2009 Senior External Examination

Chemistry

Paper Two — Question and response book

Wednesday 28 October 2009
1:00 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

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

Respond to all questions. The questions are of equal value.

Write your responses on the pages provided. If you need more space for a response, continue on pages 17 and 18 of this book.

Assessment criteria specific to each question are provided.

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 source/s that you used.

<table>
<thead>
<tr>
<th>Source number</th>
<th>Title</th>
<th>Author/s</th>
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Question 1

A forensic analyst working in an analytical laboratory has been given several $1 coins that are suspected of being counterfeit. An analysis of one of the coins for its copper and nickel content is performed as follows:

The coin is ground into metal filings and the following reactions performed and data obtained.

To determine the copper content: 4.89 g of filings from the coin is dissolved using concentrated acid to release Cu⁺ ions. Ammonium thiocyanate is then added to precipitate the copper as copper thiocyanate (CuSCN). After collecting the precipitate in a filtering crucible, it is dried in an oven at 115°C to yield a mass of 8.74 g.

To determine the nickel content: 4.89 g of filings is dissolved as above. In a carefully controlled procedure, the nickel present is then precipitated as nickel dimethyl glyoxime, formula Ni(C₄H₇O₂N₂)₂. This precipitate is collected and dried as above, yielding a final mass of 0.96 g.

The analyst checked the results against the data from the Reserve Bank and concluded that the coin was counterfeit. The Reserve Bank’s data indicated that the percentage content of metals in the coin should have been:

- 89% Cu
- 7% Al
- 4% Ni

Decide whether the analyst’s conclusion is correct. Show all relevant calculations.

Assessment criteria for Question 1:

- ability to solve problem correctly
- ability to reason logically
- ability to think critically

For an A standard: solve the problem correctly with logical reasoning and critical thinking.

For a B standard: solve the problem correctly with logical reasoning but no critical thinking.

For a C standard: demonstrate some attempt to solve the problem with valid explanations, but without a correct solution.

For a D standard: demonstrate little or no attempt to solve the problem, without success and/or invalid explanations.

Write your response on the following pages.
Planning space
Question 2

a. If 500 ml of a 0.050 M Zn(NO₃)₂ solution is added to a 400 ml solution of 0.00020 M K₂C₂O₄, will a precipitate form? Show all calculations to justify your response.

\[ K_{sp} (\text{ZnC}_2\text{O}_4) = 2.7 \times 10^{-8} \]

b. If a precipitate does form, calculate what mass of precipitate forms. If one does not form, calculate how many more moles of Zn(NO₃)₂ need to be added for a precipitate to start to be formed. Show all calculations. (State and justify any assumptions you make in order to simplify your calculations.)

Assessment criteria for Question 2:

- ability to solve problem correctly
- ability to reason logically
- ability to be critical

For an A standard: solve the problem correctly with logical reasoning and critical thinking.

For a B standard: solve the problem correctly with logical reasoning but no critical thinking.

For a C standard: demonstrate some attempt to solve the problem with valid explanations, but without a correct solution.

For a D standard: demonstrate little or no attempt to solve the problem, without success and/or invalid explanations.

Write your response on the following pages.
Planning space
Question 3

Suppose that the Pauli Principle indicated that an orbital could hold up to three electrons. Assume that the number of orbitals in each atom and their order of filling remain unchanged and that electron triplets, instead of electron pairs, are the favoured arrangement.

a. Write the electron configuration for elements 3, 7, 10 and 13.

b. Describe how the shape and structure of the periodic table would change using this model. Give strategic examples from the first three rows (Periods) to illustrate differences.

c. Sketch a graph showing how the first ionisation energies would vary using this model for the elements numbered 1 to 24.

d. Explain why you have drawn the graph the way you have.

e. State three pieces of evidence that would indicate that the model for three electrons per orbital cannot be sustained as a useful model.

Assessment criteria for Question 3:

- ability to reason logically
- ability to think critically

For an A standard: solve all parts of the problem correctly with logical reasoning and critical thinking in all sections.

For a B standard: solve all parts of the problem correctly with logical reasoning but with no critical thinking.

For a C standard: demonstrate some attempt to solve the problem with valid explanations, but without correct solutions in two or more parts.

For a D standard: demonstrate little or no attempt to solve the problem, without success and/or invalid explanations.

Write your response on the following pages.
Planning space
Question 4

A leading car tyre distributor recently advertised that it would inflate five tyres with nitrogen for the price of four.

In the advertisement, the tyre distributor made claims about the advantages that nitrogen would have for your tyres and the way your car handled. The claims were that:

“By replacing the compressed air in your tyres with nitrogen you can experience a smoother, softer ride as your tyre pressures stay constant for longer. This can help to increase tyre life, fuel economy and reduce the risk of blowouts and need for pressure checks.”

Evaluate the validity or otherwise of these claims. Use your knowledge of all appropriate aspects of the gas laws, the composition of the atmosphere and the chemistry of the various gases that may be involved.

Write a report that describes one simple experiment that could be done to support your evaluation and provide information to car owners.

Assessment criteria for Question 4:

- ability to reason logically
- ability to think critically
- ability to be creative

For an A standard: reason logically and think critically using the Kinetic Theory of Gases fully for the listed properties.

For a B standard: reason logically and think critically using the Kinetic Theory of Gases, but with minor errors and/or omissions for the listed properties.

For a C standard: demonstrate some attempt at solving the problem with some valid explanations, logical reasoning and critical thinking.

For a D standard: demonstrate an attempt to solve the problem but with limited success, and/or with invalid explanations and no critical thinking.

Write your response on the following pages.
### Assessment standards from the 1998 Senior External Syllabus for Chemistry

#### Paper Two

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<tr>
<th>Criterion</th>
<th>Very High Achievement</th>
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<th>Sound Achievement</th>
<th>Limited Achievement</th>
<th>Very Limited Achievement</th>
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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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