CHEMISTRY

PAPER 3   3051/3

Wednesday   **6 JUNE 2007**   12.30 – 2.00 P.M.

Additional materials:
 Answer booklet
 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 (1–4) 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.p.t.) is 24 000 cm^3.

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

This question paper consists of __13__ printed pages and __3__ blank pages.

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The Periodic Table of the Elements

Group

I	II	III	IV	V	VI	VII	0
							4 He Helium 2

(Format: relative atomic mass, symbol, name, proton number)

I	II	III	IV	V	VI	VII	0
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 elements (Period 4):
K 39 (19), Ca 40 (20), Sc 45 (21), Ti 48 (22), V 51 (23), Cr 52 Chromium (24), Mn 55 Manganese (25), Fe 56 Iron (26), Co 59 Cobalt (27), Ni 59 Nickel (28), Cu 64 Copper (29), Zn 65 Zinc (30), Ga 70 Gallium (31), Ge 73 Germanium (32), As 75 Arsenic (33), Se 79 Selenium (34), Br 80 Bromine (35), Kr 84 Krypton (36)

Transition elements (Period 5):
Rb 85 Rubidium (37), Sr 88 Strontium (38), Y 89 Yttrium (39), Zr 91 Zirconium (40), Nb 93 Niobium (41), Mo 96 Molybdenum (42), Tc Technetium (43), Ru 101 Ruthenium (44), Rh 103 Rhodium (45), Pd 106 Palladium (46), Ag 108 Silver (47), Cd 112 Cadmium (48), In 115 Indium (49), Sn 119 Tin (50), Sb 122 Antimony (51), Te 128 Tellurium (52), I 127 Iodine (53), Xe 131 Xenon (54)

Transition elements (Period 6):
Cs 133 Caesium (55), Ba 137 Barium (56), La 139 Lanthanum (57), Hf 178 Hafnium (72), Ta 181 Tantalum (73), W 184 Tungsten (74), Re 186 Rhenium (75), Os 190 Osmium (76), Ir 192 Iridium (77), Pt 195 Platinum (78), Au 197 Gold (79), Hg 201 Mercury (80), Tl 204 Thallium (81), Pb 207 Lead (82), Bi 209 Bismuth (83), Po Polonium (84), At Astatine (85), Rn Radon (86)

Period 7:
Fr Francium (87), Ra 226 Radium (88), Ac 227 Actinium (89)

*58-71 Lanthanoid series
Ce 140 Cerium (58), Pr 141 Praseodymium (59), Nd 144 Neodymium (60), Pm Promethium (61), Sm 150 Samarium (62), Eu 152 Europium (63), Gd 157 Gadolinium (64), Tb 159 Terbium (65), Dy 162 Dysprosium (66), Ho 165 Holmium (67), Er 167 Erbium (68), Tm 169 Thulium (69), Yb 173 Ytterbium (70), Lu 175 Lutetium (71)

†90-103 Actinoid series
Th 232 Thorium (90), Pa Protactinium (91), U 238 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 = relative atomic mass
X = atomic symbol
b = proton (atomic) number

a
X
b

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Section A

1. Iron is extracted by the blast furnace process. Aluminium is extracted by the process of electrolysis.

   (a) (i) State what this indicates about the relative reactivity of iron and aluminium.

   _____ [1]

   (ii) Explain why calcium carbonate is added to the iron ore in the blast furnace.

   _____ [1]

   (b) (i) Balance the reaction

   $$\underline{\quad} Fe_2O_3 + \underline{\quad} CO \rightarrow \underline{\quad} Fe + \underline{\quad} CO_2$$ [2]

   (ii) Name the substance in the reaction that is the reducing agent.

   _____ [1]

   (iii) Calculate the mass of iron produced from 16 tonnes of the pure iron(III) oxide.

   [2]

   (c) Give a factor that is likely to affect the cost of making aluminium using electrolysis.

   _____ [1]

   (d) Write the ionic half equation for the reaction at the cathode during the electrolysis of aluminium.

   _____ [2]

   Total marks [10]

2. Alcohols are very important chemical compounds.

   (a) Ethanol is made by the fermentation of glucose.

       (i) Name the organism that causes the fermentation of glucose to produce ethanol.

       _____ [1]

       (ii) Suggest a suitable temperature for this reaction.

