

Metal Corrosion

Mark Scheme



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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. What conclusion can be drawn from this specific comparison?

B – is the only correct answer.	1 mark
	Total: 1 mark

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

A – is the only correct answer.	1 mark
	Total: 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?

B – is the only correct answer.	1 mark
	Total: 1 mark

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

D – is the only correct answer.	1 mark
	Total: 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)?

C – is the only correct answer.	1 mark
	Total: 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?

D – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 6 marks)

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

$3\text{Fe} + 2\text{O}_2 \rightarrow \text{Fe}_3\text{O}_4$	
Award 1 mark for a 2 in front of O_2 .	1 mark
Award 1 mark for a 3 in front of Fe.	1 mark
	Total: 2 marks

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

Iron / it has lost oxygen.	1 mark
	Total: 1 mark

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

Describe a test for iron(II) ions.

A description to include the following:	
Add sodium hydroxide (solution). Allow: NaOH	1 mark
Green precipitate (forms).	1 mark
	Total: 2 marks

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

Fe_2Cl_6	2 marks
	Total: 2 marks

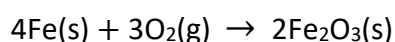
After one week, the student observes that the nails in Bottle A and Bottle B have **not** rusted.

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

An explanation to include:	
Bottle A: boiled water has no oxygen / air.	1 mark
Bottle B: calcium chloride has no water / moisture.	1 mark
	Total: 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:



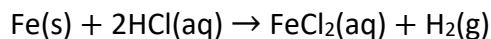
Calculate the mass of iron(III) oxide that would be produced from 11.2g of pure iron.

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

Moles of Fe = $(11.2 \div 56) = 0.2$	1 mark
Moles of $\text{Fe}_2\text{O}_3 = (0.2 \div 2) = 0.1$	1 mark
Mr of $\text{Fe}_2\text{O}_3 = 2(56) + 3(16) = 160$	1 mark
Mass of $\text{Fe}_2\text{O}_3 = 0.1 \times 160 = 16 \text{ g}$	1 mark
	Total: 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.

Volume in dm ³ = 0.050 dm ³	1 mark
Moles = 0.050 × 2.00 = 0.1 mol	1 mark
	Total: 1 mark

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

0.05 (mol)	1 mark
	Total: 1 mark

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

56	1 mark
	Total: 1 mark

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

0.05 × 56 = 2.8 (g)	1 mark
	Total: 1 mark

(Total for Question 3 is 4 marks)

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

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.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Simple statements about stopping rust (e.g. "paint it" or "put oil on it"). Little or no evaluation of suitability for the specific object.
Level 2	3 - 4	Different methods of rust prevention are described. A suitable method for the chain is suggested, but the justification regarding lubrication or the unsuitability of paint for moving parts is less detailed.
Level 3	5 - 6	A detailed description of different rust prevention methods is given. The student evaluates the methods specifically for a moving part (bicycle chain), correctly identifying oiling/greasing as the best option with a valid reason (lubrication).

Indicative content:	
Methods of prevention: Coating/Barrier methods: Painting, plastic coating, greasing/oiling. These work by stopping oxygen and water from reaching the surface of the iron. Sacrificial protection: Attaching blocks of a more reactive metal (e.g., magnesium or zinc). The more reactive metal corrodes first. Galvanising: Coating the iron in a layer of zinc. This acts as both a physical barrier and sacrificial protection. Evaluation for bicycle chain: Painting or plastic coating is not suitable. Because the chain is flexible and moves constantly over gears, a solid coating would crack, peel, or rub off very quickly. Oiling or Greasing is the most suitable method. Reason: It provides a waterproof barrier to prevent rusting AND it acts as a lubricant to reduce friction between the moving links and gears. (It can also be easily reapplied).	
	Total: 6 marks

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

Explain how galvanising protects the steel frame from rusting.

An explanation to include:	
Zinc acts as a barrier to oxygen / water.	1 mark
Zinc is more reactive than iron (steel).	1 mark
So, zinc corrodes / oxidises instead of the iron.	1 mark
	Total: 3 marks

(Total for Question 4 is 9 marks)