School Number   Candidate Number

Surname and Initials

CHEMISTRY

PAPER 3   3051/3

Wednesday   **2 JUNE 2010**   12.30 P.M. – 2.00 P.M.

Additional materials:
Lined paper
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 in the spaces provided 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 the question paper and any **TWO** questions from **Section B** on the lined paper provided.

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 printed on page 2.

ADDITIONAL INFORMATION

s.t.p. (t = 0 °C, p = 760 mmHg)
The volume of one mole of gas at room temperature and pressure (r.t.p.) is 24 000 cm³.

FOR EXAMINER'S USE	
Section A	
1	
2	
3	
4	
Section B	
5	
6	
7	
TOTAL	

This question paper consists of __14__ printed pages and __2__ blank pages.

The Periodic Table of the Elements

Group

I	II												III	IV	V	VI	VII	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** Aluminum 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** Cesium 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
226 **Fr** Francium 87	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

Key

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

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Section A

Candidates are to answer **ALL** four questions in Section A.

1.   The diagram shows the nitrogen cycle.
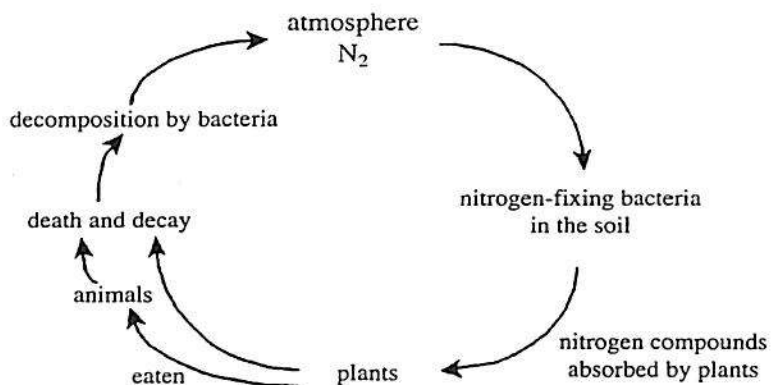
(a)   (i)   Name another factor not shown in the diagram which causes oxygen to react with nitrogen to form oxides of nitrogen.

_____ [1]

(ii)   Write the symbol of the ion produced by nitrogen-fixing bacteria that can be easily absorbed by plants.

_____ [1]

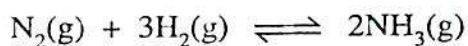(b)   Name **three** common nitrogen-containing substances.

1 _____

2 _____

3 _____ [1]

(c)   The largest consumer of nitrogen gas is the ammonia industry.

(i)   Name the process by which ammonia is manufactured.

_____ [1]

The reaction in the process has reached equilibrium

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(ii) This process produces ammonia. Find the volume of ammonia which can be formed from 144 dm³ of nitrogen if all the nitrogen is used up in the reaction.
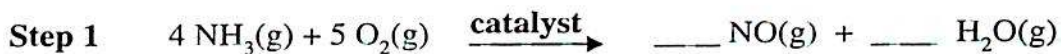
[1]

(iii) This process uses 200 atm and a temperature of 450 °C. Under these conditions only 10% of nitrogen is converted.

Explain what happens to ensure that all the nitrogen becomes ammonia.

_____

_____ [1]

(d) Ammonia prepared by the Industrial process is used to make nitric acid.

Steps 1, 2 and 3 show the reactions in the manufacture of nitric acid.

Step 1 $4\,NH_3(g) + 5\,O_2(g) \xrightarrow{\text{catalyst}} \underline{\quad} NO(g) + \underline{\quad} H_2O(g)$

Step 2 $2\,NO(g) + O(g) \xrightarrow{\text{cooled}} 2\,NO_2(g)$

Step 3 $4\,NO_2(g) + O_2(g) + 2H_2O(l) \longrightarrow 4\,HNO_3(aq)$
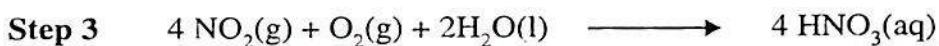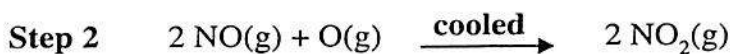
(i) Fill in the blanks in step 1 to balance the equation. [1]

(ii) Identify the catalyst for step 1.

_____ [1]

(iii) Calculate the mass of nitric acid produced from 11.5 g of nitrogen dioxide.

