UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY
0620/21
Paper 2
May/June 2011
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 at the top of this page.
Write in dark blue or black pen.
You may need to use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

Answer all questions.
A copy of the Periodic Table is printed on page 16.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner’s Use

<p>| | | | | | | | |</p>
<table>
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</table>

This document consists of 15 printed pages and 1 blank page.
The structures of some substances containing nitrogen are shown below.

A

B

C

D

E

Answer the following questions by choosing from the structures A, B, C, D or E. You can use each structure once, more than once or not at all.

Which structure represents

(a) an acidic oxide,
(b) an ionic giant structure,
(c) a gas which turns moist litmus paper blue,
(d) a compound which is formed under conditions of high temperature and pressure in car engines,
(e) a molecule containing halogen atoms,
(f) a salt?

[Total: 6]
2 Vanadium has two isotopes.

\[ \begin{array}{c}
50 \quad 23 \text{V} \\
51 \quad 23 \text{V}
\end{array} \]

(a) Define the term *isotope*.

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

(b) An atom contains protons, electrons and neutrons.
Complete the table to show the number of protons, electrons and neutrons in these two isotopes of vanadium.

<table>
<thead>
<tr>
<th>isotope</th>
<th>number of protons</th>
<th>number of electrons</th>
<th>number of neutrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>( {^{50}_{23}} \text{V} )</td>
<td>23</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>( {^{51}_{23}} \text{V} )</td>
<td></td>
<td></td>
<td>28</td>
</tr>
</tbody>
</table>

[3]

(c) Complete these sentences using words from the list.

\text{cancer} \quad \text{extra} \quad \text{industry} \quad \text{influenza} \quad \text{medicine} \quad \text{non}

Two types of isotopes are radioactive and .........................-radioactive. Radioactive isotopes are used in ......................... for treating patients with .......................... [3]

(d) Vanadium is a transition element.
Which two of these statements about vanadium are correct?
Tick two boxes.

- vanadium is a non-metal
- vanadium conducts electricity
- vanadium has a low melting point
- vanadium is less dense than sodium
- compounds of vanadium are coloured

[2]

[Total: 9]
3 Water is present in the atmosphere, the seas and in ice and snow.

(a) Describe a chemical test for water.

   test  .....................................................................................................................................
   result  .................................................................................................................................... [2]

(b) State one use of water in industry.

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

(c) Water is a good solvent.
   What do you understand by the term solvent?

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

(d) Water vapour in the atmosphere reacts with sulfur dioxide, $SO_2$, to produce acid rain.

   (i) State one source of sulfur dioxide.

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

   (ii) State two adverse effects of acid rain.

   1. ...........................................................................................................................................
   2. ........................................................................................................................................... [2]

   (iii) Calculate the relative molecular mass of sulfur dioxide.

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

(e) Water from lakes and rivers can be treated to make the water safer to drink.

   Describe two of the steps in water purification.
   For each of these steps, give an explanation of its purpose.

   step 1  ....................................................................................................................................
   ............................................................................................................................................
   step 2  ....................................................................................................................................
   ........................................................................................................................................... [4]
(f) Water is formed when hydrogen burns in air.

(i) State the percentage of oxygen present in the air.

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

(ii) When 8 g of hydrogen is burned in excess air, 72 g of water is formed. What mass of hydrogen needs to be burnt to produce 252 g of water?

[1]

[Total: 14]
4 The structures of some organic compounds are shown below.

(a) Which one of these structures represents
(i) a polymer, [□]
(ii) an unsaturated hydrocarbon, [□]
(iii) the product of the catalytic addition of steam to ethene, [□]
(iv) a product of the addition of aqueous bromine to ethene? [□] [4]

(b) (i) Balance the equation for the complete combustion of compound A, C₃H₈.

\[ C_3H_8 + ............O_2 \rightarrow 3CO_2 + ............H_2O \] [2]

(ii) State the name of two substances formed when compound A undergoes incomplete combustion.

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

(c) Complete the structure of ethanoic acid to show all atoms and bonds.

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

[Total: 9]
5 Concentrated hydrochloric acid can be electrolysed using the apparatus shown.

