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**BOTSWANA EXAMINATIONS COUNCIL**  
Botswana General Certificate of Secondary Education

CANDIDATE  
NAME

CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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\* 8 0 2 3 9 1 8 4 5 7 \*

**CHEMISTRY**

**0570/03**

Paper 3

**October/November 2013**

**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 8.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
<b>Total</b>	

1 Carbon dioxide can exist as a liquid in fire extinguishers.

(a) (i) Describe the movement of the particles in a liquid.

.....  
..... [1]

(ii) Describe how the movement of the particles in a liquid changes when the temperature is increased.

..... [1]

(b) Carbon dioxide can also exist in a solid form as dry ice.

Draw a diagram to show the arrangement of particles in a solid.

[1]

(c) Carbon dioxide dissolves in water to form carbonic acid,  $\text{H}_2\text{CO}_3$ , which is a weak acid.

(i) Suggest the pH of carbonic acid.

..... [1]

(ii) Explain what is meant by the term *weak acid*.

.....  
..... [1]

(d) Water containing dissolved carbon dioxide reacts with limestone,  $\text{CaCO}_3$ , forming hard water as shown by the equation.



(i) Name the type of hardness in the water resulting from the reaction.

..... [1]

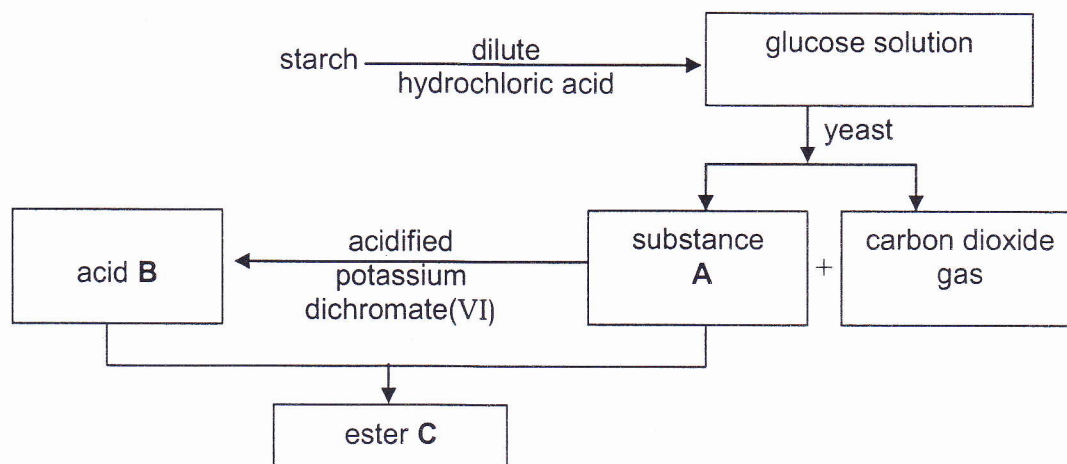
(ii) Apart from the calcium ion,  $\text{Ca}^{2+}$ , state another ion that makes water hard.

..... [1]

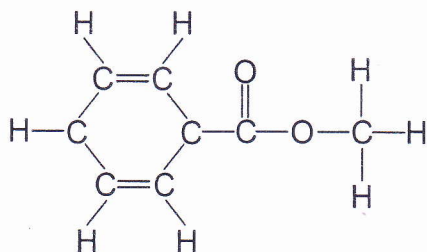
(iii) State **two** methods of softening hard water.

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

- 2 Study the reaction scheme showing reactions of different substances.



- (a) Identify the following;
- (i) substance A .....
- (ii) acid B .....
- (iii) ester C ..... [3]
- (b) Substance A is converted to acid B using acidified potassium manganate(VII).
- (i) What is the role of potassium manganate(VII) in the reaction?  
..... [1]
- (ii) Describe the colour change observed during this reaction.  
from ..... to ..... [2]
- (c) The carbon dioxide gas produced is reacted with aqueous sodium hydroxide.  
Write a balanced equation for this reaction.  
..... [2]
- (d) Methyl benzoate is an ester with the structure shown.

