STANSW YOUNG SCIENTIST AWARD

"RUST"

BY:

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YEAR 3

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Aim:

What will happen to steel nails in different liquids, with or without a covering, and why iron metals breakdown and rust?

Hypothesis:

Steel nails or screws that are covered with oil or grease will be better protected against rusting by water or rain.

Background

Rust is a reddish-brown or reddish-yellow colour that coats iron or steel when exposed to air and moisture. When iron and oxygen react in the presence of water or moisture, rust (iron oxide) is formed. Another word for rust is 'corrosion', which describes the breakdown of materials such as iron and steel.

Iron is relatively cheap for man to produce and has a large number of different uses. Machines, vehicles and building structures are commonly built with iron (usually in the form of steel). Rust can damage these machines, vehicles and building structures and cause economic loss.

To prevent iron and steel from rust damage, they can be painted, coated with plastic, galvanized (coated with Zinc) or by other methods that keep out the water and oxygen.

Equipment:

The following equipment was used:

- Large iron / steel nails – Bullet Head 125x5.6mm construction nails (Paslode brand). In first experiment, some small steel nails were also used.
- Vaseline – White petroleum jelly (Petrolatum) - Unilever brand.
- Water – tap water (Tank water).
- Plastic bottles/containers (600mL plastic disposable water bottles with tops cut off).
- Hydrogen Peroxide 3% (10vol) – approximately 300mL used (Chemist Warehouse brand.).
- Camera – for taking photos.

Method:

Experiment 1

1. We used 3 steel nails (and three small nails) and three plastic bottles.
2. We filled one bottle with water and put one big nail and one small nail in the water (fully covered).
3. We rubbed and coated one big nail and one small nail in Vaseline and placed this into a bottle filled with water. The nails were coated evenly but not too thick.
4. The last big and small nail went into a bottle with no water.
5. We put the three bottles aside in the laundry.
6. We investigated the experiment over 21 days (3 weeks).

Experiment 2

1. We took 3 big steel nails and three plastic bottles.
2. We filled one bottle with water half way (half the height of the nail) and put one big nail in this bottle.
3. We rubbed and coated half of one big nail in Vaseline and placed this into a bottle filled with water (to fully cover the nail). Similar to the first experiment, the nail was coated evenly but not too thick.
4. The last big nail went into a bottle with hydrogen peroxide, filled to cover the nail (the same as the water depth).
5. We put the three bottles aside in the laundry.
6. We investigated the experiment over 14 days (2 weeks).

Results:

Results in Summary

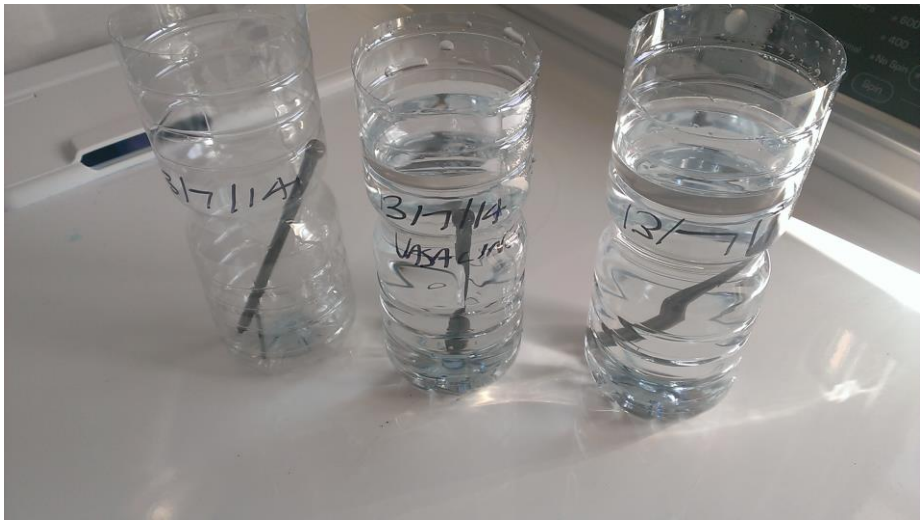
The following tables are a summary of the results of the two experiments:

