3051/3 **BGCSE**

School Number	Candidate Number
Surname and Initials	

CHEMISTRY

PAPER 3 3051/3

Friday 30 MAY 2014 12:00 noon–1:30 P.M.

Additional materials:
Graph paper

MINISTRY OF EDUCATION
NATIONAL EXAMINATIONS

BAHAMAS GENERAL CERTIFICATE OF SECONDARY EDUCATION

INSTRUCTIONS AND INFORMATION TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your school number, candidate number, surname and initials at the top of this page as well as at the top of all lined paper submitted.

Answer **ALL** the questions in **Section A** in the spaces provided on this question booklet and any **TWO** questions from **Section B** on the lined paper provided at the back of this question booklet.

Equations and diagrams should be given wherever they are helpful.

Essential working must be shown.

The intended marks for each question or part question are given in brackets [ ].

Relative atomic masses are given in the Periodic Table of elements provided.

ADDITIONAL INFORMATION

s.t.p. ($t = 0\,°C$, $p = 760\,mmHg$)

The volume of one mole of gas at room temperature and pressure (r.p.t.) is $24\,000\,cm^3$.

This question paper consists of 13 printed pages, 4 lined pages and 3 blank pages.

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

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SECTION A

Candidates must answer all questions in this section.

1. Electroplating is a very useful application of the electrolysis process.

A student wants to electroplate an iron spoon with silver metal.

(a) Draw and label the apparatus to illustrate the electroplating of an iron spoon with silver metal, using a silver anode.

[4]

(b) (i) Write balanced half-equations to show what takes place at the anode and cathode.

Anode half-equation

[2]

Cathode half-equation

[2]

(ii) State the type of reaction that occurs at the cathode.

_____ [1]

(c) Give an advantage of plating the iron spoon with silver.

_____ [1]

TOTAL MARKS [10]

2. Ammonia is made industrially by the Haber Process, summarised in the equation.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g); \qquad \Delta H = -101.3\ kJ\ mol^{-1}$$

(a) (i) Name the catalyst used in this reaction. _____ [1]

(ii) Explain what happens to the unreacted gases.

_____

_____ [1]

(iii) Only 15% of the reactants are converted to ammonia during each reaction cycle.

Calculate the mass of ammonia produced during each cycle from 1 mole of nitrogen.

[2]

(b) (i) State Le Chatelier's Principle.

_____

_____

_____ [2]

(ii) Nitrogen and hydrogen are mixed and allowed to react in a closed container at a pressure of 200 atmospheres and a temperature of 500 °C.

Explain the effect on the equilibrium concentration of ammonia, giving a reason for your answer if

the concentration of nitrogen gas is increased;

_____

_____

_____ [2]

the temperature is increased.

