# Chemistry
## Section II

**25 marks**
**Attempt ONE question from Questions 31–35**
**Allow about 45 minutes for this section**

Answer the question in a SEPARATE writing booklet.

Show all relevant working in questions involving calculations.

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**3501-1**

**Marks**

**Question 31 – Industrial Chemistry** (25 marks)

(a) Sulfuric acid is one of the world's most produced chemicals.

(i) Identify ONE safety precaution you need to take when handling sulfuric acid. **1**

(ii) The first step in the production of sulfuric acid is the extraction of elemental sulfur from mineral deposits. **4**
Describe the Frasch process used to extract sulfur, relating the method to the properties of elemental sulfur which allow its extraction.
Describe potential environmental issues that may be associated with this extraction process.

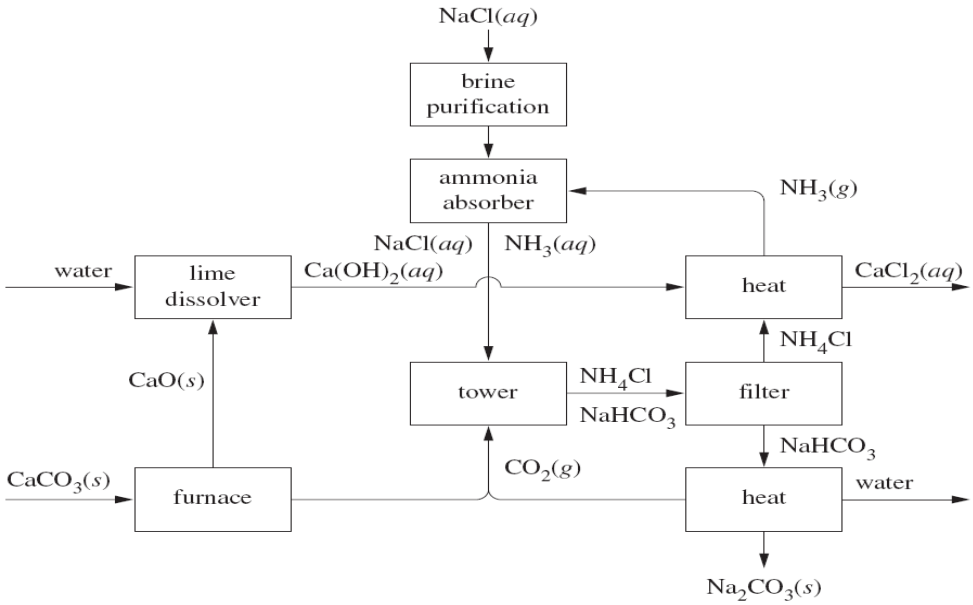
(b) In order to convert sulfur dioxide into sulfur trioxide, a chemist mixed $4.325 \times 10^3$ mol of sulfur dioxide with $2.132 \times 10^3$ mol of oxygen in a 10.00 L reaction vessel. At equilibrium, he noted that 3.762 x $10^3$ mol of sulfur trioxide had been produced.

(i) Write a balanced equation for this reaction. **1**

(ii) Write an expression for the equilibrium constant for this reaction. **1**

(iii) Calculate the equilibrium constant for the reaction at this temperature. **3**

(c) The flow chart summarises the steps involved in the Solvay process. **4**
Describe the chemistry involved in the stage of the Solvay Process which involves formation of a hydrogen carbonate compound. Include balanced equations in your response.




**Question 31 continues on page 27**

**Marks**

Question 31 (continued)

(d) The production of sodium hydroxide can be carried out industrially using different electrolytic processes. **7**
Describe the diaphragm process and products.
Compare the environmental issues and the technical considerations in the diaphragm process with those associated with the mercury-cell process.

(e) During the course of your studies you performed a first-hand investigation to carry out saponification and test the product. **4**
Outline your procedure, including any safety considerations, describe your results and describe how you tested the product.

