STEM Club experiment : iron and rusting

Bloodhound Land Speed Record car uses lots of different materials, particularly metals, in its construction. Metals can corrode over time and need protection to stop them from reacting with the air and wearing away. This investigation looks at different conditions that cause and can increase or decrease corrosion, called rusting, in iron or steel components.

You will need:

6 containers (cups or beakers)
6 iron nails
Cooled boiled water
Some cooking oil
A Silica gel sachet
Salty water
Paint (waterproof)
Cling film
Vaseline

Investigation:

Part 1: You are going to see what conditions need to be present for rusting to occur. Is it air, or water, or both?

Part 2: You are also going to test what other conditions or surface coatings could speed up or slow down rusting, comparing your results from Part 1 of the investigation.

PREDICT: What do you think will happen?

Experiment: Part 1

1. Set up 3 containers and label them 1 to 3
2. Number 1 – half fill with tap water and place a nail into it. Do not cover.
3. Number 2 – make sure it is dry and place a nail into it. Add the silica gel sachet and cover over the top with cling-film.
4. Number 3 – Place the nail completely in cooled boiled water and add a thin layer of cooking oil on the top of the water.

Experiment: Part 2

1. Set up 3 containers and label them 4, 5 and 6
2. Number 4, as number 1 but add salty water instead of tap water
3. Number 5, as number 1 but add a nail coated in paint to the container
4. Number 6, as number 1 but add a nail covered in Vaseline to the container.

Leave all containers for up to 2 weeks in a safe place.



Did you know?

Bloodhound Land Speed Record car uses steel for the floor of the car and its disc brakes.

Part 1 Results:

After 2 weeks look at your experiment and record your results.

Container number	Did it rust? (yes/no/a little)
1 (air and water)	
2 (air only)	
3 (water only)	

What conditions did you find were needed to give most rusting?

Air and water Air only Water only

Part 2 results:

After 2 weeks write down what you found in the results table.

Container number	Did it rust more, the same or less than number 1?
4 (salty water)	
5 (painted nail)	
6 (nail covered in Vaseline)	

Conclusion: Your results should show you that for **most** rusting to occur, both **air** and **water** need to be present. **Salt** water will **increase** rusting. **Coating** or covering the surface of the iron will **reduce** rusting.

Did you know?

The Humber bridge does not use salt to de-ice its roadway as this would cause the steel bridge to rust. It uses another substance called urea instead.



Iron and Oxygen

Corrosion is an oxidation reaction. Iron and oxygen react, together with water, to form rust (hydrated iron oxide). The word equation for this reaction is:

Iron + oxygen + water ➔Rust (iron oxide)

You can often see rusting on old iron structures or vehicles. The rust is a brown colour and becomes flaky, weakening the structure, so that it falls apart, as you can see in this picture.



Did you know?

The Forth Bridge is made of iron is well-known for needing regular painting. Recent advances in paint technology mean this now needs to be done much less often that it used to be.



