

GCSE Chemistry (9 – 1)

Metal Corrosion

Name:

Group:

Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.



For markers use	
Question	Mark
1	/6
2	/13
3	/4
4	/9
Total	/32
%	
Grade	

Information

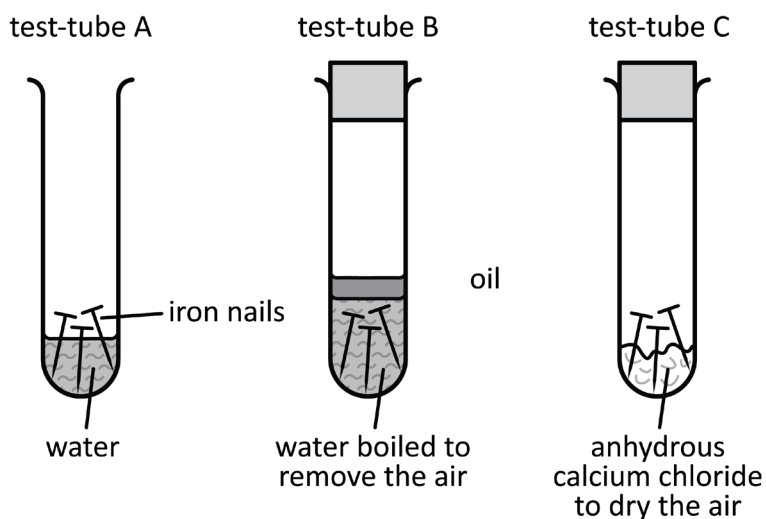
- The maximum mark for this paper is 32 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. Corrosion is the destruction of materials by chemical reactions with substances in the environment.

Circle the letter of the correct answer for each of the following questions.

- a) A student investigates the conditions required for iron to rust. They set up three test tubes, **A**, **B**, and **C** as shown in the diagram. After one week, the student observes that the nails in tube A have rusted, but the nails in tube B and tube C have not.



The diagram shows three test tubes used to investigate rusting.

Tube 1: Iron nail, water, and air.

Tube 2: Iron nail, boiled water, and oil.

Tube 3: Iron nail and drying agent.

The student compares the results from Tube 1 and Tube 2.

What conclusion can be drawn from this specific comparison?

A

B

C

D

Rusting requires water.

Rusting requires oxygen.

Rusting requires salt.

Rusting requires light.

(1 mark)

- b) Which substances in the air are needed for iron to rust?

A

B

C

D

Oxygen and water.

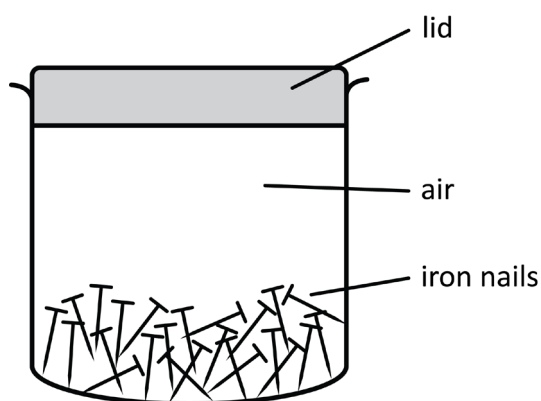
Oxygen only.

Water and carbon dioxide.

Water only.

(1 mark)

c) A number of iron nails were stored in an airtight for a week. The figure below shows the setup.



Within a few days the nails begin to rust. How could the rusting of the nails be have been prevented?

- A** Leave the lid off.
- B** Replace the air with argon.
- C** Put the container in a warm place.
- D** Seal the container in a bag.

(1 mark)

d) Which of the following metals is used to galvanise iron?

- | A | B | C | D |
|----------|----------|----------|----------|
| Copper | Lead | Tin | Zinc |

(1 mark)

e) Many metals corrode when exposed to the environment, but the term 'rusting' is used specifically for the corrosion of which metal (or alloy)?

- | A | B | C | D |
|-----------|----------|----------|-----------|
| Aluminium | Copper | Iron | Magnesium |

(1 mark)

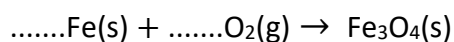
f) A steel ship can be protected from corrosion by attaching blocks of another metal to the hull. This is called 'sacrificial protection'. Which metal would be suitable to use as the sacrificial metal?

- | A | B | C | D |
|----------|----------|----------|-----------|
| Gold | Copper | Silver | Magnesium |

(1 mark)

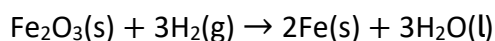
(Total for Question 1 is 6 marks)

2. Iron wire burns in oxygen.
a) Balance the chemical equation for this reaction.



(2 marks)

Pure iron can be made by reducing iron(III) oxide, Fe_2O_3 , with hydrogen.



- b) How does this equation show that iron(III) oxide is reduced?

.....
.....
.....

(1 mark)

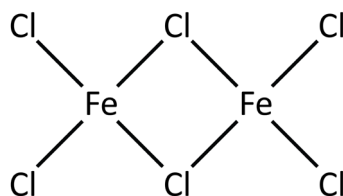
- c) When iron reacts with dilute hydrochloric acid, iron(II) chloride is formed.

Describe a test for iron(II) ions.

