Chemistry

Section II

25 marks
Attempt ONE question from Questions 34–38
Allow about 45 minutes for this section

Answer the question in a SEPARATE writing booklet.

Show all relevant working in questions involving calculations.

Question 34 – Industrial Chemistry (25 marks)

(a) Electrolysis is an important industrial process.

(i) Define *electrolysis*. **1**

(ii) Compare the reaction products from the electrolysis of molten sodium chloride and concentrated aqueous sodium chloride. **2**

(b) The reaction of methane with water vapour is shown below:

$CH_4\ (g) + H_2O\ (g) \rightleftharpoons CO\ (g) + 3H_2\ (g)$

In one experiment, 1.00 mol of pure methane was reacted with 2.00 mol of water vapour in a 10.0 L sealed flask. When equilibrium was established at 1400K, 0.046 mol of methane were in the flask.

(i) How many moles of each of H_2O, CO and H_2 were in the flask at equilibrium? **3**

(ii) Calculate the value for the equilibrium constant for the reaction, as represented in the equation, at 1400K. **2**

(iii) In another experiment, the values of the equilibrium constant (K) at 1200K and 1600K were determined and found to be 3.20 and 5.90 respectively. **2**

Is this reaction exothermic or endothermic? Explain.

(c) (i) Compare the structures of soap, anionic detergents and cationic detergents. **3**

(ii) Identify a different use for each of the above and outline how the identified use is related to the structure or properties of the surfactant. **3**

(d) During your studies a first-hand investigation was performed using sulfuric acid acting as a dehydrating agent.

(i) Describe the reaction and the observations as the experiment was carried out. **2**

(ii) Identify any safety precautions taken because of the properties of sulfuric acid. **1**

(iii) Write a balanced equation for the above reaction. **1**

(e) Evaluate how environmental issues are addressed in the Solvay process. **5**

Question 35 – Shipwrecks, Corrosion and Conservation (25 marks)

(a) (i) Identify the oxidation-reduction reaction from the list below. **1**

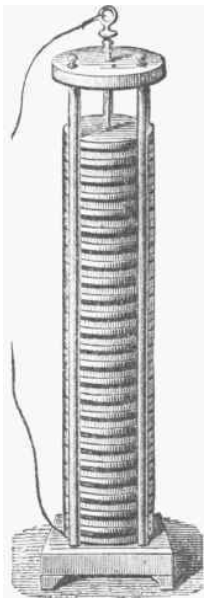
Reaction 1
zinc chloride *(aq)* + lead nitrate *(aq)* → zinc nitrate *(aq)* + lead chloride *(s)*

Reaction 2
hydrochloric acid *(aq)* + sodium hydroxide *(aq)* → sodium chloride *(aq)* + water *(l)*

Reaction 3
zinc *(s)* + copper sulfate *(aq)* → zinc sulfate (*aq)* + copper *(s)*

(ii) Explain your selection in part (i). **2**

(b) This image is of a Voltaic Pile.



(i) Identify the scientist who invented this device. **1**

(ii) Explain why the Voltaic Pile was considered to be the first battery. **2**

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Question 35 (continued)

(c) During your course, an investigation was carried out to identify the factors that affect the rate of an electrolysis reaction.

(i) What is an electrolysis reaction? **1**

(ii) For ONE of the factors in the investigation, produce a labelled diagram of the apparatus. Clearly indicate the independent variable and controlled variables. **3**

(iii) Outline how electrolysis can be used to prevent corrosion. **1**

(d) "The salvage, conservation and restoration of objects from wrecks require careful planning and an understanding of the behaviour of chemicals." **6**

Analyse this statement.

(e) The solubility and therefore the concentration of oxygen gas affect the rate of corrosion in marine environments.

