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 2010

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 **11** printed pages and **1** blank page.

[Turn over

1 Choose **one** substance from the list that fits the given description. You may use each substance once, more than once or not at all.

methane	**aluminium oxide**	**silicon(IV) oxide**
diamond	**calcium oxide**	**lead(II) iodide**
ammonia	**chlorine**	**ethanol**

(a) (i) a hydrocarbon .....[1]

(ii) an amphoteric oxide .....[1]

(iii) a macromolecular compound .....[1]

(iv) a diatomic molecule .....[1]

(v) a compound containing an element with oxidation number of +3

.....[1]

(b) Which **two** substances react forming slag during the blast furnace process?

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

(c) Which of the substances dissolves in water to form a solution which turns red litmus paper blue?

.....[1]

[Total: 8]

2 Ammonia is manufactured from nitrogen and hydrogen by the Haber process.

(a) (i) What are the sources of nitrogen and hydrogen in the production of ammonia?

nitrogen .....

hydrogen .....

[2]

(ii) State the conditions used in the Haber process for making ammonia.

catalyst .....

temperature .....°C

pressure .....atm

[3]

(b) The equation for the reaction of nitrogen and hydrogen is shown.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \Delta H = ?$$

The bond energies are given in the table.

bond	bond energy kJ/mol
N ≡ N	945
N – H	391
H – H	436

(i) Calculate the total energy change during the breaking of all the bonds in the reactants.

total energy = + ... kJ/mol [2]

(ii) Calculate the total energy change during the formation of all the bonds in the product.

total energy = – ..... kJ/mol [2]

(iii) Calculate ΔH, the total energy change for the formation of 2 moles of ammonia, NH_3.

total energy change = ... kJ/mol [2]

(iv) State whether the reaction is exothermic or endothermic.

.....[1]

(v) Draw a labelled energy level diagram, including activation energy, for the formation of ammonia from its elements.

[4]

[Total: 16]

3 The table shows two compounds of chlorine and their melting points.

compound	melting point / °C
XC*l*	770
YC*l*$_4$	–23

(a) Which of the compounds, **X**C*l* or **Y**C*l*$_4$ is covalent?

.....

Give a reason for your answer.

.....

.....

.....

[2]

(b) The ionic equation shows a redox reaction between chlorine and sodium bromide.

$$Cl_2(g) + 2Br^-(aq) \longrightarrow 2Cl^-(aq) + Br_2(aq)$$

(i) Why is this a redox reaction?

.....

.....[1]

(ii) Describe how the colour of sodium bromide solution changes when chlorine is bubbled through it.

from ..... to .....[2]

[Total: 5]

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4 The scale formed in kettles contains calcium carbonate. When ethanoic acid is added to the scale a reaction occurs. The equation for the reaction is shown.

....CH_3COOH (....) + $CaCO_3$ (.....) $\rightarrow$ ....$(CH_3COO)_2Ca$(.....) + ... H_2O(...) + ...CO_2(....)

