

Corrosion and its prevention

4.10.3.1 · Using resources · revision notes

What corrosion is, the experiment that shows iron needs both air and water to rust, and how barrier methods and sacrificial protection prevent corrosion. This is in GCSE Chemistry only, not in Combined Science. Expect practical-based questions and 'explain' questions using the reactivity series on Paper 2.

Key facts

- Corrosion = destruction of materials by chemical reactions with substances in the environment
- iron + oxygen + water → hydrated iron(III) oxide (rust)
- Barrier methods: grease, paint, electroplating (and plastic coating)
- Galvanising = coating iron with zinc (sacrificial protection)
- Rusting needs air (oxygen) AND water
- Boiling removes dissolved air; an oil layer stops air re-dissolving; anhydrous calcium chloride dries the air
- Aluminium is protected by a layer of aluminium oxide

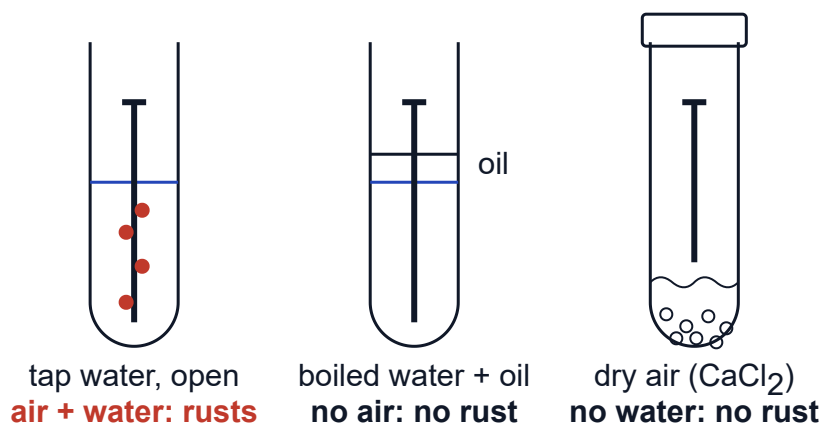
Notes

Corrosion and rusting

- Corrosion** is the destruction of materials by chemical reactions with substances in the environment.
- Rusting** is the corrosion of iron and steel. Iron needs **both air (oxygen) and water** to rust.
- iron + oxygen + water → hydrated iron(III) oxide (rust)

Experiment: what does iron need to rust?

- Tube 1: iron nail in tap water, open to the air. Result: rusts.
- Tube 2: nail in water that has been **boiled** (to remove dissolved air), with a layer of **oil** on top (to stop air dissolving back in). Result: no rust.
- Tube 3: nail in air dried by **anhydrous calcium chloride** (a drying agent that absorbs water), sealed with a bung. Result: no rust.



Iron rusts only when both air (oxygen) and water are present.

- Conclusion: iron rusts only when both air and water are present.

Preventing corrosion

- **Barrier methods** stop air and water reaching the metal: **greasing** or oiling, **painting**, coating with plastic, and **electroplating** (using electrolysis to coat the object with a thin layer of another metal).
- **Aluminium** is more reactive than iron but does not corrode away: a layer of **aluminium oxide** forms on its surface and protects the metal from further corrosion.
- **Sacrificial protection:** iron is coated with, or connected to, a **more reactive metal**. **Galvanising** coats iron with **zinc**; blocks of zinc or magnesium are attached to ships' hulls and underground pipes.

How to answer each type of question

Interpret the rusting experiment

3 to 4 marks

Grade 5

1. Say which tube rusted and what each of the other tubes lacked.
2. Give the purpose of each part: boiling removes air, oil stops air dissolving, calcium chloride removes water vapour.
3. Conclude that both air and water are needed.

Example. A student set up three test tubes, each containing an iron nail.

Tube A: nail in tap water, no bung.

Tube B: nail in boiled water with a layer of oil on top.

Tube C: nail with anhydrous calcium chloride, sealed with a bung.

After one week only the nail in tube A had rusted.

- (a) Why was the water in tube B boiled? (1 mark)
- (b) What is the purpose of the anhydrous calcium chloride in tube C? (1 mark)
- (c) What do the results show? (2 marks)

Model answer. (a) To remove dissolved air (oxygen) from the water (1)

(b) To absorb water / to dry the air in the tube (1)

(c) Iron needs air (oxygen) to rust, shown by tube B, and water to rust, shown by tube C (1); both must be present for rusting (1).

Don't lose marks

- ✗ Writing that iron rusts with air or water. It needs both.
- ✗ Saying the water is boiled to kill bacteria. It is boiled to remove dissolved air.
- ✗ Saying zinc protects iron because it is 'stronger' or 'less reactive'. The reason is that zinc is MORE reactive.
- ✗ Using 'rust' for other metals. Only iron and steel rust; other metals corrode.
- ✗ Saying aluminium does not corrode because it is unreactive. It is fairly reactive, but its oxide layer protects it.

More tips

Memory tricks

- Rust recipe: iron + air + water. Take away either air or water and there is no rust.
- Sacrificial = the more reactive metal 'sacrifices' itself to save the iron.
- Zinc and magnesium are above iron in the reactivity series (sacrificial); tin is below it (barrier only).
- The oil layer in tube 2 works like a lid that keeps air out of the water.

Exam technique

- In sacrificial protection answers, use the words 'more reactive' and 'loses electrons' or 'is oxidised instead of iron'.
- For the three-tube experiment, give the purpose of each condition, not just the result.
- For 'suggest a method' questions, match the method to how the object is used, e.g. moving parts, underground, needs to look shiny.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Define corrosion and give an example

Corrosion is the destruction of materials by chemical reactions with substances in the environment; rusting is an example.

Grade 4

State the conditions needed for rusting

Iron needs both air (oxygen) and water to rust.

Grade 4

Name barrier methods of preventing corrosion

Greasing, painting and electroplating keep air and water away from the metal.

Grade 5

Describe the rusting experiment with three tubes

Nails in water open to air, in boiled water under oil, and in dry air; only the first rusts.

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