# NAILING RUST

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## Lesson Summary for Grades 3–8

The students are grouped in pairs and go on a walking tour of the school grounds. They look for evidence of physical and chemical changes and record their findings on a Change Chart.

The students do two experiments related to the rusting process. In each experiment, the students are put into groups of 4–5 members. In the first experiment, students place a nail in three different glasses. One glass has no water. A second glass has water in it, but the nail is only half submerged. A third glass has water in it, and the nail is completely submerged. The students predict which nail will rust the most. In this discrepant event, students usually predict that the completely submerged nail will rust the most, but they find that the half-submerged nail is likely to rust the most.

The second experiment allows the students to observe nails rusting in four different liquids. A sponge is placed in each of four bowls. Tap water, distilled water, saltwater, and vinegar are used to test the rusting process. Students again predict which nail will rust the most. Students observe the nails over a period of days and discover that the nails in saltwater and vinegar rust the most.

The students write a story pretending they are nails resting on a sponge. They describe the changes taking place on their metallic bodies. They also use a nail in an art project to etch a picture.

## Science Activity

*Students explore physical and chemical changes and discover how rust forms.*

Key Science Topics:

- chemical change
- oxidation

Key Process Skills:

- predicting
- observing
- collecting data

Ohio Proficiency Learning Outcomes for Science:
Fourth Grade

I-5 Predict results of rust on nails.

I-6 Evaluate the experiments' results regarding the effects of oxygen and water on nails and explore the rust process.

I-8 Evaluate the observations and results of other teams and compare results.

## Time Required

### Part A

| | |
|---|---|
| Setup | 30 minutes |
| Procedure | 75 minutes (15 minutes a day for a week) |
| Cleanup | 10 minutes |

### Part B

| | |
|---|---|
| Setup | 30 minutes |
| Procedure | 75 minutes (15 minutes a day for a week) |
| Cleanup | 10 minutes |

## Materials

### For Getting Ready

Per class

- 12–15 clear plastic glasses
- 30–40 uncoated 2-inch x 3-inch nails
- 16–20 plastic bowls
- gallon of distilled water
- container of salt
- bottle of vinegar
- 12–18 small sponges (or larger ones cut up)
- 4–5 pairs of rubber gloves
- container of rubbing alcohol
- gallon of brine (1/2 cup of salt added to 1 gallon of water, mix until dissolved)

### For Introducing the Activity

Per class

- Change Chart
- pencil

### For Procedure, Part A

Per group of 4–5 students

- 3 clear plastic glasses
- water
- 3 uncoated nails
- Observation Chart A
- pencil
- invisible mending tape

### For Procedure, Part B

Per group of 4–5 students

- 4 plastic bowls
- 4 uncoated nails
- 4 small sponges
- distilled water
- vinegar
- pair of rubber gloves
- salt
- tap water

- rubbing alcohol
- Observation Chart B
- pencil
- brine solution

### For the Extension

Per class
- petroleum jelly
- paint
- oil
- wax
- fingernail polish

### For the Variation

Per class
- various types of liquids not already used in prior experiments

## Safety and Disposal

Plastic glasses and bowls should be used instead of glass to prevent harm from accidental breakage. None of the ingredients in the basic experiment are harmful, but care should be taken if attempting the variation. Goggles are recommended. Proper disposal of paint and oil should be maintained if used during the variation of this lesson.

## Student Background

Students should understand that water and oxygen are necessary ingredients to form rust. Students should understand the principles of chemical and physical change.

## Getting Ready

1. Several days before the scheduled activity, start gathering the items necessary to accomplish the activities.
2. Copy the Observation Chart A for Part A of the Procedure (1 per student).
3. Copy the Observation Chart B for Part B of the Procedure (1 per student).

## Introducing the Activity

Group the students into pairs, giving each group a Change Chart to work with. Take the students on a walking tour of the school grounds. According to the Change Chart, have the students look for things that appear to have changed over time, such as cracks in the sidewalk, rusty objects, and rotted wood. On the chart, have students record the location of the sighting and guess what kind of change has taken place.

Upon completion of the tour, talk about the findings and lead the students to a discussion about rust. Discuss what kinds of materials rust. Explain that the term oxidation can refer to a chemical process in which a substance combines with oxygen. Ask students to describe rusted objects that they have found in places other than the school grounds.

## Procedure

### Part A

1. Divide the students into groups of 4–5. Each group should have three, clear plastic glasses. Using invisible mending tape and a marker, label the glasses A, B, and C.
2. Fill glass A with water. Put about an inch of water in glass B. Leave glass C empty.

3. Put a nail in each glass. Make sure the nail in glass A is completely submerged and the nail in glass B is only partially under water.
4. Make a prediction: Which nail will rust the most?
5. Look at the glasses daily for a week and record any changes on Observation Chart A.
6. Compare the final results with the predictions. Students probably will have predicted that nail A would rust the most. Unexpectedly, at this point they discover that nail B rusted more.

### Transition Discussion

Discuss the results of the experiment as a class: the nails in glasses A and B began to rust, and the nail in glass C did not rust. Oxygen by itself cannot cause rusting. Observing metal objects in the classroom proves this fact. Because water contains some dissolved oxygen gas, submerged metal objects will rust. This is substantiated by sunken ships and metal objects recovered from beneath the water. When an iron object is subjected to a mixture of water (such as condensation, high humidity, or rain) and oxygen, rust develops. It must also be noted that rusting also needs an electrolyte to allow the flow of current because rusting is actually an electrochemical reaction. The nails were handled in such a way that salt from the students' sweat made contact with the nails and provided the electrolyte.

