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

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY

Paper 3

0570/03

October/November 2009

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 12.

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

This document consists of **12** printed pages.

1 **(a)** Using the elements with atomic numbers 1 to 20 on the Periodic Table, name an element which best fits the descriptions below.

(i) An element which would most readily form positive ions.

.....[1]

(ii) A gas used for filling light bulbs.

.....[1]

(iii) A non-metal used for making electrodes.

.....[1]

(iv) A yellowish-green gas used for sterilising water.

.....[1]

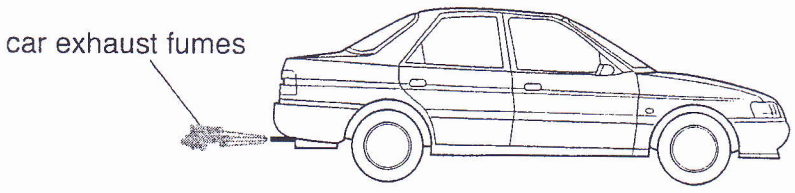
(v) The least dense element.

.....[1]

(vi) A metal that forms an ion of charge +3.

.....[1]

(b) Carbon monoxide is a poisonous gas emitted from car exhausts.



(i) What are the main products of combustion of petrol in an efficient car engine?

..... and .....[1]

(ii) How is the poisonous gas carbon monoxide formed in a car engine?

.....[1]

For Examiner's Use

(c) Carbon monoxide can be detected by using the reaction shown by the equation

$$CO + Pd^{2+} + H_2O \longrightarrow CO_2 + Pd + 2H^+$$
(orange) (black)

What type of chemical reaction is

(i) the change from Pd^{2+} to Pd? .....

Give a reason for your answer.

.....[2]

(ii) the change from CO to CO_2? .....

Give a reason for your answer.

.....[2]

(d) Which element, carbon or oxygen, has a larger atomic radius?

Explain your answer.

.....

.....

.....[2]

[Total: 14]

2 A student carried out three experiments using calcium and water. In experiment **I**, a cleaned piece of calcium of mass 0.6 g was added to 200 cm^3 of water. The equation for the reaction is shown below.

$$Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$$

(a) (i) State **two** observations made when calcium reacts with water.

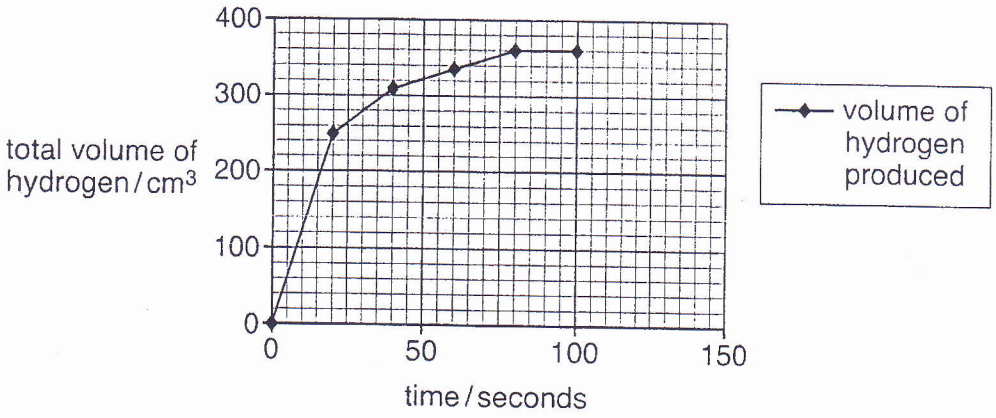
1 .....

2 .....[2]

(ii) Name a substance which could be added to the water to show that a solution containing hydroxide ions has been produced.

.....[1]

The volume of hydrogen was measured at intervals. The graph below was obtained from the results.



(b) (i) State how the rate of reaction changes during the experiment.

.....[1]

(ii) Explain why the reaction stops.

.....[1]

(c) How long does it take for all the calcium to react?

.....[1]

3 Compound **X** is a hydrocarbon. Compound **X** will react with steam in the presence of a catalyst. The product of this reaction is ethanol. Compound **X** has the same number of carbon atoms as ethanol.

(a) **(i)** Name compound **X** and the homologous series to which it belongs.

name of **X** ..... [2]

homologous series ..... [2]

(ii) Complete the following sentence to describe what is seen when compound **X** is shaken with bromine water.

The bromine water turns from ..... to ..... [2]

(b) Ethanol can also be prepared from glucose by fermentation.

State **two** conditions necessary for fermentation to take place.

1 .....

2 ..... [2]

(c) Ethanol can be oxidised to ethanoic acid by warming with a solution of an oxidising agent in the presence of sulphuric acid.

(i) Name a suitable oxidising agent.

..... [1]

(ii) Draw the structure of ethanoic acid showing all the bonds between atoms.

[1]

(iii) Suggest the pH of aqueous ethanoic acid of concentration 1.0 mol/dm^3.

..... [1]

(iv) State **one** other reaction that ethanoic acid will undergo.