(i) Explain why the concentration of oxygen gas affects the rate of corrosion. Use an appropriate equation in your response. **2**

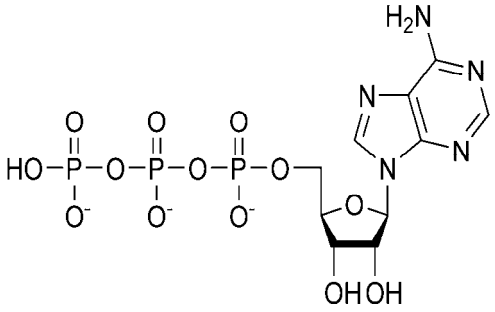
(ii) Qualitatively predict the level of dissolved oxygen in cold surface waters of the Southern Ocean. Discuss factors that enable you to make this prediction. **3**

(iii) Describe the role of anaerobic bacteria in corrosion of deep wrecks where there is little dissolved oxygen. Include an appropriate equation in your response. **3**

End of Question 35

Question 36 – The Biochemistry of Movement (25 marks)

(a) **2**



Identify the molecule above and the site of most of its production in the cell.

(b) Using a named example of an enzyme, explain why the enzyme's binding site is substrate specific. **2**

(c) As a foodstuff, a significant fraction of our caloric intake is triacylglycerol (TAGs). **6**

Assess the importance of TAGs as an energy dense store for humans and compare TAGs with glycogen as a source of energy.

(d) A first hand investigation was performed to observe the effect of changes in temperature on the reaction of a named enzyme.

(i) Identify the name of the enzyme and the group of compounds to which the enzyme belongs. **2**

(ii) Explain the results obtained and discuss the conclusions reached. **3**

(iii) Identify a safety precaution associated with the experimental procedure. **1**

(e) (i) Describe the generalised structure of a skeletal muscle cell. **2**

(ii) "Active fish such as marlin and tuna have a much darker meat than less active fish like flounder and flathead." **3**

Discuss this statement, taking into account the types of muscle used by these fish.

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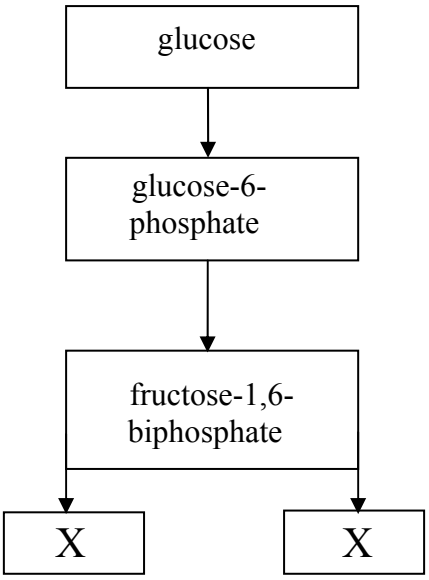
Question 36 (continued)

(f)



The flow chart above represents glycolysis, which is the first stage of cellular respiration.

(i) Two molecules of a compound X are produced as the end product of this process. Identify both the common name and the systematic name of this compound. **1**

(ii) What is the net result in terms of energy released by the above process? **1**

(iii) Under normal aerobic conditions molecule X becomes the starting point for the tricarboxylic acid cycle. During vigorous exercise not enough oxygen is available to complete this cycle. **2**

Describe the alternate pathway available to molecule X in anaerobic conditions. Include an appropriate equation.

End of Question 36

Question 37 – The Chemistry of Art (25 marks)

(a) (i) Define the Pauli Exclusion Principle. **1**

(ii) One method used in the identification of copper compounds is a flame test. Identify the flame colour typically associated with the presence of copper and explain why this colour reliably identifies the element in terms of the behaviour of copper's electrons. **2**

(iii) Describe Bohr's model of the hydrogen atom and discuss the merits and limitations of this model. **5**

(b) Early Egyptian and Roman civilisations experimented extensively with pigments. One of the most common uses of the pigments they discovered or developed was as an additive in cosmetics. **2**

Identify the chemical composition of ONE named cosmetic used by an ancient civilisation and describe the potential threat to the health of those who used this cosmetic.

(c) An experiment was performed to investigate the oxidising strength of potassium permanganate ($KMnO_4$).

