PHYSICS-CHEMISTRY-MATHEMATICS (PCM)

DURATION: 1 Hour 30 Minutes

INSTRUCTIONS TO CANDIDATES:

1. Don't open this question paper until you are told so.
2. This paper consists of **one** question which is **compulsory. (25 marks)**
3. **All** answers should be written in the spaces provided on this question paper.
4. ***Please read carefully before you start and make sure that you have all the apparatus and chemicals that you may need.***
5. **Periodic Table is not allowed.**
6. Non-programmable scientific calculators may be used.

YOU ARE PROVIDED WITH THE FOLLOWING:

- **BA** which is a solution of MCO_3 prepared by dissolving 0.5g of MCO_3 in 25 cm^3 of 1 M hydrochloric acid solution. (M is a divalent metal).
- 1M sodium hydroxide (NaOH) solution.

(Atomic mass: H=1, C= 12, O= 16, Na=23, Cl= 35.5,)

PROCEDURE

1. Pipette 25 cm^3 of **BA** into a conical flask and add 2 drops of phenolphthalein indicator.
2. Titrate the resultant solution by 1M sodium hydroxide from a burette.
3. Record your results in the table below : **(3 marks)**

Volume of the pipette used: .....

Final burette readings (cm^3)			
Initial burette readings (cm^3)			
Volume of 1M NaOH (cm^3)			

The average volume of 1M NaOH used = **(2 marks)**

(a) The total number of moles of HCl used to prepare **BA** solution = **(2 marks)**

(b) Give the equation of the reaction between MCO_3 and HCl and show the physical states of the reactants and the products: **(2 marks)**

(c) The number of moles of 1M NaOH that reacted with excess HCl = **(2 marks)**

(d) Give the equation of the reaction between NaOH and HCl and show the physical states of the reactants and the products = **(2 marks)**

(e) The mole ratio of NaOH: Cl = .../..... **(1 mark)**

(f) Therefore, the moles of the excess of HCl = **(1 mark)**

(g) The moles of HCl that reacted with MCO_3 = **(2 marks)**

(h) The mole ratio of MCO_3: HCl = ... : ..... **(1 mark)**

(i) The moles of MCO_3 that reacted with hydrogen Chloride acid = **(2 marks)**

(j) The molar mass $= \frac{Mass(g)}{Number\ of\ moles}$

Therefore the molar mass of MCO_3 = **(2 marks)**

(k) The atomic mass (Ar) of M: **(3 marks)**

Chemistry III

015

23 Nov. 2012 8.30am

REPUBLIC OF RWANDA

RWANDA EDUCATION BOARD (REB)

ADVANCED LEVEL NATIONAL EXAMINATIONS 2012

SUBJECT: CHEMISTRY

PAPER III: CHEMISTRY PRACTICAL

COMBINATIONS: PHYSICS-CHEMISTRY-BIOLOGY (PCB)
MATHS-CHEMISTRY-BIOLOGY (MCB)
BIOLOGY-CHEMISTRY-GEOGRAPHY (BCG)
PHYSICS- CHEMISTRY – MATHEMATICS (PCM)

DURATION: 1 Hour 30 Minutes

INSTRUCTIONS TO CANDIDATES:

This paper consists of **1** compulsory question.

All answers should be written in the spaces provided on this question paper/answer booklet.

Please read carefully before you start and make sure that you have all the apparatus and chemicals that you may need.

Non-programmable scientific calculators may be used.
Periodic tables are not allowed.

YOU ARE PROVIDED WITH THE FOLLOWING:

- **BA_1**, which is a hydrochloric acid solution prepared by dissolving **7.30g** of HCl in water to make **1dm^3** of the solution (atomic mass: H =1, Cl = 35.5).
- Substance **W**, which is hydrated compound of formula **X.nH_2O**, where **n** is the number of molecules of water of crystallization.
  The relative molecular mass of **X = 106**
- Solution **BA_2** which has been prepared as follow:
  5.72 g of **W** were dissolved in water to make **1dm^3** of the solution.

PROCEDURE

1) Pipette **25 cm^3** of **BA_2** into a conical flask. Add **3 drops** of phenolphthalein indicator. Titrate with **BA_1** from a burette.
2) Repeat the titration until you obtain consistent values.
3) Record your results in the table below: **(6 marks)**

Volume of the pipette used: .....

