

School Number	Candidate Number
Surname and Initials	

CHEMISTRY

PAPER 3 3051/3

Wednesday **3 JUNE 2009** 12.30 – 2.00 P.M.

Additional materials:

Lined paper

Graph paper

MINISTRY OF EDUCATION NATIONAL EXAMINATIONS

BAHAMAS GENERAL CERTIFICATE OF SECONDARY EDUCATION

INSTRUCTIONS AND INFORMATION TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your school number, candidate number, surname and initials in the spaces provided at the top of this page as well as at the top of all lined paper submitted.

Answer **ALL** the questions in **Section A** in the spaces provided on the question paper and any **TWO** questions from **Section B** on the lined paper provided.

Equations and diagrams should be given wherever they are helpful. Essential working must be shown.

The intended marks for each question or part question are given in brackets [].

Relative atomic masses are given in the Periodic Table of elements printed on page 2.

ADDITIONAL INFORMATION

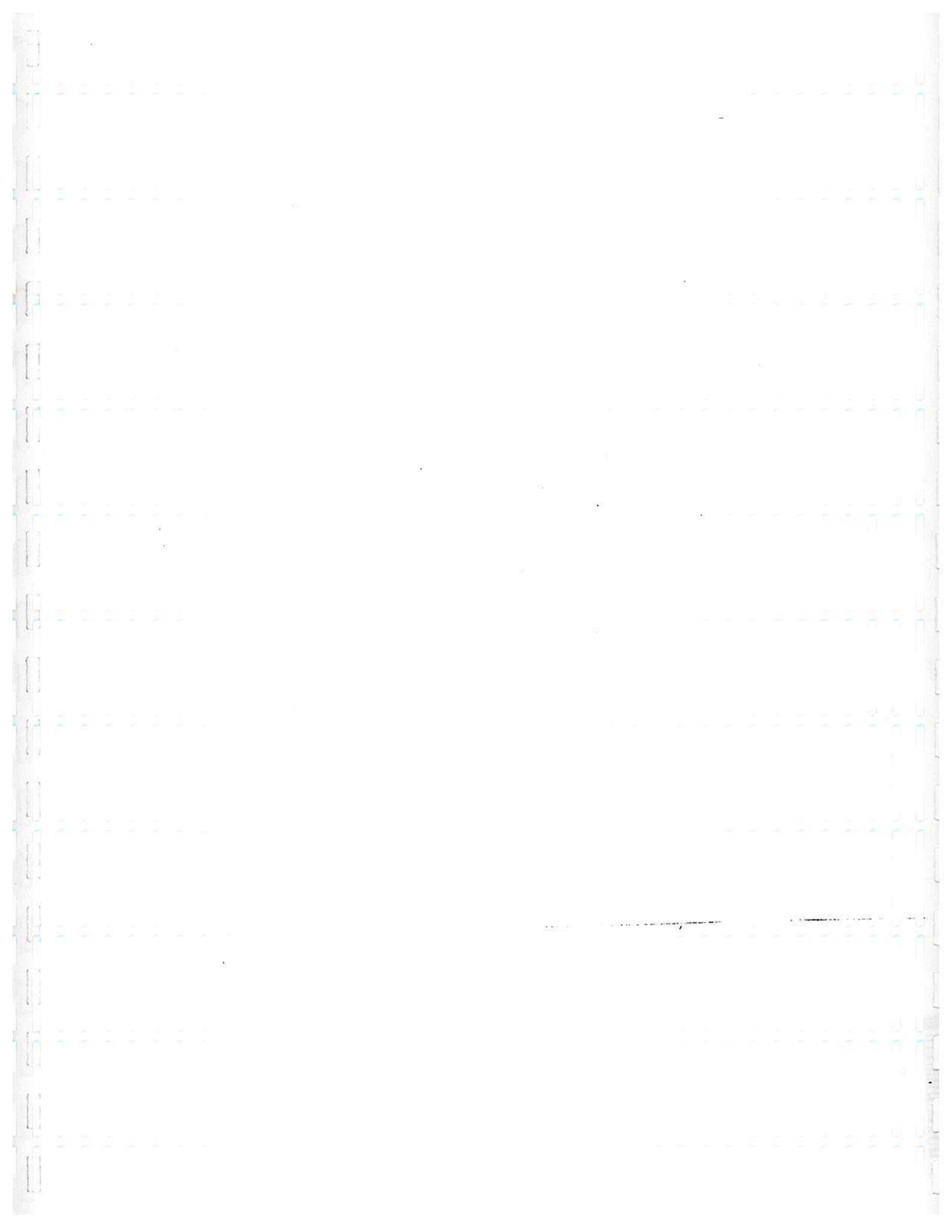
s.t.p. ($t = 0\text{ }^{\circ}\text{C}$, $p = 760\text{ mmHg}$)

The volume of one mole of gas at room temperature and pressure (r.p.t.) is $24\ 000\text{ cm}^3$.

FOR EXAMINER'S USE	
Section A	
1	
2	
3	
4	
Section B	
5	
6	
7	
TOTAL	

This question paper consists of 12 printed pages and 4 blank pages.

[Turn over



Section A

Candidates are to answer ALL four questions in Section A.