**End of Question 31**

**Marks**

**Question 32 – Shipwrecks, Corrosion and Conservation** (25 marks)

(a) Identify the scientist who first produced pure samples of active metals like sodium by passing electricity through molten compounds of the metals. **1**

(b) The composition of a sample of mild steel is given in the table below.

| *Mild steel composition (% by mass)* | | | | | |
|---|---|---|---|---|---|
| C | Mn | Si | S | P | Fe |
| 0.14 | 0.35 | 0.17 | 0.025 | 0.03 | the remainder |

(i) Calculate the percentage of iron in this sample of mild steel. **1**

(ii) Mild steel rusts readily in seawater. The reduction half-equation for this process is **1**

$O_2\,(g) + 2H_2O\,(l) + 4e^- \rightleftharpoons 4OH^-\,(aq)$

Identify the substance being reduced in this reaction.

(iii) Explain why stainless steel would be much more corrosion-resistant than this mild steel. **2**

(c) In your course you investigated conservation and restoration techniques applied to Australian maritime projects.

(i) Compare the terms *conservation* and *restoration*. **1**

(ii) Explain why artefacts recovered from the ocean are initially stored submerged in aqueous solutions. **2**

(iii) Describe a chemical procedure used to clean iron artefacts recovered from the ocean. Include an appropriate chemical equation in your response. **3**

(d) Analyse the impact of depth on the corrosion of shipwrecks in the ocean. **6**

**Question 32 continues on page 29**

**Marks**

Question 32 (continued)

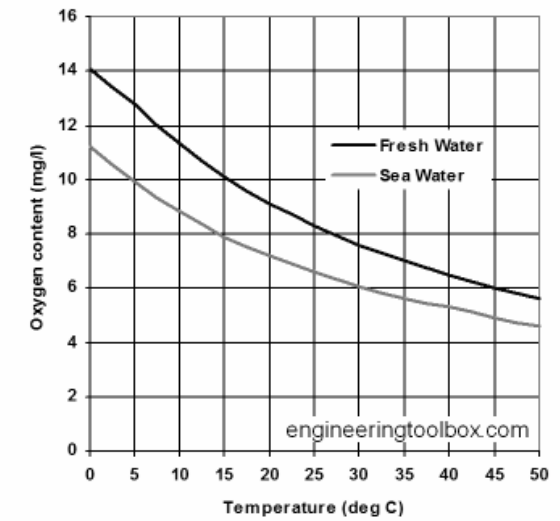
(e) The corrosion rate of a submerged wreck may be influenced by the temperature of the surrounding water.

(i) Outline the method you used to perform a first-hand investigation to compare the rate of corrosion at different temperatures. **2**

(ii) Identify strategies used to control variables in your investigation. **2**

(f) Examine the following graph.

***The solubility of oxygen in fresh and sea water versus temperature***




http://www.engineeringtoolbox.com/oxygen-solubility-water-d_841.html

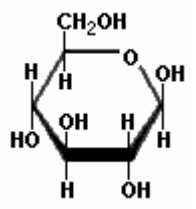
(i) Identify a relationship shown in the graph. **1**

(ii) Based on the information in the graph, a student predicted that corrosion would be faster in fresh water than in sea water. Discuss. **3**

**End of Question 32**

**Marks**

**Question 33 – The Biochemistry of Movement** (25 marks)

(a)  **1**



Identify the name of the above carbohydrate.

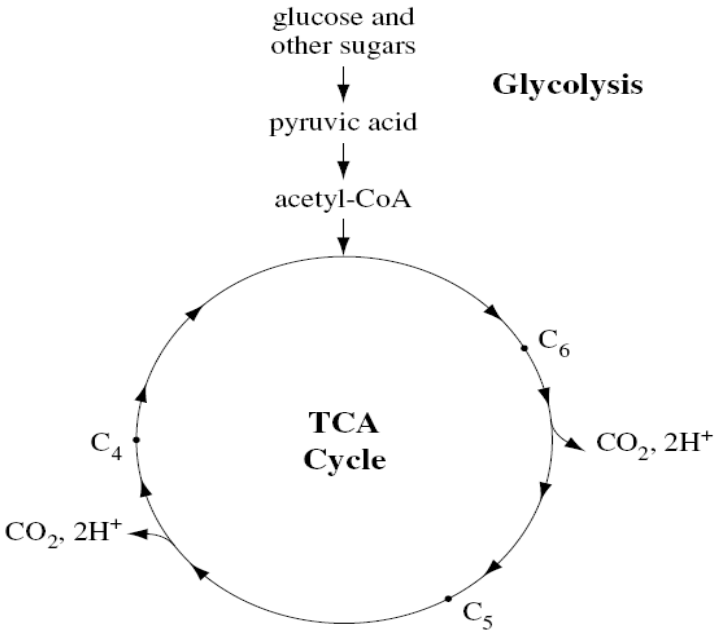
(b) During your practical work you performed a first-hand investigation to demonstrate the effect of factors on the reaction of a named enzyme.

