EXTERNAL ASSESSMENT SPECIFICATIONS

CHEMISTRY (CHM415115)

External Assessment Specifications inform the development of external assessments. The primary audience for this document is the course Setting Examiner and Exam Critics. It may also be of use to teachers and students.

These specifications must be read in conjunction with the Course Document.

The format of the external assessment is:

- a 3 hour written examination.

The criteria to be assessed are:

**Criterion 5:** identify and apply fundamental principles and theories of electrochemistry
All aspects of Criterion 5 are examinable

**Criterion 6:** identify and apply principles and theories of thermochemistry, kinetics and equilibrium
All aspects of Criterion 6 are examinable

**Criterion 7:** demonstrate knowledge and understanding of properties and reactions of organic and inorganic matter
All aspects of Criterion 7 are examinable

**Criterion 8:** apply logical processes to solve quantitative chemical problems
All aspects of Criterion 8 are examinable.
**WRITTEN EXAMINATION STRUCTURE**

The examination paper is divided into four parts. The four parts are in four separate item-and-response booklets. A set of spare diagrams used in each part is provided in the back of the relevant item-and-response booklet.

The following specifications for each part are outlined in the table below:

- the distribution across the parts of:
  - criteria
  - course content (topics)
  - time and mark allocations
- number and type of items.

<table>
<thead>
<tr>
<th>Part</th>
<th>Part 1</th>
<th>Part 2</th>
<th>Part 3</th>
<th>Part 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criteria</strong></td>
<td>Criterion 5</td>
<td>Criterion 6</td>
<td>Criterion 7</td>
<td>Criterion 8</td>
</tr>
<tr>
<td><strong>Course coverage</strong></td>
<td>Fundamental principles and theories of electrochemistry</td>
<td>Principles of thermochemistry, kinetics and equilibrium</td>
<td>Properties and reactions of organic and inorganic matter</td>
<td>Application of logical processes to solve quantitative chemical problems</td>
</tr>
<tr>
<td><strong>Number and nature of items</strong></td>
<td>From 5 to 7 items, some broken into parts</td>
<td>From 5 to 7 items, some broken into parts</td>
<td>From 5 to 7 items, some broken into parts</td>
<td>From 5 to 7 items, some broken into parts</td>
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<tr>
<td><strong>Compulsory or optional</strong></td>
<td>Compulsory</td>
<td>Compulsory</td>
<td>Compulsory</td>
<td>Compulsory</td>
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<tr>
<td><strong>Item type(s) / format</strong> (See Attachment 1 for definitions and exemplars)</td>
<td>Context of the item</td>
<td>Context of the item</td>
<td>Context of the item</td>
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<tr>
<td></td>
<td>Some extended items are in non-routine contexts.</td>
<td>Some extended items are in non-routine contexts.</td>
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<td>Some scenarios of items are real-world scenarios.</td>
<td>Some scenarios of items are real-world scenarios.</td>
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<td>Some scenarios of items are real-world scenarios.</td>
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<td></td>
<td>Response format</td>
<td>Response format</td>
<td>Response format</td>
<td>Response format</td>
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<tr>
<td></td>
<td>A balance of items ranging from short to extended response formats.</td>
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<tr>
<td></td>
<td>Assessment of response</td>
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<td>Assessment of response</td>
<td>Assessment of response</td>
</tr>
<tr>
<td></td>
<td>Responses range from closed-ended to open-ended.</td>
<td>Responses range from closed-ended to open-ended.</td>
<td>Responses range from closed-ended to open-ended.</td>
<td>Responses range from closed-ended to open-ended.</td>
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<td></td>
<td><strong>Response time</strong></td>
<td><strong>45 minutes</strong></td>
<td><strong>45 minutes</strong></td>
<td><strong>45 minutes</strong></td>
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<tr>
<td></td>
<td><strong>Mark / rating allocation (weighting must be specified)</strong></td>
<td><strong>40 marks</strong></td>
<td><strong>40 marks</strong></td>
<td><strong>40 marks</strong></td>
</tr>
</tbody>
</table>

**SPECIFIC MATERIALS AND EQUIPMENT APPROVED FOR USE BY CANDIDATES**

- A calculator as approved by TASC
- The current year's External Examination Information Sheet Chemistry.

**ASSESSMENT**

A set of solutions or a marking tool will be developed by the Setting Examiner, provided to markers at the marking meeting that follows the external written examination; and will be available from TASC in the following year.

The external assessment must include items that, separately or together, give opportunities to demonstrate the standards from rating C to rating A.

