Student Number: .....

2002

HIGHER SCHOOL CERTIFICATE

Sample Examination Paper

CHEMISTRY

Reading time - 5 minutes
Working time - Three (3) hours

Direction to Candidates

- Board approved calculators may be used.
- Write your Student Number on this Examination Book.
- Answer all questions in the spaces provided in this Examination Book.

Section I - Core

- Attempt ALL questions.
- **Part A** 15 multiple -choice questions, each worth 1 mark
  Mark your answers in pencil on the Answer Sheet on page 2 of this book.
- **Part B** Other questions with a total mark value of 60.
  Answer this part in the spaces provided in the Part B part of the Answer Book.

Section II - Electives

- Attempt ONE question only.
- Each question is worth 25 marks.
- Answer the question in a separate Elective Answer Booklet.
- You may ask for an extra Elective Answer Book if you need one.

A ***Data Sheet*** and ***Periodic Table*** are provided at the back of this paper.

Directions to School or College

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SECTION I - CORE

PART A –15 marks

Attempt all questions (1–15). Each question is worth 1 mark.
Allow about 30 minutes for this part.

Select the alternative A, B, C or D that best answers the question.

Mark your answers in pencil on the Answer Sheet on page 2.

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1. Chlorofluorocarbons (CFCs) are an environmental problem because they react with
   A. carbon monoxide
   B. carbon dioxide
   C. oxygen
   D. ozone

2. Which of the following substances is NOT involved in the fermentation process?
   A. carbon dioxide
   B. ethanol
   C. glucose
   D. oxygen

3. The molar heat of combustion of ethanol is –1367 kJ. This means that
   A. it needs 1367 kJ of energy to completely burn one mole of ethanol
   B. 1367 kJ of energy is used up when 46.1 g of ethanol undergoes complete combustion
   C. chemical energy is decreased by 1367 kJ when one mole of ethanol is converted to carbon dioxide and water
   D. there is a transfer of 1367 kJ from the environment to ethanol during the complete combustion of one mole of ethanol.

4. The nuclei of radioactive isotopes are unstable because
   A. the nucleus is too large or too small
   B. the proton to neutron ratio is too high or too low
   C. some chemical reactions upset the proton to electron balance
   D. the electrons which are formed in the nucleus destabilise the nucleus.

5. In which pair is the oxide of the first element more acidic than the oxide of the second element?
   A. Mg, S
   B. C, Pb
   C. Hg, P
   D. Sn, Si

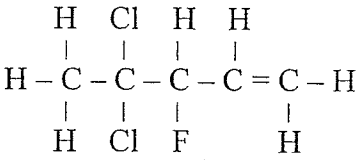
6. In a closed system sodium hydrogencarbonate establishes an equilibrium with sodium carbonate, water and carbon dioxide as shown by the equation

$$2NaHCO_{3(s)} \rightleftarrows Na_2CO_{3(s)} + H_2O_{(g)} + CO_{2(g)}$$

The reaction is exothermic.
Which of the following conditions would produce more water vapour by the time equilibrium has been established?

A. grinding the sodium hydrogencarbonate into a finer powder
B. adding a catalyst
C. heating the reaction mixture
D. increasing the size of the container.

7. What is the systematic name of the following compound?



A. 4,4-dichloro-3-fluoro-2-pentene
B. 3-fluoro-4,4-dichloro-2-pentene
C. 2,2-dichloro-3-fluoro-4-pentene
D. 2,2-dichloro-3-fluoro-2-pentene

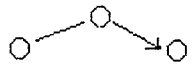
8. The non-polar nature of alkanes explains why they
A. have high reactivity
B. can serve as monomers from which polymers are made
C. have low boiling points compared to compounds with similar molar masses
D. can be industrially produced by the catalytic cracking of long chained hydrocarbons.

