1. A common indicator used to determine the pH of solutions is methyl orange. This indicator is red at lower pH and orange at higher pH. It changes colour within a pH range of 3.1–4.4.

An unknown colourless solution has a few drops of methyl orange added to it. The colour of the indicator becomes orange. This means that the unknown solution

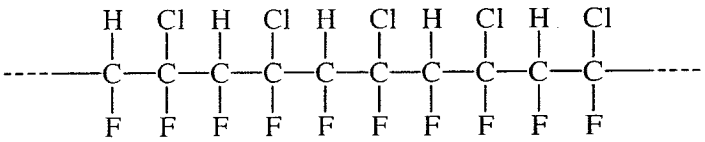
(A) must be a base.

(B) must be an acid.

(C) must be neutral.

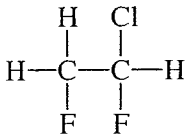
(D) still needs to be tested with further indicators to determine its pH.

2. The following diagram represents a polymer produced by the process of addition polymerisation.

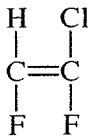


The monomer used to make this polymer is

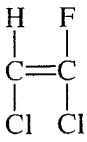
(A)



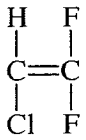
(B)



(C)



(D)



Questions 3–4 relate to the following information.

To demonstrate the concept of dilution a teacher carefully mixed 100 mL of concentrated HCl with water until the total volume was 3 litres.

3. The pH of the solution was found to be 0.27. The concentration of H^+ ions in this solution is

(A) 0.54 mol L^{-1}

(B) 160 mol L^{-1}

(C) 5.3 mol L^{-1}

(D) 0.27 mol L^{-1}

4. The teacher then made three statements.

   (i) The acid is a weak acid after it is diluted but a strong acid before dilution.

   (ii) The concentrated HCl needs more moles of NaOH for complete reaction than the dilute solution.

   (iii) Great care should be taken when diluting the concentrated acid.

   Which of the following is true?

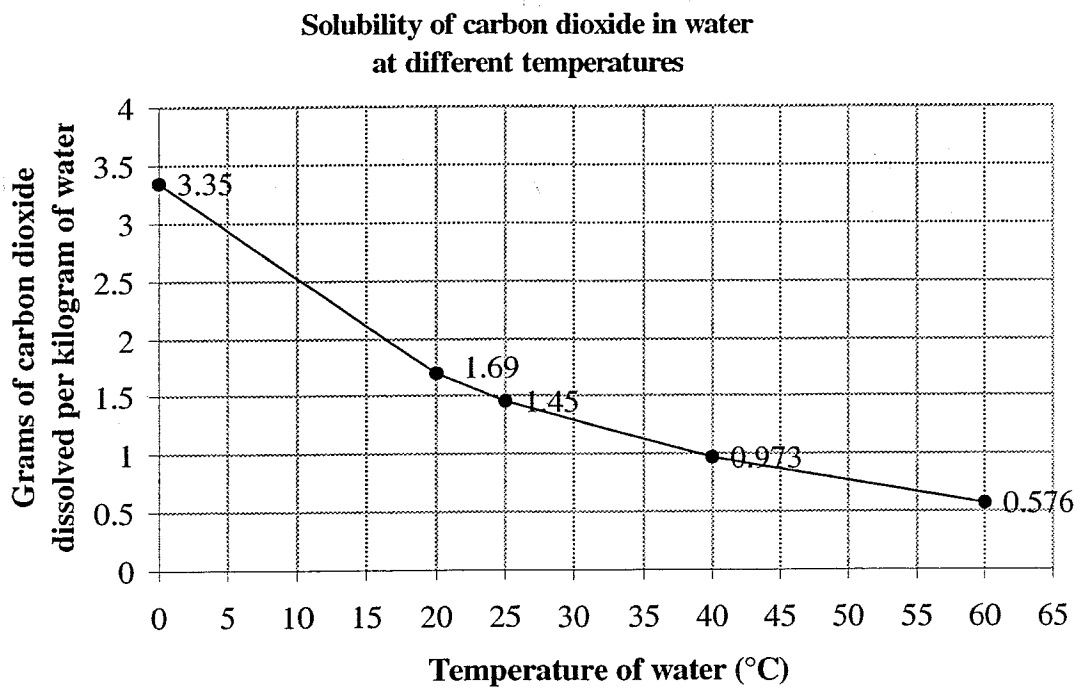
   (A) (i) and (ii) are both correct statements.