Lead the students to talk about rusting occurring in solutions other than water. Have them make suggestions about the types of liquids that might be interesting to use for a new experiment. Pose the question: Will rusting occur faster in a liquid other than water?

### Part B

1. Divide the students into groups of 4–5. Label the bowls A, B, C, and D.
2. Explain to the students that in this experiment someone in the group will have to wear rubber gloves and use rubbing alcohol to remove fingerprints and body salt that may have come in contact with the nails.
3. Next, place the freshly cleaned nails on a sponge in a plastic bowl. Be sure to avoid touching the cleaned nails.
4. Put distilled water in bowl A, tap water in bowl B, vinegar in bowl C, and brine solution in bowl D. Be sure to add just enough of the liquids to wet the sponge, not float it. This way, contact with the nail exists but the nail is not covered by the liquid.
5. Predict which liquid system will cause rust to form the fastest.
6. Observe the bowls daily for one week, looking for formations of rust. Record the daily findings on Observation Chart B.
7. Compare the findings with the predictions and with the findings of other groups.

## Variation

Students can try experiments using other kinds of liquids, such as soda pop, juices, rubbing alcohol, oil, and milk.

## Extension

Students can go beyond the experimental rusting stage and try to find out what kinds of coatings can be put on a nail to prevent rust.

## Science Explanation

The following explanation is intended for the teacher's information. Modify the explanation for students as required.

The rusting of a nail is a common example of oxidation. During the process, the nail combines with oxygen to form iron oxide, a simple type of rust.

Students should be able to distinguish differences between physical change and chemical change. Every substance has certain properties that distinguish it from other substances. Scientists divide these characteristics of substances into physical and chemical properties. Physical changes can be recognized because the changes happen without changing the substance chemically. Chemical changes, on the other hand, depend on the way a substance reacts to another substance. For instance, if a piece of wood were made into sawdust, that would be a physical change. But, if the piece of wood was burned, the wood would change into new substances, ash and gases, and that would be a chemical change.

### Assessment

- Assess students' process skills by observing their collection of data.
- Students should recount their experience in journal fashion, being sure to use the terms of chemical change, rust, and oxidation.

## Art Activity

*Using crayons and nails, the students create an etching by scratching a nail over a crayon-colored piece of paper.*

## Language Arts Activity

*Students write in journal format about what it's like to be a nail rusting on a sponge. They read* John Henry *and retell the story in their own words.*

Ohio Proficiency Learning Outcomes for Language Arts:
Fourth Grade
Reading:

I-3 Students verbally retell a story that they have written about the life of a nail.
II-7 Students analyze the actions and events in their fictional story and compare them to the actual events that took place during their experiments.

Writing:

II-3 Students write a fiction story pretending that they are a nail and describing what is happening to them as they rust.
IV-8 Students write their retelling legibly in print or cursive.

### Procedures

- Have the students pretend that they are a nail resting on a sponge. They should write in journal format the changes that are happening to them over a 5-day period.
- Have the students read *John Henry,* any version.
- Have the students write a retelling of the book, giving a beginning, middle, and ending to their story.

## Mathematics Activity

*Students use a chart to record data they have gathered from their observations.*

Ohio Proficiency Learning Outcomes for Mathematics:
Fourth Grade

VI-21 Use pencil and paper calculations to determine elapsed length of time to get sufficient data.

VIII-24 Use a table to record information gathered from experiments.

## References


*Kid's Science: Chemistry;* interactive CD-ROM; Arc Media International: Buffalo, NY, 1998. (ISBN: 1-55191-463-8)

Shymansky, J.A.; Romance, N.; Yore, L.D. *Journeys in Science*, Teacher's Edition 4; MacMillan: New York, 1988; pp 65–66. (ISBN: 0-8445-5311-5)

*World Book Encyclopedia,* Vol. 16; World Book-Child-Craft International: Chicago, IL, 1979; p 539. (ISBN: 0-7166-0079-X)


## Handout Masters

Masters for the following handouts are provided:

- Evidence of Physical and Chemical Changes—Change Chart
- Water Level Variations—Observation Chart A
- Liquid Variations—Observation Chart B

Copy as needed for classroom use.

# NAILING RUST

## Evidence of Physical and Chemical Changes—Change Chart

Group Members _____

_____

Look for things that appear to have changed over time around our school. List the evidence of the change and where you found it. Mark whether you think it's a physical or chemical change.

| Evidence of Change | Where found | Kind of change | |
|---|---|---|---|
| | | Physical | Chemical |
| **1.** | | | |
| **2.** | | | |
| **3.** | | | |
| **4.** | | | |
| **5.** | | | |
| **6.** | | | |

# NAILING RUST

## Water Level Variations—Observation Chart A

Group Members _____

_____

Make a prediction. Which nail will rust the most?
Check A, B, or C below.

| | Observations Made | | |
|---|---|---|---|
| | **A** | **B** | **C** |
| **Day 1** | | | |
| **Day 2** | | | |
| **Day 3** | | | |
| **Day 4** | | | |
| **Day 5** | | | |

# NAILING RUST

## Liquid Variations—Observation Chart B

Group Members _____

_____

Make a prediction. Which nail will rust the most?
Check A, B, or C below.

| | Observation Made | | | |
|---|---|---|---|---|
| | **A** | **B** | **C** | **D** |
| **Day 1** | | | | |
| **Day 2** | | | | |
| **Day 3** | | | | |
| **Day 4** | | | | |
| **Day 5** | | | | |