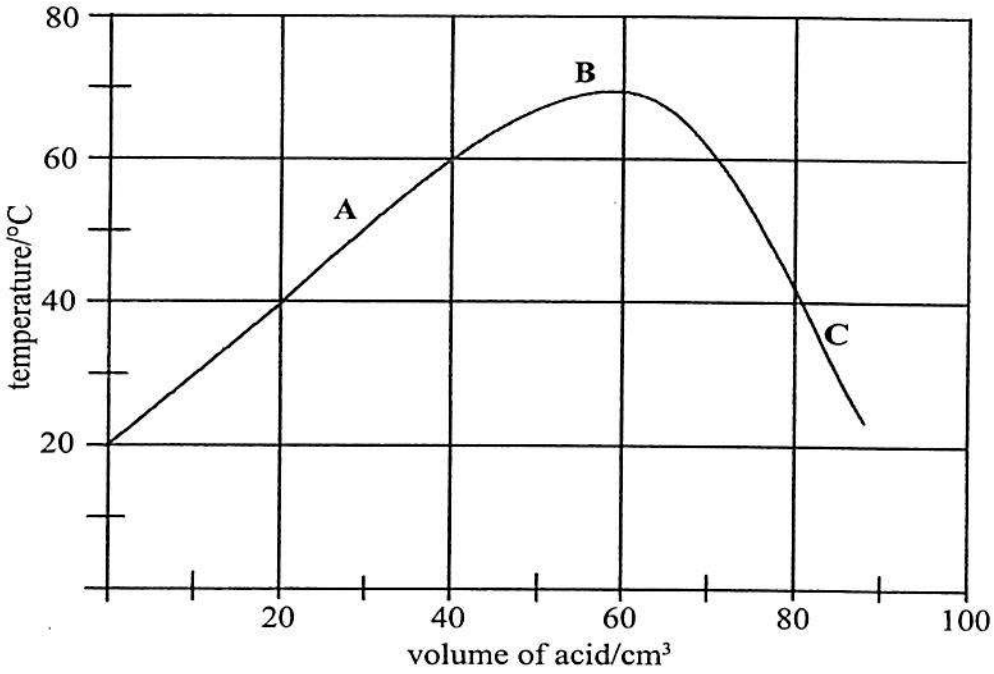
_____

_____

_____ [2]

TOTAL MARKS [10]

3. Dilute $HNO_3(aq)$ of concentration 0.50M, is added in excess from a burette a little at a time to 25 cm^3 of NaOH(aq) of unknown concentration in a conical flask. A few drops of phenolphthalein are added to the NaOH(aq) at the beginning of the titration. After each addition, the mixture is stirred and the temperature is recorded in the graph shown.



(a) (i) Give the colour change of phenolphthalein at the **end point**.

_____ to _____ [1]

(ii) Explain the shape of the graph at **A**, **B** and **C**.

A _____

B _____

C _____ [3]

(b) (i) Use the graph to determine the volume of acid added when the high temperature has been reached.

_____ [1]

(ii) Find the number of moles of acid which completely neutralises NaOH(aq).

_____ [1]

(c) (i) Write a balanced chemical equation to show the reaction between nitric acid and sodium hydroxide.

[1]

(ii) Using your answer in (b)(i) and the equation calculate the number of moles in 25 cm^3 of NaOH(aq).

[1]

(iii) Calculate the concentration of NaOH(aq) that is used in this experiment.

[1]

(d) The experiment is repeated using the same volume of NaOH(aq). Dilute H_2SO_4(aq) is added instead of HNO_3(aq).

Use your answer to **(c)(ii)**; to calculate the number of moles of H_2SO_4 needed to completely neutralise the base NaOH(aq).

[1]

TOTAL MARKS [10]

4. In the industrial production of iron, consider the reaction of between carbon monoxide and iron(III) oxide.

$$3CO\,(g) + Fe_2O_3\,(s) \rightleftharpoons 2Fe\,(s) + 3CO_2\,(g)$$

(a) What is the oxidation state of carbon in

(i) carbon monoxide,

_____ [1]

(ii) carbon dioxide?

_____ [1]

(b) What is the oxidation state of iron in

(i) iron(III) oxide,

_____ [1]

(ii) the element iron?

_____ [1]

(c) Given that 216 dm^3 of carbon monoxide (CO) reacts with excess iron(III) oxide Fe_2O_3, calculate

(i) volume of carbon dioxide (CO_2) produced,

[1]

(ii) mass of iron (Fe) produced.

[3]

(d) When bromine water is added to a solution of iron(II) bromide the following reaction occurs.

$$2FeBr_2\,(aq) + Br_2 \longrightarrow 2FeBr_3\,(aq)$$

Write an ionic half equation for the **oxidation** and **reduction** reactions

oxidation

[1]

reduction

[1]

TOTAL MARKS [10]

SECTION B

Candidates are to answer only **two** questions in this section.

5. A student investigating the reaction between hydrochloric acid and excess calcium carbonate, once using dilute acid and the other time using concentrated acid. The student measures the mass of carbon dioxide gas at regular intervals and obtained this data.

	time/min.	0	1	2	3	4	5
Experiment 1:	mass CO_2/g	0	0.54	0.71	0.78	0.80	0.80
Experiment 2:	mass CO_2/g	0	0.27	0.35	0.38	0.40	0.40

(a) Plot the data on the graph paper supplied. Label the curves **Experiment 1** and **Experiment 2**. [6]

(b) (i) Determine the mass of gas produced in 75 s in **Experiment 2**.

(ii) Explain how the final mass of gas produced in **Experiment 1** compares with the final mass in **Experiment 2**.

(iii) Explain why the slopes of the graphs become less steep as the reactions proceed.

(iv) Explain why one of the reactants had to be in excess. [4]

(c) Explain, in terms of the Kinetic Theory, what would happen to the initial rate if the

(i) acid is heated;

(ii) calcium carbonate is in the form of lumps instead of a fine powder. [4]

(d) (i) Write a balanced chemical equation for the reaction between hydrochloric acid and calcium carbonate.