1. A student carried out a titration using 0.01 mol/dm^3 hydrochloric acid. He placed 20.0 cm^3 of aqueous calcium hydroxide in the flask and added methyl orange indicator. He added the hydrochloric acid from a burette. The colour of the indicator changed after he had added 15.0 cm^3 of the acid.

(a) Write a balanced chemical equation for this neutralization reaction.

[2]

(b) Calculate the number of moles of hydrochloric acid in 15.0 cm^3 of 0.01 mol/dm^3 solution.

[2]

(c) Using your equation in (a) and your answer to (b), calculate the number of moles of calcium hydroxide that react with the hydrochloric acid.

[2]

(d) Calculate the concentration of calcium hydroxide in the original 20.0 cm^3 of solution.

[1]

(e) Calcium hydroxide solution is used as a reagent to identify a gas. Name the gas and give the positive result for identifying it.

gas _____

result _____ [2]

(f) Write the formula for the ion that makes hydrochloric acid acidic.

[1]

Total marks [10]

2. Sodium can be extracted using electrolysis. Different types of cells are used depending on the electrolyte that is to be used.

There are two different ways in which the salt can be used for electrolysis.

- 1 – as molten sodium chloride,
- 2 – as a brine.

The diagram shows a Downs Cell used for the extraction of molten sodium chloride.

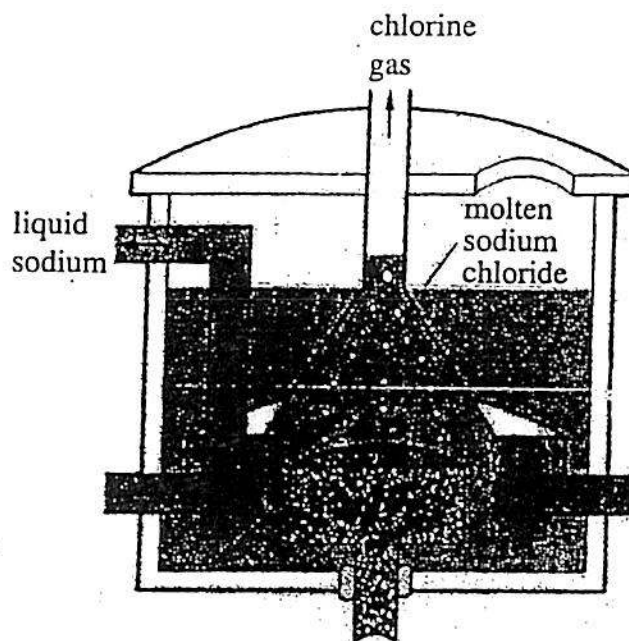


Diagram of a Downs Cell

- (a) On the diagram, mark the position of the anode and cathode. [1]
- (b) State where in The Bahamas there is a commercial supply of solid chloride readily available.
_____ [1]
- (c) Calcium chloride is added to the solid sodium chloride and the mixture is melted.
- (i) State how the melting point of the mixture compares to the melting point of the pure solid sodium chloride.
_____ [1]
- (ii) Using your answer to (c)(i), state the advantage of using the mixture.
_____ [1]

(d) (i) Identify the type of reaction occurring at the cathode.

_____ [1]

(ii) Write the ionic equation for the reaction that occurs at the cathode in the Downs Cell.

_____ [2]

(e) During the electrolysis of brine, the extracted sodium dissolves in mercury. The sodium-mercury mixture is reacted with water and then the mercury is recycled.

Name the two products produced in this process.

