CHEMISTRY

PAPER 3   3051/3

Monday   **3 JUNE 2013**   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 __14__ printed pages, 6 lined pages and __4__ blank pages.

The Periodic Table of the Elements

Group

I	II	III	IV	V	VI	VII	0
							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

Transition / main block (Period 4–6):

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 †															

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

1 **H** Hydrogen 1

Key:

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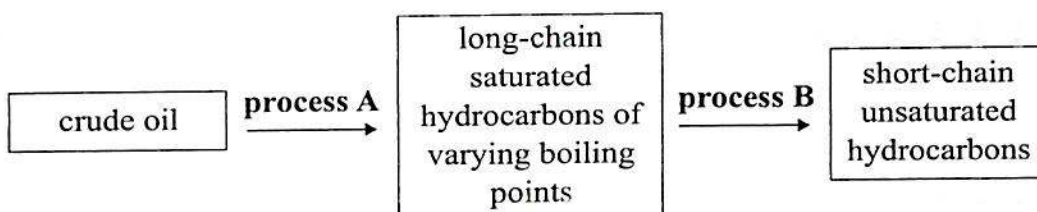
a
X
b

583104

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Section A

This section consists of 4 questions containing several parts. Candidates are to answer all the parts of each of the 4 questions.

1.　(a)　Study the schematic and use it to answer the following questions.

(i)　Name the homologous series to which long-chain saturated hydrocarbons belong.

_____ [1]

(ii)　State the names of the **processes A** and **B**.

A _____

B _____　[2]

(iii)　**Process B** requires the use of a catalyst.

Explain what effect a catalyst has on the rate of a chemical reaction.

_____ [1]

(iv)　During **process B**, long-chain saturated hydrocarbon molecules such as $C_{16}H_{34}$ are split up to give short-chain unsaturated molecules such as C_2H_4. Suggest a chemical equation for this reaction that produces only **ONE** of these unsaturated molecules.

[1]

(v) Explain why the product C_2H_4 is an important material for the production of plastics.

_____

_____

_____ [2]

(b) The unsaturated C_2H_4 may be used in the following reaction.

| C_2H_4 | reaction C $\longrightarrow$ | C_2H_5OH | reaction D $\longrightarrow$ | CH_3CO_2H |
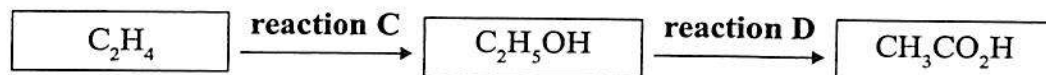
What type of reaction is

(i) **reaction C?** _____

(ii) **reaction D?** _____ [2]

(iii) Suggest the name of a reagent that can be used in the laboratory for **reaction D**, changing C_2H_5OH to CH_3CO_3H.

_____ [1]

TOTAL MARKS [10]

2. This question is about the generation of electricity. Electricity is produced in many countries using coal-fired power stations or nuclear reactors. The heat from these reactions is used to run steam-powered generators.

(a) (i) Here is a word equation for the burning of coal.

Complete the equation by using symbols that show that heat is being given out during the reaction.

coal + air ⟶ ash + **product X** (g) + **product Y** (l) + _____ [1]
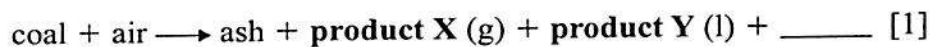
(ii) Write one word to describe a reaction which gives out heat.

_____ [1]

(iii) One of the products of the reaction in (a)(i) increases global warming. State whether **X** or **Y** causes global warming and name the product you have chosen.

_____ [1]

(iv) Coal also contains sulfur. Name a pollutant that is produced from sulfur during the burning of coal.

_____ [1]

(v) Write an equation to show the chemical change that occurs when the substance you have named in (iv) is released into the atmosphere.

_____ [2]

(vi) State an effect the product of this reaction will have on Bahamian rock.

_____

_____ [1]

(b)   Nuclear power is produced using radioactive isotopes. The element uranium exists as the isotope U^{235} and U^{238}. One of these isotopes is very radioactive.

    (i)   Explain what is meant by the term **radioactive**.

    _____

    _____ [1]

    (ii)   Name a metal that can be used in the construction of the power plant to prevent radiation from leaking into the air.

    _____ [1]

(c)   State how electricity can be produced in The Bahamas using a renewable energy source.

    _____ [1]

TOTAL MARKS [10]

3. Nitrogen is an important element needed by organisms for the growth and repair of tissue. The nitrogen cycle explains how nitrogen is recycled in the air and soil.

