



BOTSWANA EXAMINATIONS COUNCIL
Botswana General Certificate of Secondary Education

CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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CHEMISTRY

0570/03

Paper 3

October/November 2019

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces provided at the top of this page.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Show your working for any calculations.

You may use a calculator.

The number of marks is given in brackets [] at the end of each question or part question.

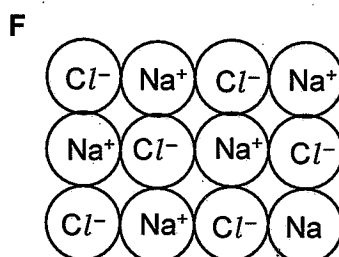
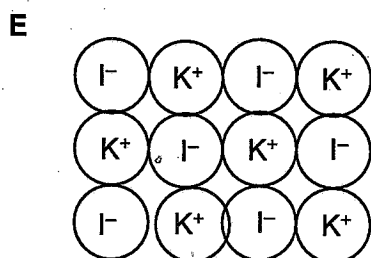
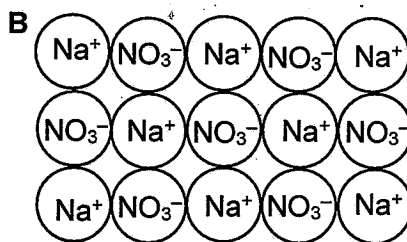
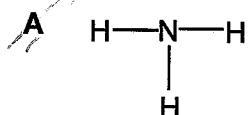
A copy of the Periodic Table is printed on page 16.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
Total	

This document consists of **13** printed pages and **3** blank pages.



1 The structures of six substances are shown.



Use the letters A, B, C, D, E and F to answer the questions.

Each letter may be used once, more than once or not at all.

(a) Which substance is an element?

..... [1]

(b) Which substance is the **most** abundant in air?

..... [1]

(c) Which substance is a salt which contains three elements?

..... [1]

(d) Which substance dissolves in water to form a solution that gives a white precipitate with aqueous silver nitrate?

..... [1]

(e) Which substance dissolves in water to give a solution of pH 4?

..... [1]

[Total: 5]



- 2 In an experiment chromium, cobalt, copper and magnesium were each reacted with the aqueous nitrates of each metal.

The results are shown in the table.

Metal	$\text{Cr}(\text{NO}_3)_3$	$\text{Mg}(\text{NO}_3)_2$	$\text{Cu}(\text{NO}_3)_2$	$\text{Co}(\text{NO}_3)_2$
chromium		no reaction	reaction occurs	reaction occurs
cobalt	no reaction	no reaction	reaction occurs	
copper	no reaction	no reaction		no reaction
magnesium	reaction occurs		reaction occurs	reaction occurs

- (a) Arrange the metals in order of decreasing reactivity starting with the most reactive.

most reactive

less reactive

..... [2]

- (b) (i) Which metal nitrate from the table will **most** readily decompose when heated?

..... [1]

- (ii) Name any **two** products of the decomposition of the nitrate named in (b).

..... and..... [2]

- (c) Suggest which metal nitrate will decompose to a metal nitrite.

..... [1]

- (d) Zinc reacts with aqueous copper(II) nitrate.

Write an equation for the reaction. Include state symbols.

..... [2]

[Total: 8]

3 Petrol is a mixture of hydrocarbons. C_5H_{12} is one of the hydrocarbons in petrol.

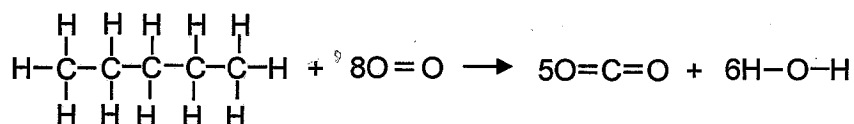
(a) Name one use of petrol.

..... [1]

(b) Name the hydrocarbon with molecular formula C_5H_{12} .

..... [1]

(c) The hydrocarbon C_5H_{12} burns in oxygen as shown by the equation.



(i) Name the type of reaction that occurs.

..... [1]

The table shows bond energies.

bond	energy (kJ/mol)
C-H	413
C-C	347
O=O	498
C=O	743
O-H	467

(ii) Calculate the total energy required to break all bonds in the reactants.

..... kJ [3]

(iii) Calculate the total energy released when all bonds are formed in the products.

