DIRECTORATE FOR QUALITY AND STANDARDS IN EDUCATION
Department for Curriculum Management and eLearning
Educational Assessment Unit
Annual Examinations for Secondary Schools 2012

FORM 4                                  CHEMISTRY                                TIME: 1h 30min

Name: _________________________                                    Class: _______________

Useful Data: Atomic numbers and relative atomic masses are shown in the periodic table printed below.
One mole of any gas occupies 22.4 dm$^3$ at standard temperature and pressure
Faraday constant = 96500 C mol$^{-1}$  \[ Q = It \]

State symbols are expected to be included in all chemical equations.

PERIODIC TABLE

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Key

\[ a \] relative atomic mass

\[ b \] symbol

atomic number

Marks Grid [ For Examiners’ use only ]

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Section A</th>
<th>Section B</th>
<th>Theory Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Max Mark</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Actual Mark

Theory Paper: 85%
Practical: 15%
Final Score: 100%
SECTION A – Answer ALL questions. This section carries 60 marks.

1a. For each of the following, decide if a reaction occurs.

   If a reaction occurs, **complete the word equation**.
   If a reaction does not occur, write: **no reaction**.

   bromine + sodium chloride \(\rightarrow\) ________________

   bromine + sodium iodide \(\rightarrow\) ________________

   chlorine + potassium bromide \(\rightarrow\) ________________

   bromine + potassium chloride \(\rightarrow\) ________________

   [4]

b. A stream of chlorine gas is passed over hot iron wool.

   (i) State what you would **observe** after some time.

   ________________________________________________________

   (ii) Give the name of the new solid formed if the apparatus is kept dry throughout.

   ________________________________________________________

   (iii) What happens if damp air is allowed to come into contact with the new solid?

   ________________________________________________________

   [3]

c. Aqueous sodium hydroxide is added to aqueous iron (II) chloride.

   (i) State what you would **observe** as the reaction proceeds.

   ________________________________________________________

   (ii) Write a full equation to represent this reaction. **Include state symbols**.

   ________________________________________________________

   [3]
2 Fill in the empty spaces in the table below:

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Substance oxidized</th>
<th>Reason to show that named substance has been oxidized</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mg + 2HCl [\rightarrow] MgCl(_2) + H(_2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. CuO + H(_2) [\rightarrow] Cu + H(_2)(_2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. 2Na + Cl(_2) [\rightarrow] 2NaCl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. 2Fe(^{2+}) + Cl(_2) [\rightarrow] 2Fe(^{3+}) + 2Cl(^{-})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Zn + H(_2)SO(_4) [\rightarrow] ZnSO(_4) + H(_2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3a. Fill in the empty spaces in the table below:

<table>
<thead>
<tr>
<th>Compound electrolysed</th>
<th>State of compound</th>
<th>Observation at cathode</th>
<th>Observation at anode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. lead bromide</td>
<td>molten electrolyte; graphite electrodes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. concentrated NaCl solution</td>
<td>aqueous electrolyte; platinum electrodes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. dilute H(_2)SO(_4)</td>
<td>aqueous electrolyte; platinum electrodes.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Identify the substance formed or gas evolved in question a. at:

(i) the cathode in Electrolysis 1: ________________________________________

(ii) the anode in Electrolysis 1: ________________________________________

(iii) the anode in Electrolysis 2: ________________________________________

(iv) the anode in Electrolysis 3: ________________________________________
Tables A and B include lists of cations and anions together with simple tests that may be used for ion identification.

<table>
<thead>
<tr>
<th>Table A</th>
<th>Cations</th>
<th>Flame test colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>lithium</td>
<td>red</td>
<td></td>
</tr>
<tr>
<td>sodium</td>
<td>yellow</td>
<td></td>
</tr>
<tr>
<td>strontium</td>
<td></td>
<td>red</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table B</th>
<th>Anions</th>
<th>Observations when dilute nitric acid is added</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbonate</td>
<td>effervescence</td>
<td></td>
</tr>
<tr>
<td>hydrogencarbonate</td>
<td>effervescence</td>
<td></td>
</tr>
<tr>
<td>hydroxide</td>
<td>no effervescence</td>
<td></td>
</tr>
</tbody>
</table>

a. Use the periodic table on the front page of this question paper to write the symbol of:
   - a lithium ion: ___________________________ ______________________ [3]
   - a sodium ion: _____________________________ _____________________ [3]
   - a strontium ion: ______________________________ ____________________ [3]

b. Give the molecular and ionic formulae of:
   - lithium hydroxide: _______________ ________________ [3]
   - sodium hydrogencarbonate: _______________ ________________ [3]
   - strontium carbonate: _______________ ________________ [3]

c. Two ionic compounds P and Q are known to contain anions and cations from Table A and Table B only.
   (i) Compound P gave a yellow flame test and produced effervescence with dilute nitric acid. Compound P may be:
       either ___________________________ or ___________________________ [4]
   (ii) Compound Q gave a red flame test and did not produce effervescence with dilute nitric acid. Compound Q may be:
       either ___________________________ or ___________________________ [4]
You are required to find the concentration of an ascorbic acid solution by titrating it against a standard iodine solution of concentration 0.5 mol dm\(^{-3}\).

\[
\text{C}_6\text{H}_8\text{O}_6 + \text{I}_2 \rightarrow \text{C}_6\text{H}_6\text{O}_6 + 2\text{HI}
\]

\text{ascorbic acid} \quad \text{dehydroascorbic acid}

Once all the ascorbic acid is neutralized, the excess iodine reacts with a starch solution indicator forming immediately a blue-black coloration. This indicates the endpoint of the titration.

a. Name \textbf{three} items of laboratory equipment necessary to conduct the titration.