Final burette readings(cm^3)			
Initial burette readings (cm^3)			
Volume of BA_1 (cm^3)			

Titration values used for calculating average volume of BA_1 are: ..... **(1 mark)**

Average value of BA_1 used : ..... **(2 marks)**

Calculate:

(i) The number of moles of HCl in the prepared solution **(2 marks)**

(ii) The molarity of hydrochloric acid solution **(2 marks)**

(iii) The number of moles of hydrochloric acid that reacted with BA_2 **(2 marks)**

(iv) The number of moles of W that reacted with HCl **(2 marks)**

(v) The molarity of BA_2 solution **(2 marks)**

(vi) he relative molecular mass of W: **(2 marks)**

$$\text{Molarity} = \frac{concentration\ \ in\ g/dm^3}{formula\ \ (molecular)\ \ mass}$$

(vii) The value of n (molecular mass of X= 106, H= 1, O=16) **(4 marks)**

Chemistry III
014
11 Nov. 2011 8.30 am– 16.30 pm

REPUBLIC OF RWANDA

RWANDA EDUCATION BOARD (REB)
P .O.BOX 3817 KIGALI. TEL/FAX: 586871

ADVANCED LEVEL NATIONAL EXAMINATIONS 2011

SUBJECT: CHEMISTRY

PAPER III: CHEMISTRY PRACTICAL

COMBINATIONS: PHYSICS-CHEMISTRY-BIOLOGY (PCB)
MATHS-CHEMISTRY-BIOLOGY (MCB)
BIOLOGY-CHEMISTRY-GEOGRAPHY (BCG)
PHYSICS- CHEMISTRY - MATHEMATICS

DURATION: 1 Hour 30 Minutes

INSTRUCTIONS TO CANDIDATES:

This paper consists of **1** compulsory question.

All answers should be written in the spaces provided on this question paper/answer booklet.

Please read carefully before you start and make sure that you have all the apparatus and chemicals that you may need.

Non-programmable scientific calculators may be used.
Periodic table may not be used.

You are provided with the following:

- BA_1, which is a 0.1 M sulfuric acid (H_2SO_4) solution.
- BA_2 which is a solution of NaOH with unknown concentration.
  (atomic mass: H= 1, S= 32, O= 16, Na= 23)

PROCEDURE.

1) Pipette 20 cm^3 or 25 cm^3 of BA_2 into a conical flask. Add 3 drops of methyl orange indicator. Titrate with BA_1 from a burette.
2) Repeat the titration until you obtain consistent values.
3) Record your results below.

Volume of the pipette used : .....

Final burette readings(cm^3)			
Initial burette readings (cm^3)			
Volume of BA_1 (cm^3)			

Titration values used for calculating average volume of BA_1 used are:

Average value of BA_1 used =

Questions:

(i) The equation of the reaction is:

(ii) Calculate the number of moles of sulphuric acid reacted

(iii) Calculate the number of moles of NaOH reacted with the sulphuric acid

(iv) Calculate the molarity of BA_2

Calculate the concentration of BA_2 in g/

Chemistry II	
023	
22 Nov. 2005	8h30 – 11h30

RWANDA NATIONAL EXAMINATIONS COUNCIL

P.O. BOX 3817 KIGALI-TEL/FAX : 586871

NATIONAL EXAMINATION 2005

SUBJECT : CHEMISTRY II

OPTION : MATH-PHYSICS

DURATION : 3 HOURS

INSTRUCTIONS :

Answer ALL questions in section A,

Choose THREE questions from Section B and ONE question from Section C.

SECTION A : Answer ALL questions /55 Marks.

1. The percentage abundances of the stable isotopes of chromium are:

$^{50}_{24}Cr$: 4.31% , $^{52}_{24}Cr$: 83.76% , $^{53}_{24}Cr$: 9.55% , $^{54}_{24}Cr$: 2.38%

(a) What is meant by the term "isotopes" and why do isotopes of chromium show similar chemical properties? **(2marks)**

(b) Calculate the relative atomic mass of chromium, correct to three significant figures. **(1mark)**

(c) Calculate the number of neutrons in the most abundant isotope of chromium. **(1mark)**

2. This question concerns the following oxides

Na_2O, MgO, SiO_2 , SO_3.

From the list above identify the oxide that best fits the description given:

