Centre Number	Candidate Number	Name

MINISTRY OF EDUCATION, BOTSWANA

in collaboration with

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

Botswana General Certificate of Secondary Education

CHEMISTRY **0570/03**

Paper 3 October/November 2004

1 hour 15 minutes

Candidates answer on the Question Paper
No additional materials are required

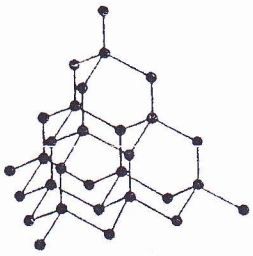
Read the following carefully before you start.

Write your centre number, candidate number and name in the spaces provided at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.
Show your working for any calculations.
Do not use staples, paper clips, highlighters, glue or correction fluid.
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.

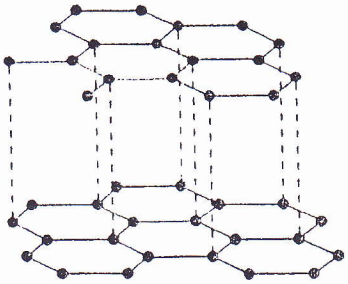
For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
TOTAL	

This question paper consists of **12** printed pages.

1 The diagrams represent the structures of two allotropes of carbon, X and Y.



X



Y

(a) (i) Identify each allotrope.

X .....

Y ..... [2]

(ii) Give **one** use of any of the allotropes and state the physical property upon which this use depends.

allotrope ..... **is used for** .....

physical property .....

..... [2]

(b) Silicon and carbon are both in Group IV of the Periodic Table.

(i) Refer to the atomic structures of silicon and carbon to explain why they are both placed in Group IV.

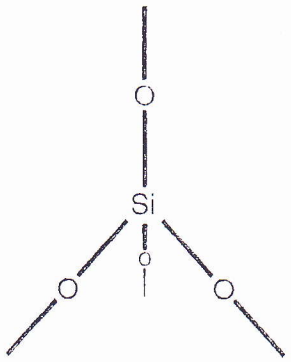
.....

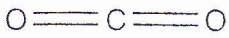
..... [1]

(ii) Draw the atomic structure of silicon showing the number of protons and neutrons in the nucleus.

[2]

(c) The structures of silicon(IV) oxide and carbon dioxide are shown below.





Silicon(IV) oxide has a high melting point whereas carbon dioxide has a very low melting point.

(i) Explain this difference in melting points. Refer to the structures of the substances and the bonding between their particles.

.....

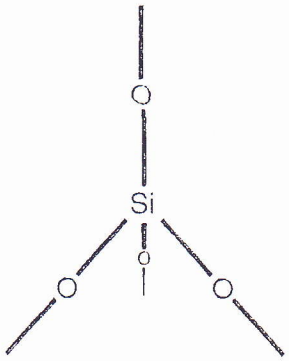
.....

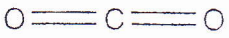
..... [3]

(ii) Draw a dot and cross diagram of **one** silicon atom in the diagram above, showing how it is bonded to four oxygen atoms. You need not show the inner shells of electrons.

[2]

(c) The structures of silicon(IV) oxide and carbon dioxide are shown below.





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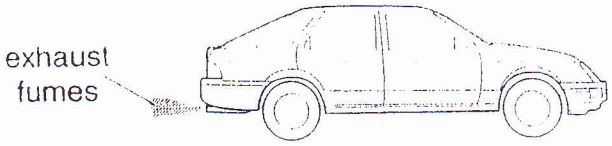
[2]

2 The increasing number of vehicles in cities like Gaborone add several pollutants to clean air from their exhausts.



(a) **(i)** Name **two** pollutants in the exhausts gases of cars.

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

(ii) State one adverse effect of **one** of the pollutants named in **(a)**.