(a) What do you understand by the term *electrolysis*?
...........................................................................................................................................
........................................................................................................................................... [1]

(b) What is the name given to the positive electrode?
Put a ring around the correct answer.

anion anode cathode cation electrolyte [1]

(c) State the name of the gas given off at the negative electrode.
........................................................................................................................................... [1]

(d) Complete the following sentence about electrolysis using words from the list.

inert magnesium platinum reactive solid

Electrodes made of graphite or ....................... are generally used in electrolysis because they are ...................... . [2]
(e) When concentrated hydrochloric acid is electrolysed, chlorine is released at the positive electrode.

(i) Draw the arrangement of the electrons in an atom of chlorine.

(ii) Draw the electronic structure of a chlorine molecule. Show only the outer electron shells.

(iii) Describe a test for chlorine.

    test ............................................................................................................................

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

(f) Hydrochloric acid reacts with the base calcium hydroxide.

(i) Complete the word equation for this reaction.

    hydrochloric acid + calcium hydroxide → ............................................................. + .............................................................

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

(ii) Hydrochloric acid also reacts with zinc. Complete the symbol equation for this reaction.

    \[ \text{Zn} + \text{HCl} \rightarrow \text{ZnCl}_2 + \text{...} \] [2]

[Total: 14]
A student observed the reaction of various metals with both cold water and steam. Her results are shown below.

<table>
<thead>
<tr>
<th>metal</th>
<th>reaction with cold water</th>
<th>reaction with steam</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium</td>
<td>reacts rapidly</td>
<td>reacts very rapidly</td>
</tr>
<tr>
<td>copper</td>
<td>no reaction</td>
<td>no reaction</td>
</tr>
<tr>
<td>magnesium</td>
<td>reacts very slowly</td>
<td>reacts rapidly</td>
</tr>
<tr>
<td>zinc</td>
<td>no reaction</td>
<td>reacts</td>
</tr>
</tbody>
</table>

(a) (i) Put these metals in order of their reactivity.

least reactive

most reactive

(ii) Iron is a metal between zinc and copper in the reactivity series. Predict the reactivity of iron with cold water, steam.

(b) The equation for the reaction of zinc with steam is:

\[ \text{Zn} + \text{H}_2\text{O} \rightarrow \text{ZnO} + \text{H}_2 \]

Write a word equation for this reaction.

(c) State three physical properties which are characteristic of most metals.

1. 

2. 

3.
(d) Some properties of the Group I metals are shown in the table.

<table>
<thead>
<tr>
<th>metal</th>
<th>melting point /°C</th>
<th>hardness</th>
<th>density / g per cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>lithium</td>
<td></td>
<td>fairly hard</td>
<td>0.53</td>
</tr>
<tr>
<td>sodium</td>
<td>98</td>
<td>fairly soft</td>
<td></td>
</tr>
<tr>
<td>potassium</td>
<td>63</td>
<td>soft</td>
<td></td>
</tr>
<tr>
<td>rubidium</td>
<td>39</td>
<td>very soft</td>
<td>1.53</td>
</tr>
<tr>
<td>caesium</td>
<td>29</td>
<td>extremely soft</td>
<td>1.88</td>
</tr>
</tbody>
</table>

(i) Estimate the melting point of lithium.

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

(ii) How does the hardness of these metals change down the group?

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

(iii) Estimate the density of potassium.

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

[Total: 10]
The diagram shows a basic oxygen converter. This is used to convert impure iron from the blast furnace into steel. During this process, some of the impurities in the iron are converted into a slag.

(a) Label the diagram to show each of the following:
- where the oxygen enters;
- the slag;
- the molten steel. [3]

(b) In the converter, the oxygen oxidises sulfur, carbon and phosphorus to their oxides.

(i) Explain why sulfur dioxide and carbon dioxide are easily removed from the converter.
........................................................................................................................................................ [1]

(ii) Explain how calcium oxide is used to remove phosphorus(V) oxide from the converter.
........................................................................................................................................................
........................................................................................................................................................
........................................................................................................................................................
........................................................................................................................................................ [3]
(c) Stainless steel is an alloy.

(i) Which one of the diagrams, A, B, C or D, best represents an alloy?
Put a ring around the correct answer.

[Diagram with options A, B, C, D]

(ii) State one use of stainless steel.

.................................................................................................................................................