EXPERIMENT 1	**DAY 1**	**DAY 7**	**DAY 14**
NAIL IN WATER	*Some rust starting*	*Nail rusting*	*Nail rusting more*
NAIL COVERED WITH VASELINE	*No rust*	*Small amounts of rust*	*Some rust*
NAIL IN NO WATER	*No rust*	*No rust*	*No rust*

EXPERIMENT 2	**DAY 1**	**DAY 5**	**DAY 10**
NAIL TOP-HALF COVERED IN VASELINE	*Top no rust. Bottom starting to rust*	*More rust*	*Top starting to rust up the bottom was rusting more*
NAIL IN H_2O_2 (HYDROGEN PEROXIDE)	*Little bit of rust*	*Stayed the same*	*Little bit more rust*
NAIL HALF IN WATER HALF AIR	*Top no rust. Bottom starting to rust*	*Top no rust. Bottom rusting more*	*Top no rust. Bottom rusting*

Results in Detail:

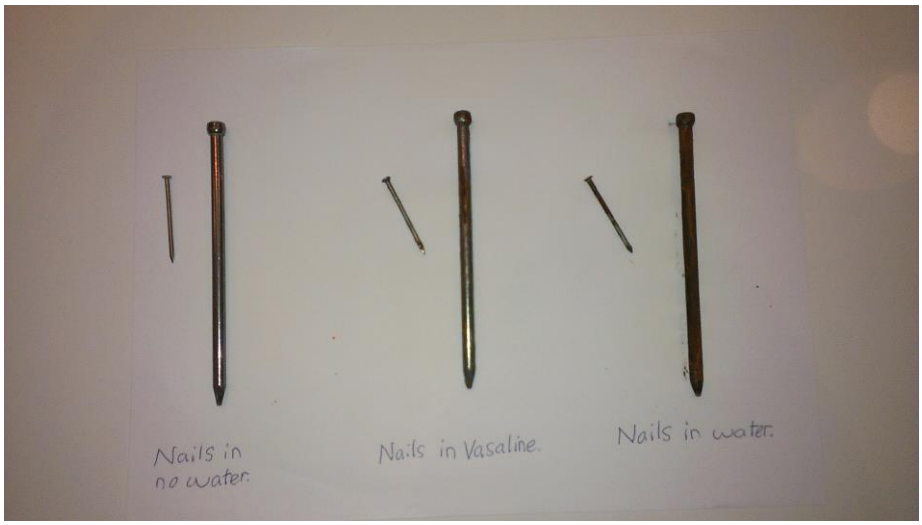
The following is a detailed explanation of the results:



Above – Nail Experiment 1 on first day. From left – "No Water/Vaseline/Water"

IRON EXPERIMENT 1 – DAY 1	13/7/14: After 6 hours the nails in the water (without Vaseline) started going rusty. The water turned orange with orange specks of dust.
IRON EXPERIMENT 1 – DAY 7	20/7/14: The nails covered in Vaseline were rusting up. The one with no water wasn't doing anything at all. The one with water was rusting up even more.
IRON EXPERIMENT 1 – DAY 14	27/7/14: The nails in no water were still shiny. The one with Vaseline on it was rusting up some more. The Vaseline was rubbing off. The nail in water looked like they were about to break into a million pieces. It was dark compared to the one in no water.

Above – Nail Experiment 1 after 21 days. From left – "No Water/Vaseline/Water"

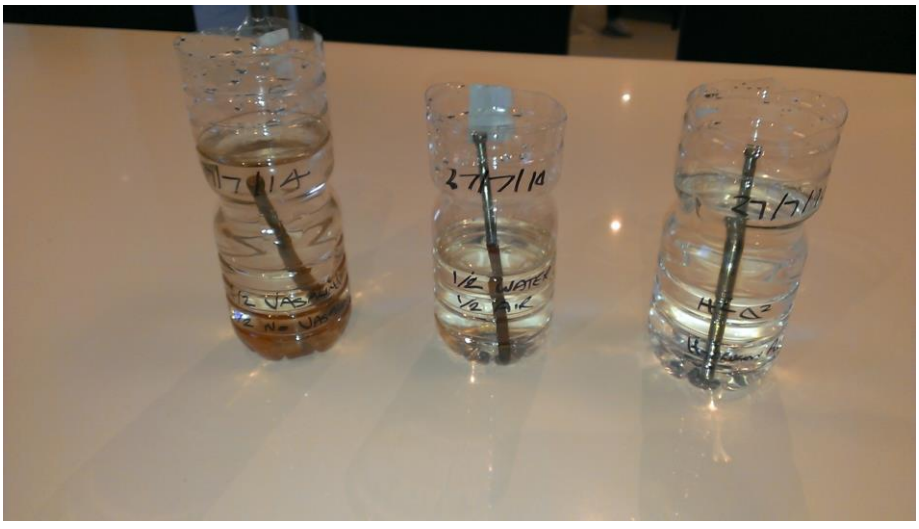


Above – Nail Experiment 1 after 21 days.

