



# Chemistry

## Section II

**25 marks**

**Attempt ONE question from Questions 30-34**

**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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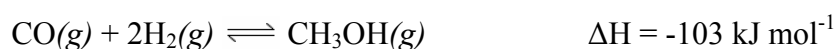
**Question 30 – Industrial Chemistry (25 marks)**

(a)  $\text{CH}_3(\text{CH}_2)_{16}\text{COO}^-\text{Na}^+$  is the structure of the soap, sodium stearate.

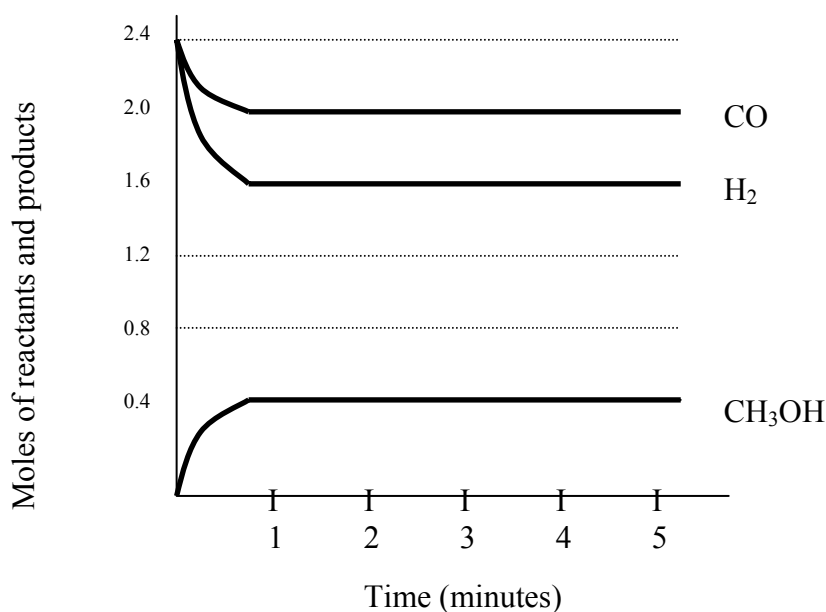
(i) Identify the TWO reactants required to produce this soap. 1

(ii) Sodium stearate is described as anionic. 4  
Explain how cationic detergents are chemically different from anionic soaps. Relate ONE use for cationic detergents to their structure.

(b) The production of methanol is performed under high pressure and moderate temperatures:



The following graph indicates the results of an experiment conducted at  $450^\circ\text{C}$  in a 10 L vessel when  $\text{CO(g)}$  and  $\text{H}_2\text{(g)}$  are reacted.



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

(ii) Calculate the value of the equilibrium constant at  $450^\circ\text{C}$ . 1

(iii) What would be the effect on the equilibrium constant if the experiment were to be performed at  $250^\circ\text{C}$ ? 1

**Question 30 continues on page 27**

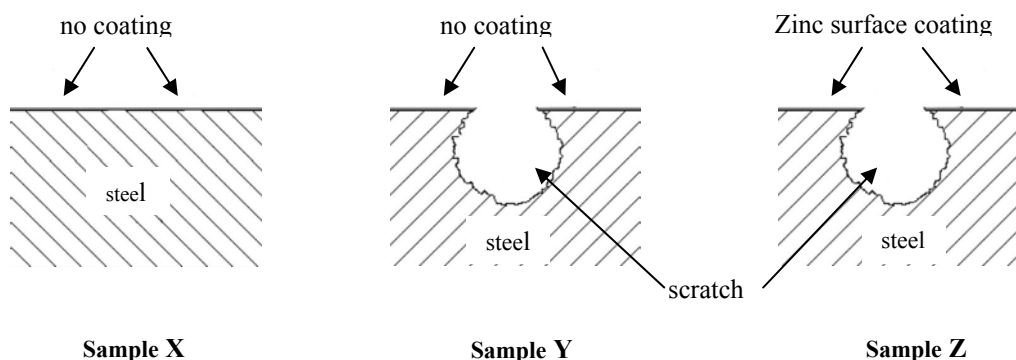
## Question 30 (continued)

