BOTSWANA EXAMINATIONS COUNCIL
Botswana General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

CHEMISTRY

Paper 3

0570/03

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.

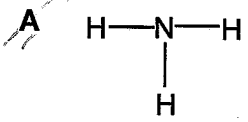
A copy of the Periodic Table is printed on page 16.

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

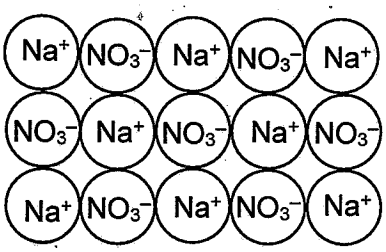
This document consists of **13** printed pages and **3** blank pages.

1 The structures of six substances are shown.

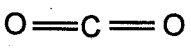
A



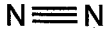
B



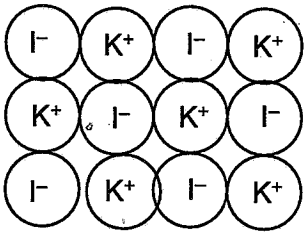
C



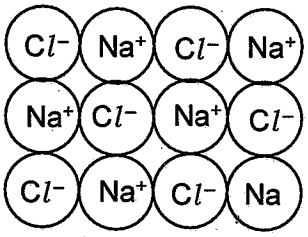
D



E



F



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	$Cr(NO_3)_3$	$Mg(NO_3)_2$	$Cu(NO_3)_2$	$Co(NO_3)_2$
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.

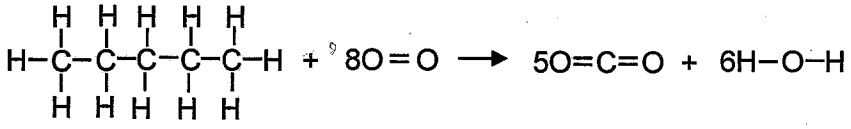
(a) Name **one** use of petrol.

..... [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]

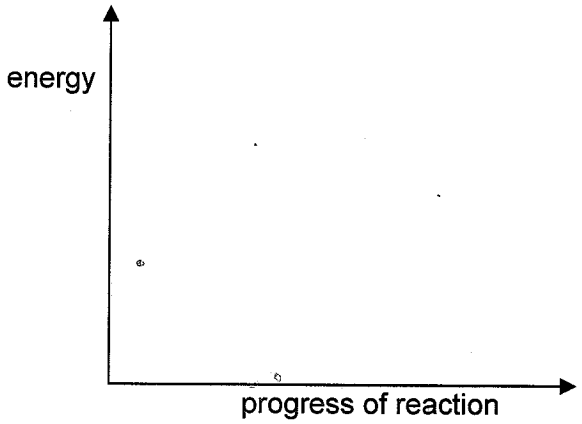
(iii) Calculate the total energy released when all bonds are formed in the products.

..... 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.

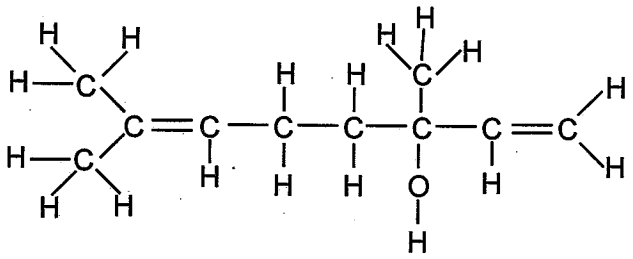


[4]

[Total:14]

For Examiner's Use

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]

For Examiner's Use

5 Ammonia is manufactured using the Haber process.

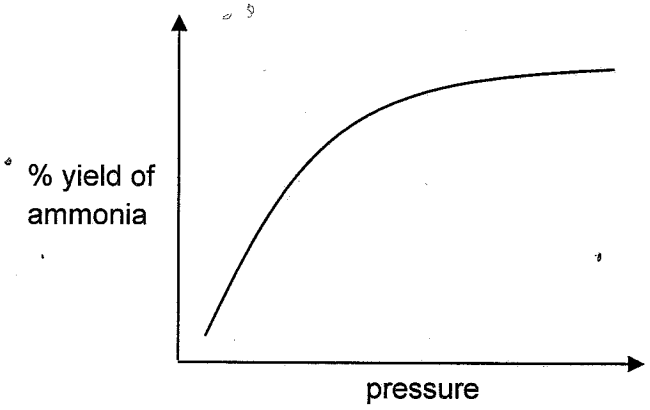
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92 \text{ kJ/mol}$$

(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.