[2]

Total marks [10]

2. In the **contact process** SO_3 is produced by a reversible reaction.

    (a) (i) Balance this equation for the reaction. [1]

         _____ SO_2 (g) + _____ O_2(g) $\rightleftharpoons$ _____ SO_3(g) ΔH is negative

         (ii) Explain the meaning of "ΔH is negative".

         _____ [1]

         (iii) State Le Chatelier's Principle.

         _____

         _____ [2]

    (b) State the effect on the concentration of SO_2(g) in the equilibrium mixture by

         (i) adding O_2 (at constant pressure);

         _____ [1]

         (ii) removing SO_3;

         _____ [1]

         (iii) adding a catalyst;

         _____ [1]

         (iv) increasing the temperature..

         _____ [1]

    (c) Find the maximum volume and mass of sulfur trioxide produced when 5 moles of oxygen, O_2(g), reacts with sulfur dioxide, SO_3(g), all volume measured at room temperature and pressure.

                                                                        [2]

                                                        Total marks [10]

3. A future source of fuel may be obtained by the electrolysis of concentrated NaCl(aq) (brine).

NaCl(aq)
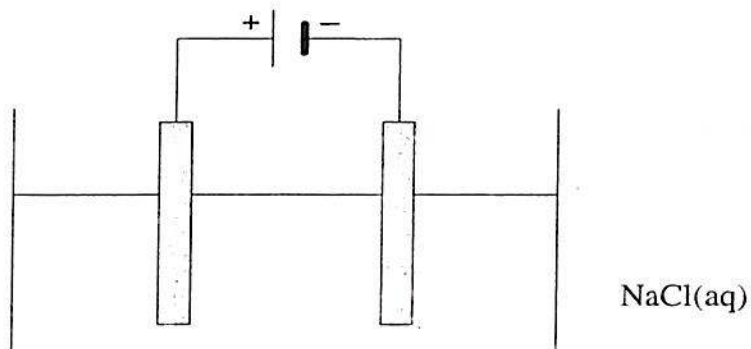
(a) (i) Write the chemical half-equation that takes place at the cathode.

_____ [2]

(ii) Using the results from the half-reaction state how many moles of electrons are needed to convert the ions into molecules.

_____ [1]

(iii) State the type of reaction taking place at the cathode.

_____ [1]

(b) State the property of seawater, NaCl(aq), and melted salt, NaCl(l), which makes them suitable for electrolysis but not common salt, NaCl(s).

_____ [1]

(c) Write the oxidation number of the element **Na**.

(i) **Na** _____ [1]

(ii) **NaCl** _____ [1]

(d) Universal Indicator is added to water before electrolysis, state the colour of the indicator after the chemical reaction.

(i) **at the anode;** _____ [1]
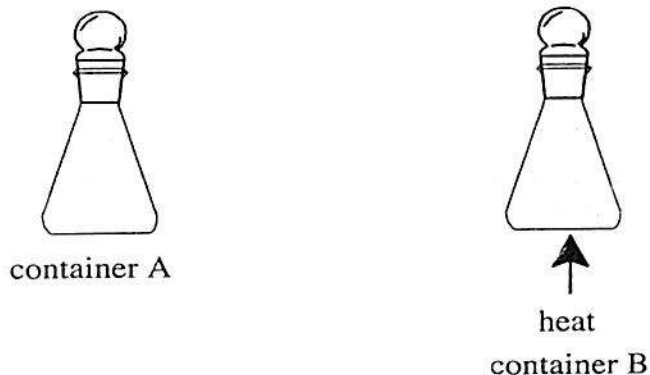
(ii) **at the cathode.** _____ [1]

(e) A 21st century engine uses H_2 fuel which oxidizes to produce energy.

Name the by-product of the oxidation reaction.

_____ [1]

Total marks [10]

4.   Tamare was given two 100 mL sealed, glass containers filled with air.

container A

heat
container B

(a)   (i)   State the volume of air in the containers.

_____ [1]

(ii)   Container **B** is gently heated. Describe the difference in molecular motion in container **A** and container **B**. Give a reason for your answer.

_____

_____

_____ [2]

(iii)   Compare the speed of movement of the two main types of molecules in containers **A** and **B**. Give a reason to support your answer.