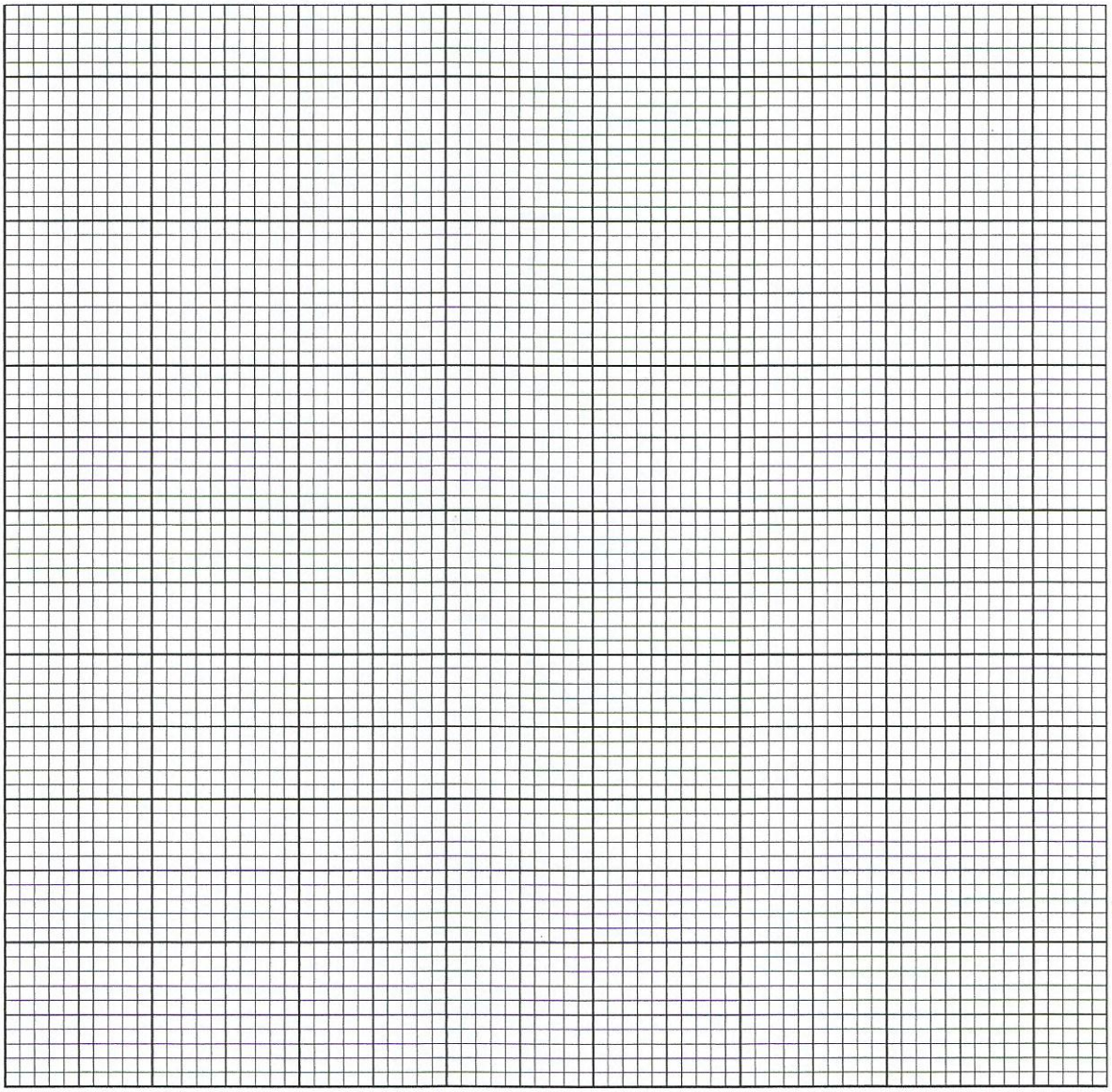
(a) Balance the equation and include state symbols. [3]

(b) In an experiment, an excess of 0.1 mol/dm^3 of ethanoic acid was added to a sample of scale and the volume of carbon dioxide produced was measured at time intervals of 20 seconds. The experiment was done at room temperature and pressure.

The results are shown in the table.

time / s	0	20	40	60	80	100	120	140
volume of carbon dioxide produced / cm^3	0	20	40	50	60	75	65	65

(i) Plot and draw the graph of volume of carbon dioxide against time on the grid provided below.



[4]

(ii) Circle the point on the graph which is incorrect. [1]

(iii) Calculate the total number of moles of carbon dioxide produced. (1 mole of gas at r.t.p. occupies 24 dm^3.)