1 _____

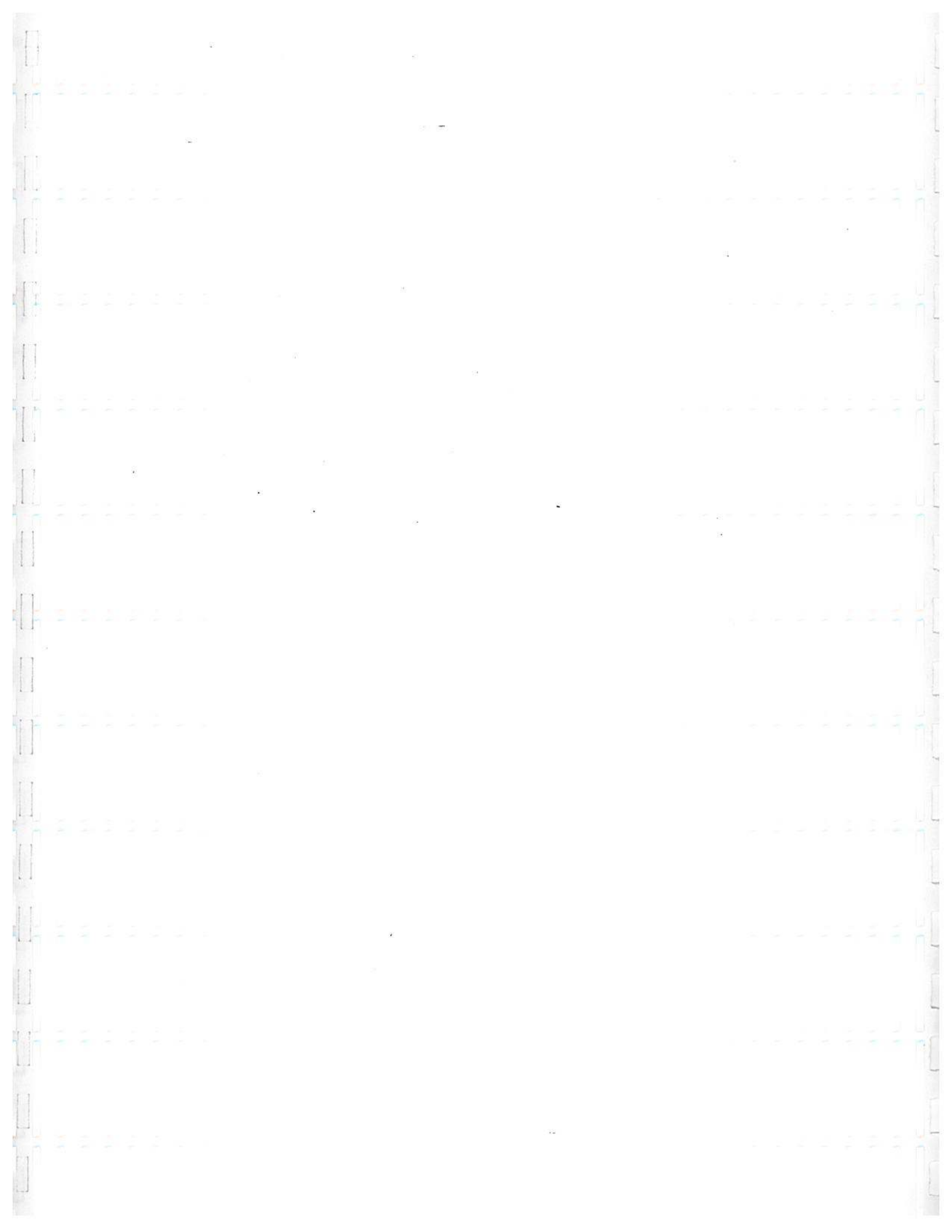
2 _____

[1]

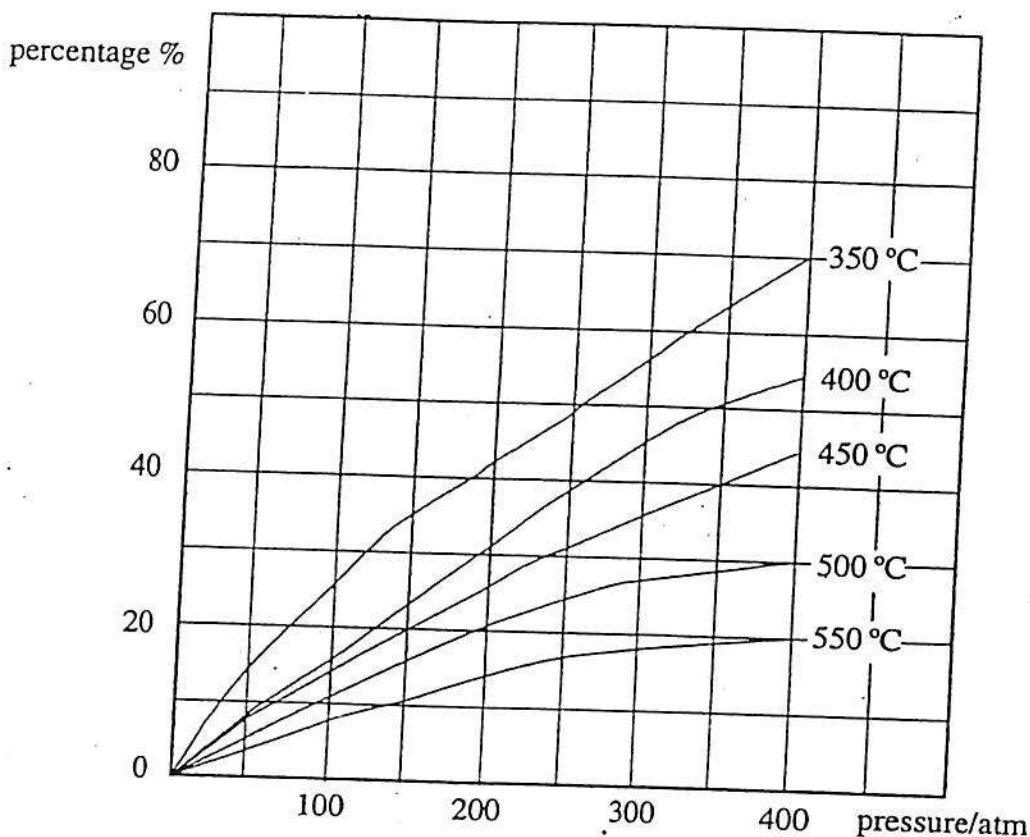
(f) Sodium can be used to extract titanium from titanium(IV) chloride. Write a balanced chemical equation for this reaction.

[2]

Total marks [10]



3. The Haber Process employs a catalytic reaction to make ammonia. The graph shows the percentage yield of ammonia at equilibrium under different conditions of temperature and pressure.