(i) Identify TWO factors you studied in the investigation. **1**

(ii) Choose ONE factor and explain its impact upon the named enzyme. **2**

(iii) Identify the safety precautions taken during the investigation. **2**

(c) Using the flow chart below, analyse and compare the total energy output from glycolysis with the total energy output from the TCA cycle. **5**





**Question 33 continues on page 31**

**Marks**

Question 33 (continued)

(d) (i) Draw a structural formula for glycerol. **1**

(ii) Account for the solubility of glycerol in water. **1**

(iii) Identify the use of triacylglycerols (TAGs) in the human body. **1**

(e) Compare the respiration processes involved in sprinting with those respiration processes involved in long distance running. **6**

(f) (i) Draw the general structural formula for amino acids and identify the major functional groups present. **2**

(ii) Identify the forces which determine the shape of a protein molecule. **1**

(iii) Account for the process of protein denaturation. **2**

**End of Question 33**

**Marks**

**Question 34 – The Chemistry of Art** (25 marks)

(a) Apart from the use of paints and dyes, identify TWO other examples of the creation and use of colour by modern humans. **1**

(b) In ancient times, several cultures used various pigments as cosmetics. They had no knowledge of the chemical composition and thus of any potential health risk of the pigments they used. **3**

Assess the potential health risk associated with the use of a named pigment used by an ancient civilisation, in relation to its chemical composition.

(c) You performed an experiment to investigate the colour changes of a transition metal as it changed its oxidation state.

(i) Explain why it is possible for the changing oxidation state of a transition metal to result in a change of colour. **2**

(ii) Outline the procedure for your first hand-investigation and describe your results, specifying the colour changes and changes in oxidation state of the species involved. **4**
Include half-equations for the oxidation or reduction reactions you carried out.

(d) Ernest Rutherford's planetary model of the atom was revolutionary in comparison to the previously accepted atomic model, but was still flawed in many ways. Niels Bohr's work improved significantly on the Rutherford model but still left some questions about the atom unanswered. **6**

Describe the Bohr model of the atom.
Discuss the extent to which this model improved upon Rutherford's planetary model and discuss the limitations of Bohr's model.

**Question 34 continues on page 33**

**Marks**

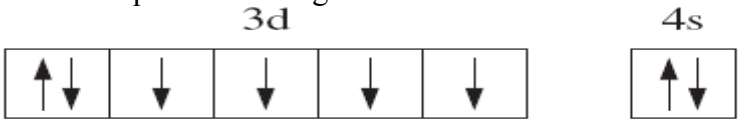
Question 34 (continued)

(e) (i) Identify TWO differences between the s and p sub-shells within the same principal shell of an atom. **2**

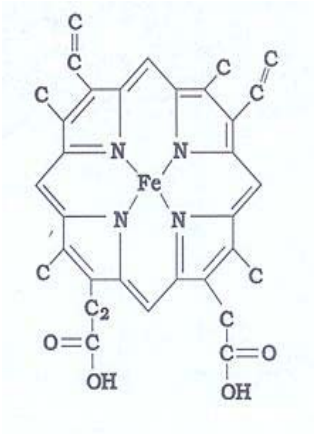
(ii) State the Pauli Exclusion Principle. **1**

(iii) State the electron arrangement for vanadium in terms of shells and sub-shells. **1**

(iv) The electron spin orbital diagram below represents the 3d and 4s electrons for an element in the first transition series. Identify the transition metal and draw the electron spin orbital diagram for the +3 ion formed from this metal. **2**




(f) The diagram below shows the heme molecule.




