

REGISTRATION CENTRE NUMBER		CENTRE NAME	
CANDIDATE'S FULL NAMES			
CANDIDATE IDENTIFICATION NUMBER		SUBJECT CODE 0715	PAPER NUMBER 2
FOR OFFICIAL USE ONLY (Candidate Random CODE):			
<b>CAMEROON GENERAL CERTIFICATE OF EDUCATION BOARD          ADVANCED LEVEL EXAMINATION</b>			
SUBJECT TITLE CHEMISTRY		SUBJECT CODE 0715	PAPER NUMBER 2
		EXAMINATION DATE: JUNE 2018	

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Three hours

Enter the information required in the boxes of the flap.

Answer ALL the SIX questions in this booklet.

The mark allocation is indicated for each question. Each question carries 20 marks.

Verify that this booklet contains six questions, no questions are repeated and there are no blank pages. Inform the invigilator in case this booklet contains less than six questions, questions are repeated or there are blank pages so that the booklet should be changed.

Blank spaces in this question booklet may be used for rough work.

In calculations you are advised to show all the steps in your working, giving your answer at each stage.

All necessary working must be shown. No marks will be awarded for answers without brief statements showing how the answers have been obtained.

Calculators may be used.

**Useful Data**

Relative atomic masses (RAM)

C = 12.0, O = 16.0, H = 1.0, Al = 27.0, S = 32.0, Na = 23.0

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## SECTION A: PHYSICAL AND GENERAL CHEMISTRY

1. This question is on the mole concept, bonding, equilibria and energetics.

(a) Define "mole" of a substance.

(1 mark)

(b) 25 cm<sup>3</sup> of a 0.005 mol dm<sup>-3</sup> solution of hydrated sodium thiosulphate (Na<sub>2</sub> S<sub>2</sub>O<sub>3</sub>·5H<sub>2</sub>O) was mixed with 25 cm<sup>3</sup> of 0.05 mol dm<sup>-3</sup> iodine solution and allowed to react.

(i) Calculate the number of moles of sodium thiosulphate used.

(2 marks)

(ii) Determine the limiting reagent, given the balanced equation:  $2S_2O_3^{2-}{}_{(aq)} + I_{2(aq)} \rightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-{}_{(aq)}$

(iii) Which indicator is most suitable for the titration of iodine solution with sodium thiosulphate?

(3 marks)

(c) (i) Draw a clear diagram to show the shape of a water molecule

Molecule	H <sub>2</sub> O
Shape	

(ii) Explain the shape of H<sub>2</sub>O as shown in C(i) above

(2 marks)

(d) (i) Define an acid and a base in terms of electron transfer.

(ii) illustrate your answer by considering the reaction between NH<sub>3</sub> and BF<sub>3</sub>.

(3 marks)

(e) A buffer solution is made by adding 75.0 g of sodium ethanoate ( $\text{CH}_3\text{CO}_2\text{Na}$ ) to 500  $\text{cm}^3$  of a 0.64M solution of ethanoic acid,  $\text{CH}_3\text{COOH}$  ( $\text{pK}_a = 4.8$ ) (RAM: C = 12, O = 16, Na = 23, H = 1)

(i) What is a buffer solution?

(ii) Write equations to show how the buffer system above neutralises:

A:  $\text{H}^+(\text{aq})$

B:  $\text{OH}^-(\text{aq})$

(iii) Calculate the pH of the solution resulting from (e) above.

(5 marks)

(iv) Define lattice energy

(v) Draw a Born-Haber cycle for the formation of Magnesium Oxide,  $\text{MgO}(\text{s})$ .

(4 marks)

(TOTAL = 20 marks)

2. (a) Draw well-labelled diagram of the mass spectrometer.

(5 marks)

Turn Over

(b) A mass spectrometer gave the following data for a sample of naturally occurring Germanium.

Isotope	Detector current/arbitrary units	Relative abundance
70	6.83	
72	9.13	
73	2.60	
74	12.17	
76	2.60	

(i) Complete the above table by calculating the relative abundance of each isotope.

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(ii) Determine the relative atomic mass of Germanium.

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(5 marks)

(c) Under specified conditions of temperature and pressure, ice, liquid water and water vapour co-exist in a heterogeneous dynamic equilibrium.

(i) Explain the term "heterogeneous equilibrium"

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(ii) How many phases and how many components exist in the equilibrium?

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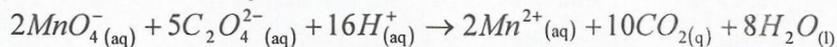
(3 marks)

(d) (i) Define "order of reaction"

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(ii) State two methods by which the rate of the reaction below can be followed.



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(iii) The data in the table below relate to the general reaction  $2A + B \rightarrow C + D$  at 500K.