The diagram represents the Nitrogen Cycle
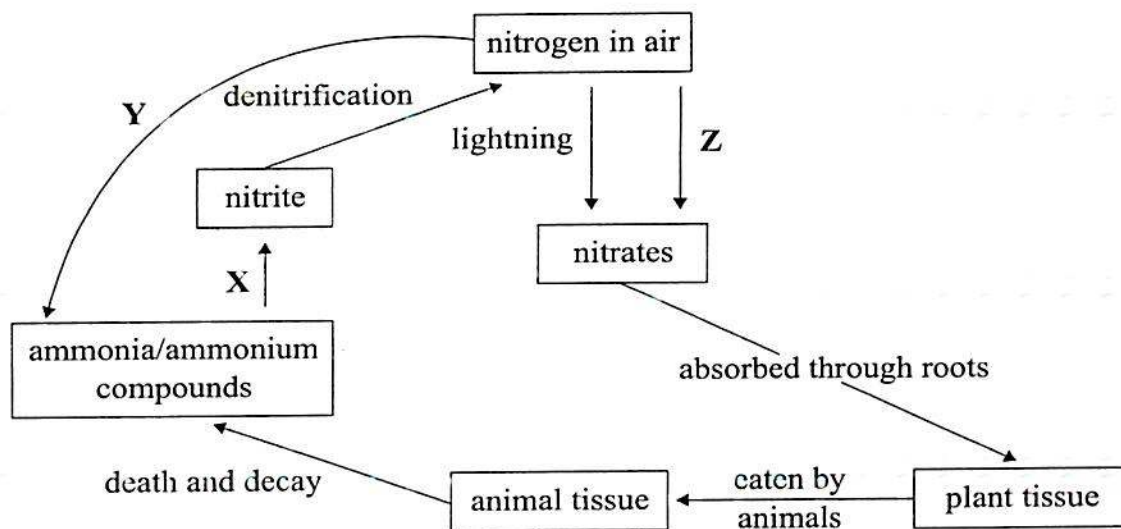
(a) Name the processes that are occurring at **X**, **Y** and **Z**.

(i) **X** _____

(ii) **Y** _____

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

(b) (i) Balance the equation to show the reaction that occurs in process **X**.

____ NH_3 + ____ $O_2 \longrightarrow$ ____ NO_2^- + ____ H^+ + ____ H_2O [3]
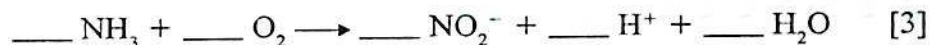
(ii) Calculate the volume of oxygen needed to react with 240 dm³ of ammonia at s.t.p.

[2]

(c)   Nitrogen gas is used to make ammonia and nitric acid on an industrial scale for the manufacture of fertilisers.

Explain how pure nitrogen gas is prepared industrially from air.

_____

_____

_____ [2]

TOTAL MARKS [10]

4. The preparation of copper metal involves roasting of the ore Cu_2S (Chalcocite) with oxygen to convert the metal sulfides to metallic oxides. The equation for the reaction is

$$Cu_2S \text{ (s)} + 3O_2 \text{ (g)} \longrightarrow 2Cu_2O \text{ (s)} + SO_2 \text{ (g)}$$

(a)   (i)   Calculate the mass of copper that could theoretically be obtained from 8 kg of Copper sulfide.

[2]

(ii)   Calculate the volume of oxygen needed to convert 8 kg of Cu_2S at r.t.p.

[3]

(b)   The copper(I) oxide is then smelted by mixing and heating with SiO_2, $CaCO_3$ and air to produce blister copper (impure copper). The impure copper can be purified by electrolysis to 99.95% purity. The diagram represents electrolysis showing the parts of the electrolytic cell.
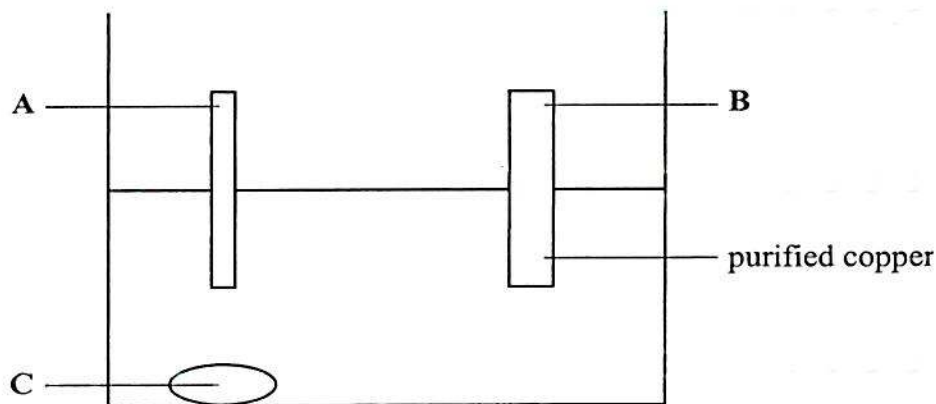
(i)   State which electrode, **A** or **B**, is connected to the positive terminal of the direct current.

