



## ACTIVITY 1

# HOW TO ACCELERATE OR SLOW DOWN THE APPEARANCE OF RUST?



## EXPERIMENT OBJECTIVES AND CONTENT

In this activity, students observe the process of rust formation on iron and discover the conditions that promote or hinder this chemical reaction.



## ESSENTIAL KNOWLEDGE

### Matter:

- Properties and characteristics of matter in different states (solid, liquid, gas)
- Changes in matter: Chemical changes (rust)

### Techniques and instrumentation:

- Use of simple measuring instruments

### Appropriate language:

- Terminology related to an understanding of the material world



## SUGGESTED MATERIALS

### Scientific equipment:

- Magnifying glasses or microscopes
- Magnets
- Scales

### Perishable non-scientific materials:

- Iron nails with no rust protection
- Distilled (or boiled) water
- Water
- Paraffin (candle)

### Household materials:

- Clear glass or plastic containers with lids
- Rags
- Bleach
- Pennies
- Table and de-icing salt
- Vegetable oil and lemon juice
- Margarine or butter
- Latex paint and varnish

### School equipment:

- Refrigerator with freezer
- Sunny window



## CONTEXT: SITUATIONAL PROBLEM OR RESEARCH QUESTION

*It's early spring and the snow has melted. You decide to go get your bicycle, which has spent all winter outside. You examine it closely and notice it is covered with orange spots. You scratch at one of the spots and see that it disintegrates easily. Your bike is rusted! How might you have protected it from rust? What allowed the rust to form?*





### SUGGESTED PREPARATORY ACTIVITIES (INTRODUCTION)

The teacher asks half the students to bring a rusty object to class, and the other half to bring an iron object that is not rusty (iron is attracted by magnets). It is suggested to have several rusty and non-rusty items on hand in case students forget to bring them. After carefully examining all the items, the class discusses the differences among the objects. What differentiates rusty objects from non-rusty objects? Did the iron just change color? How can you make rust appear? How can you prevent rust from appearing?



### INITIAL IDEAS AND HYPOTHESES

Here are a few examples of hypotheses the students might formulate based on their initial ideas:

#### Example 1

I predict that rust will appear faster in the presence of water or humidity. I predict this because some kitchen implements (can openers, graters and peelers) get rusty when they are left wet in the sink too long.

#### Example 2

I predict that rust will appear faster in salt water. I predict this because the hulls of ocean-going cargo ships are often rusty.

#### Example 3

I predict that cold can make rust appear faster. I predict this because when I leave my bike outside all winter, it rusts faster than when I store it inside, where it's warm.

#### Example 4

I predict that rust will appear more slowly on a nail if I coat it with a layer of protection. I predict this because my parents put rust-proofing on their car every year.

**IT WOULD BE A GOOD IDEA TO WEIGH THE NAIL BEFORE AND AFTER THE EXPERIMENT TO QUANTIFY THE AMOUNT OF DEGRADATION THAT OCCURS.**



### WORK PLAN AND EXPERIMENTATION

Here are a few examples of experiments the students can carry out to verify their hypotheses:

#### Example A

The students place a nail in an empty glass jar. They place a second nail in another jar and cover it completely with water. They place a third nail in a glass jar containing enough water to cover only half the nail's length.

**RECORD ALL YOUR IDEAS AND OBSERVATIONS IN YOUR EXPERIMENT WORKBOOK.**



**Example B**

The students place a nail in a glass jar filled with tap water, another nail in a jar filled with salt water, and a third nail in a jar containing diluted bleach.

Note: Carefully label each container (e.g., salt water, bleach, etc.).

**Example E**

The students plate a nail with copper by soaking it for 15 to 20 minutes in lemon juice to which they have added salt and two or three pennies. On five other nails they apply, respectively, latex paint, varnish, vegetable oil, butter and paraffin (wax from a melted candle). They place all the nails between two damp rags, along with another nail that has not been protected. They spray the rags with water frequently to keep them damp.

Note: during the experiments, the students examine the nails regularly for several days. In some cases, the first traces of rust will appear on the first day of the experiment. Because rust is brittle, it may detach from the nail and become suspended in the water, which will give the water an orange color.

**! BE CAREFUL TO AVOID SPLASHING BLEACH. STORE ALL HAZARDOUS PRODUCTS OUT OF THE REACH OF CHILDREN!**

**Example C**

The students place a nail in a glass jar filled with water and put it on a sunny window ledge. They place another nail in a jar filled with water and place it in the refrigerator. They put a third nail in a glass filled with water and place it in the freezer.

Note: Students may believe, erroneously, that the cold temperatures of winter make rust appear more quickly.

**Example D**

The students place a nail in a glass jar filled with tap water. They place another nail in a jar and add distilled (or boiled) water. They place a third nail in a jar filled with distilled water and pour a thin layer of vegetable oil on top of the water to prevent oxygen from entering the distilled water.

Note: The presence of air in the water plays a role in the phenomenon of iron oxidation.

**EXPERIMENTAL FACTORS**

To ensure scientific rigor, the students should evaluate the experimental factors that might influence the experimental results.

- Presence of oxygen in the water or liquids used
- Amount of water or liquid used
- Temperature
- Type of protective layer
- Uniformity of protective layer
- Amount of salt or diluted bleach in the water
- Duration of exposure





### DISCUSSION: SUGGESTED INTEGRATION ACTIVITIES (CONSOLIDATION)

Each team can present its results to the rest of the class in an oral presentation, class discussion, or poster.