- (a) (i) Use the graph to find the percentage yield of ammonia at 200 atmospheres pressure and a temperature of 450 °C.

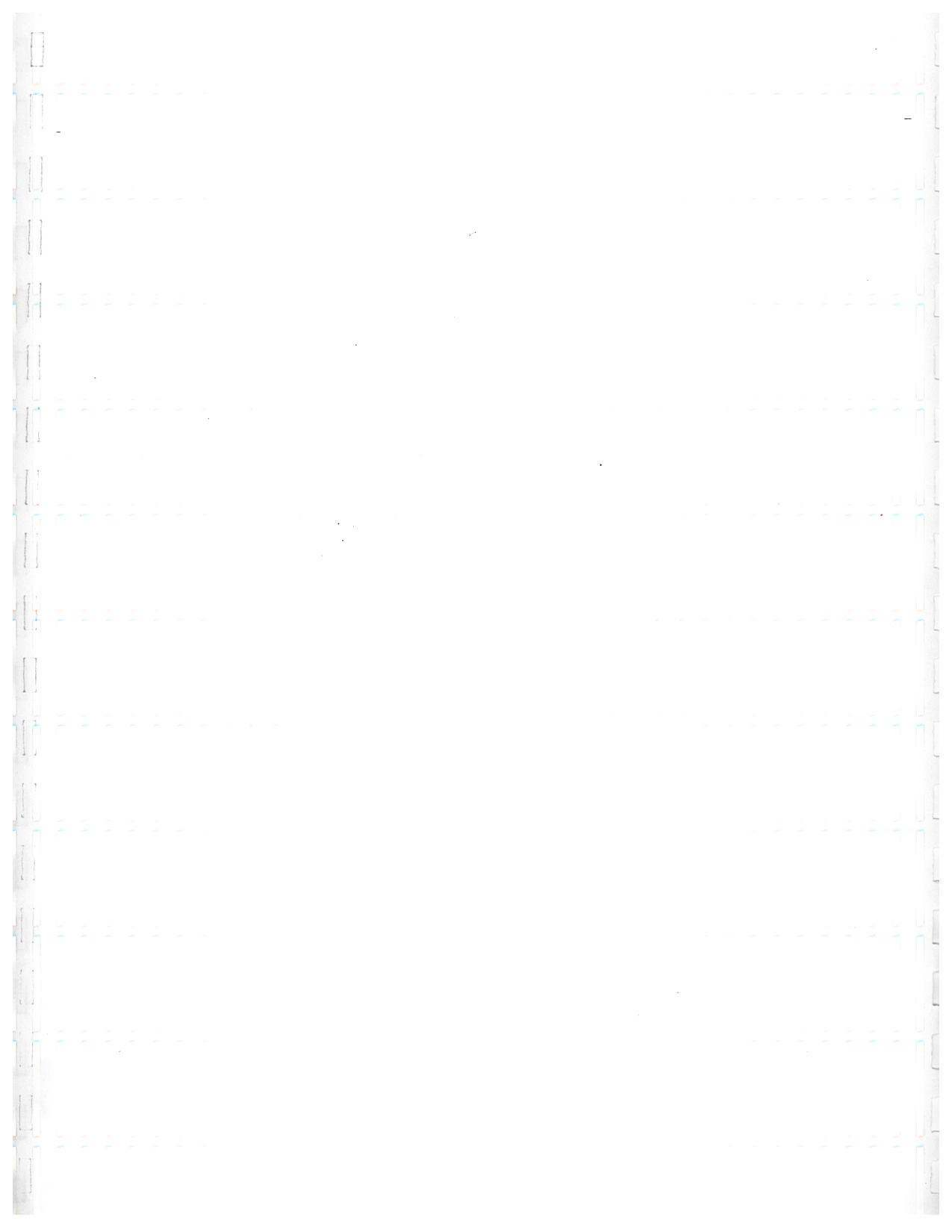
[1]

- (ii) State what happens to the percentage yield of ammonia if the temperature is increased but the pressure remains constant.

_____ [1]

- (iii) Using your answer to (a)(ii) to suggest what type of reaction takes place when ammonia is synthesized.

type of reaction _____ [1]



- (iv) Find the change in percentage yield when the pressure is increased from 150 atm to 400 atm at 550 °C.

[1]

- (b) (i) Write a balanced chemical equation for the formation of ammonia during the Haber Process, including the state symbols and the information you have given in (a)(iii).

[3]

- (ii) Name a catalyst that is used in the Haber Process.

[1]

- (c) Two useful fertilizers that can be made from ammonia are urea, $\text{CO}(\text{NH})_2$, and ammonium nitrate, NH_4NO_3 . Showing all calculations, prove that urea has more nitrogen per gram than ammonium nitrate.

calculation for urea

[1]

calculation for ammonium nitrate

[1]

Total marks [10]

4. (a) Use the Periodic Table and the table given to answer the questions. Hydrogen is included as a reference point for the metals.