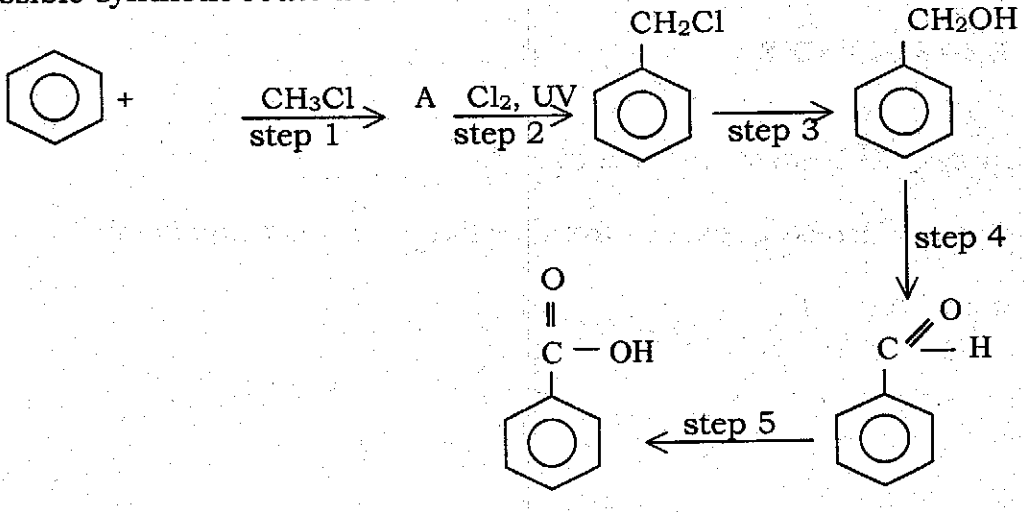
(a) An oxide that is insoluble in water. **(1mark)**

(b) An oxide that has simple molecular structure at room temperature and pressure. **(1mark)**

(c) An oxide that reacts with water forming a strongly alkaline solution. **(1mark)**

(d) An oxide that is slightly soluble in water forming a weakly alkaline solution. **(1mark)**

3. A possible synthetic route from benzene to benzoic acid is shown below:



(a) Give the name of a suitable catalyst for step 1 and give the structural formula of compound A. **(2marks)**

(b) Give the name of the reagent used and the type of reaction in step 3. **(2marks)**

(c) Name the reagent used in step 4. **(1mark)**

4. Use the bond enthalpies/bond energies in the table below to answer the questions that follow:

Bond	Average bond enthalpy/KJmol^{-1}
F – F	158
C – H	412
Cl – Cl	242
H – Cl	432
C – Cl	338

(a) Calculate the enthalpy change for the reaction:

$C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl.$ **(2marks)**

(b) By considering the bonds broken and the bonds formed, calculate the average value for the S – F bond energy in the reaction:

$SF_{4(g)} + F_{2(g)} \rightarrow SF_{6(g)} \quad \Delta H = -434KJmol^{-1}$

State any assumption you have made. **(3marks)**

5. (a) (i) Explain what is meant by the standard enthalpy change of formation of a compound. **(1mark)**

(ii) Write a balanced equation which represents the standard enthalpy change of formation of propane. **(1mark)**

(b) Calculate the standard enthalpy charge of formation of propane from the standard enthalpy changes of combustion given below:

	ΔH_c^{θ} /KJmol^{1}
Carbon	- 393
Hydrogen	- 286
Propane	- 2220

(3marks)

6. This question concerns some reactions of a compound X which has the structure:

$CH_3 — CH_2 — CH_2 — CH_2 — OH$

(a) Give the systematic name of compound X. **(1mark)**
(b) Is X a primary, secondary or tertiary alcohol? **(1mark)**
(c) What name is given to the intermolecular forces in compound X? **(1mark)**

(d) Give the structural formulae for two organic compounds which could be obtained by reacting X with a hot mixture of potassium dichromate and sulphuric acid. **(2marks)**

7. Boron, nitrogen and oxygen form fluorides with molecular formulae BF_3 , NF_3 and OF_2

(a) Draw the shape of each molecule and show the position of lone pairs of electrons, if any. **(3marks)**

(b) Give the bond angle in each case, explaining your reasons **(3marks)**

8. (a) Write down the electronic configuration of a calcium atom and of a calcium ion in terms of s.p..... orbitals.
(The atomic number of calcium = 20) **(2marks)**

(b) Why is the atomic radius of calcium significantly greater than the ionic radius of the calcium ion? **(1mark)**

(c) Explain why the hydration energy (enthalpy change of hydration) of Mg^{2+} is more exothermic than that of Ca^{2+} ? **(1mark)**

9. Over one million tons of manganese are produced in the world each year.

(a) Write the electronic configuration of manganese (atomic number = 25) and use it to explain why manganese is a transition element. **(2marks)**

(b) State, with specific examples, two properties of manganese or its compounds which are typical of transition elements. **(2marks)**

(c) Calculate the oxidation number of manganese in the ion MnO_4^{2-} . **(1mark)**

10. Explain the following:

(a) The boiling point of water (H_2O) is higher than that of hydrogen sulphide (H_2S). **(1mark)**

(b) The boiling points of ethane, water and sodium hydride increase in the order: $C_2H_6 < H_2O <$ NaH. **(2marks)**

11. Give brief explanations for the following trends of period 3 in the Periodic Table.

(a) The first ionization energy shows a general increase from Na to Cℓ. **(2marks)**

(b) The first ionization energy of S is less than that of P. **(2marks)**
(Atomic Number of S= 16, Atomic Number of P = 15).