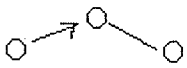
9. The overall neutral species equation for the reaction which occurs during the discharge (i.e. normal use) of a lead-acid cell is

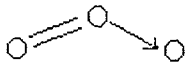
$$Pb_{(s)} + PbO_{2(s)} + H_2SO_{4(aq)} \rightarrow 2PbSO_{4(s)} + 2H_2O_{(l)}$$

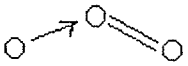
In this reaction there is a change in the oxidation state of
A. lead in $Pb_{(s)}$ from +2 to +4
B. lead in $PbO_{2(s)}$ from +4 to +2
C. oxygen in $PbO_{2(s)}$ from –4 to –2
D. oxygen in $H_2SO_{4(l)}$ from –2 to –4.

10. Which of the following could be a correct representation of the structure of ozone?

A. 

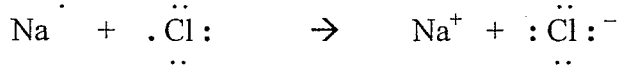
B. 

C. 

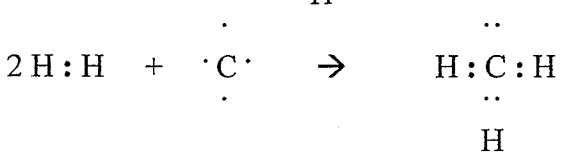
D. 

11. Which of the following is an acid-base reaction according to the Lewis definition of acids and bases?

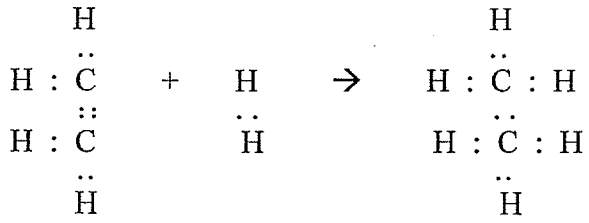
A.



B.



C.



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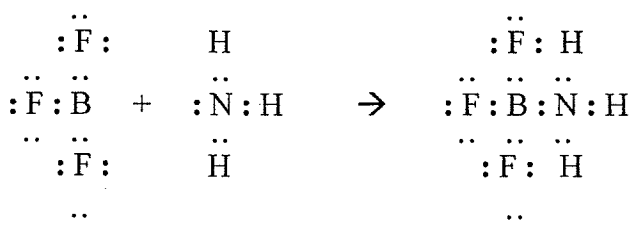


12. Which of the following can act as a Bronsted-Lowry base when mixed with water?
    A. HCO_3^-
    B. Cl^-
    C. CH_3COOH
    D. $NaNO_3$

13. In a buffer solution there is an equilibrium between a weak acid and approximately the same concentration of its conjugate base,

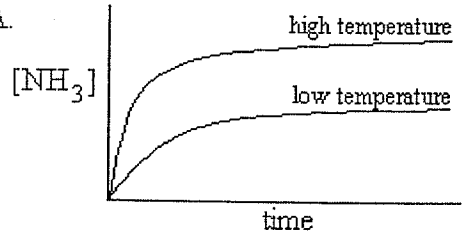
    e.g. $H_2PO_4^- \rightleftarrows H^+ + HPO_4^{2-}$

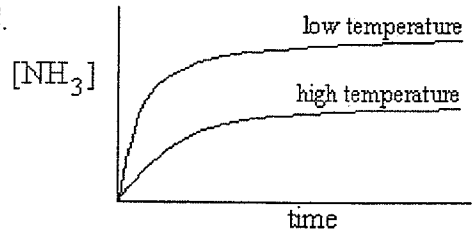
    When a small amount of hydroxide ions is added to this equilibrium system there is virtually no change in pH, because as the OH^- ions react with
    A. H^+ ions, the H^+ ions are used up, and the position of the equilibrium shifts in order to produce more H^+
    B. $H_2PO_4^-$ ions, water and more HPO_4^{2-} ions are produced
    C. $H_2PO_4^-$ ions, the HPO_4^{2-} ions are used up and equilibrium shifts to produce H^+ ions
    D. H^+ ions, OH^- ions are used up, and equilibrium moves to produce more OH^- ions.

