2010 Senior External Examination

Chemistry

Paper Two — Question and response book

Wednesday 27 October 2010
1 pm to 3:10 pm

Time allowed
- Perusal time: 10 minutes
- Working time: 2 hours

Examination materials provided
- Paper Two — Question and response book
- Paper Two — Resource book

Equipment allowed
- QSA-approved equipment
- non-programmable calculator

Paper Two is an open book examination. You may refer to any paper-based material that you have brought into the examination room.

Directions
Do not write in this book during perusal time.
Paper Two has four questions. Attempt all questions.
Cross out any draft work that is not to be assessed.

Assessment
Assessment standards are at the end of this book.

After the examination session
The supervisor will collect this book when you leave.
Planning space
Complex reasoning processes

Paper Two has four questions of equal value. Attempt all questions.

Write your responses on the pages provided. If you need more space for a response, continue on pages 18 and 19 of this book.

In each response, give full reasoning in terms of your knowledge and application of chemistry and use the range of scientific processes and complex reasoning objectives learned throughout your study of the subject.

You may refer to any paper-based material that you have brought into the examination room. In the table below, give the bibliographical details of the sources you have used.

In the boxes at the end of the space provided for your response to each question, indicate the source number/s and the pages from the sources that you used.

<table>
<thead>
<tr>
<th>Source number</th>
<th>Title</th>
<th>Author/s</th>
<th>Publisher</th>
<th>Date of publication</th>
</tr>
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<tbody>
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Grade descriptions for each question are provided below.

A grade:
- Has arrived at a valid solution.
- Has successfully demonstrated logical reasoning and critical thinking.
- Has made few, if any, (minor) errors.

B grade:
- Has made substantial progress towards an appropriate solution.
- Has applied logical reasoning and critical thinking.

C grade:
- Has made some progress towards a solution.
- Has demonstrated some logical reasoning and critical thinking.

D grade:
- Response is unintelligible or does not satisfy the requirements for any other grade.
Question 1

a. A 35.00 g sample of a compound containing carbon, hydrogen and oxygen is burnt in excess oxygen to produce 83.23 g of carbon dioxide (CO₂) and 42.56 g of water (H₂O). Determine an empirical formula for this compound.

b. Given that the molar mass of the compound is 74.0 g mol⁻¹ and that it can be oxidised by potassium dichromate to produce a substance that will react with zinc to produce hydrogen, draw two possible structures for the compound.

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Question 2

In an experiment to demonstrate how the relative atomic masses of metals can be determined, a teacher set up a series of electrolytic cells as shown below. A current of 10.0 ampere was applied.

![Electrolytic cells diagram]

a. For what length of time must the 10.0 ampere current be run through the cells for 19.05 g of Cu to be formed on the cathode of the copper cell?

b. The cells were then dismantled and the mass of metal that had formed on the cathodes in the other four cells was found. The following data table was constructed.

<table>
<thead>
<tr>
<th>Cell</th>
<th>Mass of metal formed on cathode (g)</th>
</tr>
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<tbody>
<tr>
<td>Ag</td>
<td>64.76</td>
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<tr>
<td>Zn</td>
<td>19.62</td>
</tr>
<tr>
<td>Cu</td>
<td>19.05</td>
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<tr>
<td>Al</td>
<td>5.40</td>
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<tr>
<td>Sn</td>
<td>35.61</td>
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</tbody>
</table>

Explain how the results from this experiment can be used to determine the relative atomic masses of these elements.
Question 3

A teenage boy buys some balloons to fill with Helium (He) for a party. To stop them floating away, he decides to tie small metal rings to each balloon.

Use the following information to find the minimum number of metal rings he will need to tie to each balloon to stop it floating away.

- Mass of a balloon: 3.6 g
- Mass of string tied to each balloon: 1.5 g
- Mass of each metal ring: 1.2 g
- Volume of balloon when inflated: 15 L
- Pressure of gas in inflated balloon: 1.2 atm
- Temperature: 25° C.

Notes:
1. The balloon will float upwards if the total mass of the balloon, string, metal rings and the helium gas inside the balloon is less than the mass of the air displaced.
2. The density of air is 28.8 g mole⁻¹.
Planning space
Question 4

Calculate the pH of a solution made by adding 500 ml of 1.0 mole L\(^{-1}\) acetic acid (CH\(_3\)COOH) with 500 ml of 1.0 mole L\(^{-1}\) sodium acetate (NaCH\(_3\)COO).

State any assumptions you have used to simplify your calculations.

Calculate what the pH will be when 1 L of 1.0 mole L\(^{-1}\) hydrochloric acid is added to the solution.

Notes:
1. For CH\(_3\)COOH, \(K_a = 1.8 \times 10^{-5}\).
2. NaCH\(_3\)COO is highly soluble.
### Assessment standards from the 1998 senior external syllabus for Chemistry

**Paper Two**

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Very High Achievement</th>
<th>High Achievement</th>
<th>Sound Achievement</th>
<th>Limited Achievement</th>
<th>Very Limited Achievement</th>
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<tbody>
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<td>Complex reasoning processes</td>
<td>A high ability to use complex reasoning in challenging situations involving the candidate’s understanding of subject matter, and a high ability to use scientific processes at an advanced level.</td>
<td>Competence in using complex reasoning in challenging situations involving the candidate’s understanding of subject matter, and competence in using scientific processes at an advanced level.</td>
<td>Some success in using complex reasoning in challenging situations involving the candidate’s understanding of subject matter, and some success in using scientific processes at an advanced level.</td>
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