12. A radioactive isotope X decays by emitting beta particles. It was found that only $\frac{1}{32}$ of the original isotope remained after 100 days. Calculate the half-life of the radioactive isotope. **(2marks)**

13. $^{232}_{90}Th$ emits three alpha-particles to form element X. Element X emits four beta-particles to form element Y.

(a) Give the symbol of a beta particle showing the charge and mass number of the particle. **(1mark)**

(b) Write balanced equations for the change

(i) $^{232}_{90}Th$ to X (one equation)

(ii) X to Y (one equation)

Show the mass and atomic numbers of X and Y in your equations. **(2marks)**

SECTION B: Choose THREE questions from this section /30 Marks.

14. Agricultural lime is manufactured from limestone (calcium carbonate) in two stages. Limestone is heated strongly in a lime kiln. The product is cooled and a calculated amount of water is added. The highly exothermic reaction yields a white powder called slaked lime.

(a) Write balanced equations for the two stages, showing state symbols. **(2marks)**

(b) Lime is used by farmers in agriculture. Why is it used? **(1mark)**

(c) Briefly explain how the manufacture of lime may have an effect on the environment. **(2marks)**

(d) The following table shows the melting points of the oxides of Group II elements.

Oxide	Melting point /°C
MgO	2852
CaO	2614
SrO	2430
BaO	1918

(i) Explain why the melting points of these oxides are generally high. **(2marks)**

(ii) Suggest an explanation of the trend in these melting points. **(2marks)**

(iii) Suggest a use for one of these oxides, based on its melting point. **(1mark)**

15. (a) Give the formulae of the three structural isomers of C_4H_8 which are non-cyclic. **(3marks)**

(b) One of these isomers shows a type of steroisomerism.
(i) Give the structures of the stereoisomers and name them. **(2marks)**

(ii) Give a chemical test for the functional group present in the isomers and describe the expected observation. **(2marks)**

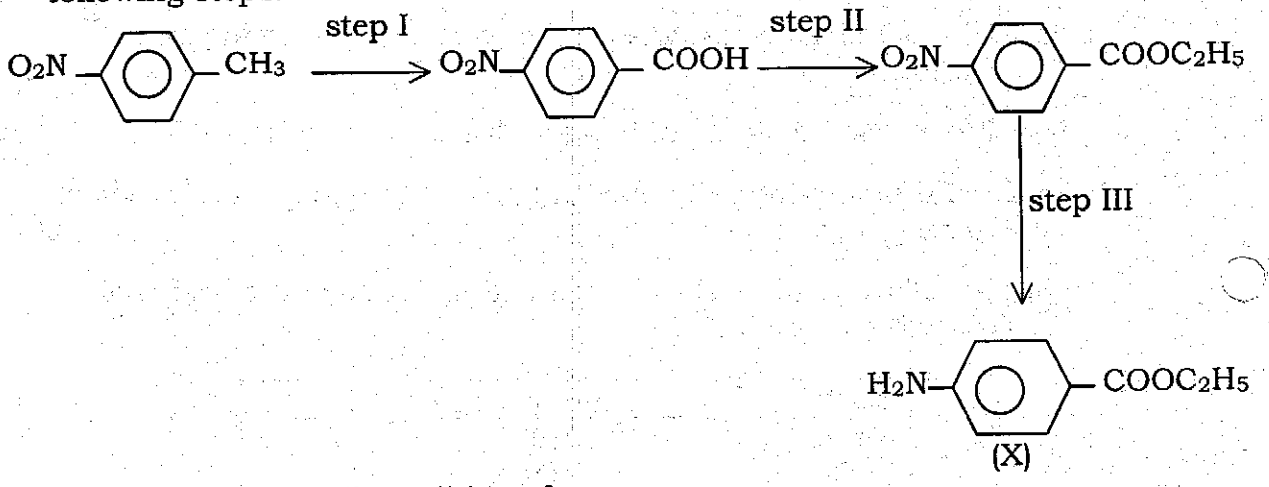
(c) One of the isomers of C_4H_8 in (a) reacts with HBr to give two different products, the major one of which is a chiral molecule.
(i) Identify this isomer of C_4H_8. **(1mark)**

(ii) Give the mechanism for the reaction of this isomer with HBr. **(2marks)**

16. (a) What reagents and conditions are used to prepare nitrobenzene from benzene? **(2marks)**

(b) The reaction in (a) is described as electrophilic substitution. Describe the mechanism of this reaction, clearly indicating how the electrophile is formed and its role in all the steps. **(2marks)**

(c) The local pain killer labeled as X below is synthesized from the aromatic compound 4 – nitromethylbenzene as shown in the following steps.