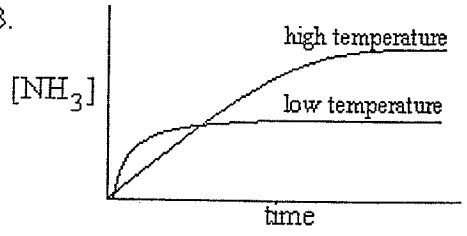
14. The equilibrium involved in the Haber process of ammonia production can be represented as

    $$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)} + \text{heat}$$

    Which of the following graphs correctly shows the difference in the change of the concentration of ammonia at high and low temperatures?

A.


C.


B.


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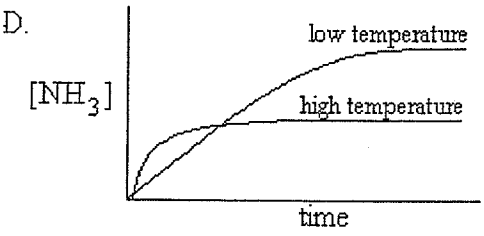
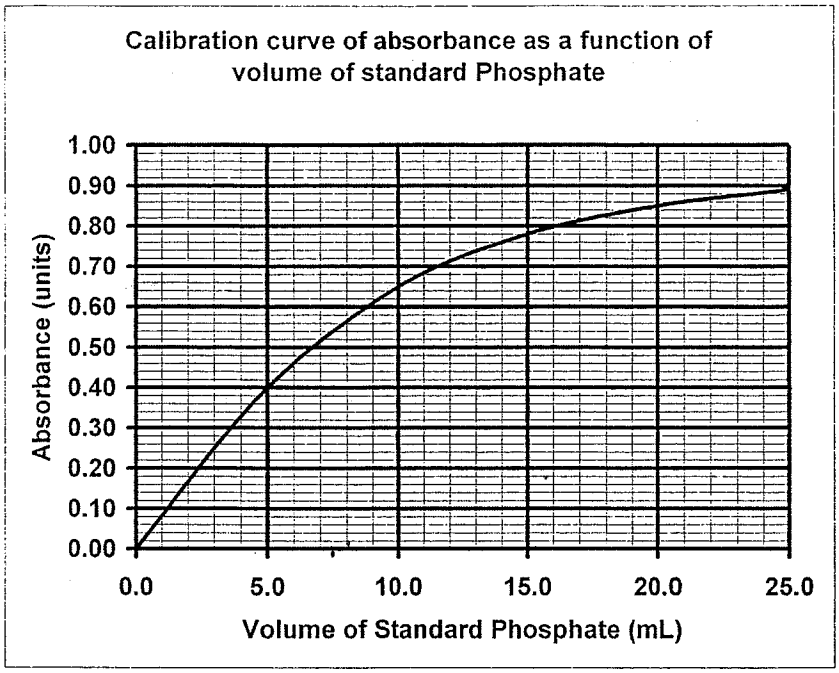


15. A standard 0.015 g L^{-1} (i.e. 0.015 mg mL^{-1}) phosphate solution was used to prepare the calibration curve shown by making up different volumes of the solution to 25 mL with distilled water. The graph shows absorbance as a function of the volume of standard phosphate.



1.00 mg of a detergent was diluted to 25.0 mL. The absorbance of the solution was found to be 0.56 absorbance units.
The mass of phosphate in 1.00 mg of the detergent is closest to

A. 0.002 mg
B. 0.015 mg
C. 0.12 mg
D. 0.8 mg

PART B – 60 marks
Attempt All questions (16–29)
Allow about 1 hour and 45 minutes for this part

Show all relevant working in questions involving calculations.

Marks

16. a. Below is part of the sequence of fission products formed as uranium-238 decays to lead 206. **2**

$$\rightarrow \boxed{X} \xrightarrow{\alpha} {}^{218}_{84}Po \xrightarrow{\beta} \boxed{Y} \rightarrow$$

Identify isotopes X and Y.