[Total: 9]
8 Bromine is a red-brown liquid. When warmed, it forms an orange vapour.

(a) Describe what happens to the arrangement and motion of the particles when bromine changes state from a liquid to a vapour.

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

(b) Bromine can be obtained from bromide ions in seawater.

(i) The symbol equation for this reaction is:

\[ \text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2 \]

Complete the word equation for this reaction.

...................... + bromide ions \rightarrow ......................... + ...................... [1]

(ii) Bromine is very volatile, so it can be removed from solution by bubbling air through the solution.
What do you understand by the term volatile?

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

(c) Hydrogen reacts with bromine in the presence of a hot platinum catalyst to form hydrogen bromide.

(i) Define the term catalyst.

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

(ii) Hydrogen bromide reduces hydrogen peroxide, \( \text{H}_2\text{O}_2^- \).

\[ 2\text{HBr} + \text{H}_2\text{O}_2 \rightarrow \text{Br}_2 + 2\text{H}_2\text{O} \]

Explain how this equation shows that hydrogen peroxide is reduced.

........................................................................................................................................... [1]
(iii) A solution of hydrogen bromide in water is called hydrobromic acid. Hydrobromic acid has similar reactions to hydrochloric acid.

State the names of three products formed when hydrobromic acid reacts with sodium carbonate.

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

[Total: 9]
<table>
<thead>
<tr>
<th>Group</th>
<th>Periodic Table of the Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Li 3 Be 4 B 5 C 6 N 7 O 8 F 9</td>
</tr>
<tr>
<td></td>
<td>Ne 10 Na 11 Mg 12 Al 13 Si 14</td>
</tr>
<tr>
<td></td>
<td>P 15 S 16 Cl 17 Ar 18 K 19</td>
</tr>
<tr>
<td></td>
<td>Ca 20 Sc 21 Ti 22 V 23 Cr 24</td>
</tr>
<tr>
<td></td>
<td>Mn 25 Fe 26 Co 27 Ni 28 Cu 29</td>
</tr>
<tr>
<td></td>
<td>Zn 30 Ga 31 Ge 32 As 33 Se 34</td>
</tr>
<tr>
<td></td>
<td>Br 35 I 36 Xe 37 Cs 38 Ba 39</td>
</tr>
<tr>
<td></td>
<td>La 40 Ce 41 Pr 42 Nd 43 Pm 44</td>
</tr>
<tr>
<td></td>
<td>Sm 45 Eu 46 Gd 47 Tb 48 Dy 49</td>
</tr>
<tr>
<td></td>
<td>Ho 50 Er 51 Tm 52 Yb 53 Lu 54</td>
</tr>
<tr>
<td>II</td>
<td>Li 6 Be 7 B 8 C 9 N 10 O 11</td>
</tr>
<tr>
<td></td>
<td>F 12 Ne 13 Na 14 Mg 15 Al 16</td>
</tr>
<tr>
<td></td>
<td>Si 17 P 18 S 19 Cl 20 Ar 21</td>
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<td>K 22 Ca 23 Sc 24 Ti 25 V 26</td>
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<td>Cu 32 Zn 33 Ga 34 Ge 35 As 36</td>
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<td>Se 37 Br 38 I 39 Xe 40 Cs 41</td>
</tr>
<tr>
<td></td>
<td>Ba 42 La 43 Ce 44 Pr 45 Nd 46</td>
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<td></td>
<td>Pm 47 Sm 48 Eu 49 Gd 50 Tb 51</td>
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<tr>
<td></td>
<td>Dy 52 Ho 53 Er 54 Tm 55 Yb 56</td>
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<tr>
<td></td>
<td>Lu 57 Hf 58 Ta 59 W 60 Re 61</td>
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<tr>
<td></td>
<td>Os 62 Ir 63 Pt 64 Au 65 Hg 66</td>
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<td></td>
<td>87 88 89 90 91 92 93 94 95 96</td>
</tr>
<tr>
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<td>97 98 99 100 101 102 103 104</td>
</tr>
</tbody>
</table>

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

<table>
<thead>
<tr>
<th>Key</th>
<th>a = relative atomic mass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b = proton (atomic) number</td>
</tr>
</tbody>
</table>

58-71 Lanthanoid series
190-103 Actinoid series

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