(ii) Calculate the mass of calcium carbonate needed to produce 0.80 g carbon dioxide in **Experiment 1**.

(iii) Using **Experiment 1**, calculate the final volume of gas produced at r.t.p. [6]

TOTAL MARKS [20]

6. Most of the Earth's hydrocarbons exist in deposits of Natural Gas and petroleum formed from the compressed, decomposed remains of ancient plants and animals. These hydrocarbons are known as fossil fuels.

(a) Explain why fossil fuels are known as "buried sunshine". [1]

(b) Natural Gas is mainly methane and is the first member of the alkanes. [1]

Explain why alkanes do not undergo addition reactions.

(c) The fuel propane is used in The Bahamas as cooking gas.
The chemically balanced equation for this reaction is shown.

$$C_3H_8\,(g) + \underline{X}\,O_2\,(g) \longrightarrow 3CO_2\,(g) + 4H_2O\,(l)$$

(i) Give the value of $\underline{X}$.

(ii) Calculate the volume of carbon dioxide gas produced at room temperature and pressure (r.t.p.) when 1.10 g of propane is burned. [3]

(d) Ripening fruits naturally produce ethene gas which helps them ripen. Ethene belongs to an homologous series of unsaturated hydrocarbons.

Write the general formula for this homologous series. [1]

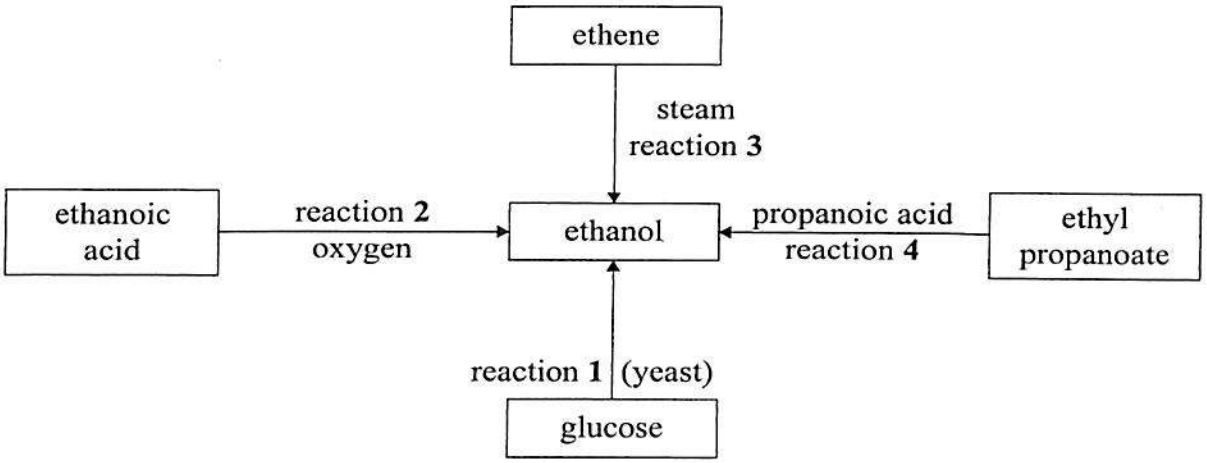
(e) In an industrial process ethene is made by cracking longer chains of hydrocarbons. An alkane with 10 carbon atoms is cracked and produces ethene as one of the products.

(i) Name a catalyst used in the cracking process. [1]

When the 10-carbon alkane molecule is cracked only two molecules are obtained.

(ii) Write a balanced equation to show the cracking of this 10-carbon hydrocarbon into its products. [2]

(f) The reaction scheme shows some reactions involving ethanol.



(i) State the types of reactions going on in reactions **1**, **2**, **3** and **4**.

(ii) Write a balanced chemical equation to represent reaction **4**.

