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BOTSWANA EXAMINATIONS COUNCIL
in collaboration with
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE
Botswana General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6121045369

CHEMISTRY

Paper 3

0570/03

October/November 2008

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number and candidate number 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 12.

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

This document consists of **10** printed pages and **2** blank pages.

[Turn over

1 Chromium, Cr, is a transition metal.

It is obtained from its oxide by the reaction shown.

$$Cr_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Cr$$

(a) What is the oxidation state of

(i) chromium in Cr_2O_3,

..... [1]

(ii) aluminium in Al_2O_3?

..... [1]

(b) State the reducing agent in the reaction.

..... [1]

(c) Describe a test to confirm that the substance named in **(b)** is a reducing agent.

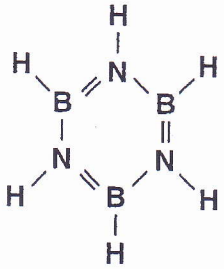
test .....

.....

result ..... [2]

[Total: 5]

2 The compound borazine was first made over 90 years ago. It was thought to have the structure shown below.



(a) **(i)** What is the molecular formula and the empirical formula of borazine?

molecular formula .....

empirical formula ..... [2]

(ii) If the structural formula is correct, what will be the number of bonding electrons around one nitrogen atom in the molecule of borazine?

..... [1]

(iii) Liquid borazine reacts with water to form ammonia, hydrogen and an aqueous solution of boric acid, H_3BO_3.

Construct a balanced equation for this reaction, including state symbols.

..... [2]

(b) Carbon forms many organic compounds which fall into various homologous series.

Explain why carbon is able to form many organic compounds.

..... [1]

(c) **(i)** Draw the structural formulae of ethyl ethanoate and butanoic acid showing all the bonds around all the atoms.

ethyl ethanoate butanoic acid [2]

(ii) Explain why ethyl ethanoate and butanoic acid are said to be structural isomers.

.....

..... [2]

(iii) Describe a chemical test to distinguish between ethyl ethanoate and butanoic acid.

test .....

result with ethyl ethanoate .....

.....

result with butanoic acid .....

..... [5]

[Total: 15]

3 A student is provided with aqueous solutions of four metal sulphates. Each metal rod is dipped in turn into each of the four metal sulphate solutions. The results are shown in the table.

	iron	magnesium	zinc	copper
copper(II) sulphate	copper displaced	copper displaced	copper displaced	
magnesium sulphate	no reaction		no reaction	no reaction
zinc sulphate	no reaction	zinc displaced		no reaction
iron(II) sulphate		iron displaced	iron displaced	no reaction

(a) Write the metals in order of increasing reactivity.

.....

least reactive most reactive

[2]

(b) Suggest an explanation in terms of electron loss or gain for your answer to **(a)**.

.....

.....

..... [2]

(c) Write an ionic equation for the reaction which takes place between iron and copper(II) sulphate.

..... [2]

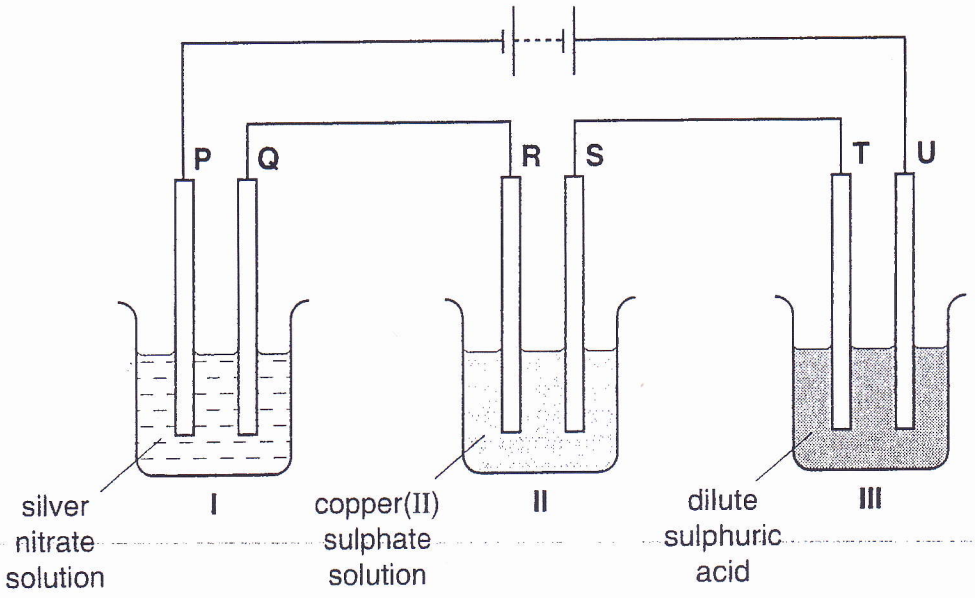
(d) When an aluminium rod is dipped into iron(II) sulphate solution, no change is seen, yet aluminium is higher in the activity series than iron. Explain why there is no reaction.