   (B) (i) and (iii) are both correct statements.

   (C) (iii) is a correct statement.

   (D) (i), (ii) and (iii) are correct statements.

5. The solubility of carbon dioxide gas in water varies at different temperatures as shown in the following graph.



   From this graph we can conclude that

   (A) the temperature of the water is dependent on the amount of carbon dioxide dissolved in it.

   (B) the dissolution of carbon dioxide is exothermic.

   (C) the ratio of carbon dioxide dissolved:mass of water can be increased by using more water.

   (D) the solubility of carbon dioxide in water is unaffected by Le Chatelier's principle.

6. Which of the following equations could represent the formation of a transuranic element in a nuclear reactor?

   (A) $^{238}_{92}U + {}^{4}_{2}He \rightarrow {}^{239}_{94}Pu + 3{}^{1}_{0}n$

   (B) $^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$

   (C) ${}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{1}H + {}^{1}_{1}H$

   (D) ${}^{1}_{0}n + {}^{238}_{92}U \rightarrow {}^{88}_{38}Sr + {}^{136}_{54}Xe + 12{}^{1}_{0}n$

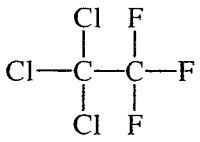
7. A student performed an experiment using 4 different metals known to her only as metals "W", "X", "Y" and "Z" (not their real symbols). Each metal was placed into a solution which contained ions of one of the other metals. The student tabulated the results of the experiment as follows:

	Solution of W ions	*Solution of X ions*	*Solution of Y ions*	*Solution of Z ions*
W placed into	no visible change	W dissolved; X produced	W dissolved; Y produced	W dissolved; Z produced
X placed into	no visible change	no visible change	no visible change	X dissolved; Z produced
Y placed into	no visible change	Y dissolved; X produced	no visible change	Y dissolved; Z produced
Z placed into	no visible change	no visible change	no visible change	no visible change

From the table of results, which of the following correctly places the metals in order of increasing relative activity?

(A) W Y X Z
(B) X W Y Z
(C) Z Y X W
(D) Z X Y W

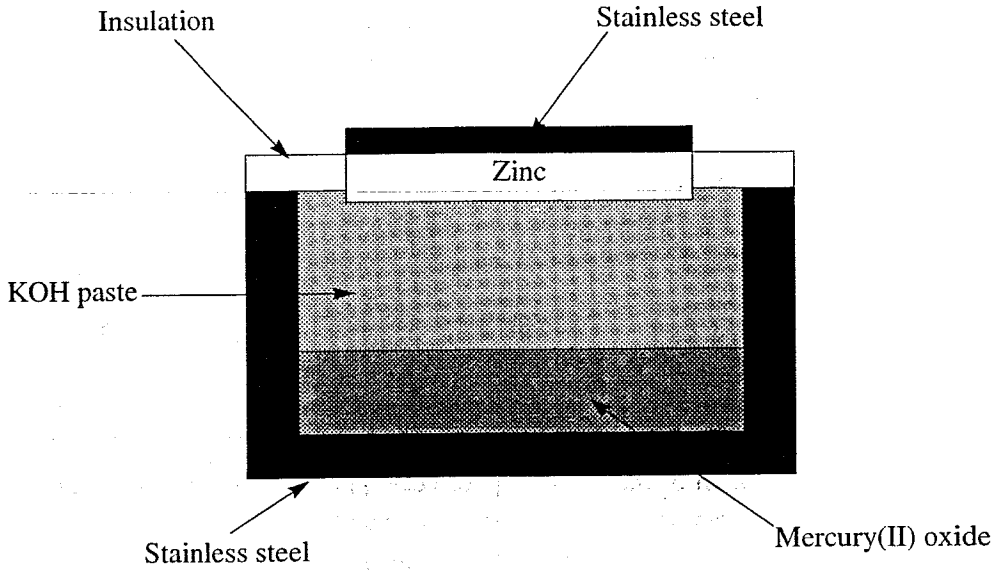
8. The molecular structure of the compound known as Freon-113 can be represented by the following diagram.



