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.

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

(a) The gas carbon oxyfluoride (COF_2) decomposes to the gas tetrafluoromethane (CF_4) and carbon dioxide.

$2COF_2(g) \Leftrightarrow CF_4(g) + CO_2(g)$

The reaction is carried out at 200°C in a fixed volume 5.00 L container. Initially 0.400 mol of carbon oxyfluoride is present in the flask. At equilibrium 0.080 mol of carbon oxyfluoride remains.

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

(ii) Determine the value of the equilibrium constant. **3**

(iii) An increase in temperature results in 0.090 mol of carbon oxyfluoride being present at equilibrium. Is the decomposition of carbon oxyfluoride exothermic or endothermic? Explain your answer **1**

(b) Outline the steps and conditions necessary for the industrial production of H_2SO_4 from its raw materials. **4**

(c) During the course of your studies you performed a first-hand investigation to identify the products of electrolysis of NaCl.

(i) Use equations to identify the products when both concentrated NaCl and dilute NaCl solutions are electrolysed. Explain the tests you used to identify the products in each case. **4**

(ii) What would be the products of electrolysis of *molten* sodium chloride? **1**

(d) During the past 50 years, different classes of synthetic detergents have been developed to replace soap as the dominant cleaning agent. Assess the impact on the environment of the use of these synthetic detergents as a replacement for soap. **5**

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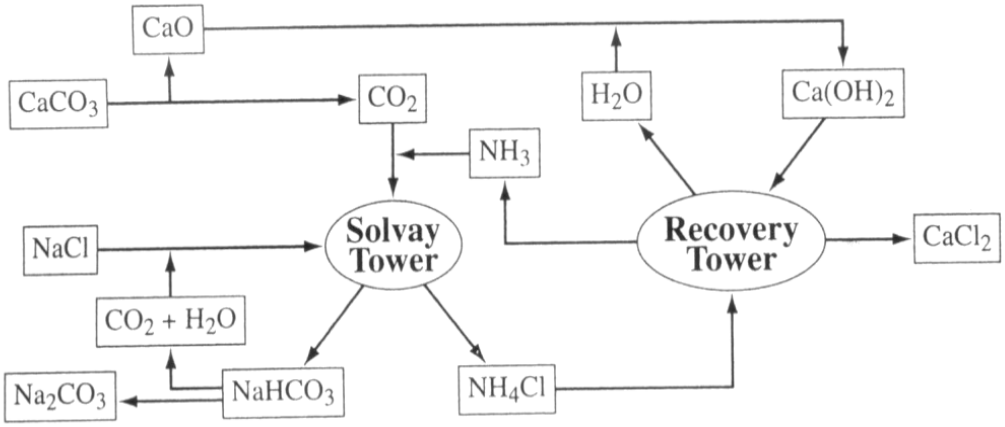
Question 30 (continued) **Marks**

(e) The flow chart below summarises the Solvay Process.



(i) What are the raw materials needed for this industrial process? **1**

(ii) Write equations for the steps in the process which result in the formation of sodium hydrogen carbonate and ammonium chloride. **2**

(iii) The outputs of the Solvay process include sodium carbonate and a waste chemical product. Identify this waste product and explain how the disposal of this waste influences the choice of location of the manufacturing plant. **3**

End of Question 30

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

(a) (i) Minerals are leached by rainwater from terrestrial environments into the oceans.
Identify another significant source of minerals in the ocean. **1**

(ii) Describe the processes that occur when a saturated solution evaporates and relate this to the potential damage to drying artefacts. **2**

(iii) Discuss a chemical procedure for removing salts from a metal artefact. **3**

(b) The chemical analysis of TWO steels is summarised in this table.

Steel X		Steel Y	
Element	%	Element	%
C	0.08	C	0.95
Mn	2.00	Mn	1.1
Si	0.75	Cr	0.6
Cr	16.0	W	0.6
Mo	2.0	V	0.1
Ni	10.0	Si	0.25

(i) Identify the main element in steel. **1**

(ii) Outline the steps that could be carried out to make a valid comparison of the corrosion rates of these TWO steels in a marine environment. **3**

(iii) Justify the selection of Steel X for handrails on a marine vessel. **2**

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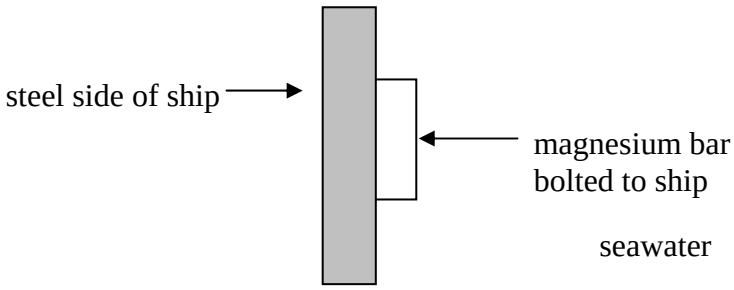
(c) The diagram below shows an application of cathodic protection.