Suggest reagents and conditions for:
Step I
Step II
Step III **(6marks)**

17. The following table shows some properties of oxides of period 3 elements.

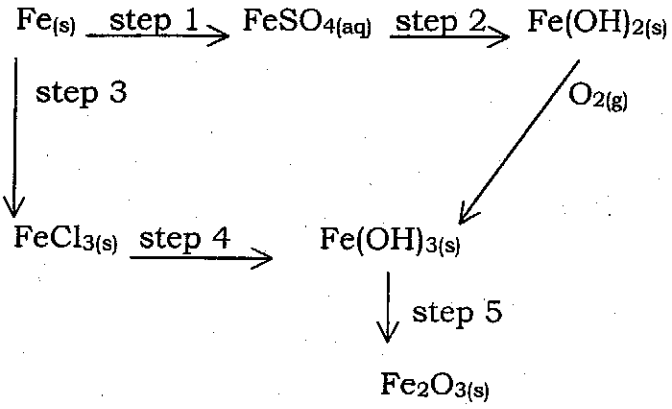
Formula	Na_2O	MgO	Al_2O_3	SiO_2	P_4O_{10} (P_4O_6)	SO_3 (SO_2)	Cl_2O_7 (Cl_2O)
State at 25°C	solid	solid	solid	solid	solid (solid)	liquid (gas)	liquid (gas)
Melting point/°C	1275	2852	2027	1610	26	17	-92

(a) Briefly explain how the melting point is related to the type of bonding and structure of the oxide. Use the examples of MgO, SiO_2 and Cl_2O_7. **(3marks)**

(b) With the help of equations, show the acid-base character of these oxides: MgO, Al_2O_3 and SO_3. **(4marks)**

(c) Describe briefly a method you would use to prepare and collect a dry sample of SO_2 gas in the laboratory. **(3marks)**

18. The following scheme shows some reactions of iron and its compounds.



For each of the steps 1 to 5,

(a) State the reagents and conditions for the reaction. **(5marks)**

(b) Write a balanced equation for the reaction (ionic equations are acceptable where appropriate) **(5marks)**

SECTION C: Answer ONE question from this section /15 Marks.

19. For each of the following pairs of compounds identify the chemical test which can be used to distinguish between them. State clearly the expected observation and write relevant equations for the reactions involved.

(a) $CH_3CH_2CH_2CH_2OH$ and $CH_3CH_2CH_2CHO$ **(3marks)**

(b) $CH_3CH_2CH_2CO_2H$ and $CH_3CH_2CH(OH)CH_3$ **(3marks)**

(c) $CH_3CH(OH)CH_3$ and $(CH_3 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} - OH)$ or $(CH_3)_3CHO$ **(3marks)**

(d) $Zn(NO_3)_2$ and $Pb(NO_3)_2$ **(3marks)**

(e) Na_2SO_3 and Na_2SO_4 **(3marks)**

20. The enthalpy change of hydration of anhydrous copper(II) sulphate corresponds to the enthalpy change of the reaction

$CuSO_{4(s)} + 5H_2O_{(\ell)} \rightarrow CuSO_4.5H_2O_{(s)}$

It is indirectly determined as follows:

- 4.0g of anhydrous solid is added to 50.0g of water and the temperature rise is 8°C.
- 4.0g of the hydrated solid is added to 50.0g of water and the temperature falls by 1.3°C.
- In each case the solid is added to water in a plastic cup and the mixture is stirred until a steady temperature is reached.

In all the calculations, assume the total mass of each solution is 50.0g and the specific heat capacity of the solution is $4.2Jg^{-1}°C^{-1}$.
Cu = 63.5, S = 32, O = 16, H = 1

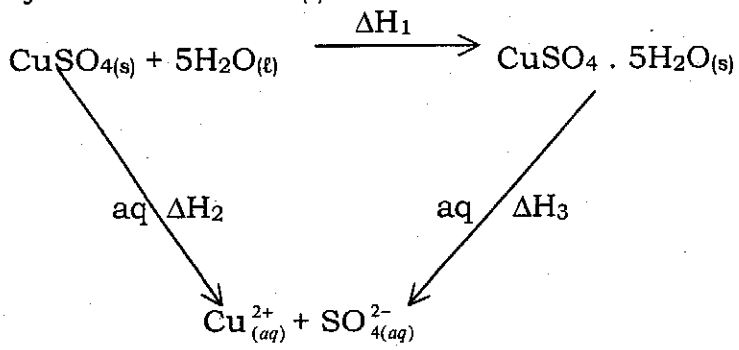
(a) Calculate the heat evolved when 4.0g of anhydrous copper(II) sulphate ($CuSO_{4(s)}$) is dissolved in 50.0g of water. **(2marks)**