- (c) The production of sulfur trioxide is an important step in the production of sulfuric acid.
- (i) Write an equation for the production of sulfur trioxide. **1**
  - (ii) Identify TWO conditions which would increase the yield of sulfur trioxide. **2**
  - (iii) Justify the safety precautions which must be taken in preparing a dilute solution of sulfuric acid from the concentrated acid. **3**
- (d) The production of sodium hydroxide can be carried out industrially using the mercury cell process. **6**
- Describe the mercury cell process and products and state the environmental issues and the technical considerations in operating this plant.
- (e) During the course of your studies you performed a first-hand investigation to model a chemical step involved in the Solvay process. Describe the procedure you used, identifying any difficulties associated with the laboratory modelling of the step and describe the risk factors involved in the procedure. **5**

**End of Question 30**

**Question 31 – Shipwrecks, Corrosion and Conservation (25 marks)**

- (a) Oxygen is usually required for the corrosion of iron. 3  
Discuss the factors that influence the concentration of dissolved oxygen in the oceans.
- (b) In your course you performed a first-hand investigation to compare and describe the rate of corrosion of metals in different acidic and neutral conditions.
- (i) Outline the type of data collected and the method of data collection used in your investigation. 2
- (ii) Evaluate the appropriateness of the type of data collected and the method of data collection outlined in part (i). 3
- (c) Analyse the impact of the work of Volta on the understanding of electron transfer reactions as proposed by Galvani. 4
- (d) Three pieces of identical steel were treated as shown in the diagram (magnified 10x) to produce Samples X, Y and Z. All three samples were placed in a shallow tub of seawater.

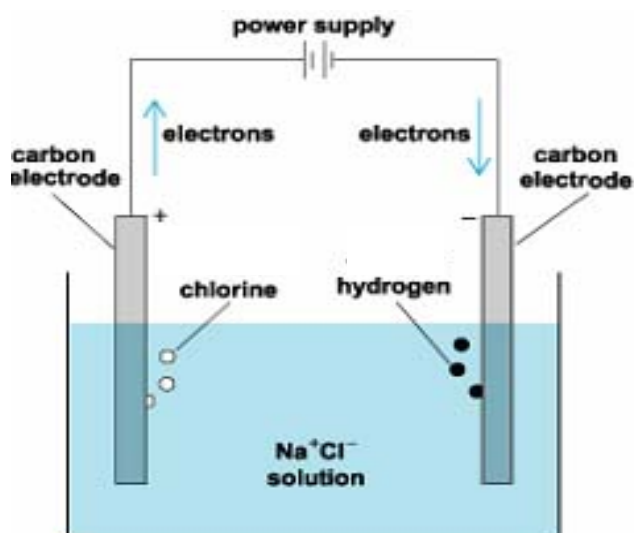


- (i) Identify the composition of steel. 1
- (ii) Write the equation for the oxidation process occurring in Sample X. 1
- (iii) Predict the relative rates of corrosion for the steel in Samples X, Y and Z. Justify your prediction. 4

**Question 31 continues on page 29**

## Question 31 (continued)

(e) An electrochemical cell was set up as shown in the diagram below:

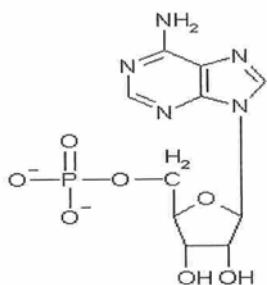


- |       |  |   |
|-------|--|---|
| (i)   | Identify the products of the chemical process in this cell.  | 1 |
| (ii)  | Identify a method of increasing the rate of production of these products, other than by changing the power supply or the solution. | 1 |
| (iii) | Write the half-equation for the reduction process occurring in this cell.  | 1 |
| (iv)  | Describe changes to the reaction in the cell if the sodium chloride solution were changed to molten sodium chloride.               | 2 |
| (v)   | Outline TWO uses of this chemical process in the stabilising and restoring of metal artefacts from wrecks.                         | 2 |