Copy the diagram into your answer book.

(i) On your diagram, label the anode. **1**

(ii) On your diagram, indicate the flow of electrons. **1**

(iii) Write the reduction half equation. **1**

(d) Explain how an understanding of electron transfer reactions can be used to clarify the role of bacteria in accelerating the corrosion of deeply submerged wrecks. **6**

(e) In an investigation to predict the rate of corrosion of a metal at great depths, the following items of information were discovered.

GRAPH: Pressure versus Ocean Depth

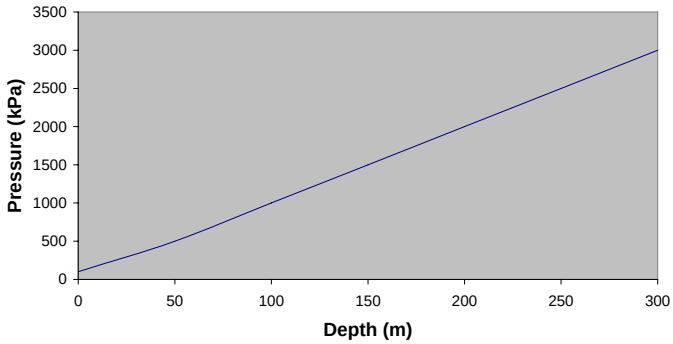


TABLE: *Solubility (g/100g H_2O)*

Pressure (atm)	O_2	N_2	CO_2
5	0.08	0.04	0.8
10	0.16	0.08	1.6

(i) Use the items to deduce the qualitative relationship between depth and solubility of gases. **1**

(ii) Evaluate the relevance of these TWO items to the investigation. **3**

End of Question 31

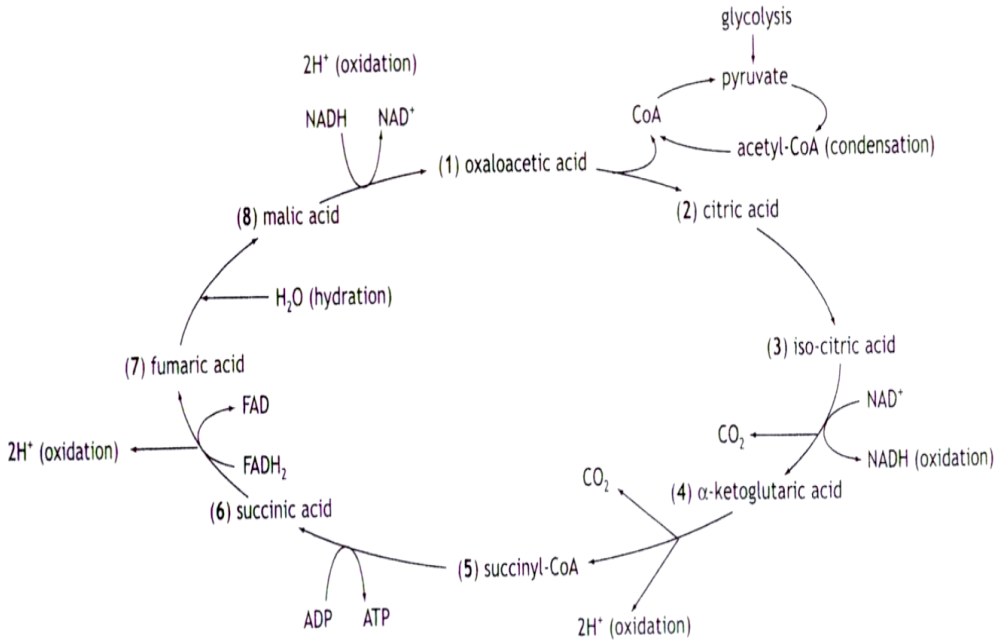
Question 32 – The Biochemistry of Movement (25 marks) **Marks**

(a) (i) Describe how amino acids bond to form peptide chains. Include an equation or diagram of a peptide bond in your answer. **2**

(ii) Identify the amino acid which makes disulfide bonding possible and sketch TWO appropriate sections of amino acid chains connected by a disulfide bond. **2**

(iii) Assess the influence of disulfide bonds on the shape of a protein. **4**

(b) The diagram below summarises the aerobic release of energy in cells.



Glycolysis is the first step in this process. **3**

Summarise the process of glycolysis. Ensure that you include in your summary:

- the identity of the raw material used
- the form in which the energy is captured
- the end product of the process.

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(c) (i) Identify the chemical cause of muscle cell contractions. **1**

(ii) Outline the role of ATP in muscle contraction movement. **1**

(d) Assess the relative importance of triacylglycerols (TAGs) and carbohydrates as energy resources for humans. **8**

(e) In your study of enzymes, you performed a first-hand investigation of factors which can affect the reactions of an enzyme. **2**

Identify the enzyme you studied and TWO factors which you investigated.