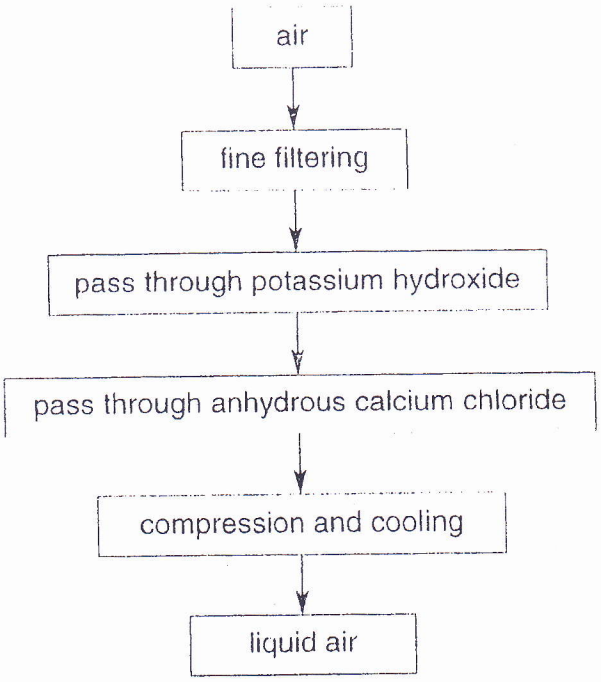
pollutant .....

effect ..... [1]

(iii) How can the amount of pollutants in the exhaust gases of a car engine be reduced?

..... [1]

(b) The flow chart shows a method of liquefying air.



Name the substance that is removed when air passes through

(i) potassium hydroxide .....

(ii) anhydrous calcium chloride .....
[2]

(c) Explain by reference to the behaviour of molecules, why compression and cooling help to liquefy air.

.....

..... [2]

(d) The table shows the boiling points of some of the gases in air.

gas	boiling point / °C
argon	–186
helium	–269
krypton	–153
neon	–246
nitrogen	–196
oxygen	–183
xenon	–108

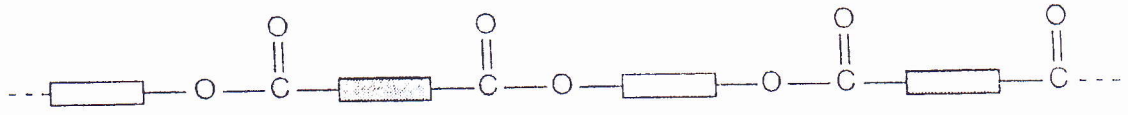
(i) Name **two** substances that will remain as gases when air is cooled to –200 °C.

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

(ii) Name the method by which the rest of the components of liquid air will be separated.

..... [1]

3 The simplified diagram shows the structure of the terylene.



(a) **(i)** Name the type of linkage in terylene.

..... [1]

(ii) Name a natural polymer with the same linkage as terylene.

..... [1]

(iii) Deduce the structures of the monomers of terylene and complete the diagrams below.

[2]

(b) Proteins are also polymers.

(i) What are the products of the acid hydrolysis of proteins?

..... [1]

(ii) State how the products of the acid hydrolysis of proteins are separated and identified.

separated ..... [1]

identified ..... [1]

4 Hazel reacted 25.0 cm^3 of a 2.0 mol / dm^3 hydrochloric acid solution with 2.0 g of an unknown carbonate of formula XCO_3. She titrated the resulting mixture with aqueous sodium hydroxide. The un-reacted hydrochloric acid needed 10 cm^3 of 1.0 mol / dm^3 sodium hydroxide to neutralise it.

(a) **(i)** Write the equation for the reaction between hydrochloric acid and sodium hydroxide.

..... [1]

(ii) Calculate the number of moles in 10 cm^3 of 1.0 mol / dm^3 sodium hydroxide.

[1]

(iii) State the number of moles of hydrochloric acid that reacted with the sodium hydroxide.

..... [1]

(iv) Calculate the number of moles in 25 cm^3 of 2.0 mol / dm^3 hydrochloric acid.

[2]

(v) Use your answer to **(iii)** and **(iv)** to calculate the number of moles of hydrochloric acid that reacted with 2.0 g of XCO_3.