_____

_____

_____ [2]

(b)   The diagram illustrates Boyle's Law.
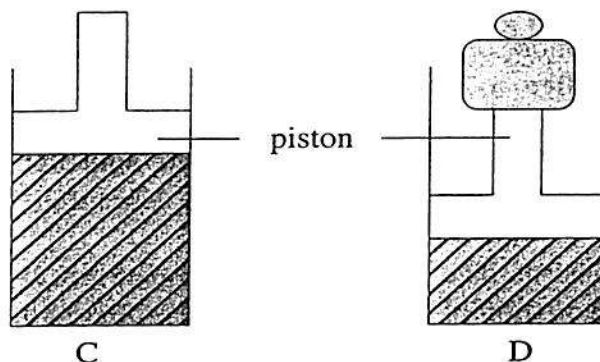
(i)   State **Boyle's Law**.

_____

_____ [1]

(ii)   Explain why the piston can never be pushed to the bottom of the container no matter how much pressure is applied.

_____

_____ [1]

(iii)   State **ONE** condition that must be kept constant in the experiment shown by the diagram.

_____ [1]

(iv)   Container **C** contains 200 mL of gas at 200 atmospheres pressure. Find the new volume of gas if the pressure is raised to 500 atmospheres.

[3]

Total marks [10]

Section B

5. This question is about organic compounds, including alkanes, alkenes, alcohols and carboxylic acids.

    (a) Briefly explain why alkanes undergo substitution reactions and alkenes undergo addition reactions. [2]

    (b) Ethanol is the alcohol found in beer, wine and whiskey and is produced by the fermentation of glucose in barley, grapes or corn.

    $$\text{glucose} \xrightarrow{\text{yeast}} \text{ethanol + carbon dioxide}$$
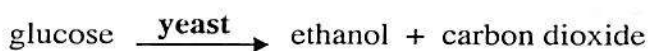
    (i) Write a chemically balanced equation for the reaction. [2]

    (ii) State why ethanol solution of greater than about 12% concentration cannot be made directly by this reaction. [1]

    (iii) State how the beer produced by fermentation can be so concentrated that it contains a higher percentage of alcohol. [1]

    (iv) Write an equation for the synthesis of ethanol from ethene. [2]

    (v) Give one important use for this commercially prepared ethanol. [1]

    (c) Ethanol will react with acidified potassium dichromate, making ethanoic acid.

    $$\textbf{ethanol} \xrightarrow{\textbf{K}_2\textbf{Cr}_2\textbf{O}_7} \textbf{ethanoic acid}$$
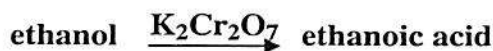
    (i) Name this type of reaction [1]

    (ii) Give the formula for ethanoic acid. [1]

    (d) Ethanol reacts with ethanoic acid in the presence of acid, according to the equation shown.

    $$\textbf{ethanol + ethanoic acid} \longrightarrow \textbf{product 1 + water}$$

    (i) Name product 1 and give its formula.

    name _____ [1]

    formula _____ [1]

(ii)   Name this type of reaction.

_____ [1]

(e)   The most common form of nylon consists of carbon − 63.72%, nitrogen − 12.39%, hydrogen − 9.73% and the remainder is oxygen.

Calculate the empirical formula of the nylon.   [4]

(f)   The empirical formula of a compound is CH_2Cl used as an additive. The rmm of this compound is 99.00.

Determine its molecular formula.   [2]

Total marks [20]

6. In an investigation, 10 g of marble, $CaCO_3$, chips is placed in a flask with excess dilute nitric acid. The carbon dioxide produced in the reaction is allowed to escape.

calcium carbonate + nitric acid → calcium nitrate + water + carbon dioxide

The mass of the flask is recorded after every minute and the mass of the marble remaining is calculated.

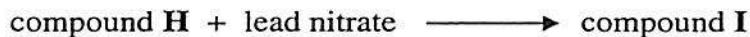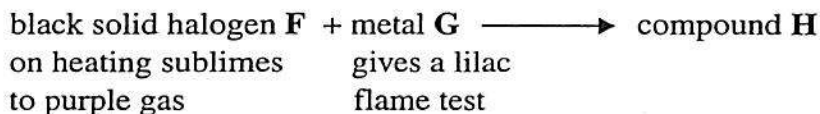| time (min)	0	1	2	3	4	5	6	7	8
mass of $CaCO_3$ (g) remaining	10.0	6.9	4.6	3.1	2.1	1.4	0.8	0.3	0