(f) Explain when anaerobic respiration occurs and outline a problem associated with anaerobic respiration. **2**

End of Question 32

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

(a) Identify the element whose neutral atom has the following electronic configuration: **1**

$1s^2\ 2s^2\ 2p^3$

(b) The first FOUR ionisation energies for boron are: **1**

$I_1 = 807$ kJ mol^{-1}
$I_2 = 2433$ kJ mol^{-1}
$I_3 = 3666$ kJ mol^{-1}
$I_4 = 25033$ kJ mol^{-1}

Explain why there is such a large difference between the third and fourth ionisation energies.

(c) (i) Explain how flame tests could be used to distinguish between potassium chloride and strontium nitrate. **1**

(ii) Describe, with an example, how you could show that the metal ions in a compound are responsible for the flame colour and not the anions. **2**

(d) A green complex is identified as $[Ni(H_2O)_6]^{2+}$.

(i) For the above complex identify the metal ion and its oxidation state. **1**

(ii) Identify the property of the atoms within the ligand that allow it to be bonded to the metal ion. **1**

(iii) Identify the block in the Periodic Table which contains elements that tend to form coloured compounds. Explain, in terms of electronic configurations and using a *specific example*, why these compounds are coloured. **5**

(e) With reference to a particular pigment, explain why pigments used for cave paintings, self decoration or burial needed to be insoluble in most substances. **2**

(f) Discuss the merits and limitations of the Bohr model of the atom. **4**

(g) You have carried out a first hand investigation to demonstrate that potassium permanganate is a STRONG *oxidising agent.*

(i) What is the oxidation state of manganese in the permanganate ion? **1**

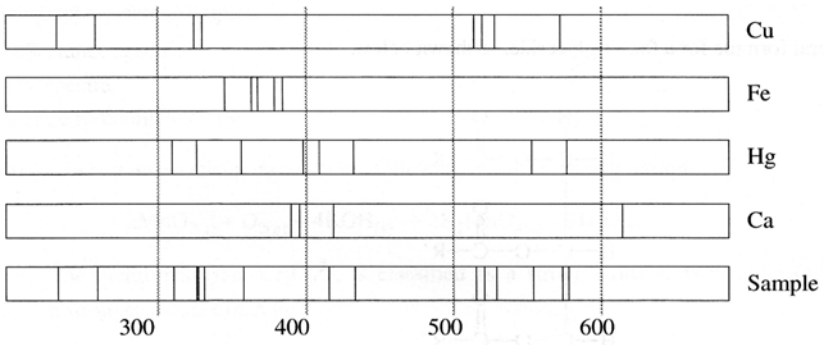
(ii) Describe your experimental procedure and the observations you made. **3**

(iii) Write half equations and an overall equation for the reactions you describe. **3**

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

(a) An illegal shipment of endangered snakes was confiscated at Kingsford Smith Airport.
The major mineral compositions and possible origins of a sample of soil found in the container are shown in the table below.
Atomic emission analysis was performed on the sample and on soil samples taken from THREE possible sites A, B and C, to confirm its origin.

Possible origin	*Minerals present*	*Chemical composition of mineral*
Site A	cinnabar azurite	HgS $CuCO_3.Cu(OH)_2$
Site B	calcite malachite	$CaCO_3$ $CuCO_3.Cu(OH)_2$
Site C	haematite cuprite	Fe_2O_3 Cu_2O



Atomic Absorption Data

(i) Use the data provided to identify the origin of the sample. **1**

(ii) Outline the conditions necessary for elements to emit light. **2**

(b) (i) Describe a simple procedure that can be used to distinguish between organic and inorganic compounds. **2**

(ii) Name TWO classes of organic compounds. For each class, draw the structural formula of a compound which is a member of this class and circle the functional group in the compound. **2**

Question 34 continues on page 34

(c) (i) Use an appropriate example to describe when destructive testing is a problem in forensic analysis. **1**

(ii) Name ONE non-destructive method for testing small samples. **1**

(d) (i) Use a diagram or equation to explain the chemical difference between reducing and non-reducing sugars. **2**

(ii) Outline the procedure that you followed to distinguish between a reducing and a non-reducing sugar. **3**

(e) (i) Proteins can be grouped on the basis of their function. Distinguish between the TWO main groups of proteins. **2**

(ii) Chromatography and electrophoresis are TWO procedures regularly used by forensic chemists. Compare and contrast these TWO procedures. **4**

(f) Advances in DNA technology have changed the way in which evidence can affect the outcome of civil and criminal proceedings. However, the use of DNA technology has raised ethical issues for society. **5**

Discuss these statements.

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