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Pictures from pixabay

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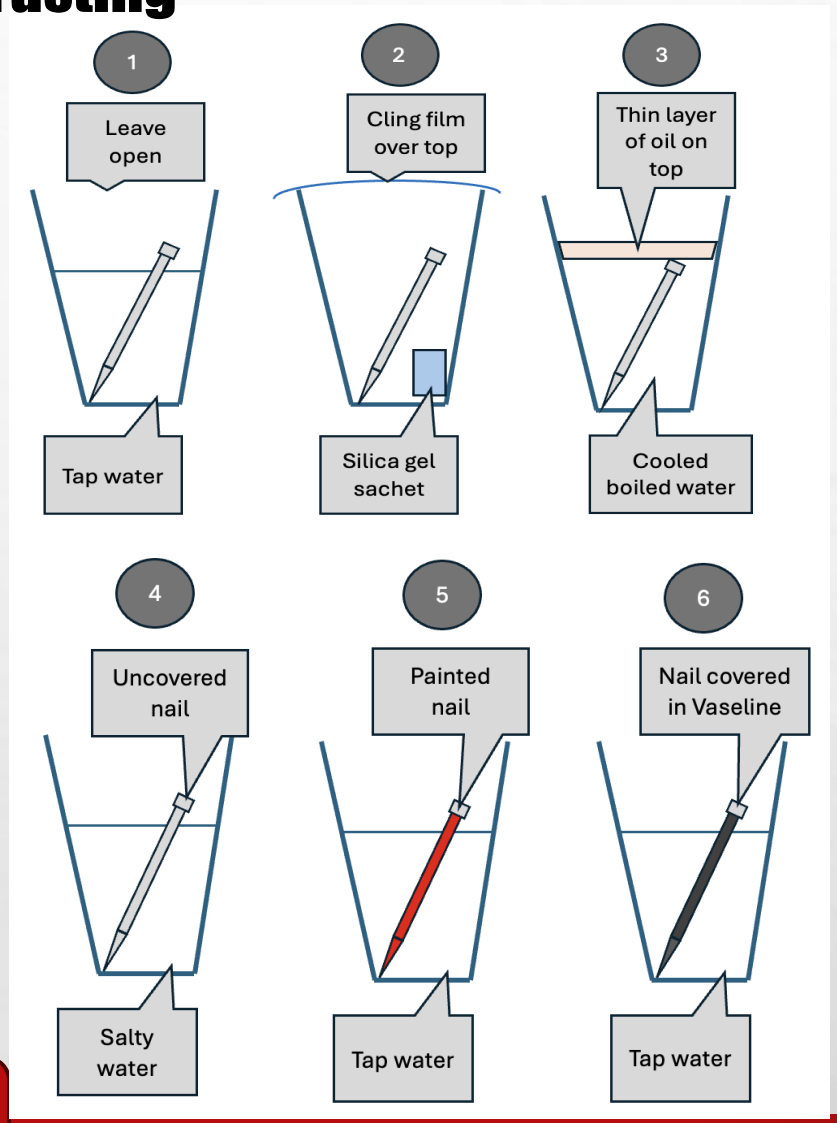
Experiment: Part 1

1. Set up 3 containers and label them 1 to 3
2. Number 1 – half fill with tap water and place a nail into it. Do not cover.
3. Number 2 – make sure it is dry and place a nail into it. Add the silica gel sachet and cover over the top with cling-film.
4. Number 3 – Place the nail completely in boiled water and add a thin layer of cooking oil on the top

Experiment: Part 2

1. Set up 3 containers and label them 4, 5 and 6
2. Number 4, as number 1 but add salty water instead of tap water
3. Number 5, as number 1 but add a nail coated in paint to the container
4. Number 6, as number 1 but add a nail covered in Vaseline to the container.

Leave all containers for 2 weeks in a safe place.



Student worksheet

Container number	Did it rust? (yes/no/a little)
1 (air and water)	
2 (air only)	
3 (water only)	

Container number	Did it rust more, the same or less than number 1?
4 (salty water)	
5 (painted nail)	
6 (nail covered in Vaseline)	

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Iron and Rusting : Teacher's notes

Sponsored by the Surface Engineering Association

Safety Considerations

Boiled water – allow to cool before using
Silica gel – do not open sachet
Paint – for solvent-based paint, use in a well-ventilated area, dry painted nail thoroughly before use.

Expected results

Part 1: Number 1 – air and water - rusts most.
Part 2: Number 4 should rust more than number 1, numbers 5 and 6 should rust less. Covering the surface may mean no rusting occurs depending on how well it is coated.

Requirements

- 6 container of the same size, either cups or beakers, or even jars. If in a school science lab you can use test tubes or boiling tubes as long as the nails fit inside them.
- 6 iron nails. Make sure they are the same size. Do not use galvanized ones as these will not rust.
- Cooled boiled water. Use a kettle to heat to boiling and allow to cool. This removes the air from the water.
- Cooking oil, any type, as long as there is enough to form a layer over the water. This keeps any air out.
- Silica gel sachets come in all manner of packages, usually when ordering things from a mail order company. They are to keep objects dry during transit. If you do not have any available, just ensure the container stays dry. If you are in a school lab, a small amount of calcium chloride could be used instead.
- Salty water, just a heaped dessert spoon of table salt (sodium chloride) dissolved in a beaker or cup of water
- Paint must be waterproof, such as Humbrol modelling paint or household paint. Allow to dry thoroughly before use.
- Cling-film and Vaseline can be easily obtained from a local store.