**End of Question 31**

**Question 32 - The Biochemistry of Movement (25 marks)**

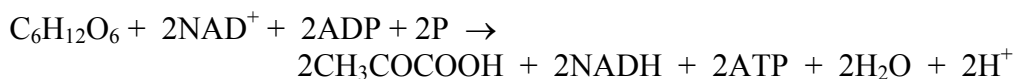
- (a) This diagram shows a structural representation of adenosine monophosphate.



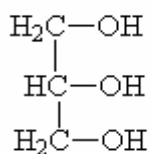
In your ANSWER BOOK, complete a similarly formatted sketch of adenosine triphosphate.

1

- (b) An important aspect of cell respiration is summarised by the following equation:



- (i) Identify the process summarised by the equation. 1
- (ii) Identify the product of this process which can be converted to lactic acid, and describe the conditions under which this happens. 2
- (iii) Outline the significance of adenosine triphosphate and its relationship with the process of cellular respiration. 2
- (c) The condensed structural formula of glycerol may be shown as follows:



- (i) Identify the systematic name for glycerol. 1
- (ii) Explain the high viscosity of glycerol in terms of its structure. 2
- (iii) Using the same format as shown above for glycerol, draw the structural formula of a triacylglycerol (TAG) produced by reacting glycerol with three molecules of lauric acid ( $\text{CH}_3(\text{CH}_2)_{10}\text{COOH}$ ). 1
- (iv) Explain why this TAG will be insoluble in water. 2
- (v) Assess the importance of TAGs for humans. 3

**Question 32 continues on page 31**

	<b>Marks</b>
Question 32 (continued)	
(d) (i) Explain why an enzyme is substrate specific.	<b>2</b>
(ii) During your study of enzymes, you carried out a first-hand investigation to observe the effect of changes in temperature on the reaction of a named enzyme.	<b>4</b>
<ul style="list-style-type: none"> <li>• Describe how you carried out this experiment.</li> <li>• Explain why changes in temperature impacted on the reaction of the named enzyme.</li> </ul>	
(e) The human body fuels exercise in different ways, depending on whether the exercise is steady and gentle or explosive and powerful. Some athletes, in preparation for a major competition, believe that “carb loading” helps their preparation.	<b>4</b>
Carbohydrate loading involves two steps:	
<ul style="list-style-type: none"> <li>• the athlete reduces carbohydrate intake while increasing exercise, beginning a week before the event, to run down the body’s carbohydrate supplies.</li> <li>• just before the event, the athlete will eat higher than usual amounts of carbohydrate to replenish and bolster energy supplies.</li> </ul>	
Assess the worth of the practice of “carb loading” from a biochemical perspective, for each type of exercise.	