(iii) Showing all the bonds, write the formula of the **functional group** to which ethanoic acid belongs. [7]

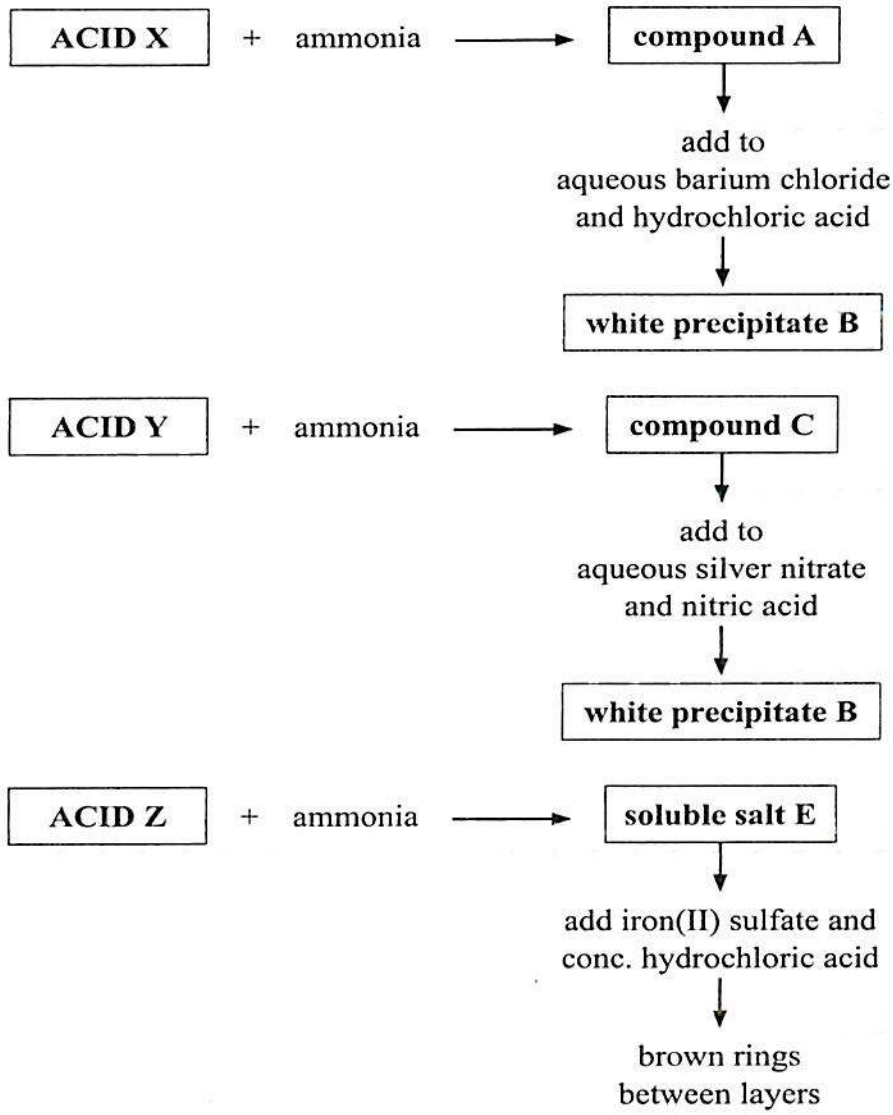
(g) An organic compound has a relative molecular mass of 46. It consists of 52.17% carbon, 13.04% hydrogen and 34.78% oxygen.

Determine both the empirical and molecular formula for this substance. [4]

TOTAL MARKS [20]

7. A mishap occurred in a chemistry lab when the labels of three bottles of acids fell off and were lost.

An investigator uses a series of steps to determine the names of each acid.



(a) Use the data to identify

(i) compound **A**;

(ii) white precipitate **B**;

(iii) compound **C**;

(iii) white precipitate **D**;

(v) soluble salt **E**. [5]

(b) Write the name of each acid.

(i) **Acid X**

(ii) **Acid Y**

(iii) **Acid Z** [3]

Artificial fertilisers are produced through the reaction of an acid with ammonia.

(c) Reacting phosphoric acid with ammonia makes the fertiliser ammonium phosphate, $(NH_4)_3PO_4$.

(i) Calculate the percentage of nitrogen in ammonium phosphate. [2]

(ii) Write a balanced chemical equation for the reaction of ammonia and phosphoric acid. [2]

(iii) From the equation in (ii), calculate the mass (to 2 decimal places) of ammonium phosphate produced at r.t.p. from 350 cm^3 of ammonia. [3]

The overuse of fertilisers can lead to eutrophication.

(d) (i) Explain the process of eutrophication. [3]

(ii) Write the formula of the ions that causes eutrophication. [2]

TOTAL MARKS [20]

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