(a) (i) Plot a graph to show the decrease in the mass of marble, $CaCO_3$(s) against time. [6]

From the graph,

(ii) Determine the mass of $CaCO_3$ used up in the first 30 seconds. [1]

(iii) Name **ONE** factor that can cause this particular reaction to go faster. [1]

(iv) On the same graph paper sketch a graph that shows this. [2]

(v) The particles of the two reactants collide but bounce apart unchanged. Give **ONE** reason that could account for this failure to react. [1]

(b) (i) Write an equation for reaction between calcium carbonate and nitric acid. [2]

(ii) Use the equation to calculate the total volume, measured at r.t.p., of carbon dioxide, CO_2 produced when 10 g of marble, $CaCO_3$ dissolves in the acid. [3]

(iii) Use the results from part (ii) to calculate the volume produced if the gas is cooled to 0 °C under the same pressure. The room temperature is 25 °C. [2]

(c) Describe a test and its positive results for the carbon dioxide gas. [2]

Total marks [20]

7. Metal **A**, a group II metal that burns in air with a blinding white light, can be extracted from sea-water. The sea-water is reacted with the required amount of calcium oxide, producing an insoluble hydroxide. The hydroxide is filtered off and then reacted with hydrochloric acid.
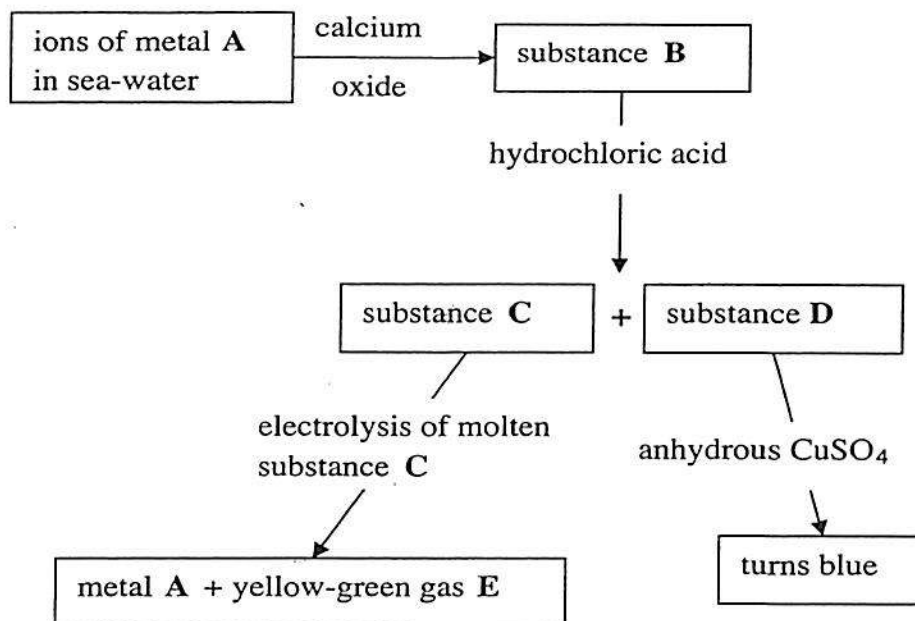
(a) Identify substances **A – E**   [5]

(b) Sea-water is a source for many other elements. It is a great source of halogens.

black solid halogen **F** + metal **G** ⟶ compound **H**
on heating sublimes   gives a lilac
to purple gas   flame test

compound **H** + lead nitrate ⟶ compound **I**

(i)   Identify substances **F – I**.   [4]

(ii) Write a chemically balanced equation for the reaction between compounds **H** and lead nitrate, $Pb(NO_3)_2$.   [2]

(iii) Write a chemically balanced equation for the reaction between gas **E** and compound **H**.   [2]

(iv) Based on the reaction in (b)(iii), deduce the relative reactivity of **E** and **F**.   [1]

(c) Icebergs could be dragged from the Arctic to the deserts of Arabia to be used as a source of drinking water. Explain why sea-water icebergs can be used as a source of drinking water. [1]

(d) (i) Name two processes that can be used to purify sea-water in The Bahamas. [2]

(ii) Select one of the two methods suggested in (d)(i) to purify water and give a reason for your choice. [1]

(e) Name the mineral mined from the floor of the ocean around The Bahamas and state one industrial use of this mineral. [2]

Total marks [20]