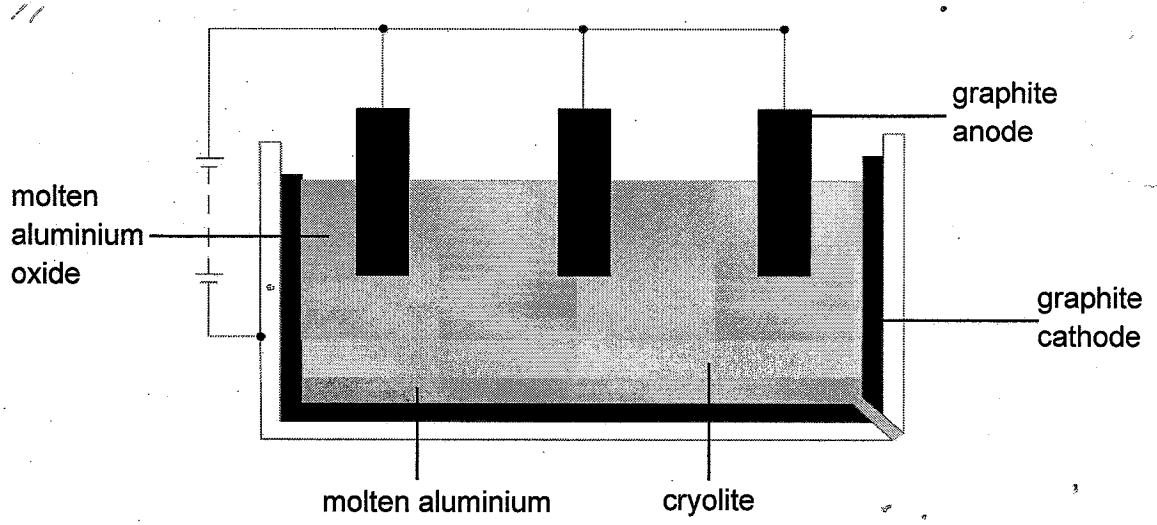
.....

.....

..... [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 500C].

[2]

For Examiner's Use

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

$$Al^{3+} + 3e \longrightarrow Al$$

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

[2]

[Total: 9]

For Examiner's Use

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

$$Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$$

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

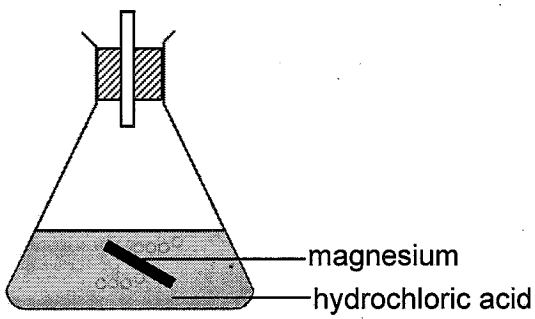
..... [2]

(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.



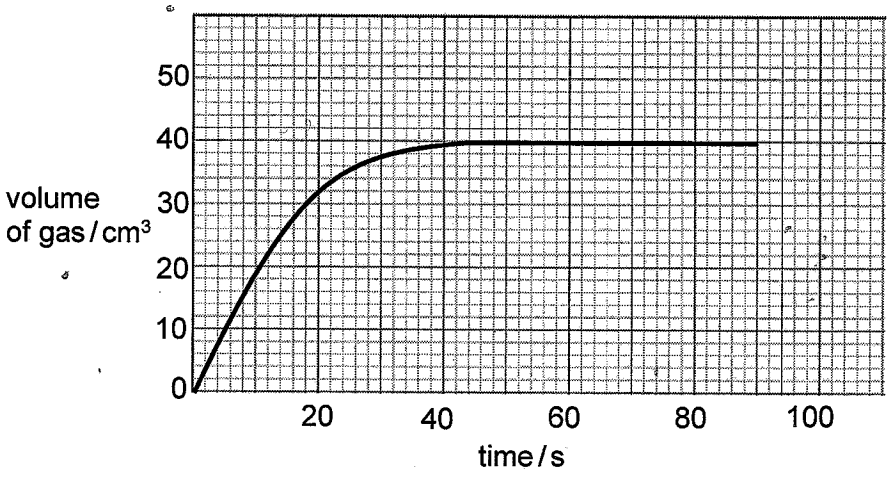
[2]

(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]

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 cm^3 sample of waste water was diluted with distilled water to make a volume of 250 cm^3 of solution. In a titration, 25.0 cm^3 of the diluted solution of the mixture completely reacted with 23.5 cm^3 of 0.020 mol/dm^3 acidified potassium dichromate, $K_2Cr_2O_7$.

(i) Calculate the number of moles of potassium dichromate in 23.5 cm^3 of 0.020 mol/dm^3 of potassium dichromate.

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

The equation for the reaction is shown.

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 3Fe^{2+}(aq) \longrightarrow 3Fe^{3+}(aq) + 2Cr^{3+}(aq) + 7H_2O(l)$$

(ii) Calculate the number of moles of iron(II) sulphate in 25.0 cm^3 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 cm^3 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 $FeSO_4$.....mol/dm^3 [1]

[Total: 8]

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
																4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a X b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
											1 H Hydrogen 1						4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a X b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number