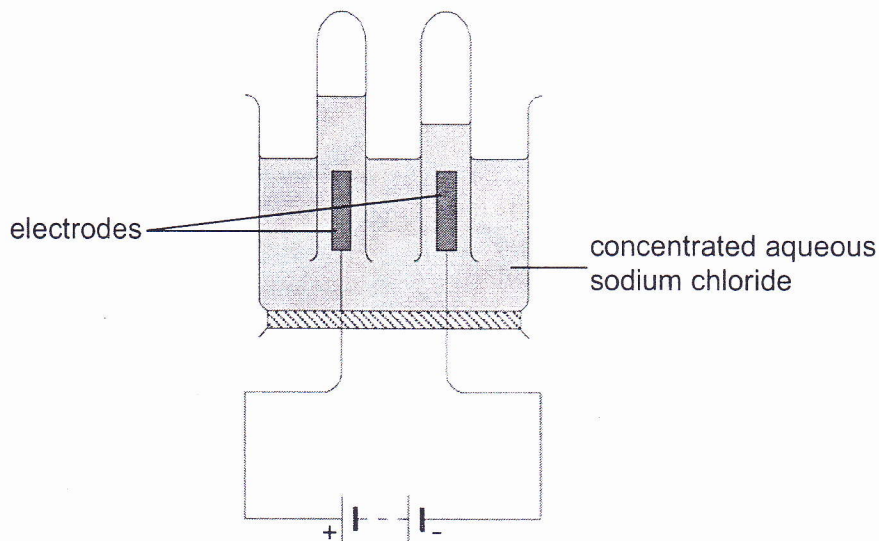


What is the empirical formula of this compound?

..... [1]

[Total: 9]

- 3 (a) The diagram shows a set-up used to produce chlorine by electrolysis of concentrated aqueous sodium chloride.



- (i) Suggest the material used to make the electrodes.  
 ..... [1]
- (ii) State **two** observations that would be made during this electrolysis.  
 .....  
 ..... [2]
- (b) State **one** factor other than concentration that influences the discharge of ions during electrolysis of aqueous electrolytes.  
 ..... [1]
- (c) A steady current of 15 A was allowed to flow through the electrolyte for 1 hour 30 minutes.

The equation shows how chlorine is produced in the experiment.



- (i) Calculate the quantity of electricity in coulombs that was passed through the electrolyte.  
 ..... [2]
- (ii) Use your answer to (c)(i) to calculate the number of moles of electrons used.  
 [1 Faraday = 96 500 C]  
 ..... [1]

- (iii) Use your answer to (c)(ii) to calculate the volume of chlorine that will be produced in the experiment.  
[1 mole of any gas occupies 24 dm<sup>3</sup> at r.t.p.]

[2]

[Total: 9]

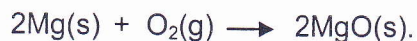
4 The metals sodium and magnesium are found in period 3 of the Periodic Table.

- (a) Sodium is in group I in the Periodic Table and reacts with halogens to form sodium halides.

Describe by means of a simple diagram, the lattice structure of an ionic compound such as sodium chloride.

[2]

- (b) The equation between magnesium and oxygen is



This reaction is exothermic.

- (i) State the number of valency electrons in an atom of magnesium.

..... [1]

- (ii) Using the ideas of bond breaking and bond forming explain why this reaction is exothermic.

.....  
.....  
..... [3]

[Total: 6]

- 5 In an experiment, metals **Q**, **R**, **T** and **Z** are reacted with aqueous nitrates of the metals. The letters **Q**, **R**, **T** and **Z** are not symbols of elements in the periodic table. The results are shown in the table.

metal	$\text{Q}(\text{NO}_3)_2$	$\text{R}(\text{NO}_3)_2$	$\text{T}(\text{NO}_3)_2$	$\text{Z}(\text{NO}_3)_2$
<b>Q</b>		reaction occurs	reaction occurs	no reaction
<b>R</b>	no reaction		reaction occurs	no reaction
<b>T</b>	no reaction	no reaction		no reaction
<b>Z</b>	reaction occurs	reaction occurs	reaction occurs	

- (a) (i) Each of the metals has the same number of valency electrons.  
Suggest the valency of the metals.  
..... [1]
- (ii) Arrange the metals in order of decreasing reactivity, starting with the most reactive.  
**most reactive** ..... **less reactive**  
..... [1]
- (b) Nitrates of metals **Q**, **R**, **T** and **Z** decompose when heated giving nitrogen dioxide gas,  $\text{NO}_2$ , as one of the products.
- (i) Which of these nitrates will **most** readily decompose when heated?  
.....  
Explain your answer.  
.....  
..... [2]
- (ii) Name **two** other products of the decomposition of metal nitrates.  
..... and ..... [2]
- (iii) Suggest a chemical test to confirm that nitrogen dioxide gas is acidic.  
test .....  
result ..... [2]

(c) Nitrogen dioxide is one of the pollutants found in car exhaust fumes.