(b) Calculate the enthalpy change of solution per mole of $CuSO_{4(s)}$. Remember to show the sign of ΔH sol. **(2marks)**

(c) Calculate the heat absorbed when 4.0g of $CuSO_4 . 5H_2O$ (hydrated copper(II)sulphate) is dissolved in 50.0g of water. **(2marks)**

(d) Calculate the enthalpy change of solution per mole of $CuSO_4 . 5H_2O_{(s)}$. **(2marks)**

(e) Using the energy cycle shown below, calculate ΔH_1, the enthalpy of hydration of $CuSO_{4(s)}$



(2marks)

(f) In this experiment, why is it better to use a plastic cup than a metal calorimeter? **(1mark)**

(g) Suggest two possible sources of error in this experiment. **(2marks)**

(h) 'If the enthalpy change for a reaction is negative then that reaction will take place very quickly'. Is this statement true or false? Give a reason for your answer. **(2marks)**

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CONSEIL NATIONAL DES EXAMENS AU RWANDA

024

B.P. 3817 KIGALI TEL/FAX 86871

EXAMEN NATIONAL DE FIN D'ETUDES SECONDAIRES 2001/2002

EPREUVE : CHIMIE II

OPTION : MATHS-PYSIQUE.

DUREE : 3 HEURES.

INSTRUCTIONS :

- L'épreuve comprend trois sections : A, B, et C.
- Répondez à toutes les questions de la section A, à trois questions au choix de la section B et à une question au choix de la section C.
- Les calculatrices peuvent être utilisées.

SECTION A.

Répondez à toutes les questions de cette section.

1. La composition centésimale en masse d'un composé A se présente comme suit : carbone : 22,24%, hydrogène : 3,715% et brome : 74,05%.
(a) Cherchez la formule empirique du composé A. **2pts.**

(b) Si la masse moléculaire relative de A est 215,8, quelle est la formule moléculaire de A ? **1pt.**

(c) Ecrivez la formule structurale d'un isomère à chaîne ramifiée de A et donnez son nom. **1pt.**

2. Dessinez les diagrammes qui montrent la forme d'une molécule de chacun des composés suivants et dans chaque cas indiquez le nom de la forme : $BeCl_2$, BCl_3, $SiCl_4$.
Vous pouvez utiliser les nombres atomiques suivants : Be = 4 ; B = 5 ; Si = 14 ; Cl = 17. **3pts.**

3. (a) Qu'entendez-vous par enthalpie standard de formation ? **1,5pts.**

(b) Utilisez les enthalpies standards de formation du tableau ci-dessous pour calculer l'enthalpie standard de combustion de l'éthane (C_2H_6). **1,5pts.**

Composé	C_2H_6 (g)	CO_2 (g)	H_2O (l)
Enthalpie standard de formation en kJ mol^{-1} à 298K	- 85	- 394	- 286

4. (a) Dessinez et nommez la formule structurale d'un isomère de $CH_3CH_2CH = CH_2$ qui présente une isomérie géométrique. **1pt.**

(b) Ecrivez l'isomère géométrique de l'isomère nommé au 5 (a). **1pt.**

(c) Ecrivez le mécanisme de réaction montrant la formation du produit principal quand $CH_3CH_2CH = CH_2$ réagit avec le gaz HCl. **2pts.**

5. Le tableau ci-après montre l'abondance isotopique relative de l'élément titane Ti :

Isotope	^{46}Ti	^{47}Ti	^{48}Ti	^{49}Ti	^{50}Ti
Abondance %	8,02	7,31	73,81	5,54	5,32

(a) En utilisant l'information dans le tableau ci-dessus, calculez la masse atomique relative du titane. **2pts.**

(b) Indiquez deux dangers qui peuvent être causés par des radio-isotopes. **1pt.**

(c) Le brome gazeux contient les isotopes ^{79}Br et ^{81}Br, indiquez et expliquez le nombre de pics formés dans un spectre de l'ion moléculaire de brome. **2pts.**

6. Expliquez ce qui suit :

(a) La phénylamine ($C_6H_5NH_2$) est une base plus faible que l'éthylamine ($CH_3CH_2NH_2$). **2pts.**

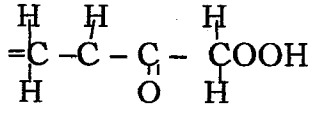
(b) L'acide chloroéthanoïque $CH_2ClCOOH$ est un acide plus fort que l'acide éthanoïque CH_3COOH. **2pts.**

7. Le tableau ci-dessous montre les points de fusion des éléments de la période 3. Utilisez ce tableau pour répondre aux questions qui suivent.