Y -

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b. Identify a reaction mechanism which was determined by use of a radioisotope, and name the radioisotope which was used in the determination. **2**

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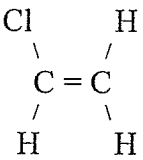
17. a. The structural formula of vinyl chloride is **1**



What is its systematic name?

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b. When vinyl chloride is mixed with bromine water the brown colour of the bromine water disappears. A similar result is obtained when bromine water is mixed with many other substances. What is the common structural feature of the compounds that react in this way with bromine water? **1**

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Marks

c. Vinyl chloride, ethene and styrene are commercially significant monomers **2**

i. Draw a segment of the polymer poly(ethene), commonly known as polythene. Include at least 6 carbons.

ii. Outline the steps in the production of polythene.

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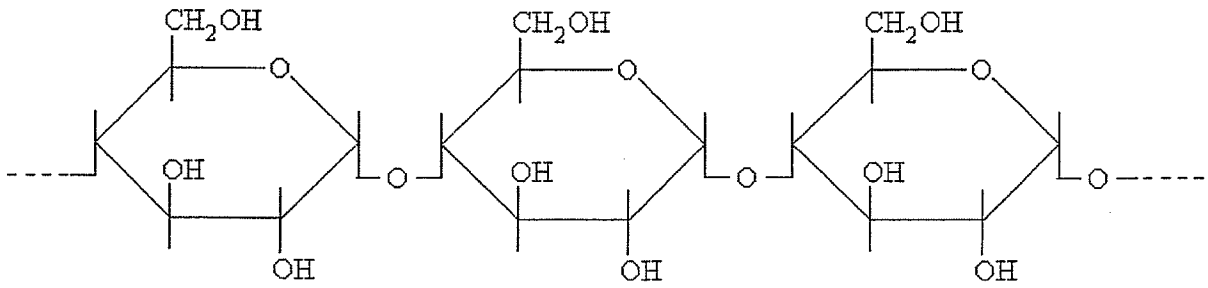
18. Starch is a condensation polymer. A section of a starch molecule is shown here:



a. Explain what is meant by the term "condensation polymer". **1**

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b. Cellulose is also a condensation polymer, made from the same monomer as starch. **1**

In which way is the structure of cellulose different from the structure of starch?

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Marks

19. Discuss the advantages and the disadvantages of using ethanol as an alternative fuel. **4**

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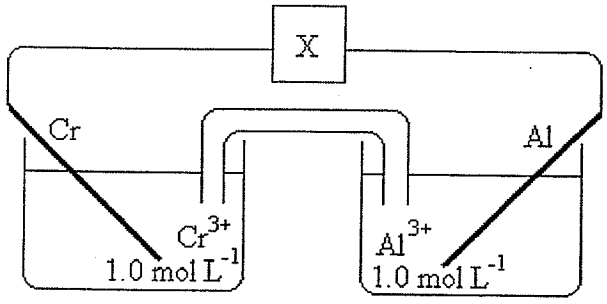
20. Two half cells were connected as shown.



a. What does the box, labelled X, represent when the set-up operates as an **electrolytic** cell? **1**

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b. The reduction potentials of the ions in these solutions, are: **2**

$Al^{3+} + 3e^- \rightleftharpoons Al_{(s)}$ $\quad -1.68$ V

$Cr^{3+} + 3e^- \rightleftharpoons Cr_{(s)}$ $\quad -0.74$ V

Write the two half equations and the overall redox equation, including the reduction E^o values, when the set-up operates as an **electrochemical** cell.

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Marks

21. Give two examples of everyday use of indicators. **2**

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22. The following equation shows the equilibrium that exists between gaseous and dissolved carbon dioxide.