An isomer of Freon-113 would be

(A) 1,2,3-trichloro-1,2,3-trifluoroethane
(B) 1,1,1-trichloro-2,2,2-trifluoroethane
(C) 1,1,2-trichloro-1,2,2-trifluorethane
(D) 1,2,2-trichloro-1,2,2-trifluorethane

9. The diagram below shows a mercury cell, which can be used to power hearing aids.



The half equations for the reaction process are given as follows:

$$Zn_{(s)} + 2OH^-_{(aq)} \rightarrow ZnO_{(s)} + H_2O_{(l)} + 2e^-$$

$$HgO_{(s)} + H_2O_{(l)} + 2e^- \rightarrow Hg_{(l)} + 2OH^-_{(aq)}$$

Which of the following correctly summarises the parts of the cell?

	Anode reactant	*Cathode reactant*	*Electrolyte*
(A)	mercury(II) oxide	zinc	potassium hydroxide
(B)	stainless steel	zinc	water
(C)	zinc	mercury(II) oxide	potassium hydroxide
(D)	zinc	mercury(II) oxide	water

10. Which of the following correctly represents a neutralisation process?

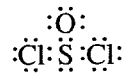
(A) $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$ $\Delta H = +60$ kJ mol^{-1}

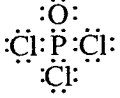
(B) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$ $\Delta H = -92$ kJ mol^{-1}

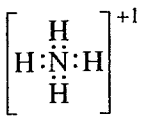
(C) $C_3H_{8(l)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(l)}$ $\Delta H = -2220$ kJ mol^{-1}

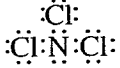
(D) $HNO_{3(aq)} + KOH_{(aq)} \rightarrow KNO_{3(aq)} + H_2O_{(l)}$ $\Delta H = -61$ kJ mol^{-1}

11. Which of the following Lewis electron dot structures does not include a coordinate covalent bond?

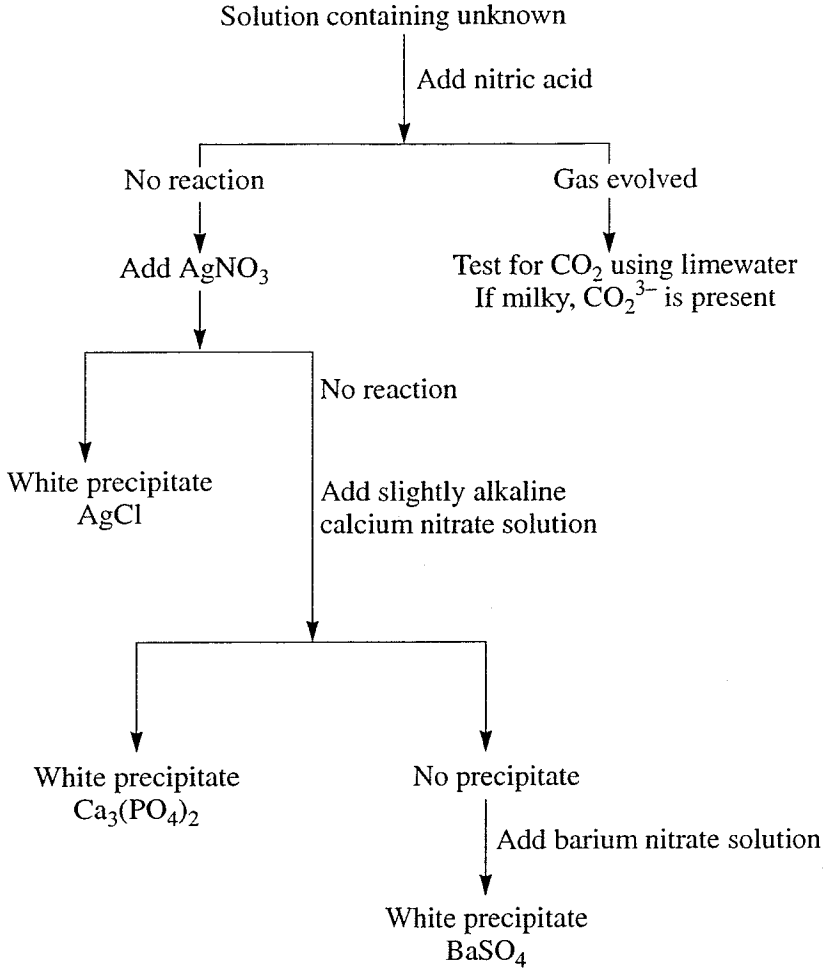
(A) 