Activity Series of Selected Metals

element	oxidation half-reaction	electrode potentials/volts
lithium	$\text{Li} \rightarrow \text{Li}^+ + \text{e}^-$	-3.03
sodium	$\text{Na} \rightarrow \text{Na}^+ + \text{e}^-$	-2.71
magnesium	$\text{Mg} \rightarrow \text{Mg}^{+2} + 2\text{e}^-$	-2.37
aluminum	$\text{Al} \rightarrow \text{Al}^{+3} + 3\text{e}^-$	-1.66
zinc	$\text{Zn} \rightarrow \text{Zn}^{+2} + 2\text{e}^-$	-0.76
iron	$\text{Fe} \rightarrow \text{Fe}^{+2} + 2\text{e}^-$	-0.44
hydrogen	$\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$	0.00
copper	$\text{Cu} \rightarrow \text{Cu}^{+2} + 2\text{e}^-$	+0.34

- (i) Name a metal that will more easily lose electrons than zinc.

_____ [1]

- (ii) Name a metal that is more easily oxidized than aluminium.

_____ [1]

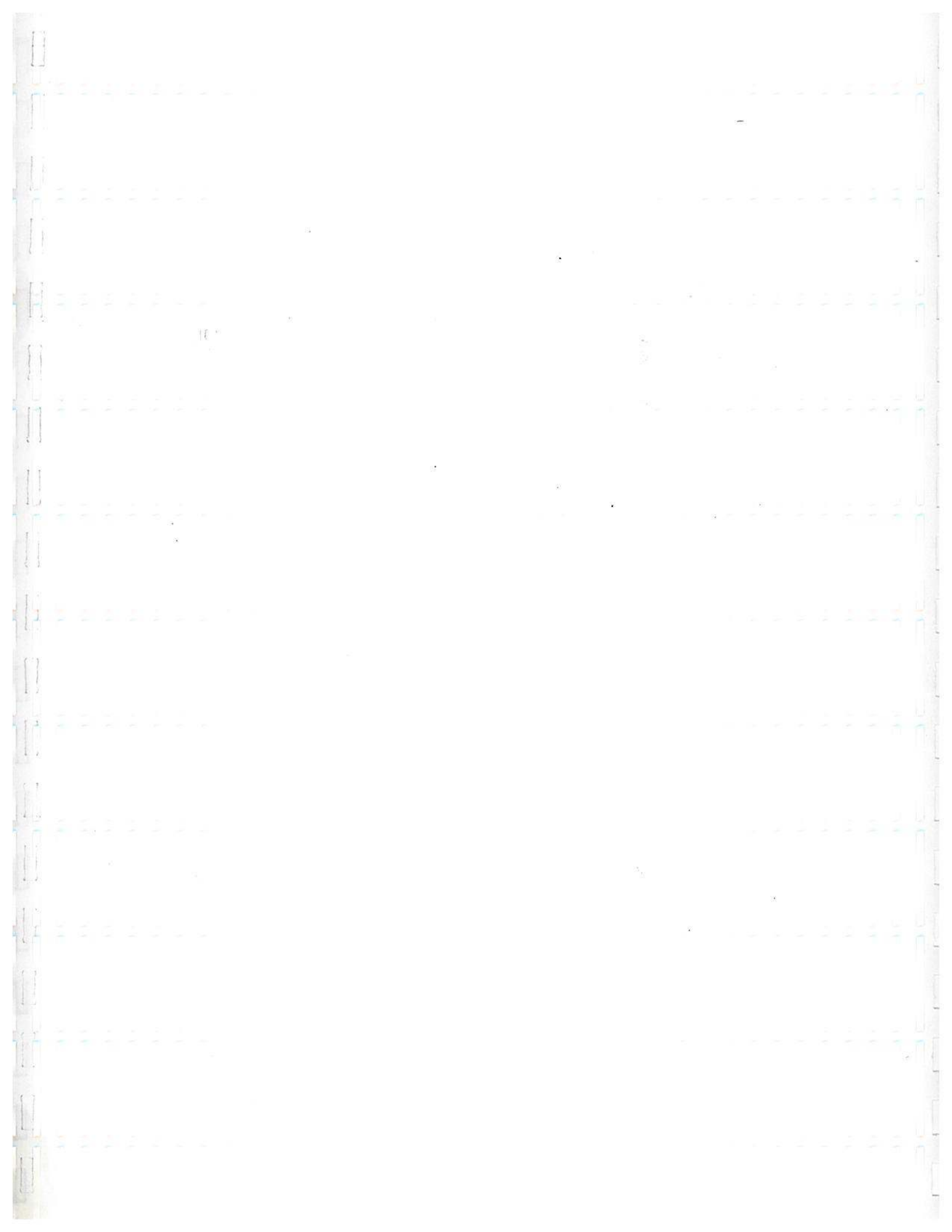
- (iii) Describe what is **observed** when an iron nail is placed in a solution of copper(II) sulfate. Explain your answer.

observation _____

_____ [2]

explanation _____

_____ [1]



- (iv) Based on the position of zinc and iron in the table, explain how attaching zinc blocks to a steel ship hull protects the steel from corrosion.

[2]

- (b) Copper may be purified by electrolysis using aqueous copper(II) sulfate as the electrolyte.

In the electrolysis apparatus, name the material that is placed at the anode and state what happens to the mass of the cathode.