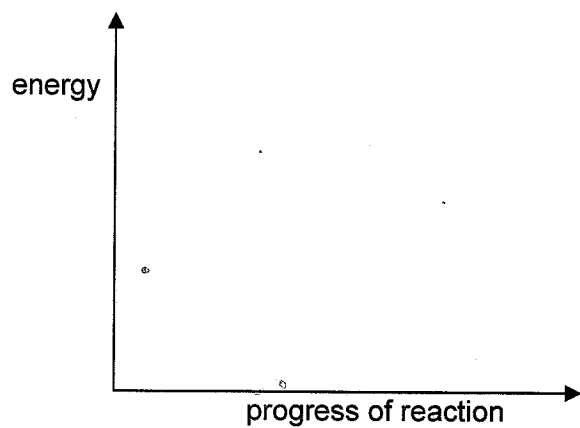
..... kJ [2]

(iv) Calculate the total energy change, ΔH , for the reaction.

..... kJ [2]



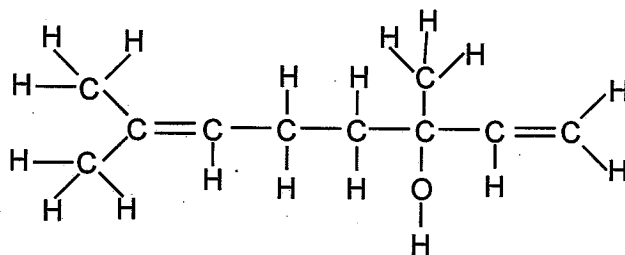
- (v) Draw an energy level diagram for the reaction when C_5H_{12} burns in oxygen. Include the activation energy.



[4]

[Total: 14]

- 4 Linalool is an unsaturated organic compound found in the seeds of a coriander plant. The structural formula of linalool is shown.



- (a) (i) Put a ring around the alcohol functional group on the structure of linalool. [1]

- (ii) Deduce the molecular formula of linalool.

..... [1]

- (iii) Describe a test to show that linalool is an unsaturated organic compound.

test.....

result.....

[2]

- (b) Linalool is burned in a limited supply of oxygen.

Name the products formed from the reaction.

..... and..... [2]

- (c) Butene is another unsaturated organic compound.

Draw the structural formula of butene.

[1]

[Total: 7]



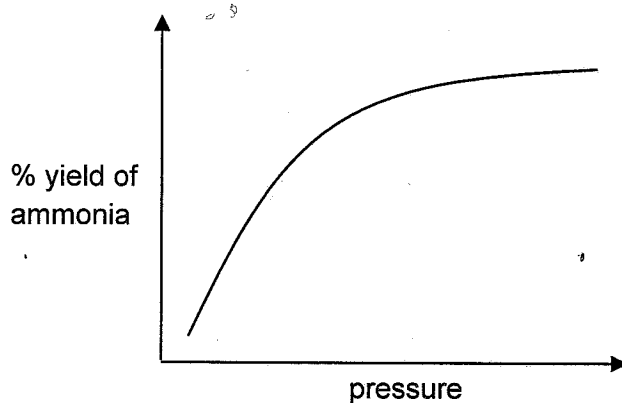
- 5 Ammonia is manufactured using the Haber process.



- (a) State **two** conditions required for the manufacture of ammonia by the Haber process.

.....
..... [2]

- (b) The graph shows how the yield of ammonia changes with pressure at constant temperature in the Haber process.



What conclusion can be drawn from the graph?