IRON EXPERIMENT 2 – DAY 1	28/7/14: The nail with half Vaseline and half no Vaseline was rusting up in the area with no Vaseline (the bottom half was rusting but the top didn't). The nail in H_2O_2 (Hydrogen Peroxide) was bubbling up around the nail (bubbles on nail). It was clear of rust and the water was clear. The nail with half water half air had the top half with no rust and the bottom half with rust.

Nail Experiment 2 on first day. From left – "Half Vaseline half no Vaseline/half air half water/hydrogen peroxide"

IRON EXPERIMENT 2 – DAY 5	2/8/14: The nail with half Vaseline half no Vaseline had more rust than before. The top half was rusting up a bit. The bottom bit was rusting but had a little line of no rust. The nail in the H_2O_2 stayed the same. The one with half water half air was rusting up more. The water was orange.
IRON EXPERIMENT 2 – DAY 10	8/8/14: The nail in half water half air had lots of orange rust on it. The top half stayed the same but the bottom bit was still rusting a lot. The nail in H_2O_2 had a little bit of rust on it. The water was still clear. Little bubbles were going to the top then back down. The one with half Vaseline half no Vaseline was still rusting. The top Vaseline half was starting to rust. The bottom was rusting up more.



Above – Nail Experiment 2 on tenth day. From left – "Half Vaseline half no Vaseline/half air half water/hydrogen peroxide"

Above – Nail Experiment 1 after 10 days.

Discussion:

- From the results, it is seen that nails rust in water. The nails that were not in water didn't rust.
- The nails covered in Vaseline had a little bit of rust in the end but the Vaseline protected the nails compared to nails in water. The nails in water had lot of rust.
- I thought that the one with H_2O_2 was not going to rust at all until the last day. It slowly started to rust.
- In Experiment 1, I thought the nails in Vaseline would rust less and this occurred. The Vaseline protected them from rusting.
- I thought the nails in no water in Experiment 1 would rust a little bit. The nail in half water half air in Experiment 2 also had no rust above the water, which I thought would not happen.
- I thought the nail in water would rust a little bit more than it did.
- An interesting thing that happened is the small bubbles that were on the nail in the H_2O_2 compared to the other nails in water (H_2O) which had no bubbles.
- If I did the experiment next time, I would try and use salt water, as rust occurs quicker in salt/sea water. I would also maybe try other solutions (eg sugar or vinegar) or I would try other metals (like copper wire or aluminium).

- My baby brother rubbed extra Vaseline on the Experiment 1 nails after they were out of the bottles, and therefore they look different.

- If I had more time, I would run both experiments over the same time length.

Conclusion:

From the 'background', it is known that iron and oxygen react in the presence of water or moisture. That is why the nails in water rusted.

Water is a chemical substance with the chemical formula H_2O – one molecule of water has two hydrogen atoms bonded to a single oxygen atom. The rusting of iron is an electrochemical process that begins with the transfer of electrons from iron to oxygen. Rust is formed by the union of the oxygen with the iron. Water helps as an agent in producing the rust change in iron metals.

A coating such as Vaseline slowed the rusting process down by preventing or stopping this union or reaction. The Vaseline protected the nail. Many nails are made with protection, such as galvanised nails which have a coating of metal (such as zinc) over them to prevent rust. Painting over steel or nails also prevents rusting, that is why many steel products are painted (such as the guttering on our house and fences – "Colorbond" steel).

Other liquids like H_2O_2 also cause some rust, but the amount of rust was different to water.

In conclusion, the hypothesis was confirmed in that the nails that were covered in oil or grease were better protected against rusting by water, as they rusted less than the nails that were not protected.

References:

- *Wikipedia – "Rust".*
- *Kids.net.au – "Rust"*
- *The World Book Encyclopedia 'Rust' article..*