..... [1]

[Total: 7]

For Examiner's Use

4 When an electric current is passed through the circuit shown in the diagram for a set time, 0.54 g of silver is deposited on the cathode in cell **I**.



(a) Which electrode is the cathode in cell **I**?

..... [1]

(b) At which electrode is copper deposited in cell **II**?

..... [1]

(c) **(i)** Write an equation for the formation of silver at the cathode in cell **I**.

..... [1]

(ii) How many moles of electrons were used to produce 0.54 g of silver?

[2]

(iii) Calculate the mass of copper deposited at the cathode in cell **II**.

[3]

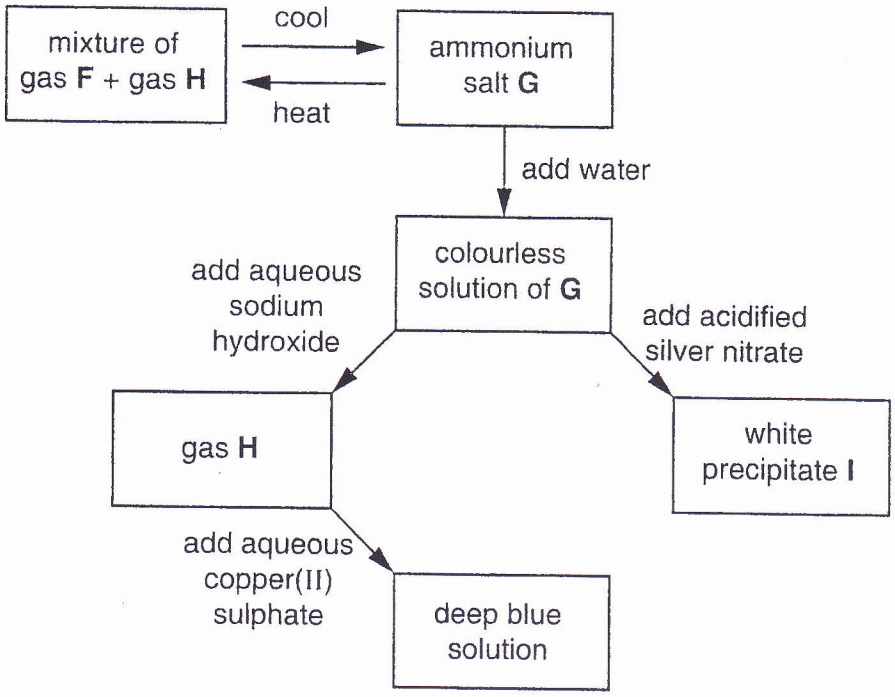
In cell **III** hydrogen is produced by the equation

$$2H^+ + 2e^- \longrightarrow H_2$$

(iv) Calculate the volume of hydrogen produced in cell **III** at r.t.p.

[2]

5 Study the flow chart shown and answer the questions that follow. The letters **F – I** are **not** the chemical symbols for the substances.



(a) (i) What is the name of gas **H** evolved in the reaction?

..... [1]

(ii) Describe the colour change when a drop of Universal Indicator is added to a solution of gas **H**.

from ..... to ..... [1]

(b) (i) Give the name and formula of the cation present in salt **G**.

name .....

formula ..... [2]

(ii) Name the white precipitate **I**.

..... [1]

(iii) Name the change which occurs when salt **G** is heated.

..... [1]

[Total: 6]

6 A sample of water from a limestone area needed a large quantity of soap to form lather. After heating, the same amount of the sample of water formed lather easily with a very small quantity of soap.

(a) Name a compound which caused the hardness in the sample of water.

..... [1]

(b) Explain why hard water does not lather easily.

.....

..... [1]

(c) Explain why after heating the sample of water, lather was formed with a very small quantity of soap. Include an equation in your answer.

.....

.....

.....

.....

..... [4]

(d) Describe how the compound which causes the hardness gets into this water.

.....

.....