$CO_{2(g)} \rightleftarrows CO_{2(aq)}$ + heat

Explain, in terms of Le Chatelier's Principle, what happens to the solubility of carbon dioxide

a. in the oceans as the temperature increases (as in going from winter to summer). **1½**

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b. in a soft drink bottle as the pressure decreases (as when taking the lid off the closed bottle). **1½**

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23. Aluminium reacts with dilute sulfuric acid according to the equation **3**

$$2Al_{(s)} + 3H_2SO_{4(aq)} \rightarrow Al_2(SO_4)_{3(aq)} + 3H_{2\,(g)}$$

What is the maximum volume of hydrogen, measured at 25°C and 101.3 kPa, that can be produced when 5.4 g of aluminium is put into excess sulfuric acid?

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Marks

24. a. The pH of a 0.20 mol L-1 hydrochloric acid, HCl, is lower than the pH of a 0.20 mol L-1 citric acid, $CH_2(COOH)COH(COOH)CH_2(COOH)$. Explain why this is so. **5**

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b. What is the pH of a 0.20 mol L-1 hydrochloric acid? **1**

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c. What is the conjugate base of hydrochloric acid? **1**

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25. a. Write a chemical equation for the formation of the ester propyl acetate. **1**

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b. The reaction will only proceed at an appreciable rate if the reaction mixture is refluxed. What is the purpose of refluxing? **2**

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Marks

26. Explain the formation and effects of acid rain. (Give at least two causes and two effects.) Support your explanation with chemical equations. **7**

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27. The equilibrium involved in the Haber process of ammonia production can be represented as

$$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$$

It is an exothermic process which is carried out at moderately high temperatures.

a. Explain the advantage and the disadvantage of increasing the temperature of this manufacturing process. **2**

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b. Describe three other methods used to optimise the amount of ammonia produced in the shortest time possible. **3**

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Marks

28. Describe a test that can be used to determine the total hardness of water. **6**

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29. a. Explain the need to monitor levels of lead and phosphate in our waterways. **4**

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b. Describe chemical tests to identify each of these two ions. **4**
Include equations if appropriate.

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Part	Marks	Out of
A		15
B		60
Elective		25
Total		100

Student number .....

TRIAL EXAMINATION 2002

CHEMISTRY
2 Unit

PART A

Select the alternative A, B, C or D that best answers the question.
Mark your answers in pencil on this Answer Sheet.

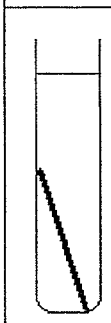
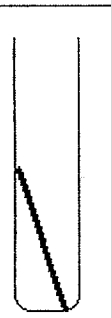
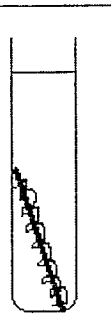
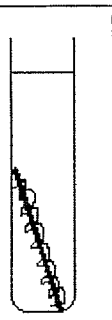
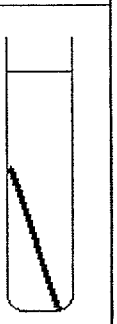
	A	B	C	D
1	O	O	O	O
2	O	O	O	O
3	O	O	O	O
4	O	O	O	O
5	O	O	O	O
6	O	O	O	O
7	O	O	O	O
8	O	O	O	O
9	O	O	O	O
10	O	O	O	O
11	O	O	O	O
12	O	O	O	O
13	O	O	O	O
14	O	O	O	O
15	O	O	O	O

Question 31 – SHIPWRECKS AND SALVAGE (25 marks)

Marks

a. What are the origins of the minerals in the oceans? **2**

b. The illustrated table gives the conditions to which strips of iron were subjected to study the factors contributing to rusting.

1	2	3	4	5	6	7
						
fresh tap water	no liquid	cold boiled tap water	tap water, wrapping of zinc wire	tap water, wrapping of copper wire	sugar solution	fresh sea water
open	open	closed	open	open	closed	open

i. Rust developed in tube 1, but not in tubes 2 or 3.
What conclusion can be drawn from these findings? **1**

ii. Comparing tubes 1, 4 and 5, in which would the rate of rusting be the lowest? Explain. **3**

iii. The aim of comparing tubes 1, 6 and 7 has two parts. What are they? **2**

c. The rate of corrosion near the surface of oceans depends primarily on temperature and on the concentration of dissolved oxygen. From these considerations it could be expected that corrosion deep down in the ocean would be minimal compared to that near the surface.