.....
.....
.....
.....
.....
.....

(2 marks)

At high temperatures, iron(III) chloride exists as a molecule with the structure shown in the diagram below.

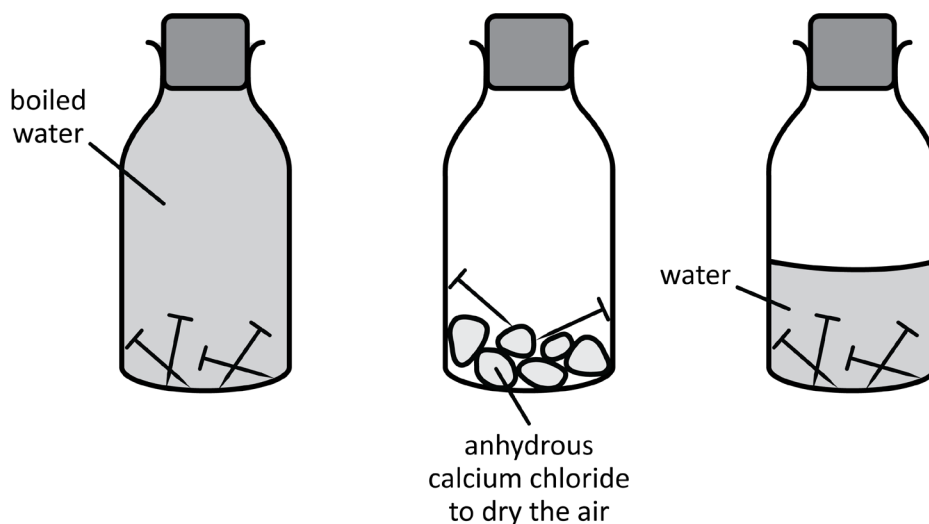


- d) Determine the **molecular formula** of this compound.

.....

(2 marks)

A student places iron nails into three bottles, A, B, and C, to investigate rusting.



Bottle A: Contains iron nails and boiled water covered with a layer of oil.

Bottle B: Contains iron nails and anhydrous calcium chloride (a drying agent).

Bottle C: Contains iron nails and distilled water left open to the air.

After one week, the student observes that the nails in Bottle A and Bottle B have **not** rusted.

e) **Explain** the reason for the lack of rusting in both of these bottles.

.....

.....

.....

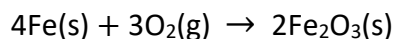
.....

.....

(2 marks)

f) When iron rusts completely, it reacts with oxygen to form iron(III) oxide Fe_2O_3 .

The balanced chemical equation for this reaction is:



Calculate the mass of iron(III) oxide that would be produced from 11.2g of pure iron.

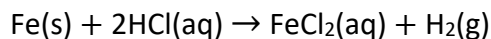
(Relative atomic masses (Ar): O = 16, Fe = 56)

Mass of iron(III) oxide = ... g

(4 marks)

(Total for Question 2 is 13 marks)

3. Iron corrodes rapidly when exposed to acid rain which often contains dissolved acids.
The equation below shows iron reacting with hydrochloric acid.



A scientist investigates how much iron is corroded by a sample of acid rain.
They use 50.00 cm³ of 2.00 mol/dm³ hydrochloric acid.

Calculate the mass, in g, of iron that would react exactly with this amount of acid using the following steps.

- a) Calculate the number of moles of HCl present in 50.00 cm³ of 2.00 mol/dm³ HCl.

Mol = ...
(1 mark)

- b) Determine the number of moles of Fe which would react with this amount of HCl.

..... mol
(1 mark)

- c) State the relative atomic mass, *A_r*, of Fe.

.....
(1 mark)

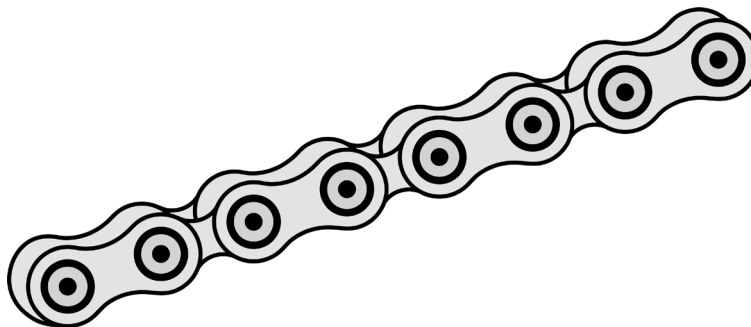
- d) Calculate the mass of Iron (Fe) needed to react exactly with the acid.

Mass = ...
(1 mark)

(Total for Question 3 is 4 marks)

4. The image below shows a bicycle chain. The chain is made of steel.

When the bicycle is ridden in wet weather, the chain is exposed to water and oxygen.



- a) **Describe** different methods that can be used to prevent iron and steel from rusting.

In your answer, **evaluate** which method is most suitable for protecting a bicycle chain and explain why other methods are not suitable.

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

(6 marks)

b) The frame of the bicycle is also made of steel.

The manufacturer chooses to protect the frame by galvanising it with zinc.

Explain how galvanising protects the steel frame from rusting.

In your answer, explain what happens if the zinc coating is scratched or damaged.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

(Total for Question 4 is 9 marks)