- (i) material at anode; _____ [1]

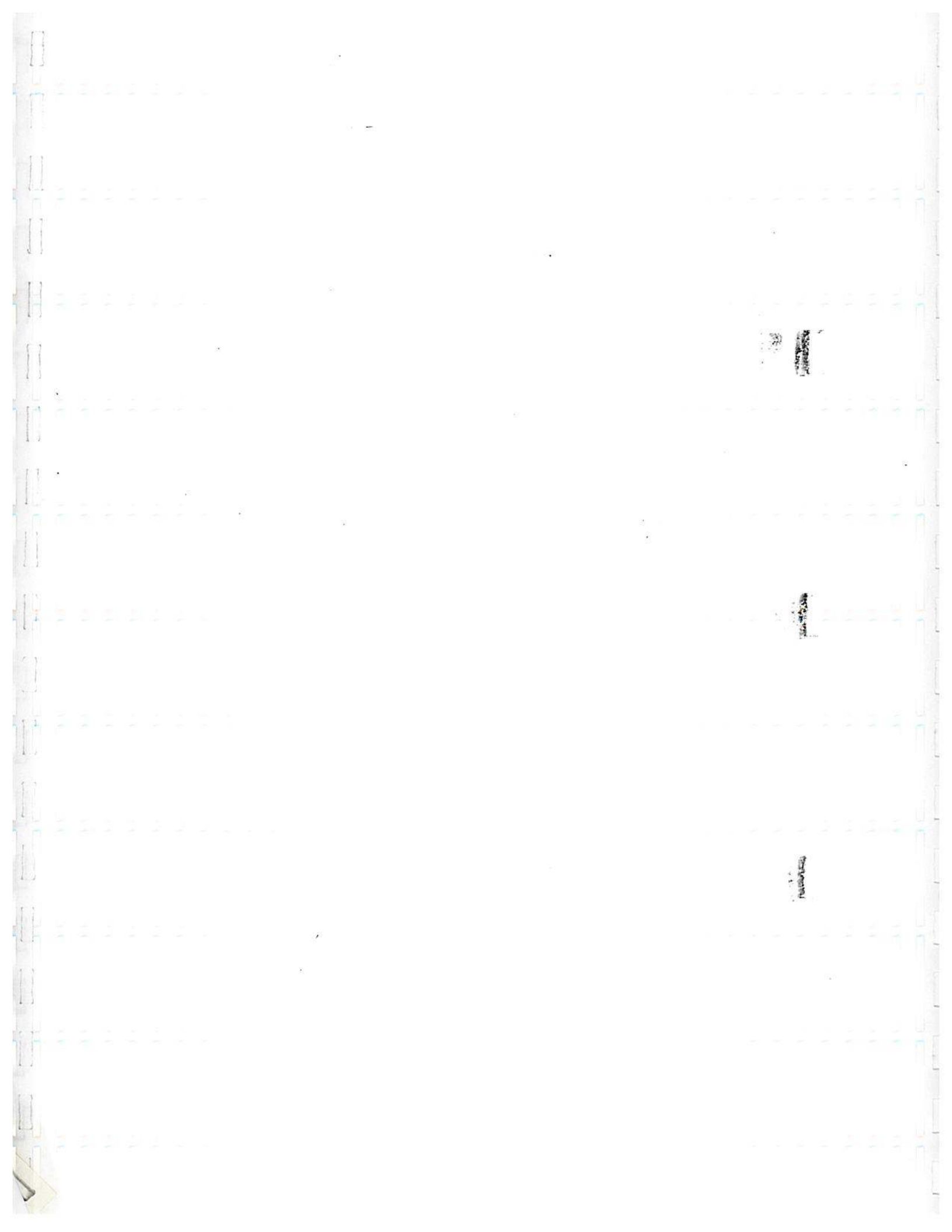
- (ii) statement of what happens to the mass of the cathode during electrolysis.

[1]

- (iii) Write the ionic equation for the reaction that occurs at the cathode.

[1]

Total marks [10]



Section B

Answer any TWO questions in the answer booklet provided.

5. Hydrogen peroxide undergoes decomposition yielding oxygen and water when manganese(IV)oxide is added as a catalyst.

A small conical flask is connected to a gas syringe by means of a stopper and a delivery tube. 30 cm³ of water and 0.5 g of manganese(IV)oxide are placed in the flask. A volume of 5 cm³ of pure hydrogen peroxide is added, the flask is quickly stoppered and readings of the volumes of gas in the syringe are recorded every 10 seconds.