_____ [1]

(ii)   Suggest what substance **C** is most likely to be.

_____ [1]

(iii) Write the symbol equations for the anode and cathode half-reactions.

Anode reaction

Cathode reaction   [2]

(iv)   Name a suitable electrolyte that could be used in the purification of impure copper.

_____ [1]

TOTAL MARKS [10]

Section B

This section consists of 3 questions. Candidates are to select any two of the questions numbered 5, 6 and 7.

5.   A student carried out two experiments **A** and **B** to investigate rates of reaction using equal masses of zinc and equal excess dilute hydrochloric acid. The total volume of hydrogen given off was measured at r.t.p., every 30 seconds.

The results for the two experiments were recorded in a table.

time/s		0	30	60	90	120	150	180	210
volume of hydrogen/cm³	**Expt. A**	0	200	320	420	500	560	590	600
	Expt. B	0	265	400	490	560	600	600	600

(a)   (i)   Draw graphs of the volume of hydrogen against time. Use the same axes for both **experiment A** and **experiment B**.   [7]

(ii)   Draw a diagram to show the apparatus used to produce and collect the gas.   [2]

(b)   (i)   Use your graph to find the volumes of gas produced in 100 s in **both** experiments.

(ii)   Suggest a reason why one reaction is able to proceed faster.

(iii)   Explain why the slopes of the graphs become less steep as the reactions proceed.   [4]

(c)   (i)   Write a chemically balanced equation for the reaction between zinc and hydrochloric acid.

(ii)   Calculate the total number of moles of hydrogen produced by the two experiments.

(iii)   Using the equation calculate the mass of zinc reacted in each experiment.   [6]

(d)   In past years, hydrogen was used in passenger-carrying airships. State why it is no longer used in this way.   [1]

TOTAL MARKS [20]

6. Fermentation of sucrose is a process used in industry to make a useful chemical.

    (a)   (i)   Name a useful product of fermentation. [1]

            (ii)   Write a balanced symbol equation for the fermentation of sucrose $C_{12}H_{22}O_{11}$. [2]

            (iii)   Other than as a drink, suggest a use for the product you have named in (a)(i). [1]

    (b)   Sucrose, $C_{12}H_{22}O_{11}$ is a disaccharide that can be split into two monosaccharide sugars. One of these 6-carbon sugars is used by the human body as a fuel to produce quick energy.

            (i)   Sucrose is often purchased in grocery stores in 5 lb bags. If one pound is equal to 454 grams, calculate the number of moles of sucrose (to two decimal places) contained in one 5 lb bag of pure sucrose. [Show all working] [2]

            (ii)   Determine the percentage composition, by mass, of sucrose. [1]

            (iii)   Write the name and chemical formula of the 6-carbon sugar used by the body to produce quick energy. [1]

            (iv)   Write the empirical formulae of the 6-carbon sugar named in part (ii). [1]

    (c)   Human respiration produces the energy needed to power our biological processes.

            (i)   Write the formula for oxidation of glucose during respiration. [2]

            (ii)   Explain a chemical test to positively identify **ONE** of the products of this reaction. [2]

    (d)   Sulfuric acid is one of the most important industrially produced chemicals.

            (i)   Sulfur dioxide reacts with oxygen in the presence of a catalyst. Name this reaction. [1]

            (ii)   Write the equation for this reaction. [2]

            (iii)   Name a catalyst that is used for this reaction. [1]

            (iv)   State **ONE** industrial use for sulfuric acid. [1]

TOTAL MARKS [20]