Final results will be awarded as a rating of A, B, C, t or z in the above criteria. These ratings are used in determining the final award according to the algorithm in the course document.
WRITTEN EXAMINATION CHECKLIST

PART 1: DEMONSTRATE KNOWLEDGE AND UNDERSTANDING OF FUNDAMENTAL PRINCIPLES AND THEORIES OF ELECTROCHEMISTRY

☐ Assesses all aspects of Criterion 5
☐ Items give opportunities to demonstrate standards from rating C to rating A
☐ Marks add up to 40
☐ Includes a representative sample of course content from fundamental principles and theories of electrochemistry
☐ Included 5 – 7 items, some broken into parts
☐ Some extended items are in non-routine contexts
☐ Some scenarios are real-world with approximations to reality stated
☐ Responses are a balance range from short to extended formats
☐ Responses range from closed-ended to open-ended

PART 2: DEMONSTRATE KNOWLEDGE AND UNDERSTANDING OF PRINCIPLES AND THEORIES OF THERMOCHEMISTRY, KINETICS AND EQUILIBRIUM

☐ Assesses all aspects of Criterion 6
☐ Items give opportunities to demonstrate standards from rating C to rating A
☐ Marks add up to 40
☐ Includes a representative sample of course content from principles and theories of thermochemistry, kinetics and equilibrium
☐ Included 5 – 7 items, some broken into parts
☐ Some extended items are in non-routine contexts
☐ Some scenarios are real-world with approximations to reality stated
☐ Responses are a balance range from short to extended formats
☐ Responses range from closed-ended to open-ended

PART 3: DEMONSTRATE KNOWLEDGE AND UNDERSTANDING OF PROPERTIES AND REACTIONS OF ORGANIC AND INORGANIC MATTER

☐ Assesses all aspects of Criterion 7
☐ Items give opportunities to demonstrate standards from rating C to rating A
☐ Marks add up to 40
☐ Includes a representative sample of course content demonstrating knowledge and understanding of properties and reactions of organic and inorganic matter
☐ Included 5 – 7 items, some broken into parts
☐ Some extended items are in non-routine contexts
☐ Some scenarios are real-world with approximations to reality stated
☐ Responses are a balance range from short to extended formats
☐ Responses range from closed-ended to open-ended
PART 4: APPLY LOGICAL PROCESSES TO SOLVE QUANTITATIVE CHEMICAL PROBLEMS

☐ Assesses all aspects of Criterion 8
☐ Items give opportunities to demonstrate standards from rating C to rating A
☐ Marks add up to 40
☐ Includes a representative sample of course content applying logical processes to solve quantitative chemical problems
☐ Included 5 – 7 items, some broken into parts
☐ Some extended items are in non-routine contexts
☐ Some scenarios are real-world with approximations to reality stated
☐ Responses are a balance range from short to extended formats
☐ Responses range from closed-ended to open-ended
ATTACHMENT I

In these specifications, the term ‘item’ is defined as an individual task to be undertaken by candidates. The task may be divided into several parts. Item types can be categorised in terms of:

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ITEM TYPES AND DEFINITIONS</th>
<th>EXEMPLARS</th>
</tr>
</thead>
</table>
| The context of the item         | Routine context  
These items require rehearsed skills in Chemistry, and in familiar contexts.                        | TCE Chemistry Exam 2012 – Q23 Combined Gas Equation calculation  
Air that has a volume of 500 mL, a pressure of 99.4 kPa and a temperature of 32°C is cooled to −15°C. Calculate the volume of air at this temperature if the pressure is increased to 205.9 kPa. (3 marks) |
| Non-routine context             | Non-routine context  
These items require procedures not previously encountered in expected prior learning activities. These require the combination, and sometimes the selection, of a set of skills in unfamiliar contexts. | TCE Chemistry Exam 2011 – Q27 Non-standard (difficult) empirical formula calculation  
12.66 g of pure Pb₃O₄(s) was heated. 240 mL of oxygen at 27.0°C and 96.0 kPa was produced and another oxide of lead.  
(a) Calculate the mass of oxygen gas produced. (2 marks)  
(b) Hence calculate the empirical formula of the lead oxide produced. (4 marks) |
### Real-world scenarios

**TCE Chemistry Exam 2014 – Q4 Corrosion of water pipes**

A hot water system was repaired by connecting a steel pipe to a copper pipe. After a short time the steel pipe became very corroded where the two pipes connected.

![Diagram of corroded pipes]

(a) Explain, including half equations, why the steel pipe corroded so quickly where the two pipes connected. (4 marks)

(b) Describe two different ways in which the corrosion of the steel pipe could have been slowed down. There is no need to give any equations. (2 marks)
### The format of response
*Short response format*

These items are composed of a brief prompt that demands a response to some stimulus material that varies from a single response to a few written points. This sort of item is suited to assessing the candidate’s ability to:
- recall specific information and methods related to key content
- apply rehearsed methods to familiar situations
- demonstrate understanding of key concepts in previously unseen stimulus material.