___________________        ______________ ______        _____________________  \[3\]

b. It was found that 50 cm\(^3\) of the ascorbic acid available were exactly neutralized by 12.5 cm\(^3\) of iodine solution of concentration 0.5 mol dm\(^{-3}\).

(i) How many moles of iodine solution were used?

______________________________________

(ii) How many moles of ascorbic acid were used?

______________________________________

(iii) Find the concentration of the ascorbic acid used.

______________________________________  \[6\]

c. In this titration, the ascorbic acid solution is:

\begin{itemize}
  \item reduced \hfill
  \item oxidized \hfill
  \item neither reduced nor oxidized
\end{itemize}

\[1\]
6a. Write down full chemical equations, **including state symbols** to represent each of the following reactions:

(i) Copper metal heated in a stream of oxygen.
\[ \text{Cu(s)} + \text{O}_2(g) \rightarrow \text{Cu}_2\text{O(s)} \]

(ii) The thermal decomposition of copper (II) carbonate.
\[ \text{Cu}_2\text{CO}_3(s) \rightarrow \text{Cu}_2\text{O(s)} + \text{CO}_2(g) + \text{CO}_2(g) \]

(iii) The action of dilute hydrochloric acid on copper (II) oxide.
\[ \text{Cu}_2\text{O(s)} + 2\text{HCl(aq)} \rightarrow 2\text{CuCl}_2(aq) + \text{H}_2\text{O(l)} \]

[6]

b. (i) Copper compounds, particularly copper (II) oxide are often used as **catalysts** in industry. Which general property of copper makes copper compounds suitable as catalysts in chemical reactions?

(ii) Copper compounds, particularly copper (II) chloride are used in fireworks as a colouring agent. Which colour in a fireworks display originates from copper compounds?

[2]

c. Give one reason for each of the following:

(i) When exposed to moist air, a reddish-brown copper sheet becomes green-coloured.

(ii) Copper compounds can be used as a wood preservative.

[2]
SECTION B – Answer TWO questions only on the foolscap provided.  
This section carries 40 marks.

7a. Draw a labelled diagram of the apparatus you would use to show that a graphite rod conducts electricity but a polythene rod does not.  

b. Draw a labelled diagram of the apparatus you would use to show that aqueous copper (II) sulfate is an electrolyte but ethanol is not.

c. Each of the compounds:
   - aqueous copper (II) chloride
   - aqueous sodium iodide
   - aqueous magnesium sulfate
   is tested for electrical conductivity using a modified version of the apparatus you used in question b.

   For each of these electrolytes:
   (i) outline your observations and identify the new products formed at each electrode.
   (ii) explain what happens in terms of the preferential discharge of ions.

8 Comment on each of the following statements:
   Your comments should include:
   - a detailed explanation of any reaction that occurs
   - chemical equations where appropriate

   a. An aqueous solution of hydrogen chloride is a good electrolyte but hydrogen chloride dissolved in methylbenzene is a non-electrolyte.

   b. Aluminium does not react with sulfuric acid unless it is rubbed with abrasive paper but zinc reacts readily.

   c. Zinc oxide reacts with both dilute hydrochloric acid and aqueous sodium hydroxide but copper (II) oxide reacts with dilute hydrochloric acid only.

   d. The reaction between aluminium powder and iron (III) oxide is highly exothermic.
9a. The Environmental Protection Agency has established 10 mg/litre as the maximum contaminant level for nitrate ions in underground water and 1 mg/litre for nitrate ions in drinkable tap water.

(i) Name two sources that are responsible for contaminating water with nitrate ions.
(ii) Which property of nitrates makes it possible for them to leach easily into underground water? [3]

b. (i) Give the name of a coloured gas that is evolved when most metallic nitrates are heated.
(ii) Give two properties of this gas.
(iii) Draw a labelled diagram of the apparatus that can be used for the laboratory preparation and collection of this gas.
(iv) Name one safety precaution you should take when preparing this gas in the laboratory.
(v) Write a full equation complete with state symbols for the reaction. [12]

c. Pure dry ammonia can be decomposed into its elements by passing it over heated iron wool.
(i) Write an equation complete with state symbols for this reaction.
(ii) What is the purpose of the iron wool?
(iii) 40 cm$^3$ of pure dry ammonia were completely decomposed into its elements. Calculate the total volume of gases produced if the original temperature and pressure were left unchanged throughout. [5]