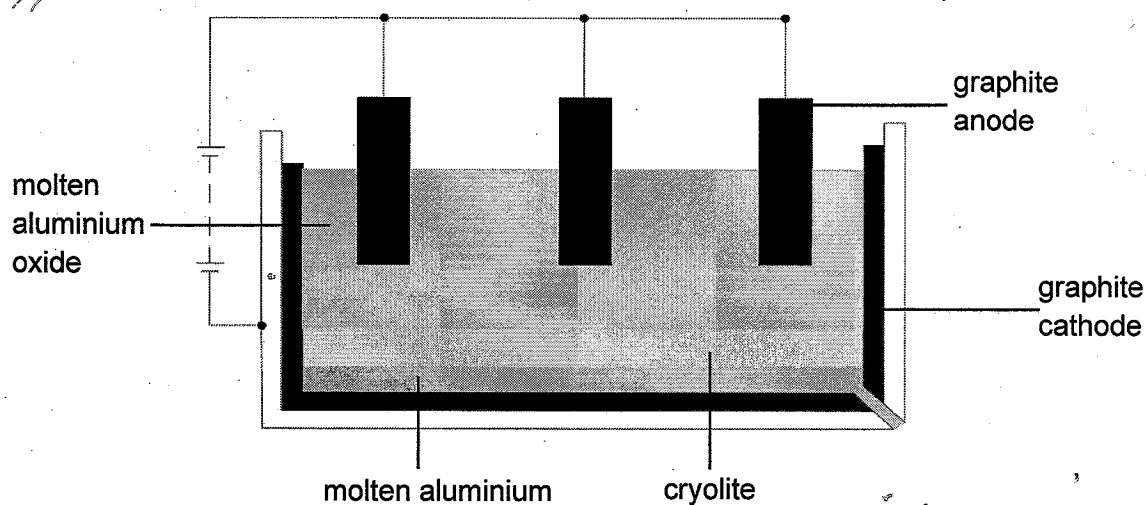
..... [1]

- (c) State and explain how increasing the temperature affects the amount of ammonia produced in the process.

.....
.....
..... [2]

[Total: 5]

- 6 The diagram shows a cell used to extract aluminium from its ore, bauxite. Bauxite contains aluminium oxide.



- (a) (i) Write the chemical formula of aluminium oxide.

[1]

- (ii) The anode has to be replaced because it is used up in the process.

Write an equation for the reaction that causes the anode to be used up.
Include state symbols.

[2]

- (b) A steady current of 15.0 A was allowed to pass through the molten aluminium oxide for 2 hours.

- (i) Calculate the charge, in Coulombs, that was passed through the molten aluminium oxide.

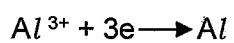
[2]

- (ii) Use your answer to (b)(i) to calculate the number of Faradays used.
[1 Faraday = 96 500 C].

[2]



(iii) The equation for the formation of aluminium at the cathode is shown.



Use your answer to (b)(ii) to calculate the mass of aluminium that will be produced.

[2]

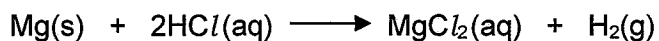
[Total: 9]

918

A005



- 7 A student investigated the reaction of magnesium with dilute hydrochloric acid at 25 °C. The equation for the reaction is shown.



- (a) (i) Write the ionic equation for the reaction.

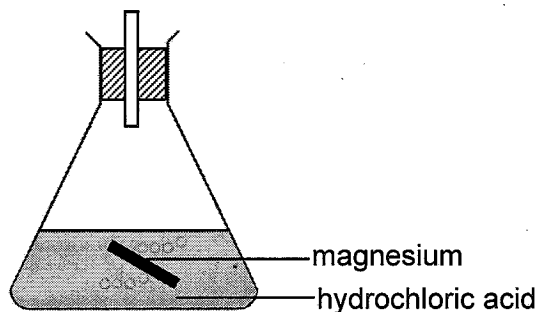
..... [2]

- (ii) Draw a 'dot and cross' diagram to show the bonding in magnesium chloride, MgCl_2 . Show all electrons.

[3]

- (b) The volume of hydrogen gas given off was measured.

- (i) Complete the diagram by drawing the apparatus used to collect and measure the volume of the gas.



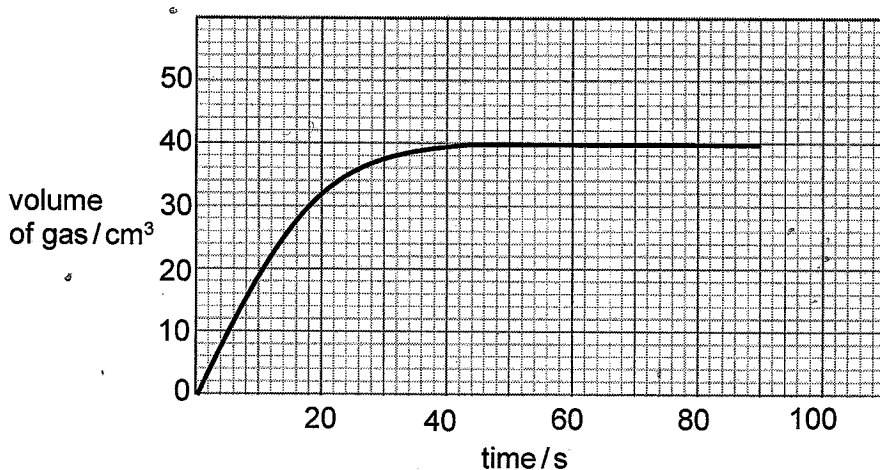
[2]

- (ii) Bubbles are given off during the reaction.
State **one** observation, other than bubbles, that could be made during the reaction.