       _____ [1]

       (iii) Write a balanced equation for this reaction.

                                                          [2]

       (iv) State one use of ethanol, other than in alcoholic drinks.

       _____ [1]

   (b) Esters are another group of organic compounds.

       (i) Name ONE commercial use of esters.

       _____ [1]

       (ii) Name an ester and write its formula.

       name _____

       formula _____ [1]

       (iii) Name the class of compounds that react with alcohols to form esters.

       _____ [1]

(iv) Complete the table showing the differences in properties of an ester and a salt. [2]

property	ester	salt
type of bonding it contains		
soluble or insoluble in water		

Total marks [10]

3.   Coal from the Earth's crust is an abundant source of power. However, when it is burned, coal produces large amounts of pollutant gases. _

   (a)   When coal is burned, carbon in the coal becomes the gas carbon dioxide.

         Suggest the names of two other gases that are produced from the elements nitrogen and sulphur when coal burns.

         (i)   nitrogen _____ [1]

         (ii)   sulphur _____ [1]

   (b)   State two different pollutant effects that the gases in part (a) have on the environment. Each time, match the name of the gas to the effect it causes.

         (i)   pollutant effect _____

                gas causing this effect _____ [1]

         (ii)   pollutant effect _____

                gas causing this effect _____

                _____ [1]

(c) The gas carbon dioxide can be removed from exhaust gases of a coal-fired power station. The gas is cooled and compressed. The carbon dioxide is pumped down the pipes of an old oil rig into the space left after oil has been extracted. This is shown in the diagram.
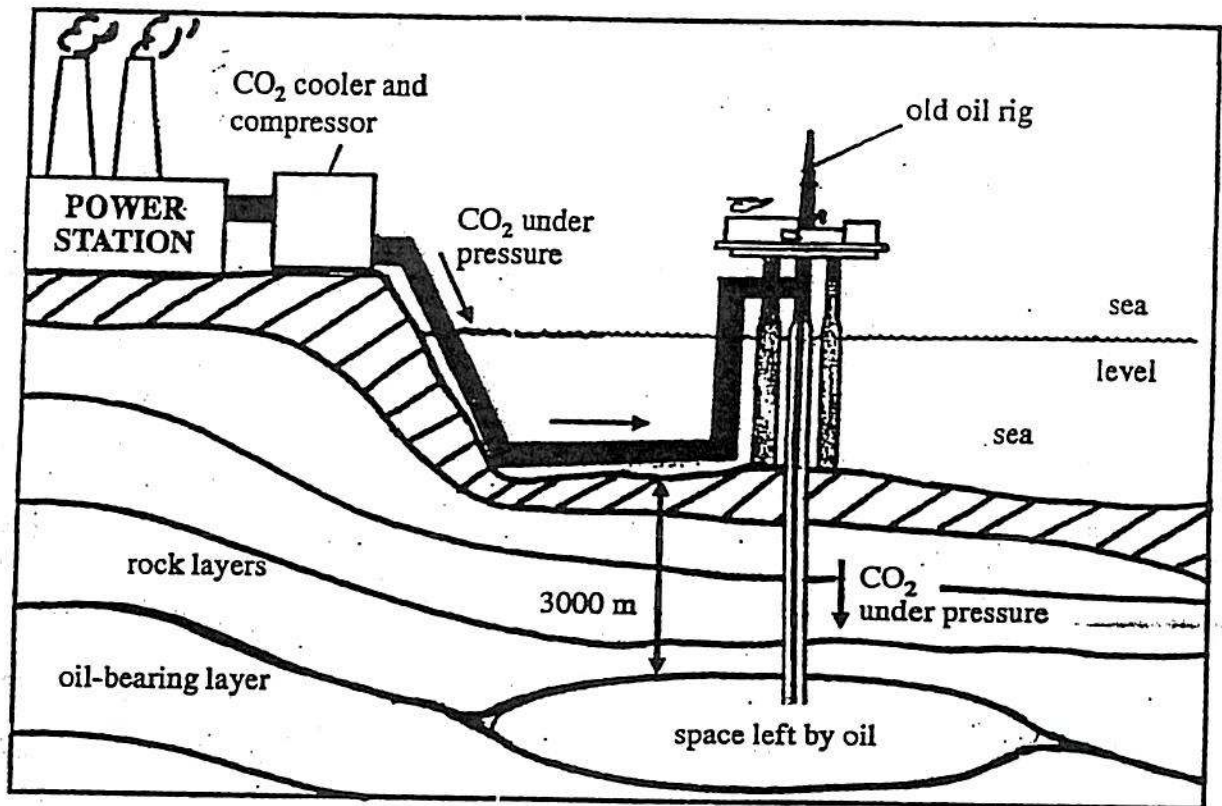
(i) State the effect that cooling and compressing will have on the carbon dioxide.