(B) 

(C) 

(D) 

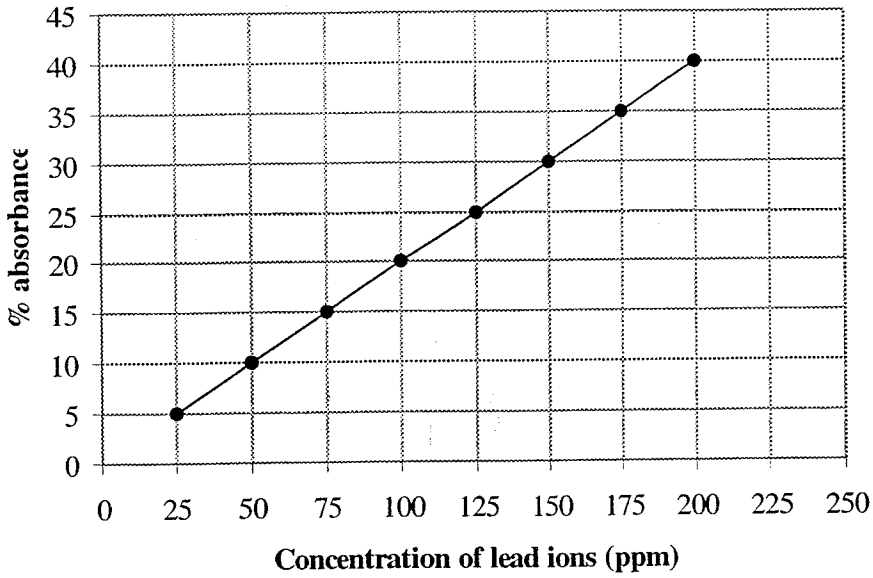
12. A student decided to use the following flow chart to identify the anion present in an unknown solution.



The student added only silver nitrate to the unknown solution. No precipitate formed.
The student concluded that the solution could NOT contain

(A) carbonate
(B) chloride
(C) phosphate
(D) sulfate

13. The graph below shows the results of atomic absorption spectroscopy (AAS) of a number of standard lead ion, Pb^{2+}, solutions.



A sample of river water was analysed using AAS to determine its lead ion concentration. It was found to have an absorbance of 33%. The concentration of lead ions in the water is

(A) 100 ppm
(B) 145 ppm
(C) 165 ppm
(D) 185 ppm

14. The composition of dry air by volume includes 0.0005% helium and 0.0001% krypton. These values can also be represented respectively as

(A) 0.0005 parts per million (ppm) and 0.0001 ppm
(B) 0.0005 g and 0.0001 g
(C) 5 parts per million (ppm) and 1 ppm
(D) 5 g and 1 g

15. The greatest change in oxidation state occurs when

(A) copper oxidises to copper(I)
(B) copper(I) oxidises to copper(II)
(C) copper(I) reduces to copper(II)
(D) copper(II) reduces to copper

Marks

Question 16 (4 marks)

Water self-ionises slightly to produce hydronium and hydroxide ions. **4**

Compare the Lowry-Bronsted and Lewis acid-base theories, using the above example to illustrate your answer.

.....

.....

.....

.....

.....

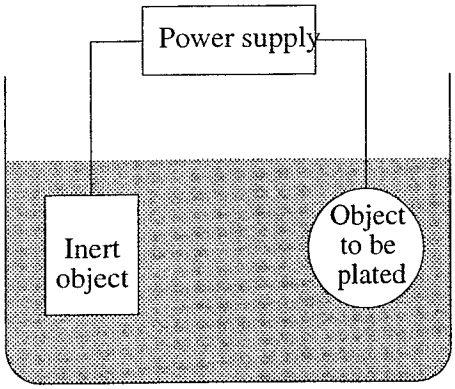
.....

.....

.....

Question 17 (2 marks)

Electroplating is a process common in industry. An example of this process is shown in the diagram below.