7. An unlabelled bottle containing a dull-green **powder A** was found in a lab. The dull-green powder is analysed and the scheme of the process and results are recorded in the chart.
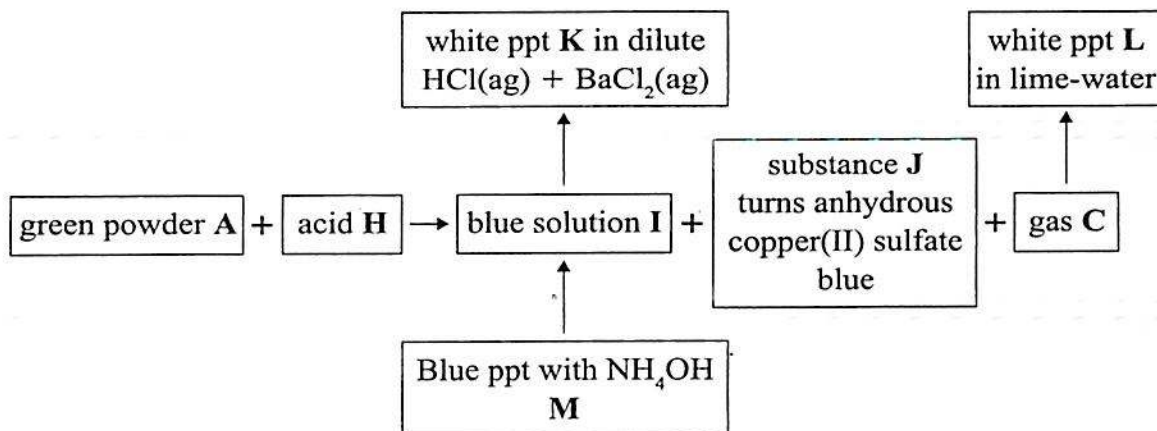
Reaction Scheme 1
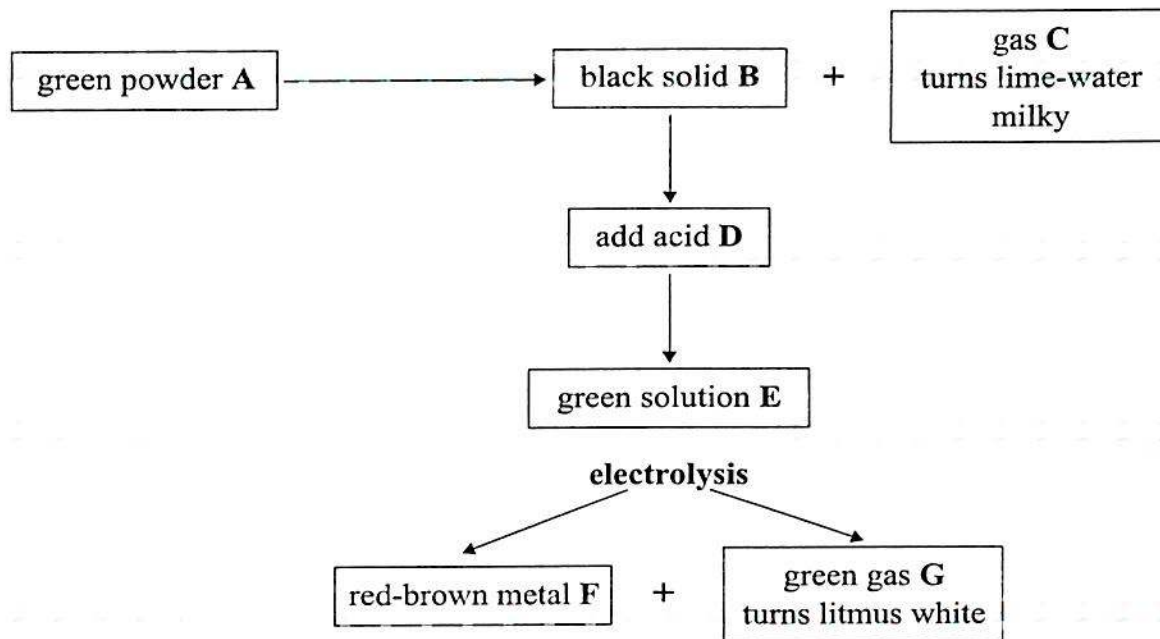
Use the information given in the schematic to answer the questions.

(a) (i) Identify the substances lettered from **A** to **G** in the reaction scheme.

(ii) Write a symbol equation for the reaction that occurs when the green powder is heated. [10]
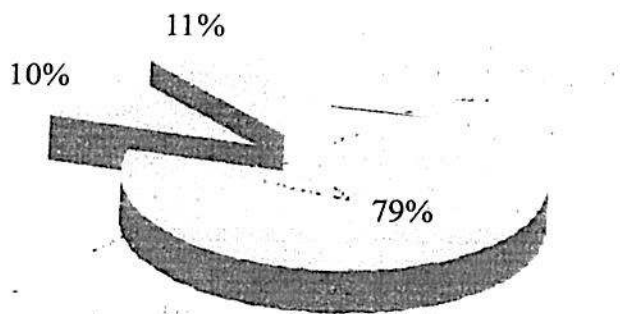
Reaction Scheme 2

(iii) Identify the substances lettered **H** to **M** in the reaction scheme. [5]

(b)   Magnesium metal occurs as a mixture of three isotopes.

(i)   Define the term **isotopes**.   [1]

(ii)   Use the Periodic Table to answer the question. State how many neutrons are present in one atom of each of the isotopes Mg-25 and Mg-26.   [1]

11%

10%

79%

The percentages of the three isotopes are

79% of Mg-24
10% of Mg-25
11% of Mg-26

(iii)   Taking into account the different percentages of the three isotopes, Calculate the relative atomic mass of magnesium.   [3]

TOTAL MARKS [20]

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