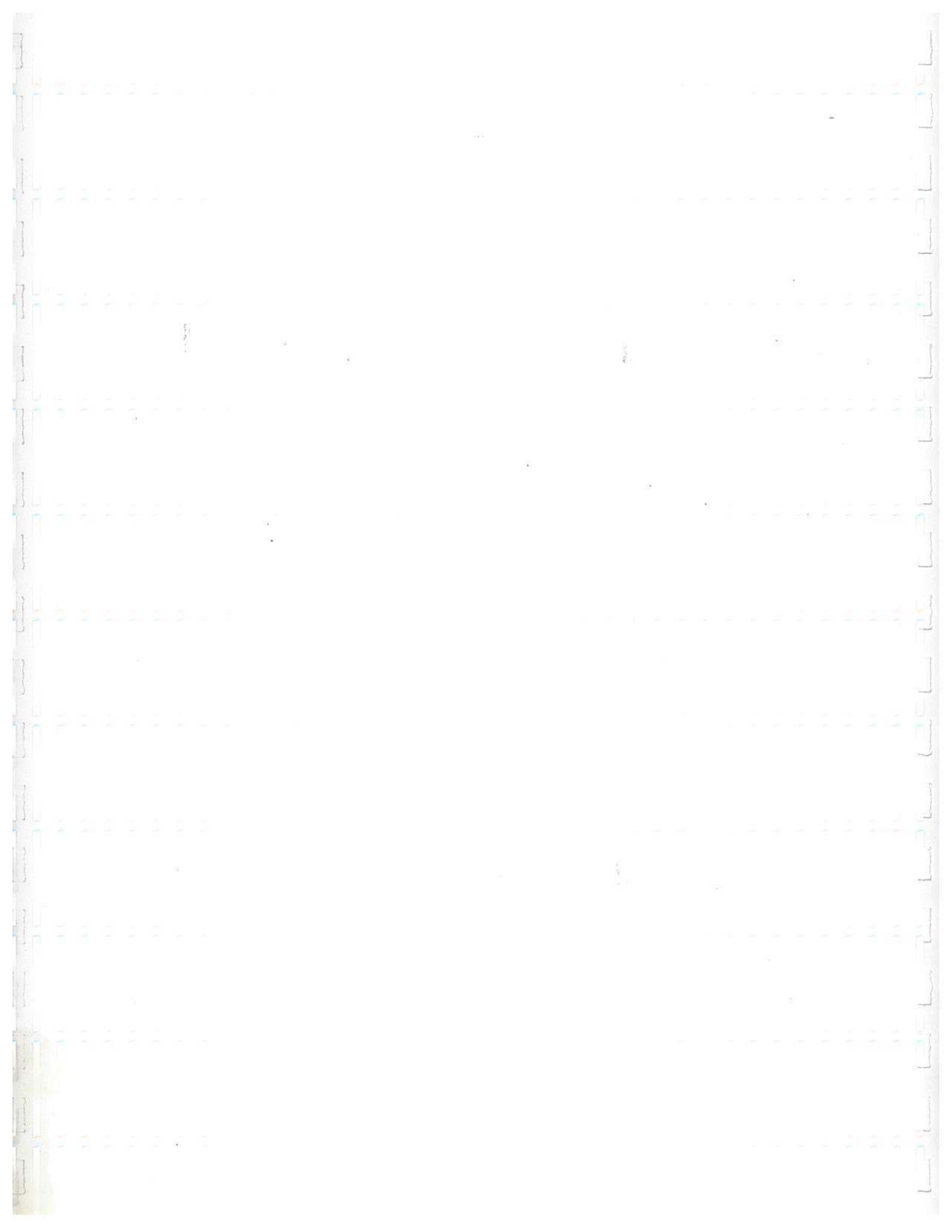
time/sec	0	10	20	30	40	50	60	70	80
volume/cm ³	0	18	30	40	48	53	57	58	58

- (a) (i) Plot a graph of the volume against time and label this curve as A. [6]
- (ii) Determine the volume of gas produced at 32 s in graph A. [1]
- (iii) Draw the apparatus used in the experiment. [2]

When the reaction was complete, the syringe was emptied of the gas. Without emptying the flask, another 10 cm³ of water was added and 5 cm³ of pure hydrogen peroxide was added, and the experiment was repeated as before.

- (iv) On the same axes, sketch a second graph to show how the volume of gas collected would vary with time. Label this curve B. Explain fully how you determined the shape and position of curve B. [3]
- (v) Manganese(IV) oxide acts as a catalyst in this experiment. Using the information given in the introduction, find the mass of catalyst which remains in the flask after the second experiment. [1]
- (b) Name TWO factors that can increase the pressure inside an adjustable oxygen tank. [2]
- (c) Explain the following in terms of the kinetic theory of gases.
- (i) A hot-air-balloon shrinks when the heating source is turned off. [2]
- (ii) Aerosol cans (pressurized cans) carry the warning message **Do not incinerate**. [3]

Total marks [20]



6.

A series of experiments are performed in a high school laboratory to identify some unknown compounds, two of them are solutions X and Y and the third one is solid Z. Deduce the formulae of X, Y, and Z from the following qualitative analysis.

(a) (i) solution X + NaOH(aq) → dirty-green precipitate

filtrate after filtering

this precipitate + dilute HCl(aq) + BaCl₂(aq) → white precipitate

(ii) solution Y + NaOH(aq) → red-brown/rusty-brown precipitate

filtrate after filtering

this precipitate + dilute HNO₃(aq) + AgNO₃(aq) → white precipitate
that turns grey in
sunlight

(iii) solid Z + HCl(aq) → salt + water + gas that turns lime water milky

flame test solid Z → brick-red flame

[6]

(b) Write four balanced equations based on the information given.

- solid Z when heated produces solid D + Gas E.

- solid D + H₂O produces a cloudy mixture, filtered to produce solution F.

- solution F + Gas E → mixture G [water with a white precipitate]

- mixture G + excess gas E → solution H

[8]

(c) Two unknown chlorides produce a golden yellow flame and an apple-green flame when tested in a colourless flame. Give the symbols for the two metal ions present in the chlorides.