In the case of chrome plating, an acidic dichromate solution is used as the electrolyte. The chromium is produced as shown in the following half equation:

$$Cr_2O_7^{2-}{}_{(aq)} + 14H^+{}_{(aq)} + 12e^- \rightarrow 2Cr_{(s)} + 7H_2O_{(l)}$$

(a) Is the item to be plated at the anode or at the cathode? Explain your reasoning. **1**

.....

.....

(b) Describe the benefits of electroplating. **1**

.....

.....

Marks

Question 18 (5 marks)

Spider silk is a biopolymer. It is made of organic acids linked to form silk fibres. A synthetic version of silk has been developed by using genetically modified goats to produce milk containing the same organic acids as in spider's silk. The acids are isolated and are used to produce the silk.

(a) Identify a different biopolymer that is used industrially and the enzyme or organism used to synthesise the material. **2**

.....

.....

.....

(b) Clarify the need for the development of industrial biopolymers. Assess their impact on society and the environment. **3**

.....

.....

.....

.....

.....

.....

Question 19 (3 marks)

Fractional distillation of crude oil does not provide enough suitable hydrocarbons to meet the demand for petrol. Catalytic cracking is used to increase the yield. **3**

Describe the process of catalytic cracking.

.....

.....

.....

.....

.....

.....

Marks

Question 20 (2 marks)

A student is given two test tubes during a practical lesson. He is told that one test tube contains hexane while the other contains 1-hexene. The student is asked to use a chemical test which can identify the chemicals. The student decides to use bromine water in his test.

(a) The student adds some bromine water to each test tube and mixes each thoroughly. What are his observations for each test tube? **1**

.....

.....

.....

.....

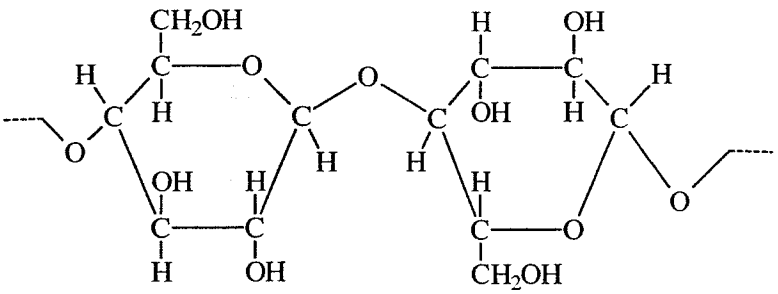
(b) How does the student use these results to identify the chemicals? **1**

.....

.....

Question 21 (5 marks)

Cellulose is an example of a natural biopolymer produced by condensation. Molecules of glucose ($C_6H_{12}O_6$) join together to form this complex molecule. A section of its structure is shown in the following diagram.



(a) Cellulose is a major component of biomass. What does the term biomass mean? **1**

.....

.....

(b) The production of cellulose from glucose produces another product. What is the name of this second product? **1**

.....

Marks

Question 21 (Continued)

(c) Discuss the potential of cellulose as a raw material in the production of petrochemicals. 3

.....

.....

.....

.....

.....

.....

.....

Question 22 (5 marks)

(a) Write a balanced equation for the complete combustion of ethanol. 1

.....

(b) Incomplete combustion of petrol (which can be considered to be mainly octane, C_8H_{18}) produces significant pollutants.

(i) Identify the pollutants. 1

.....

.....

(ii) Explain why ethanol can be regarded as being less polluting than petrol. 1

.....

.....

(c) Ethanol is widely used as a solvent. Discuss how it is effective in this use based on its molecular structure. 2

.....

.....

.....

.....

.....

Marks

Question 23 (4 marks)

A student was asked to analyse the concentration of nitrogen in a fertiliser. In this particular fertiliser the nitrogen was present in the form of ammonium sulfate, $(NH_4)_2SO_4$. She decided to precipitate the sulfate from solution using an excess solution of barium nitrate, $Ba(NO_3)_2$, and then use the mass of the precipitate formed to determine the concentration of the nitrogen.

$$Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$$

She tabulated the results of her experiment as follows:

Mass of fertiliser used = 11.35 g
Mass of barium sulfate precipitated = 1.45 g

(a) Determine the number of moles of barium sulfate formed in the precipitation. **1**

.....

.....

.....

(b) Hence determine the amount of nitrogen in the fertiliser sample. **1**

.....

.....

.....

(c) Calculate the percentage nitrogen by mass in the fertiliser. **1**

.....