..... [1]

(d) Tartaric acid and nitric acid are commonly occurring alkanoic acids.

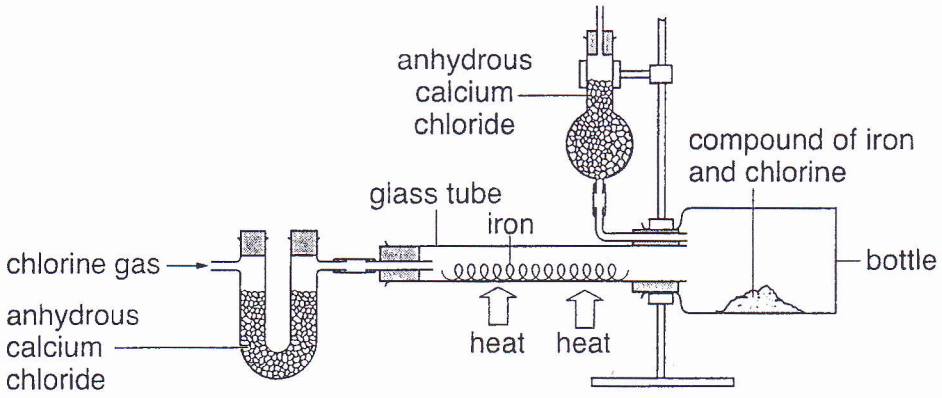
Complete the table about the sources and uses of the acids.

alkanoic acid	source	use
tartaric acid		
citric acid		

[4]

For Examiner's Use

4 In an experiment to determine the formula of a compound of iron and chlorine, chlorine gas was passed over heated iron as shown.



The results of the experiment are shown below.

Mass of empty glass tube	= 11.52 g
Mass of glass tube and iron	= 12.19 g
Mass of empty bottle	= 13.17 g
Mass of bottle and compound of iron and chlorine after heating	= 15.11 g

(a) **(i)** Suggest a safety precaution that should be used for this experiment.

.....[1]

(ii) Give a reason for your suggestion in **(a)(i)**.

.....[1]

(b) Explain why chlorine is passed through anhydrous calcium chloride before reacting with the iron.

.....

.....[2]

(c) **(i)** Calculate the mass of iron used in the experiment.

[1]

(ii) Calculate the mass of the compound of iron and chlorine in the experiment.

[1]

(iii) Calculate the mass of chlorine which reacted with the mass of iron calculated in **(c)(i)** above.

[1]

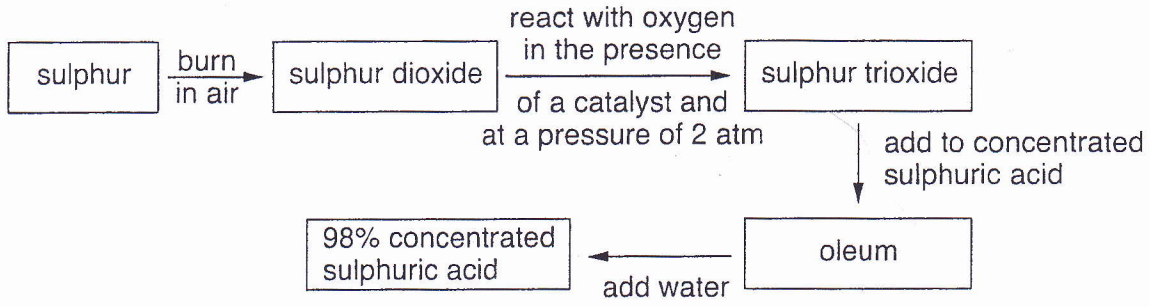
(iv) Deduce the empirical formula of the compound.

[3]

[Total: 10]

For Examiner's Use

5 The diagram shows the stages during the manufacture of sulphuric acid by the Contact Process.



(a) Give **one** source of sulphur.

.....[1]

(b) **(i)** Write a balanced equation for the reversible reaction between sulphur dioxide and oxygen to form sulphur trioxide.

.....[2]

(ii) Name the catalyst used in the Contact Process.

.....[1]

(iii) Explain why a temperature of 450 °C is preferred to higher temperatures like 1000 °C.

.....

.....[1]

(c) The reaction between sulphur dioxide and oxygen to make sulphur trioxide is endothermic. Explain why sulphur trioxide is not dissolved directly in water to make oleum.

.....

.....[1]

(d) Ammonium sulphate, $(NH_4)_2SO_4$, is made by reacting dilute sulphuric acid with excess ammonia and then evaporating the solution.

(i) State a use for ammonium sulphate.

.....[1]

(ii) Describe a positive chemical test for ammonium ions.

test: .....

result: .....[3]

For Examiner's Use

(e) Dilute sulphuric acid can also be used to prepare hydrated iron(II) sulphate of formula $FeSO_4.\boldsymbol{X}H_2O$ and relative molecular mass 278.

(i) Calculate the value of ***X*** in the formula.

[3]

(ii) Calculate the percentage of water by mass in hydrated iron(II) sulphate.

[1]

[Total: 14]

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 thium	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 idium	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 sium	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 cium	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.).