[2]

(d) 0.6 g of magnesium is burned in air to produce magnesium oxide.

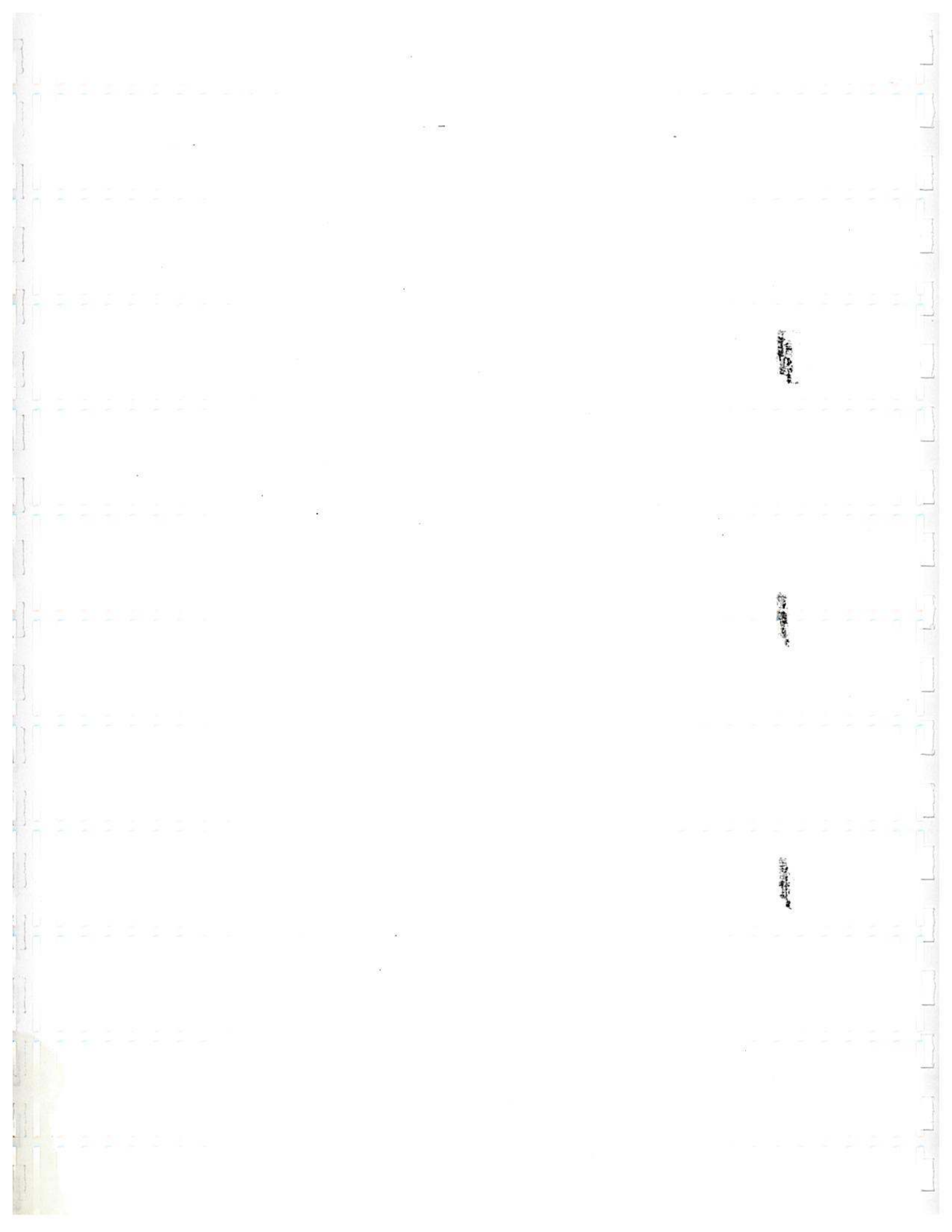
(i) Write a chemically balanced equation for this reaction.

[2]

(ii) Calculate the mass of magnesium oxide produced in the reaction.

[2]

Total marks [20]



7. A compound of carbon was analyzed. It contains 40.68% carbon, 54.24% oxygen and the rest is hydrogen. Its molecular formula is twice the empirical formula.

(a) Determine

(i) The empirical formula [5]

(ii) The molecular formula [1]

(b) The molecule of the compound is symmetrical.

(i) Draw its structural formula. [2]

(ii) Name the functional group for this compound. [1]

(iii) State the effect that this compound would have on green Universal Indicator. [1]

(c) (i) Penicillin is an organic antibiotic. Explain the terms organic and antibiotic.

(ii) The formula of penicillin is $C_{14}H_{20}N_2SO_4$. Calculate the M_r and the percentage composition of carbon in this compound. [6]

(d) Alcohols can be used as antiseptics. They can also be converted to sweet-smelling compounds.

Choose an alcohol that has between 1 and 4 carbon atoms in its molecule to be reacted with ethanoic acid.

Answer these questions about this reaction.

(i) Name the type of reaction that takes place.

(ii) Name the compound formed.

(iii) Draw the structural formula of the compound formed. [4]

Total marks [20]