.....

.....

(d) Explain why it is necessary to monitor the amount of nitrogen present in fertilisers. **1**

.....

.....

.....

Marks

Question 24 (6 marks)

Scientific evidence suggests that nitrogen oxide emissions from supersonic aircraft which fly in the stratosphere can reduce the concentration of ozone. Similar conclusions have been drawn regarding chlorofluorocarbons (CFC) emission.

(a) Identify two possible sources of CFCs in the atmosphere. **2**

.....

.....

.....

.....

(b) Describe the function of ozone in the upper atmosphere and the benefits it provides. **2**

.....

.....

.....

.....

.....

.....

(c) Discuss the problems associated with the use of CFCs in respect to the concentration of ozone in the upper atmosphere. **2**

.....

.....

.....

.....

.....

.....

Marks

Question 25 (10 marks)

In the "Annual Environment and Public Health Report (2000)" released by Sydney Water, monitoring sites along the Hawkesbury-Nepean Rivers were rated as being "poor" or "very poor" in terms of their protection from eutrophication. It had been noted on the report that there were a number of algal blooms in areas of the river.

(a) Define the term *eutrophication* and identify two causes. 3

.....

.....

.....

.....

.....

.....

(b) Discuss the relative importance of the tests used to determine if eutrophication is present in waterways. 3

.....

.....

.....

.....

.....

.....

(c) Critically analyse the effects of eutrophication on living things in the waterways. 4

.....

.....

.....

.....

.....

.....

.....

.....

Marks

Question 26 (3 marks)

When a mixture of 1 mol $N_{2(g)}$ and 3 mol $H_{2(g)}$ are brought to equilibrium over a catalyst at 500°C and 1013 kPa, the mixture reacts to form ammonia as shown in the following equation:

$$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)} \qquad \Delta H = -92 \text{ kJ}$$

The yield is small under these conditions; only about 2.5% of the reactants are converted.

(a) Explain how the following conditions can be changed to produce a greater yield in terms of Le Chatelier's principle: **2**

- Temperature
- Pressure

.....

.....

.....

.....

.....

(b) In the industrial manufacture of ammonia, the use of high temperatures is still maintained. Explain why this is the case. **1**

.....

.....

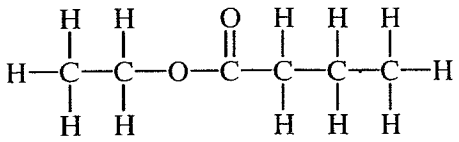
.....

.....

Marks

Question 27 (5 marks)

A compound "X" has a boiling point of 163°C. A compound "Y" has a boiling point of 78°C. When "X" and "Y" were reacted together, they formed a compound with the following structural formula.



(a) Draw and name X . Justify your choice. **2**

.....

.....

.....

.....

(b) Describe the process you would follow in a school laboratory to carry out this reaction. As part of your response use a well-labelled diagram to identify the equipment required. **3**

.....

.....

.....

.....

Marks

Question 28 (6 marks)

As a major practical task a student was set three tasks:

- Prepare a standard solution from a primary standard.
- Use this standard to determine the concentration of a hydrochloric acid solution
- Use the hydrochloric acid solution to determine the amount of citric acid in a sample of lime juice.

(a) Name a specific primary standard and outline the characteristics which make its use suitable. **2**

.....

.....

.....

.....

.....

.....

(b) The HCl solution was standardised and found to have a concentration of 0.608 mol L^{-1}. The student then determined the amount of citric acid in a sample of lime juice, using the method shown below. **4**

A sodium hydroxide solution was standardised against the hydrochloric acid and found to have a concentration of 0.075 mol L^{-1}. A 25 mL sample of lime juice was diluted to 250 mL and 25 mL aliquots of the diluted sample were titrated with the sodium hydroxide to determine how much citric acid was present. The reaction was:

$$C_6H_8O_7 + 3NaOH \rightarrow C_6H_5O_7Na_3 + 3H_2O$$

Given that the average amount of NaOH used was 40.0 mL, calculate the concentration of citric acid in the original lime juice, as %(w/v).