(i) Explain how nitrogen dioxide is produced in the car engine.

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

(ii) How is the emission of nitrogen dioxide from car exhausts controlled?

..... [1]

(iii) Describe the effect of nitrogen dioxide in the environment.

..... [1]

[Total: 12]

- 6 A 10g sample of impure iron(II) sulphate,  $\text{FeSO}_4$ , was dissolved in water to make  $250 \text{ cm}^3$  of solution. Exactly  $25.0 \text{ cm}^3$  of the solution was titrated with  $0.025 \text{ mol/dm}^3$  potassium manganate(VII),  $\text{KMnO}_4$ , until the solution just turned pink. The volume of potassium manganate(VII) that reacted with  $25.0 \text{ cm}^3$  of the solution was  $23.5 \text{ cm}^3$ .

The equation for the reaction is as shown.



- (a) Calculate the number of moles in  $23.5 \text{ cm}^3$  of  $0.025 \text{ mol/dm}^3$  potassium manganate(VII).

number of moles of potassium manganate(VII) = ..... [2]

- (b) Calculate the number of moles of iron(II) sulphate in  $25.0 \text{ cm}^3$  of solution.

number of moles of iron(II) sulphate = ..... [2]

- (c) Use your answer to (b) to calculate the number of moles of iron(II) sulphate in  $250 \text{ cm}^3$  of solution.

number of moles of iron(II) sulphate = ..... [2]

- (d) Use your answer to (c) to calculate the mass of iron(II) sulphate in the sample.

mass of iron(II) sulphate = ..... [2]

- (e) Calculate the percentage of purity of the sample.

percentage of purity = ..... [2]

- (f) What type of reaction occurred when  $\text{Fe}^{2+}$  changed to  $\text{Fe}^{3+}$ ?

.....

Explain your answer.

..... [2]

[Total: 12]

7 A man is working inside an enclosed well with a petrol generator running in order to power a lamp to provide light.

(a) Explain why it is dangerous for the man to work in these conditions.

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

(b) Petrol is a mixture of hydrocarbons which belong to the alkane homologous series.

(i) What is a hydrocarbon?

..... [1]

(ii) State **two** characteristics of a homologous series.

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

(c) A hydrocarbon has a molecular formula  $C_5H_{12}$ . The equation shows the reaction of the hydrocarbon  $C_5H_{12}$ .



(i) What type of reaction is shown by the equation?

..... [1]

(ii) Draw **two** structural isomers of  $C_5H_{12}$ .

[2]

(d)  $C_3H_6$  undergoes addition polymerisation to form a macromolecule X.

(i) Name the macromolecule.

..... [1]

(ii) Draw the structure of the macromolecule.

(iii) Give **one** problem caused by the commercial use of the macromolecule.

.....

Explain your answer.

..... [2]

[Total: 13]