(i) Identify the type of structure attached to the transition metal, iron, in the heme molecule. **1**

(ii) Briefly describe the method of formation of the bond between Fe and N and name the type of bond that has been formed. **2**

**End of Question 34**

**Marks**

**Question 35 – Forensic Chemistry** (25 marks)

(a) Explain, using relevant examples, how the inorganic components of soils can provide useful forensic evidence. **2**

(b) 1-hexanol and hexanoic acid belong to TWO different classes of organic compounds.

(i) Draw the structural formula and identify EACH of the TWO named compounds. **2**

(ii) Outline a test that could be used to distinguish between the two classes of compounds and describe the results. Include equations or half-equations in your response. **3**

(c) Electrophoresis is a procedure that can be used to separate a number of different biological compounds.

(i) Describe the procedure that you used during the course to separate a mixture using electrophoresis. **3**

(ii) Explain, in terms of their structures, why amino acids can be separated using electrophoresis. **4**
Use the separation of amino acids as an example to explain why electrophoresis is a useful analytical method for forensic investigations.

(d) It is the non-coding regions of DNA that make us unique. **6**

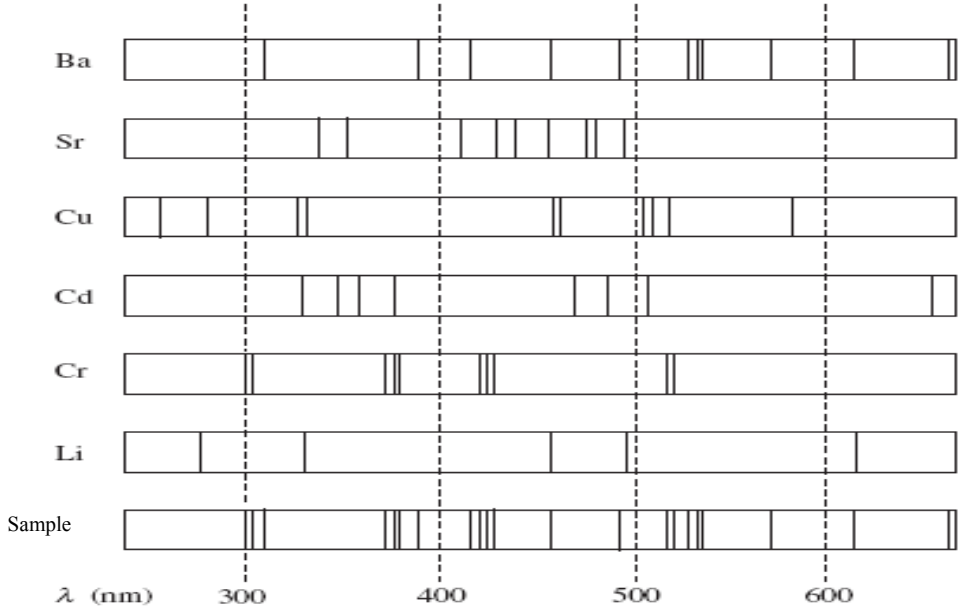
Explain this statement and evaluate the use of DNA analysis in forensic science.

**Question 35 continues on page 35**

**Marks**

Question 35 (continued)

(e) A sample of material was collected from a crime scene and analysed using emission spectroscopy to determine its possible origins.




(i) Use the emission spectrum above to identify the elements present in the sample. **1**

(ii) Compare the use of mass spectrometry with emission spectroscopy in forensic analysis. **4**

**End of paper**

**EXAMINERS**

| | |
|---|---|
| Bronwen Hegarty (convenor) | Educational Consultant |
| Dallas Demeny | Ravenswood School for Girls, Gordon |
| Jo McGrouther | St Vincent's College, Potts Point |
| Troy McMurrich | Oakhill College, Castle Hill |
| Mark Shore | Queenwood School for Girls, Mosman |
| Andrew Szabo | St Ignatius' College, Riverview |

## Sources

Question 13 – Diagram from http://www.chemistry.nmsu.edu/Instrumentation/AAS.html
Question 18 – Diagram from http://www.ecobiomaterial.com/research-002.php
Question 32(f) – Diagram from http://www.engineeringtoolbox.com/oxygen-solubility-water-d_841.html