i. Explain why in cold water (about 4°C at great depths) corrosion is expected **1**
to be slower than in warmer water.

ii. Using Le Chatelier's Principle, explain why the concentration of dissolved oxygen should increase with increasing depth (i.e. increasing pressure). **1**

iii. Why does the concentration of dissolved oxygen decrease instead of increase with increased distance from the surface water? **1**

iv. Why is it that in spite of the low temperatures and the virtual absence of dissolved oxygen, many deep-ocean shipwrecks corrode at a much faster rate than expected? **3**

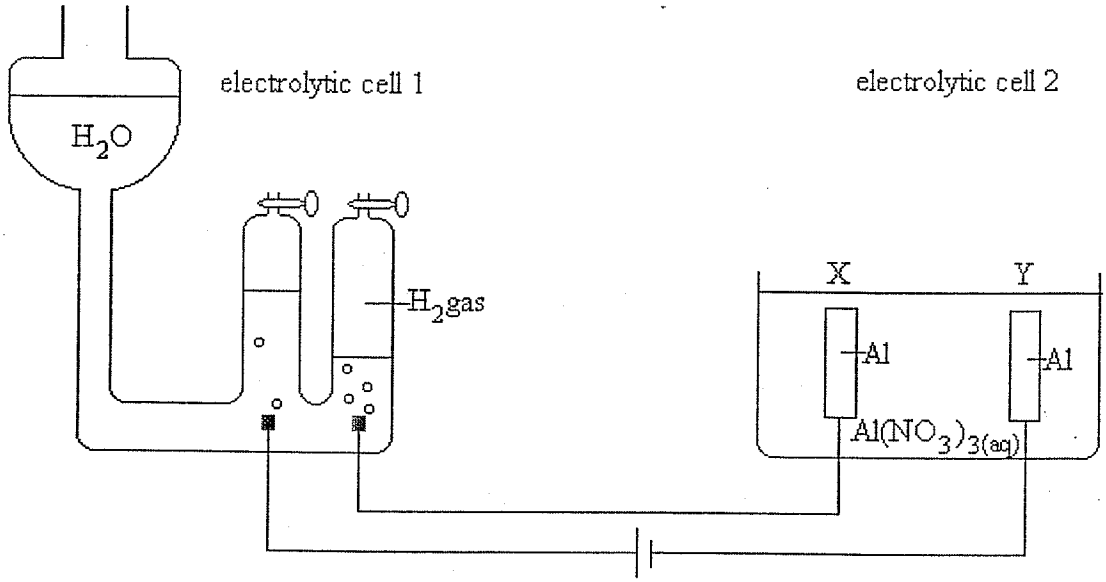
Marks

d. After the large 17th century Swedish wooden ship, the Vasa, was raised from the ocean floor about 40 years ago, it was placed on land, and a building was quickly constructed around it. Visitors could view this magnificent ship from behind glass walls, and see thousands of misty jets of water spraying every part of the ship. This stage of the restoration lasted for many years.

i. - Explain the purpose of the prolonged rinsing. **4**
- What would have happened to the wreck if this procedure had not been carried out?
- Explain why would this have happened.

ii. Give an example of a chemical means of salvaging objects from ship wrecks, and write the a chemical equation for the reaction. **2**

e. Two electrolytic cells were connected in series, as shown in the diagram.



In cell 1 acidified water was electrolysed, in cell 2 aluminium electrodes were immersed in 1.0 mol L^{-1} aluminium sulfate solution.

During the electrolysis 489 mL of hydrogen gas were collected in cell 1, measured at 25°C and 101.3 kPa. During this same time the mass of each electrode, X and Y, has changed in cell 2.

i. How many moles of hydrogen gas were produced? **1**

ii. How many moles of electrons were involved in the production of this amount of hydrogen gas? **1**

iii. Write the equation for the reaction occurring at electrode X. **1**

iv What was the change of mass of electrode Y? **2**