_____ [1]

This process is expensive to carry out. Important industrial chemicals might be made from the other pollutants in the power station emissions, and sold. Name an important chemical that could be made from

(ii) the nitrogen compounds;

_____ [1]

(iii) the sulphur compounds in the emissions.

_____ [1]

(d)   Oil and coal are fossil fuels. They are non-renewable sources of energy.

Explain what is meant by

(i)   *fossil fuels*

_____

_____ [1]

(ii)   *non-renewable*

_____

_____ [1]

(iii)   Name one renewable source of energy.

_____ [1]
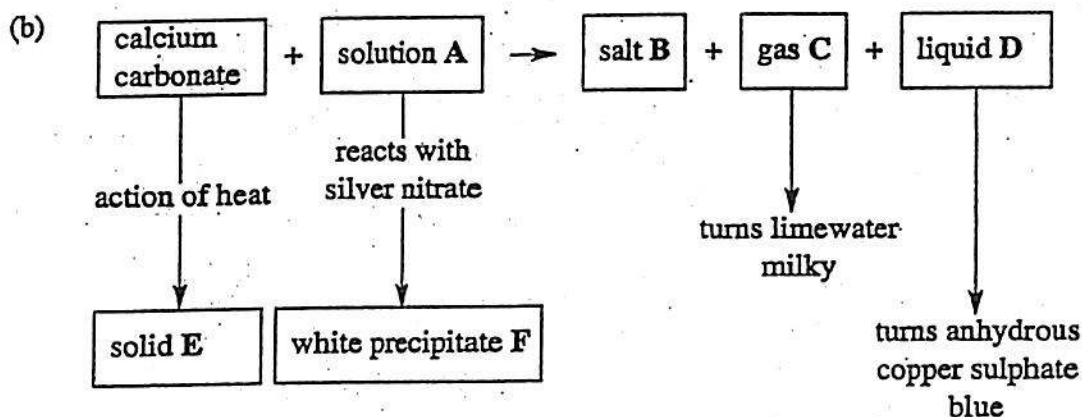
Total marks [10]

4.   On many occasions chemists are required to carry out qualitative analyses.

(a)   (i)   Identify the flame colour that would be produced by the metal in each substance.

METAL   COLOUR

potassium nitrate in a match head   _____ [1]

sodium carbonate in washing soda   _____ [1]

calcium carbonate from a marble tile   _____ [1]

(ii)   Name the metal that produces a blue-green flame.

_____ [1]

(b)

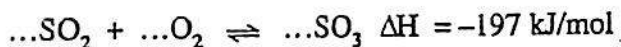Use the reaction scheme to help you to name

(i)   solution A,   _____

(ii)   salt B,   _____

(iii)   gas C,   _____

(iv)   liquid D,   _____

(v)   substance E,   _____

(vi)   white precipitate F.   _____ [6]

Total marks [10]

[Turn over

Section B

Choose **two** of the three questions.

5. (a) Sulphuric acid is made from sulphur dioxide by a catalytic process. The reaction is reversible.

$$...SO_2 + ...O_2 \rightleftharpoons ...SO_3 \quad \Delta H = -197 \text{ kJ/mol}$$

   (i) Name this industrial process. [1]

   (ii) Rewrite the equation so that it is balanced. [2]

   (iii) Explain the meaning of $\Delta H = -197$ kJ/mol. [1]

   (iv) Name a catalyst that can be used in this process. [1]

(b) Suppose that a mixture of sulphur dioxide and oxygen, in presence of the catalyst, is allowed to reach equilibrium with the product, sulphur dioxide.