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#### TCE Chemistry Exam 2013 – Q17 Ionization energy

The graph below shows the first ionisation energy (first I.E.) for elements 11 to 19 of the periodic table.

![Graph showing first ionisation energy for elements 11 to 19](image)

(a) **Account for the general increasing trend** in first ionisation energies for sodium to argon.  

(b) **Account for the fact that the first ionisation energy of aluminium is less than that of magnesium.**

(2 marks)
Extended response format
These items involve lengthy and/or multi stage responses [of increasing complexity]. Greater complexity may be due to one or more of, but not limited to, the following:
  o a greater cognitive demand of Chemistry concepts
  o the necessity to select appropriate information
  o justification of a response via a logical line of reasoning.

TCE Chemistry Exam 2011
Q4 Electrochemical Cells EMF values

Some electrochemical cells were constructed based on the metals labelled A, B, C, D and E and their corresponding ions. The equations for the overall cell reactions and their measured voltages are given below. (Assume that the ions undergo only the reactions shown.)

<table>
<thead>
<tr>
<th>Overall cell reaction</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A_{(aq)} + B^{2+}<em>{(aq)} → A^{2+}</em>{(aq)} + B_{(s)}</td>
<td>0.98</td>
</tr>
<tr>
<td>B_{(s)} + D^{2+}<em>{(aq)} → B^{2+}</em>{(aq)} + D_{(s)}</td>
<td>1.05</td>
</tr>
<tr>
<td>2C_{(s)} + B^{2+}<em>{(aq)} → 2C^{+}</em>{(aq)} + B_{(s)}</td>
<td>1.68</td>
</tr>
<tr>
<td>B_{(s)} + B^{2+}<em>{(aq)} → B^{2+}</em>{(aq)} + B_{(s)}</td>
<td>0.00</td>
</tr>
<tr>
<td>B_{(s)} + E^{2+}<em>{(aq)} → B^{3+}</em>{(aq)} + E_{(s)}</td>
<td>0.66</td>
</tr>
</tbody>
</table>

(a) Arrange the half cell equations in decreasing order of reduction potentials. State the voltage relative to the reference cell used in this experiment. List the metal and the metal ions in solution using the letters A, B, C, D or E. (5 marks)

(b) Explain why a solution of D^{2+}_{(aq)} ions will not react with a solution of A^{2+}_{(aq)} ions. (1 mark)
<table>
<thead>
<tr>
<th>Assessment of response</th>
<th>Closed-ended response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>These are items for which there is a single 'correct' or 'best' response.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TCE Chemistry Exam 2013 – Q11 Hess' Law</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider the following thermochemical reactions.</td>
</tr>
</tbody>
</table>
| \[
\begin{align*}
\text{Cu}_2(\text{s}) + \frac{1}{2}\text{O}_2(\text{g}) & \rightarrow \text{CuO}_2(\text{s}) \quad \Delta H = -155 \text{ kJ} \\
\text{Cu}_2(\text{s}) + \text{S}_2(\text{s}) & \rightarrow \text{CuS}_2(\text{s}) \quad \Delta H = -53.1 \text{ kJ} \\
\text{S}_2(\text{s}) + \text{O}_2(\text{g}) & \rightarrow \text{SO}_2(\text{s}) \quad \Delta H = -297 \text{ kJ} \\
4\text{CuS}_2(\text{s}) + 2\text{CuO}_2(\text{s}) & \rightarrow 3\text{Cu}_2\text{S}_2(\text{s}) + 2\text{SO}_2(\text{s}) \quad \Delta H = -13.1 \text{ kJ}
\end{align*}
\] |
| Use the above data to predict the heat released or absorbed (in kJ) for the reaction below for the production of copper(I) sulfide: |
| \[
\text{CuS}_2(\text{s}) + \text{Cu}_2(\text{s}) \rightarrow \text{Cu}_2\text{S}_2(\text{s}) 
\] |
| (4 marks) |

<table>
<thead>
<tr>
<th>Open-ended response</th>
</tr>
</thead>
<tbody>
<tr>
<td>These are items for which there may be multiple correct responses OR in which the quality of the argument and/or the expression is being assessed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TCE Chemistry Exam 2013 – Q14 Equilibrium – Ammonia synthesis conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen monoxide is produced industrially when ammonia gas reacts with oxygen gas.</td>
</tr>
</tbody>
</table>
| \[
4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g}) \quad \Delta H = -910 \text{ kJ}
\] |
| In order to maximise yields of nitrogen monoxide, the reaction conditions involve: |
| • relatively low pressure (100 kPa) |
| • temperatures of approximately 900 °C |
| • the use of a catalyst |
| Using your understanding of reaction kinetics and equilibrium chemistry, explain why these conditions are used. |
| (6 marks) |