Elément	Na	Mg	Al	Si	P	S	Cl	Ar
Point de fusion en °C	98	650	660	1407	44	119	- 101	- 189

(a) Pourquoi le magnésium a-t-il un point de fusion plus élevé que celui du sodium ? **2pts.**

(b) Expliquez la variation de la première ionisation dans la période 3. **2pts.**

8. On donne le composé organique A : 

(a) Plusieurs groupements fonctionnels sont présents dans A, nommez-en deux. **1pt.**

(b) Qu'observeriez-vous si le composé A réagissait avec :

(i) le carbonate de sodium ? **1pt.**

(ii) le réactif de Brady (dinitro-2,4phénylhydrazine) ? **1pt.**

(iii) la liqueur de Fehling ? **1pt.**

9. (a) Ecrivez la configuration électronique des éléments suivants :

(i) chrome ; **1pt.**

(ii) cuivre. **1pt.**

Les nombres atomiques du chrome et du cuivre sont respectivement 24 et 29.

(b) Pourquoi les composés du cuivre sont-ils bleus ? **2pts.**

10. Le nitrobenzène est produit au laboratoire en utilisant le benzène et d'autres réactifs sous certaines conditions.

(a) Indiquez les autres réactifs et les conditions de la réaction. **2pts.**

(b) Dégagez le mécanisme entier de la réaction entre le benzène et les autres espèces réagissant jusqu'à la formation du produit final. **3pts.**

11. En vous servant de la théorie de Brönsted-Lowry, identifiez l'acide, la base, la base conjuguée et l'acide conjugué pour chacune des réactions suivantes :

(i) $NH_3 + HBr \rightarrow NH_4^+ + Br^-$ **2pts.**

(ii) $C_6H_5OH + NaOH \rightarrow C_6H_5ONa + H_2O$ **2pts.**

12. Complétez les tableaux ci-après:

(a) **3pts**

	Masse relative	Charge relative
Proton		
Electron		
Neutron		

(b) **2pts.**

	Masse relative	Charge relative
Une particule α		
Une particule β		

13. Le vanadium est un élément de transition dont le nombre atomique est 23.

(a) Indiquez trois traits caractéristiques du vanadium et de ses composés. **3pts.**

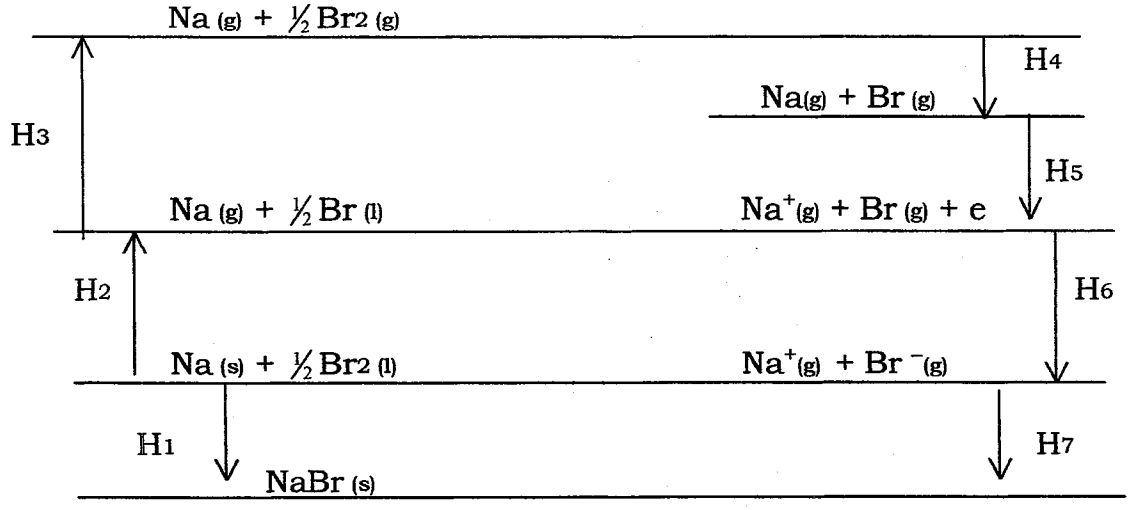
(b) Etant donné que VCl_4 est un acide de Lewis, prédisez, avec des raisons à l'appui, si oui ou non VCl_4 réagira avec l'éthanol. **2pts.**

(c) Ecrivez la configuration électronique du vanadium. **1pt.**

SECTION B.

Répondez à trois questions au choix.

14. Le cycle de Born Haber ci-dessous représente la formation du bromure de sodium à partir de ses éléments dans leur état naturel.