**End of Question 32**

**Question 33 – The Chemistry of Art (25 marks)**

- |     |   |          |
|-----|---|----------|
| (a) | Write the ground state configuration of the manganese atom using subshell notation.   | <b>1</b> |
| (b) | (i) Define the term transition element.   | <b>1</b> |
|     | (ii) Explain why transition elements may have more than one oxidation state.  | <b>2</b> |
| (c) | During your course you were required to carry out a first-hand investigation to determine the different flame colours of a variety of metal ions.   |          |
|     | (i) Identify ONE metal ion you used in your investigation and outline the method used in carrying out the flame test on this metal ion. Include any risk analysis you undertook.  | <b>4</b> |
|     | (ii) Explain why the metal ion you used was able to produce its specific flame colour.  | <b>2</b> |
|     | (iii) Outline another method you could have used to identify the metal ion in a sample.   | <b>1</b> |
| (d) | Use a specific example of the use of a current analytical technique to describe the methodology and to assess the importance of this technique.   | <b>5</b> |
| (e) | Outline the processes used and the chemistry involved to prepare and attach a named pigment to the surface of a named example of medieval or earlier artwork.   | <b>3</b> |
| (f) | Outline the chemical composition of an identified cosmetic used in an ancient culture and assess the potential health risk associated with its use.   | <b>2</b> |
| (g) | Consider the following three chemical species:  |          |
|     | <ul style="list-style-type: none"> <li>• <math>[\text{Co}(\text{NH}_3)_6]^{3+}</math></li> <li>• <math>[\text{Cu}(\text{OH}_2)_4]^{2+}</math></li> <li>• <math>[\text{Cu}(\text{C}_2\text{O}_4)_2]^{2-}</math></li> </ul> |          |
|     | (i) Identify ONE hydrated complex ion.  | <b>1</b> |
|     | (ii) Identify ONE chelated ligand.  | <b>1</b> |
|     | (iii) Explain the difference between ligands and chelated ligands, with reference to the above THREE chemical species.  | <b>2</b> |

**End of Question 33**



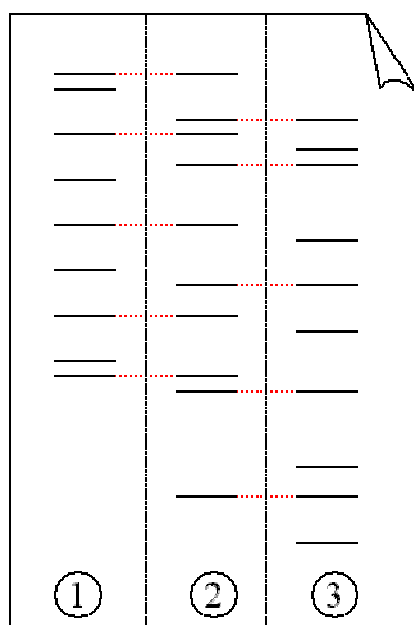
**Question 34 – Forensic Chemistry (25 marks)**

- (a) (i) Identify a monomer in a polysaccharide. **1**
- (ii) Identify a polysaccharide found in plants and a polysaccharide found in animals. **2**
- (iii) Briefly outline a test used to distinguish the polysaccharides named in part (ii). **1**

- (b) In your course you performed a first-hand investigation to separate a mixture of organic materials. **5**

Outline the procedure that you followed, clearly indicating the mixture that you separated.

- (c) DNA analysis of samples collected for paternity screening is shown below.



**Paternity testing**

Electrophoresis of PCR-amplified DNA fragments.

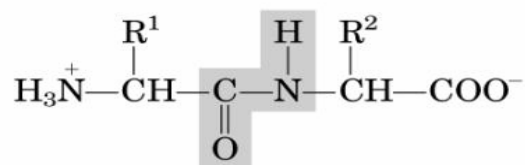
- (1) Possible Father.  
(2) Child.  
(3) Mother.

- (i) Discuss each of the steps required to obtain a DNA fingerprint. **3**
- (ii) Explain whether the results from the paternity test indicated above suggest that the possible father is the biological parent. **2**

**Question 34 continues on page 34**

Question 34 (continued)

- (d) (i) 1



Identify the shaded area in the diagram above.

- (ii) Account for the importance of this type of structure in the sequencing of protein samples. 2
- (e) Explain why each element has a unique emission spectrum. 2
- (f) Evaluate the importance of the statements below with reference to at least ONE recent example that you have investigated as part of this course. 6
- Statement 1:  
“Police and forensic scientists must follow a ‘chain of custody’ to ensure that samples are not contaminated.”
  - Statement 2:  
“Progress in analytical chemistry and changes in technology can alter the outcome of a forensic investigation.”

**End of Question 34**

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### EXAMINERS

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### Sources

- Question 31(e) – Diagram adapted from <http://www.answers.com/topic/electrolysis>  
Question 34 (c) – Diagram from [dictionary.laborlawtalk.com/PCR](http://dictionary.laborlawtalk.com/PCR)