[2]

(b) The equation shows how XCO_3 reacted with dilute hydrochloric acid.

$$XCO_3 + 2HCl \longrightarrow XCl_2 + CO_2 + H_2O$$

(i) Use information in the equation and your answer to **(a)(v)** to calculate the number of moles of XCO_3 in 2.0 g.

[1]

(ii) Calculate the mass of 1 mole of XCO_3.

[1]

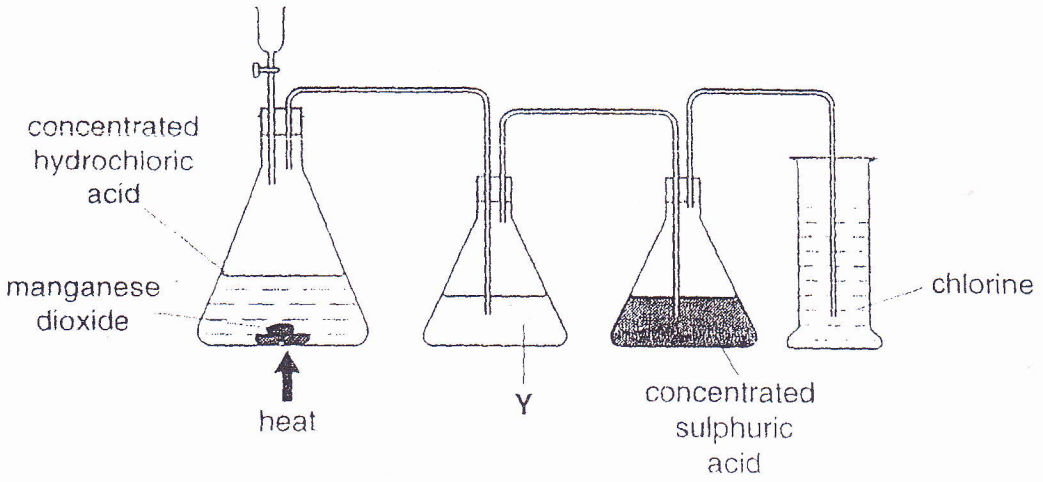
(iii) Calculate the relative atomic mass of element **X**.

[2]

(iv) Identify element **X** from the Periodic Table.

..... [1]

5 The diagram shows the laboratory preparation of chlorine from manganese dioxide and concentrated hydrochloric acid.



(a) Name the liquid **Y** and state its function.

name .....

function ..... [2]

(b) State the property of chlorine that makes it possible for it to be collected by the method shown.

..... [1]

(c) The equation for the reaction is shown below.

MnO_2 + ...HCl → $MnCl_2$ + ...Cl_2 + ...H_2O

(i) Balance the equation. [1]

(ii) Show how the oxidation number of manganese has changed during this reaction.

..... [1]

(iii) Explain why this is a redox reaction.

..... [1]

(d) Chlorine dissolves in water. Some of the chlorine reacts forming chloric(I) acid, $HClO$, as one of the products.

(i) Construct the equation for the reaction of chlorine, Cl_2, with water.

..... [1]

(ii) State the action of chlorine on damp litmus paper.

.....

..... [1]

(c) The equation for the reaction between hydrogen and iodine at 450 °C is shown.

$$H_2\,(g) + I_2\,(g) \rightleftharpoons 2HI\,(g)$$

(i) Re-write the equation showing all the covalent bonds.

[2]

(ii) Explain why the reaction will begin only when the activation energy is supplied.

..... [1]

(iii) Explain, in terms of bonds broken and formed, why the forward reaction is slightly endothermic.

..... [1]

(iv) The reaction reaches a dynamic equilibrium after a while.

Explain what is meant by *dynamic equilibrium*.

.....

..... [1]

(v) State the effect of increasing pressure on the position of the equilibrium.

..... [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
																4 He Helium 2
							1 H Hydrogen 1									
7 Li Lithium	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	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	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	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	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	226 Ra Radium 88	227 Ac Actinium 89 †															

* 58-71 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
† 90-103 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.).