(i) One of the variables kept constant in this experiment was the concentration of the species to be oxidised. Explain why controlling the concentration is essential to the validity of the results. **2**

(ii) Manganese acts as an oxidising agent in many compounds, three of which are $KMnO_4$, $MnCl_2$ and MnO_2. Account for the difference in the oxidising strengths of $KMnO_4$ and $MnCl_2$ and predict where the oxidising strength of MnO_2 would lie compared with the other two compounds, giving a reason for your prediction. **3**

Question 37 continues on page 36

(d) When outlining the reason for a permanganate ion solution's purple colour, a teacher found the following explanation on the internet. **4**

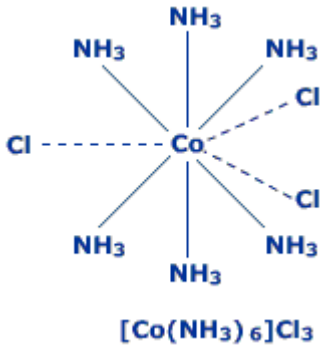
1. White light containing all visible wavelengths shines upon the permanganate ion.
2. One or more wavelengths of light corresponding to the purple colour are absorbed by ground state electrons, enabling them to jump to a higher energy level.
3. These electrons return to their ground state, emitting the same purple wavelengths of light.
4. The emitted purple light enters our eyes and we see the permanganate solution as purple.

The teacher said the explanation was wrong. Write an alternative step by step explanation that correctly describes how the behaviour of light and the electrons in the permanganate ion lead to the solution's purple appearance.

(e) (i) Write appropriate electron configurations for the ions V^{5+} and Fe^{3+}. **2**

(ii) Relate the stability of each ion to its electron configuration. **2**

(f) The diagram below represents $[Co(NH_3)_6]Cl_3$. **2**



Describe the bonding within the complex ion in this salt.

End of Question 37

Question 38 – Forensic Chemistry (25 marks)

(a) Describe a significant difference between organic and inorganic compounds. **1**

(b) Outline a series of tests that could be used to distinguish between unsaturated hydrocarbons, alkanols and alkanoic acids. Include in your answer any safety precautions that should be used. **4**

(c) (i) Identify the three elements found in carbohydrates. **1**

(ii) Compare the condensation reactions between glucose molecules to form a polysaccharide and between amino acid molecules to form proteins. **3**

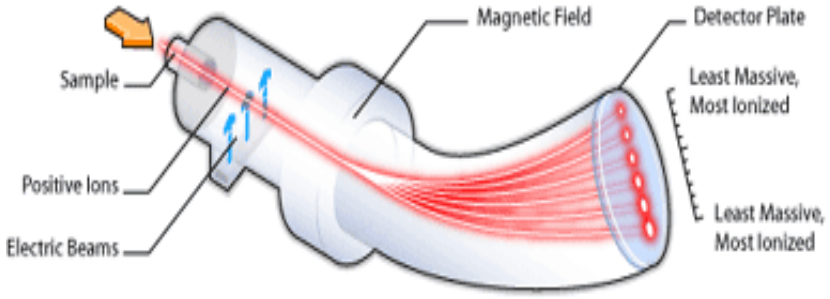
(d) Explain why a range of solvents can be used to separate different mixtures when performing chromatography. **2**

(e) Justify the uses of DNA analyses in forensic chemistry. **5**

Question 38 continues on page 38

Question 38 (continued)

(f) A schematic diagram of a mass spectrometer is shown below.



(i) Describe how a mass spectrometer operates. **2**

(ii) Account for the use of mass spectrometry in forensic chemistry. **3**

(g) Discuss the importance of the use of line emission spectra in determining the origins of a mixture. **4**

End of Question 38

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Sources

Question 32	http://surendranath.tripod.com/Sat/Sat06/Che/Che.htm
Question 33	http://www.bom.gov.au/climate/glossary/ozone.shtml
Question 35 (b)	http://chestofbooks.com/reference/American-Cyclopaedia-V7/Galvanism-Or-Voltaic-Electricity-Part-4.html
Question 38 (f)	http://www.scq.ubc.ca/mass-spectrometry

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