Experiment	[A]/mol dm <sup>-3</sup>	[B]/mol dm <sup>-3</sup>	Initial rate/mol dm <sup>-3</sup> s <sup>-1</sup>
1	0.130	0.20	$1.50 \times 10^{-5}$
2	0.130	0.40	$6.50 \times 10^{-5}$
3	0.065	0.40	$3.00 \times 10^{-5}$
4	0.065	0.20	$0.75 \times 10^{-5}$

A: Determine the order of reaction with respect to A and with respect to B.

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B: Calculate the value of the Rate constant from experiment 1.

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(7 marks)  
(TOTAL = 20 marks)

### SECTION B: INORGANIC CHEMISTRY

3. (a) This questions concern the d-block elements of the periodic table. The elements Cobalt, Nickel, Iron and Zinc are of the d-block.

(i) Which of the elements above is (are) not(a) transition metal(s).  
Explain.

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(ii) Distinguish between a d-block element and a transition metal.

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(iii) How is a complex ion formed by a transition metals.

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(iv) What do you understand by the coordination number of a complex ion.

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Turn Over

(v) Give the name of a complex cation formed by cobalt and draw its shape.

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(9 marks)

(b) This question is on the Group VII elements of the periodic. (Fluorine, Chlorine, Bromine and Iodine)

(i) Give the general outermost shell electronic configuration of these elements

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(ii) Give the chemical formula in each case of one compound of Chlorine in which the oxidation number is;

oxidation state	compound
+1	
+7	

(iii) The halogens undergo disproportionation reactions, using equation give an example of a reaction in which Chlorine undergoes disproportionation

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(iv) Arrange the oxo-acids of chlorine ( $\text{HClO}$ ,  $\text{HClO}_2$ ,  $\text{HClO}_3$ ,  $\text{HClO}_4$ ) in order of decreasing acid strength starting with the strongest.

Explain your reasoning.

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(6 marks)

(c) Sulphur exhibits several oxidation states in its compound.

(i) Complete the table below by giving either the formula, name or oxidation state of the compound or ion.

Oxidation state	Name	Formula
-2		$\text{H}_2\text{S}$
	Thiosulphate	
		$\text{H}_2\text{SO}_4$
	Persulphate	$\text{S}_2\text{O}_8^{2-}$

(ii) Write balance equations to show how  $\text{SO}_3$  is converted to  $\text{H}_2\text{SO}_4$  in the contact process.

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(5marks)

TOTAL = 20 marks)

4. (a) (i) Explain why the melting and boiling point of Group 1 and II. Metals are lower than those of transition metals.

(ii) Indicate the colours associated with the following elements in a flame test.

Element	Flame colour
Sodium	
Calcium	
Potassium	
Strontium	

(iii) Give one reaction in each case to illustrate how the chemistry of:

A: Lithium differs from that of other elements of group I.

B: Beryllium differs from that of other elements of group II.

(6 marks)

(b) The elements of the first short period of the periodic table are, Li, Be, B, C, N, O, F and Ne.

(i) Give the formula of one stable oxide of each element of the period.

Element	Li	Be	B	C	N	O	F	Ne
Stable oxide								

(ii) Give balanced equations to show how the oxides of lithium and Carbon react with water.

(iii) Give the formulae of the chlorides of the elements Li, Be, B, C, N, O and classify them according to their bond types.

Element	Li	Be	B	C	N	O
Formula of Chloride						
Bond type						

(8 marks)

(c) This question concern the Group IV elements (Carbon - Lead)

(i) Give equations to show how the tetrachlorides of Si and Pb react with water.

Turn Over

(ii) Complete the table below by giving the formulae of the dioxides of the elements and their acid base character

Element	Silicon	Lead
Formula of dioxide		
Acid base character		

(4 marks)

(d) Outline the steps in the conversion of ammonia to nitric acid specifying the reaction conditions

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(2 marks)

(TOTAL = 20 marks)

### SECTION C: ORGANIC (MINERAL) CHEMISTRY

5. (a) (i) Explain why Carbon catenates extensively whereas Silicon does not?

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(ii) Give the type of hybridization of Carbon and the shape of the molecule in the following compounds:

A: Ethene:..... shape.....

B: Ethyne: hybridization.....shape.....

(3 marks)

(b) Compound A  $\text{CH}_3\text{CH}_2\text{CH}(\text{NH}_2)\text{COOH}$  is an organic nitrogen compound

(i) Describe how the presence of nitrogen could be identified in compound A above.

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(ii) Identify any one type of isomerism exhibited by compound A and give the structures of the isomeric compounds.

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(6 marks)

(c)  Write equations that illustrate the following reactions of Carbonyl compounds.

A: a nucleophilic addition reaction.

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B: a condensation reaction.

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(ii) How would you account for the fact that Aliphatic Aldehydes are more reactive than their Ketones counterparts.

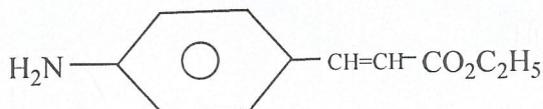
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(3 marks)

(d) An organic compound X, has the structural formula below.