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Marks

Question 30 — Shipwrecks and Salvage (25 marks)

(a) A student was asked to make a prediction about the corrosion of shipwrecks found at different ocean depths. She believed that corrosion would be considerably greater in shallow water. She based her reasoning on the following assumptions:

- the rate of reaction is proportional to temperature
- concentration of dissolved oxygen decreases with added pressure

(i) Explain how the student's first assumption can be related to the depth of the water. **1**

(ii) With reference to Le Chatelier's principle and the use of an equation, explain how the student's assumption about dissolved oxygen concentration is incorrect. **2**

(iii) Dissolved oxygen levels achieve minimum values between depths of around 500 to 1000 m. However the corrosion of shipwrecks still continues by the action of anaerobic bacteria.

1. Give one reason why oxygen depletion can occur at such great depths. **1**

2. Define the term "anaerobic". **1**

3. Explain how anaerobic bacteria can cause this corrosion to accelerate at these great depths. **1**

(b) The following table compares the composition and properties of iron and steel.

Substance	*Composition*	*Properties*
Pure iron	100% Fe	Malleable, corrodes slowly
Cast iron	4% C, 1% Mn, 1% Si, 94% Fe	Hard, brittle, corrodes easily
Structural steel	0.5% C, 99.5% Fe	Hard, malleable, corrodes easily
Stainless steel	15% Cr, 10% Ni, 75% Fe	Hard, resistant to corrosion

The corrosion of steel is dependent on its composition.

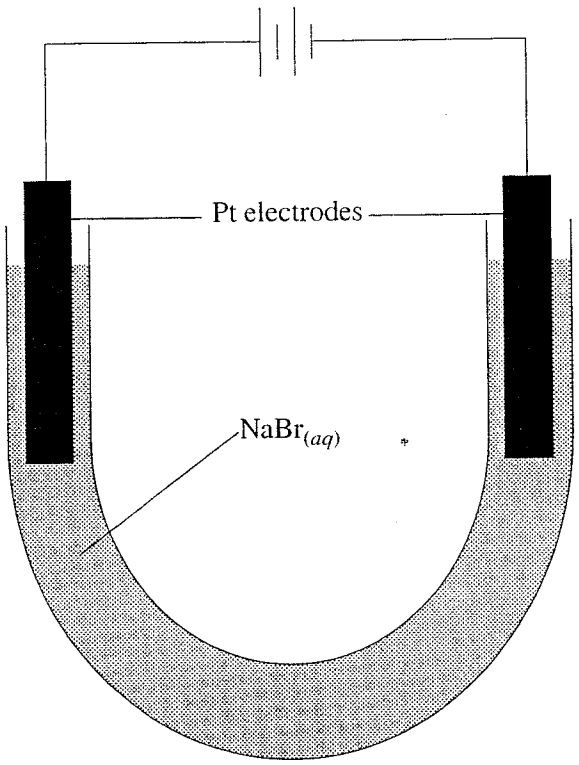
(i) You have performed a first hand investigation in which you compared the rate of corrosion of pure iron and an identified form of steel. Describe how you performed this experiment. Identify the factors that needed to be considered during this investigation to ensure that the result produced a fair comparison in the rate of corrosion between the two substances. **2**

(ii) Account for the difference in corrosion of active and passivating metals. **2**

Marks

Question 30 (Continued)

(c) An experiment is set up using the following equipment.



The electrodes were connected to an external power source. Once the current had flowed for a few minutes, small bubbles formed in the solution near one electrode. Around the other electrode, a brown colour appeared in the solution.

(i) Write a half equation which represents the formation of the brown substance in the solution. 1

(ii) Is the formation of the brown substance occurring at the anode or the cathode? Explain your reasoning. 2

(iii) Write a half equation which represents the formation of the bubbles in the solution 1

(d) Draw a fully labelled diagram showing how you would determine the standard potential of a cell made from $Sn_{(s)}|Sn^{2+}_{(aq)}$ and $Pb_{(s)}|Pb^{2+}_{(aq)}$. On your diagram include the direction of movement of all charged particles as well as half equations at the specified electrodes. 6

(e) Various methods can be used to protect the hulls of ships from corrosion. Outline two such methods and how they work to prevent corrosion. 4

(f) A common problem that occurs in shipwrecked artefacts is that they become saturated with chloride ions due to their long period in sea water. The removal of an artefact from sea water can eventually ruin it. 1

Describe the changes that occur to a wooden, leather or textile artefact if it is removed from salt-saturated water and allowed to dry.