(a) Nommez les changements d'enthalpie H1 à H7. **4pts.**

(b) Etant donnés : H_1 = - 361 kJ mol^{-1} ;
H_2 = + 107 kJ mol^{-1} ;
H_3 = x kJ mol^{-1} ;
H_4 = + 97 kJ mol^{-1} ;
H_5 = + 498 kJ mol^{-1} ;
H_6 = - 375 kJ mol^{-1} ;
H_7 = - 753 kJ mol^{-1} ;
Calculez la valeur de H_3. **3pts.**

(c) Expliquez pourquoi le changement d'enthalpie H_7 pour NaBr est plus grand que celui de KBr.
N.B : Le potassium est au-dessous du sodium dans le groupe I du tableau périodique des éléments. **3pts.**

15. Suggérez les voies de synthèse montrant les conditions et les réactifs pour la conversion suivante :
(i) du benzène en trinitro-2,4,6métylbenzène. **5pts.**

(ii) du méthanol en éthanol. **5pts.**

16. Expliquez l'observation suivante :
(a) Le pouvoir réducteur des éléments du groupe VII augmente généralement de haut en bas. **2pts.**

(b) La solubilité des hydroxydes des éléments du groupe II augmente de haut en bas. **3pts.**

(c) Les points d'ébullition des hydrures des éléments du groupe VI augmente généralement de haut en bas, mais H_2O a un point d'ébullition plus élevé que celui auquel on pouvait s'attendre. **3pts.**

(d) Le chlorure de plomb(IV) est un composé covalent mais le chlorure de plomb(II) est ionique. **2pts.**

17. (a) Qu'entendez-vous par réactions SN_2 et SN_1 ? **2pts.**

(b) Le bromo-2propane $CH_3CHBrCH_3$ réagit avec le KOH pour former deux produits différents.
(i) Indiquez les conditions pour chaque type de réaction. **2pts.**

(ii) Montrez la formule structurale de chaque produit formé. **2pts.**

(c) Etant donné que le bromo-2propane réagit facilement avec le cyanure de potassium :
(i) écrivez une équation de cette réaction. **2pts.**

(ii) montrez le mécanisme de cette réaction. **2pts.**

18. L'acide sulfurique est fabriqué par « le procédé par contact. ».
(a) Indiquez le nom du catalyseur, les conditions utilisées dans le procédé et écrivez les équations des principales réactions qui apparaissent. **6pts.**

(b) Indiquez et expliquez quatre considérations dont il faut tenir compte avant qu'un site ou un emplacement d'une usine du procédé par contact soit décidé. **4pts.**

SECTION C.

Répondez à une seule question au choix.

19. A l'aide des équations, si possible, décrivez un test chimique que vous pourriez réaliser pour distinguer entre eux les composants des paires suivantes. Dans chaque cas, indiquez les conditions de réaction et les observations qui pourraient être faites.
(a) $CH_3CH_2NH_2$ et CH_3CONH_2 (b) CH_3COCH_3 et CH_3CHO

(c) $Pb^{2+}_{(aq)}$ et $Zn^{2+}_{(aq)}$ (d) $Cu^{2+}_{(aq)}$ et $Al^{3+}_{(aq)}$

(e) Le gaz Cl_2 et le gaz HCl. **3pts pour chaque cas.**

20.(a) Décrivez une expérience simple qui peut être utilisée pour déterminer l'enthalpie de combustion de l'éthanol. **8pts.**

(b) Indiquez trois sources d'erreurs dans l'expérience que vous avez présentée. **3pts.**

(c) Etant donné que l'enthalpie de combustion de l'éthanol est $-1368\ kJmol^{-1}$, l'enthalpie de formation de $CO_2 = -394\ kJmol^{-1}$ et l'enthalpie de formation de $H_2O_{(l)} = -286\ kJmol^{-1}$; calculez l'enthalpie de formation de l'éthanol. **4pts.**

21. Un composé organique A qui contient deux groupements « acide carboxylique » et un autre groupe fonctionnel, a la composition centésimale suivante : C = 35,8 %, O = 59,7 %, H = 4,5 % . Quand on fait réagir A avec l'éthanol en présence d'acide sulfurique concentré sous des conditions réversibles, un composé B de formule moléculaire $C_8H_{14}O_5$ est formé. Le composé B réagit avec le sodium métallique pour produire du gaz hydrogène et peut être oxydé pour former un composé carbonylé C. C ne réagit pas avec la liqueur de Fehling.
(a) Déterminez la formule empirique et la formule moléculaire de A. **4pts.**

(b) Suggérez les structures des composés A, B et C. Expliquez complètement comment vous arrivez à ces conclusions. **8pts.**
(c) Indiquez les observations que vous pourriez faire quand le composé A réagit avec ce qui suit : **3pts.**
(i) $NaHCO_3$;
(ii) PCl_5 ;
(iii) Br_2 dans CCl_4.