[2]

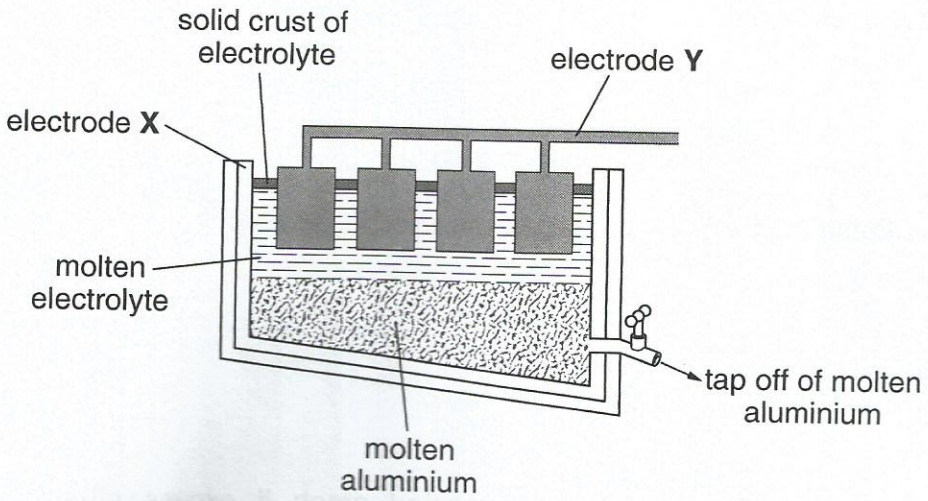
(iv) Calculate the mass of calcium carbonate used in the reaction.

[3]

(v) On the same axes, sketch the expected graph if excess ethanoic acid of concentration 0.2 mol/dm^3 is added to the same mass of the scale.
Label the graph **X**. [2]

[Total: 15]

5 The diagram shows the electrolytic cell for the extraction of aluminium from molten aluminium oxide.



(a) (i) Which element are the electrodes made from?

.....[1]

(ii) Which electrode must be regularly replaced?

.....

Why is replacement necessary?

.....

.....

.....

[3]

(b) A steady current of 250 A was allowed to flow through the cell for 2 hours.

The equation shows how aluminium is produced in the cell.

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

(i) Calculate the quantity of electric charge used.

.....coulombs [2]

(ii) Calculate the number of moles of electrons used.
[1 faraday = 96 500 C]

.....moles of electrons [1]

(iii) Calculate the mass of aluminium produced.

[2]

(c) Excess aluminium metal powder reacts with moderately concentrated sulphuric acid to form hydrogen and aluminium sulphate. Describe how crystals of hydrated aluminium sulphate, $Al_2(SO_4)_3.12H_2O$, may be made.

.....

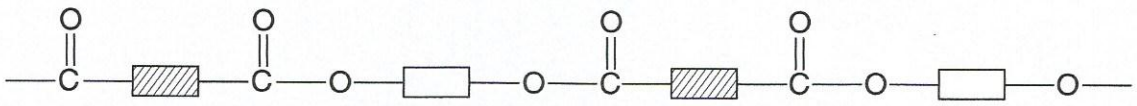
.....

.....

.....[4]

[Total: 13]

6 The structure of a macromolecule Terylene is shown.



(a) (i) What is a macromolecule?

.....

.....[1]

(ii) Draw the structures of the **two** monomers of Terylene.

[2]

(iii) Name the type of linkage in Terylene.

.....[1]

(iv) State **one** use of Terylene.

.....[1]

(b) A molecule of fat contains the same linkages as a molecule of Terylene.
Fat is one of the main constituents of food.

(i) Name **two** other main constituents of food.

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

(ii) Describe how soap can be prepared from fats.

.....

.....

.....[2]

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(c) Soap formed from fats can be used to determine the hardness of water.

(i) Compare the effect of the addition of soap solution to hard water with its addition to distilled water.

.....

.....

.....[2]

(ii) Suggest the names or formulae of **two** ions which cause hardness of water.

.....

.....

.....[2]

[Total: 13]

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 = 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.).