   State and explain the effect on the amount of sulphur trioxide formed if

   (i) the concentration of oxygen in the mixture of gases is increased; [2]

   (ii) the temperature is raised. [1]

(c) State **one** commercial use of sulphuric acid. [1]

(d) State **ONE** observation that would be seen when concentrated sulphuric acid is added to sucrose (table sugar). [1]

(e) Ammonia is manufactured by the Haber process and the equation for the reaction is

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$
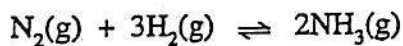
   Nitrogen and hydrogen are reacted under a pressure of 200 atmospheres, in the presence of powdered iron and at a temperature of 450°C.

   (i) State one large-scale source of hydrogen and one large-scale source of nitrogen. [2]

   (ii) Using your knowledge of the kinetic theory of gases, explain the need for
   – the high pressure,
   – the high temperature,
   – the powdered iron. [6]

(f)   Calculate the volume of ammonia produced at r.t.p. from 30 moles of hydrogen at 100% yield.   [2]

Total marks [20]

6. An unknown material may be identified by finding its percentage composition by mass. This method of analysis has many applications.

(a) (i) Caffeine is a mild-acting drug found in coffee and tea. Determine the percentage of carbon in caffeine, $C_8H_{10}N_4O_2$. [1]

(ii) Carbon found in natural substances consists of two isotopes, C^{12} (99%) and C^{13} (1%). Calculate the relative atomic mass of carbon. [2]

Succinic acid is present in lichens found on trees. It is extracted from these organisms to manufacture perfumes and dyes. The percentage composition of succinic acid is 40.68% C, 5.08% H and 54.24% O. Its molecular mass is 118.

(iii) Determine its empirical formula. [3]

(iv) Determine its molecular formula. [2]

(v) Succinic acid is a carboxylic acid. Showing **all** the bonds between the atoms, draw the structural formula of the group of atoms in succinic acid that makes the molecule acidic. [1]

(vi) Ibuprofen, $C_{13}H_{18}O_2$, an active ingredient in pain relievers has a molar mass of 206 g. Calculate the number of moles present in 33 g of ibuprofen. [2]

(b) In exothermic reaction used to warm food, magnesium undergoes a super corrosion process as shown by the equation:

$$Mg(s) + 2H_2O(\ell) \rightarrow Mg(OH)_2(s) + H_2(g) \quad \Delta H = -353 \, kJ$$
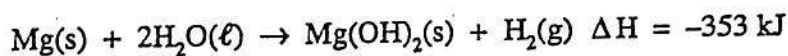
Calculate the mass of magnesium required to make 21.9 g of magnesium hydroxide. [3]

(c) Chemistry is involved in processes observed every day. Use the Kinetic Theory of Matter to explain each of these observations.

(i) The contents of aerosol cans are under pressure. The message **Do not incinerate** is printed on the outside. [2]

(ii) Balloons filled with helium rise, those filled with carbon dioxide sink. [2]

(iii) Liquids cannot be compressed, but gases can be compressed. [2]

Total marks [20]

7. Two pieces of fresh calcium of 2.0 g each were used in separate experiments. In one experiment a piece was added to excess water.

In the other experiment a piece was added to excess dilute hydrochloric acid.

The volume of hydrogen produced was recorded at 10 s intervals. The results are given below.

time/s	0	10	20	30	50	60	80	90	100	110

experiment 1
volume of hydrogen/cm^3

	0	6	12	20	40	54	88	109	119	120

experiment 2
volume of hydrogen/cm^3

	0	24	50	80	116	120	120	120	120	120

(a) (i) Plot the two graphs of the volumes of hydrogen produced with time on the x-axis. [6]

(ii) Use the graph to explain which reaction was the most rapid at the start. [2]

(iii) Use the graphs to determine the volumes of hydrogen produced at 40 s for water and at 70 s for the acid. [2]

(iv) Sketch on the same graph the curve that would be expected if the same mass of calcium was reacted with water which was colder than the original water experiment. [2]

(v) Predict the volume of hydrogen which would have been formed in 60 s if the same mass of calcium had reacted with an excess of a higher concentration of hydrochloric acid. [1]

(b) (i) Write a chemically balanced equation for the reaction between calcium and water. [2]

(ii) Calculate the number of moles in 120 cm^3 of hydrogen produced at r.t.p. in the experiment. [2]

(iii) Use the equation in (b)(i) to calculate the mass of calcium required to produce 10 grams of hydrogen. [3]

Total marks [20]

End]

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