.....

..... [1]

- (c) The volume of hydrogen gas given off at 25 °C was plotted against time as shown on the graph.



- (i) How long does it take for the reaction to stop?

..... [1]

- (ii) What is the volume of hydrogen gas produced after 25 seconds?

..... [1]

- (iii) Circle on the graph the part where the rate of the reaction was the highest.
Give an explanation for your answer.

.....

.....

..... [2]

- (iv) On the same grid, sketch a graph to show how the volume of the gas would change, if the experiment was repeated at 15 °C. [2]

[Total: 14]

918

A005



- 8 Waste water from a cotton manufacturing company contains a mixture of sulphuric acid, iron(II) sulphate and calcium oxide.

(a) Name **two** cations present in the mixture.

.....and..... [2]

- (b) A 10.0 cm³ sample of waste water was diluted with distilled water to make a volume of 250 cm³ of solution. In a titration, 25.0 cm³ of the diluted solution of the mixture completely reacted with 23.5 cm³ of 0.020 mol/dm³ acidified potassium dichromate, K₂Cr₂O₇.

(i) Calculate the number of moles of potassium dichromate in 23.5 cm³ of 0.020 mol/dm³ of potassium dichromate.

moles of potassium dichromate..... [2]

The equation for the reaction is shown.



(ii) Calculate the number of moles of iron(II) sulphate in 25.0 cm³ of the diluted waste water solution.

moles of iron(II) sulphate..... moles [2]

(iii) Use your answer to (b)(ii) to calculate the number of moles of iron(II) sulphate in 250 cm³ of the diluted waste water solution.

moles of iron(II) sulphate..... moles [1]

(iv) Use your answer to (b)(iii) to calculate the concentration of iron(II) sulphate in the original sample of waste water.

concentration of FeSO₄.....mol/dm³ [1]

[Total: 8]



DATA SHEET
The Periodic Table of the Elements

		Group									
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1 H Hydrogen											
3 Li Lithium	4 Be Beryllium		5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon			
11 Na Sodium	12 Mg Magnesium		13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulphur	17 Cl Chlorine	18 Ar Argon			
19 K Potassium	20 Ca Calcium		27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine
37 Rb Rubidium	38 Sr Strontium		45 Cr Chromium	46 Mn Manganese	47 Fe Iron	48 Co Cobalt	49 Ni Nickel	50 Cu Copper	51 Zn Zinc	52 Ga Gallium	53 Ge Germanium
55 Cs Caesium	56 Ba Barium		52 Cr Chromium	53 Mn Manganese	54 Fe Iron	55 Co Cobalt	56 Ni Nickel	57 Cu Copper	58 Zn Zinc	59 Ga Gallium	60 Ge Germanium
87 Fr Francium	88 Ra Radium		74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead
			81 Y Yttrium	82 Zr Zirconium	83 Nb Niobium	84 Mo Molybdenum	85 Tc Technetium	86 Ru Ruthenium	87 Rh Rhodium	88 Pd Palladium	89 Ag Silver
			89 La Lanthanum	90 Ce Cerium	91 Pr Praseodymium	92 Nd Neodymium	93 Pm Promethium	94 Sm Samarium	95 Eu Europium	96 Gd Gadolinium	97 Tb Terbium
			101 Bi Bismuth	102 Po Polonium	103 At Astatine	104 Rn Radon					
			105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium
			115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson					
			119 Uu Ununennium	120 Uub Unbibium	121 Uut Ununtrium	122 Uuq Ununquadium	123 Uup Ununpentium	124 Uuq Ununhexium	125 Uuh Ununheptium	126 Uuq Ununoctium	127 Uuh Ununnonium
			132 Uub Unbibium	133 Uut Ununtrium	134 Uuq Ununquadium	135 Uup Ununpentium	136 Uuq Ununhexium	137 Uuh Ununheptium	138 Uuq Ununoctium	139 Uuh Ununnonium	140 Uuq Ununoctium
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