# DATA SHEET

## The Periodic Table of the Elements

Group

	I	II	III	IV	V	VI	VII	0									
	<table style="width: 100%; border: none;"> <tr> <td style="width: 10%;"></td> <td style="width: 10%;"><b>1</b> <b>H</b> Hydrogen 1</td> <td colspan="6"></td> <td style="width: 10%;"><b>4</b> <b>He</b> Helium 2</td> </tr> </table>									<b>1</b> <b>H</b> Hydrogen 1							<b>4</b> <b>He</b> Helium 2
	<b>1</b> <b>H</b> Hydrogen 1							<b>4</b> <b>He</b> Helium 2									
<b>7</b> <b>Li</b> Lithium 3	<b>9</b> <b>Be</b> Beryllium 4	<b>11</b> <b>B</b> Boron 5	<b>12</b> <b>C</b> Carbon 6	<b>13</b> <b>Al</b> Aluminium 13	<b>14</b> <b>Si</b> Silicon 14	<b>15</b> <b>P</b> Phosphorus 15	<b>16</b> <b>S</b> Sulphur 16	<b>17</b> <b>Cl</b> Chlorine 17	<b>18</b> <b>Ar</b> Argon 18								
<b>19</b> <b>K</b> Potassium 19	<b>20</b> <b>Ca</b> Calcium 20	<b>21</b> <b>Sc</b> Scandium 21	<b>22</b> <b>Ti</b> Titanium 22	<b>23</b> <b>V</b> Vanadium 23	<b>24</b> <b>Cr</b> Chromium 24	<b>25</b> <b>Mn</b> Manganese 25	<b>26</b> <b>Fe</b> Iron 26	<b>27</b> <b>Co</b> Cobalt 27	<b>28</b> <b>Ni</b> Nickel 28	<b>29</b> <b>Cu</b> Copper 29	<b>30</b> <b>Zn</b> Zinc 30	<b>31</b> <b>Ga</b> Gallium 31	<b>32</b> <b>Ge</b> Germanium 32	<b>33</b> <b>As</b> Arsenic 33	<b>34</b> <b>Se</b> Selenium 34	<b>35</b> <b>Br</b> Bromine 35	<b>36</b> <b>Kr</b> Krypton 36
<b>37</b> <b>Rb</b> Rubidium 37	<b>38</b> <b>Sr</b> Strontium 38	<b>39</b> <b>Y</b> Yttrium 39	<b>40</b> <b>Zr</b> Zirconium 40	<b>41</b> <b>Nb</b> Niobium 41	<b>42</b> <b>Mo</b> Molybdenum 42	<b>43</b> <b>Tc</b> Technetium 43	<b>44</b> <b>Ru</b> Ruthenium 44	<b>45</b> <b>Rh</b> Rhodium 45	<b>46</b> <b>Pd</b> Palladium 46	<b>47</b> <b>Ag</b> Silver 47	<b>48</b> <b>Cd</b> Cadmium 48	<b>49</b> <b>In</b> Indium 49	<b>50</b> <b>Sn</b> Tin 50	<b>51</b> <b>Sb</b> Antimony 51	<b>52</b> <b>Te</b> Tellurium 52	<b>53</b> <b>I</b> Iodine 53	<b>54</b> <b>Xe</b> Xenon 54
<b>55</b> <b>Cs</b> Caesium 55	<b>56</b> <b>Ba</b> Barium 56	<b>57</b> <b>La</b> Lanthanum 57	<b>58</b> <b>Ce</b> Cerium 58	<b>59</b> <b>Pr</b> Praseodymium 59	<b>60</b> <b>Nd</b> Neodymium 60	<b>61</b> <b>Pm</b> Promethium 61	<b>62</b> <b>Sm</b> Samarium 62	<b>63</b> <b>Eu</b> Europium 63	<b>64</b> <b>Gd</b> Gadolinium 64	<b>65</b> <b>Tb</b> Terbium 65	<b>66</b> <b>Dy</b> Dysprosium 66	<b>67</b> <b>Ho</b> Holmium 67	<b>68</b> <b>Er</b> Erbium 68	<b>69</b> <b>Tm</b> Thulium 69	<b>70</b> <b>Yb</b> Ytterbium 70	<b>71</b> <b>Lu</b> Lutetium 71	
<b>87</b> <b>Fr</b> Francium 87	<b>88</b> <b>Ra</b> Radium 88	<b>89</b> <b>Ac</b> Actinium 89	<b>90</b> <b>Th</b> Thorium 90	<b>91</b> <b>Pa</b> Protactinium 91	<b>92</b> <b>U</b> Uranium 92	<b>93</b> <b>Np</b> Neptunium 93	<b>94</b> <b>Pu</b> Plutonium 94	<b>95</b> <b>Am</b> Americium 95	<b>96</b> <b>Cm</b> Curium 96	<b>97</b> <b>Bk</b> Berkelium 97	<b>98</b> <b>Cf</b> Californium 98	<b>99</b> <b>Es</b> Einsteinium 99	<b>100</b> <b>Fm</b> Fermium 100	<b>101</b> <b>Md</b> Mendelevium 101	<b>102</b> <b>No</b> Nobelium 102	<b>103</b> <b>Lr</b> Lawrencium 103	

**68-71 Lanthanoid series**  
**89-103 Actinoid series**

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

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).

*file*



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