The compound undergoes combustion giving a highly luminous, sooty flame.

(i) What accounts for the sootiness of the flame.

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(ii) Give the product formed when compound X reacts with.

A: Bromine in Carbon Tetrachloride.

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B: Bromine water.

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(iii) Compound X reacts with dilute  $\text{HCl (aq)}/\text{NaNO}_2(\text{aq})$  at temperatures below  $5^\circ\text{C}$ . Suggest a reason why temperatures below  $5^\circ\text{C}$  are needed.

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(4 marks)

(e) (i) Write the structural formula of 2-Chloromethylbenzene

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(ii) Show in TWO steps how you would prepare 2-Nitromethylbenzene from Benzene

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(iii) What name is given to the first step of reaction in e (ii) above.

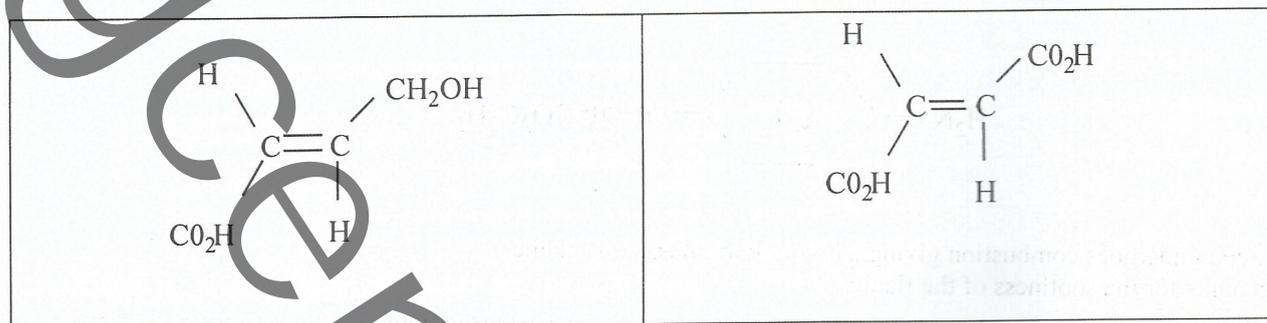
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(4 marks)

(Total = 20 marks)

Turn Over

6. (a) Given compounds A and B below.



(i) How would the compound B be obtained from A.

(ii) Compound B is a solid. How could a pure sample of this compound be obtained?

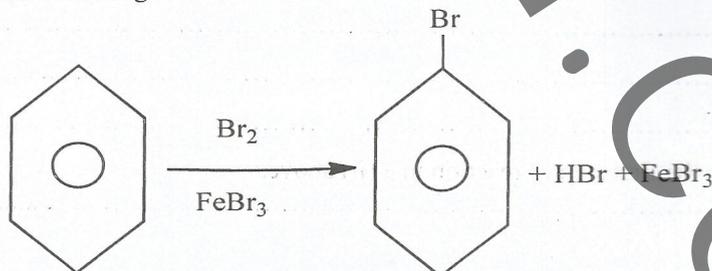
(iii) How could its purity be verified?

(4 marks)

(b) (i) Arrange the following compounds in order of their reactivity towards electrophile such as  $E^+$  (with the most reactive first): Benzene, Phenol, Nitrobenzene and explain.

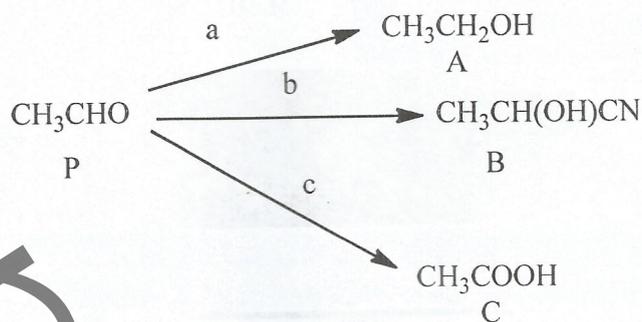
Explain:

(ii) Write the mechanism for the following reaction



(6 marks)

(c) The compound P, can be converted to other products according to the scheme below.



(i) Give the reagents and reaction conditions for the conversions a, b and c

conversion	reagents	Reaction conditions
a		
b		
c		

(ii) Write the mechanism for the formation of B.

(iii) Write the equation for the reaction of compound A with concentrated sulphuric acid at 170°C.

(iv) Name the reaction that occurs between compound C and A.

(7 marks)

(d) Organic compounds can be classified according to the functional group.

(i) Define the term "functional groups"

(ii) Write an equation for the reaction between Bromoethane ( $\text{CH}_3\text{CH}_2\text{Br}$ ) and each of the following compounds.  
A: Potassium cyanide.

B: Aqueous Sodium hydroxide.

(3 marks)  
(Total = 20 marks)