..... [2]

[Total: 8]

7 Bronze, an alloy of copper, is used to make ornaments some of which corrode when exposed to air for a long time.

(a) Write the symbol for the other element in bronze.

..... [1]

(b) The table gives information about some of the compounds formed when bronze corrodes.

compound	formula	mass of 1 mole	percentage copper
P	Cu_2O	144	88.9
Q	$CuCO_3.Cu(OH)_2$	222	57.7
R	$Cu_2(OH)_3Cl$		

(i) Complete the table. [2]

(ii) Suggest one substance in the air responsible for the corrosion of bronze.

..... [1]

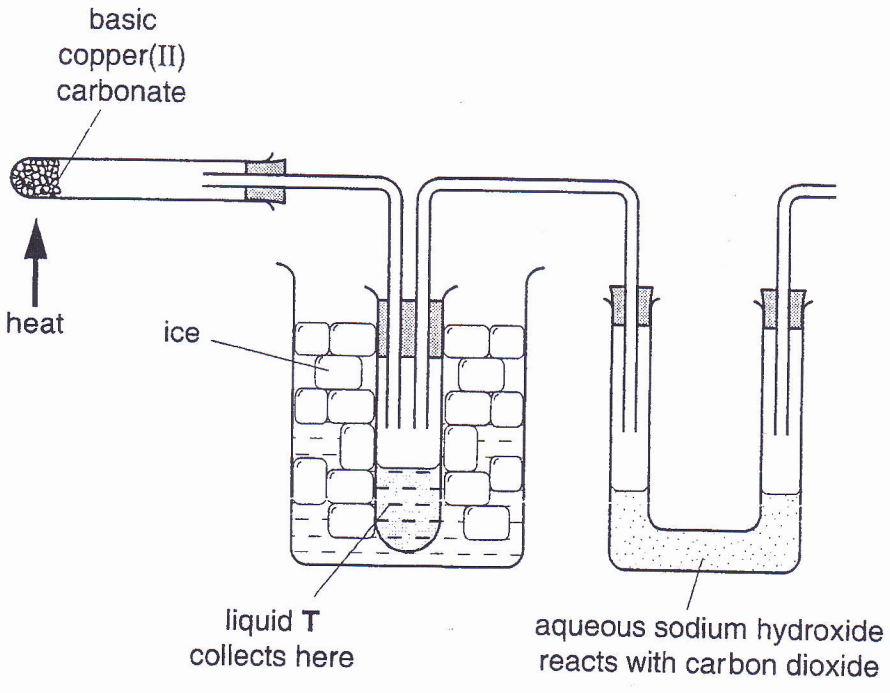
(iii) Describe a chemical test to show that compound **Q** contains carbonate ions.

test .....

results ..... [2]

(c) Another product of the corrosion of bronze is basic copper(II) carbonate. It has a formula of the type $\mathbf{x}Cu(OH)_2.\mathbf{y}CuCO_3$, where **x** and **y** are whole numbers.

The basic copper(II) carbonate is heated in the apparatus shown.



Aqueous sodium hydroxide reacts with carbon dioxide.

(i) Explain why this reaction occurs.

.....

.....

..... [3]

(ii) Name the products formed when aqueous sodium hydroxide reacts with carbon dioxide.

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

(d) Equations for the reactions that occur when basic copper(II) carbonate is heated are shown below.

$CuCO_3 \longrightarrow CuO + CO_2$

$Cu(OH)_2 \longrightarrow CuO + H_2O$

When a certain mass of basic copper(II) carbonate is heated, 5.28 g of carbon dioxide and 1.08 g of water are formed.

Use this data to find the values of **x** and **y** in the formula of basic copper carbonate, $\mathbf{x}Cu(OH)_2.\mathbf{y}CuCO_3$. Follow the steps below.

(i) State the mass of 1 mole of carbon dioxide. ..... g [1]

(ii) Calculate the number of moles of carbon dioxide formed.

[2]

(iii) State the mass of one mole of water. ..... g [1]

(iv) Calculate the number of moles of water formed.

[1]

(v) Use the number of moles of water and carbon dioxide to calculate the value of **x** and **y**.

x ..... **y** ..... [2]

(e) Write the chemical formula of basic copper(II) carbonate.

..... [1]

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 ithium	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 odium	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 assium	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 bidium	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 esium	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 ncium	226 Ra Radium 88	227 Ac Actinium 89 †															

* 71 Lanthanoid series	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
† 103 Actinoid series	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

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).