### SUGGESTED ACTIVITIES FOR APPLYING KNOWLEDGE (APPLICATION)

To enrich the presentations, the students could take artistic photographs of the rusted items or reproduce the effect of the rust using paint.



### SCIENTIFIC CONCEPTUAL CONTENT

#### Chemical reaction

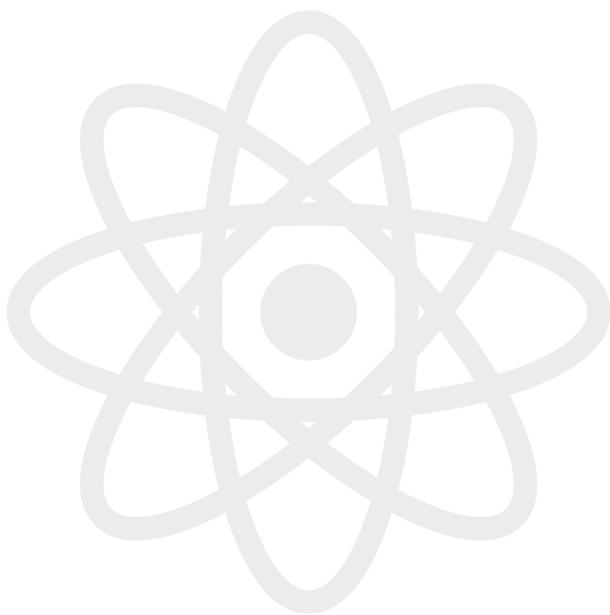
A chemical reaction is a change in matter. It occurs when two or more substances combine (e.g., water, oxygen and iron) to produce a new substance with new properties (e.g., rust).

#### Oxidation

Oxidation is a chemical reaction that occurs when substances (e.g., iron) combine with oxygen. The presence of oxygen and moisture are the conditions necessary for the oxidation of iron. It should be noted that rust does not form if the water is frozen.

#### Iron oxide

Iron oxide occurs naturally in nature. It is the scientific name for rust, a porous substance that disintegrates and allows air to penetrate it. Hence, rust can penetrate deeply into iron objects and weaken them. Oxidation can be stopped or prevented, but the chemical reaction cannot be reversed, so rusty objects can never regain their pre-rust properties.





### Catalyst

A catalyst is a substance that does not take part in the chemical reaction but that facilitates it.

A catalyst can accelerate the appearance of rust. In the chemical reaction of iron oxidation, heat, salt or bleach dissolved in the water can accelerate the formation of rust on iron objects. Most acids also accelerate rust formation.

### Slowing down rust

Copper plating, paint, varnish and other protective layers applied to iron will hinder the formation of rust because they prevent direct contact between oxygen and iron. Stainless steel, which is an iron alloy, resists rust because it combines iron with other metals such as chromium and nickel.



### CULTURAL REFERENCES

#### Impacts

Québec's climate conditions can sometimes accelerate the formation of rust on iron objects that are exposed to the elements. In winter, salt is used extensively on roads and sidewalks to melt ice. The melted water loaded with salt has the property of accelerating rust formation. It is therefore a good idea to store bicycles indoors during winter. Iron must also be protected if it is to be used as a building material because rust weakens iron structures such as bridges and ship hulls. To prevent rust formation, such structures must be painted regularly or coated with some protective layer. In fact, bicycles and cars are painted to preserve their appearance for as long as possible.

**FOR MORE CULTURAL REFERENCES,  
VISIT THE ÉCLAIRS DE SCIENCES WEBSITE:  
[www.eclairsdesciences.qc.ca](http://www.eclairsdesciences.qc.ca)**





## REFERENCES

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### Conception

Montréal Science Centre

#### A project of



#### Produced by



#### Major financial partners



# PROCESS OF ACTIVE DISCOVERY

GENERAL LEARNING PROCESS IN SCIENCE AND TECHNOLOGY (IN ELEMENTARY SCHOOL)

Context related to everyday life



- Situation problem or
- Discovery question or
- Need to be fulfilled
- Question related to the operation of an object (how does it work?)

## Initial ideas and hypothesis

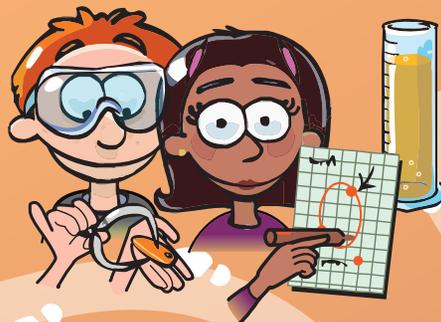
**My initial ideas:**

- I share my own ideas.

**My hypothesis:**

- I predict that... I think that because...
- I imagine my prototype.
- I think it works like this...

## Planning and carrying out



**My equipment:**

- I observe and handle the equipment.
- How could this equipment be useful to me?
- I choose my equipment and my materials.

**Carrying out my process:**

- What will the steps be?
- What precautions should I take?

**My actions:**

- I carry out the steps of my protocol.
- I note or draw what I observe, what I do and what I discover.

**My results:**

- What is my answer to the problem, question or need?

## Outcome



**My outcome:**

- Do my results confirm my hypothesis or not?
- Are my results similar to those of the other teams?
- Can the other teams' results help me to find answers to my problem, my question or my initial need?
- What could I communicate concerning my discoveries?

**What I learned:**

- What do I retain from this activity?
- What could I communicate concerning my results or my discoveries?

New question?