

## Photo Description



This image shows many old, rusty nails and metal objects scattered on weathered wooden boards. The metal pieces have turned brown and orange colors, and some round metal discs are mixed in with the nails. All the metal objects look very old and have been sitting outside for a long time.

## Scientific Phenomena

The anchoring phenomenon here is corrosion and oxidation - specifically the rusting of iron and steel objects. When iron-containing metals are exposed to oxygen and water over time, they undergo a chemical reaction that forms iron oxide (rust). This process breaks down the original metal structure, creating the reddish-brown coating we see. The wooden surface also shows weathering from exposure to the elements, demonstrating how different materials respond to environmental conditions over time.

## Core Science Concepts

1. Chemical vs. Physical Changes: Rusting is a chemical change because new substances (iron oxides) are formed that have different properties than the original iron.
2. Material Properties: Different materials respond differently to environmental conditions - metals corrode while wood weathers and decays through different processes.
3. Environmental Interactions: Air, water, and time work together to change materials through chemical and physical processes.
4. Observable Evidence: Scientists can observe changes in color, texture, and structure to understand what processes are occurring.

### Pedagogical Tip:

Have students compare fresh nails to rusty ones using magnifying glasses. This hands-on observation helps them see the dramatic difference between original and changed materials, making the abstract concept of chemical change concrete and observable.

### UDL Suggestions:

Provide multiple ways for students to document their observations: drawing, photography, verbal descriptions, or simple data tables. This allows students with different strengths to engage meaningfully with the scientific observation process.

### Zoom In / Zoom Out

**Zoom In:** At the molecular level, iron atoms are combining with oxygen atoms from the air to form new compounds. This happens when water acts as a catalyst, allowing electrons to move between the iron and oxygen atoms, creating entirely new molecular structures.

**Zoom Out:** This rusting process is part of larger Earth systems where materials constantly cycle and change. Weathering and corrosion help break down human-made objects and return materials to natural cycles, while also showing why engineers must consider material durability when designing structures like bridges, buildings, and vehicles.

### Discussion Questions

1. What conditions do you think these nails needed to become so rusty? (Bloom's: Analyze | DOK: 2)
2. How might engineers use this information when building outdoor structures? (Bloom's: Apply | DOK: 3)
3. What evidence tells you that rusting is a chemical change rather than just getting dirty? (Bloom's: Evaluate | DOK: 3)
4. If you found similar nails in a dry desert versus near the ocean, how might they look different and why? (Bloom's: Synthesize | DOK: 4)

### Potential Student Misconceptions

1. "Rust is just dirt on metal" - Students may think rust can be washed off. Clarification: Rust is actually a new substance formed when iron chemically combines with oxygen, permanently changing the metal.
2. "Only old things rust" - Students might believe age alone causes rusting. Clarification: Rusting happens when iron is exposed to oxygen and moisture, regardless of age. New metal can rust quickly in the right conditions.
3. "All metals rust the same way" - Students may generalize that all metals corrode identically. Clarification: Different metals react differently - aluminum forms a protective coating, while copper turns green, and gold doesn't corrode at all.

### Cross-Curricular Ideas

1. Math - Data Collection and Graphing: Have students collect rusty and non-rusty nails, measure them, and graph how rust affects the size or weight of the nails. Students can create bar graphs or pictographs comparing the data they collect.
2. ELA - Descriptive Writing: Ask students to write detailed descriptions of the rusty nails using sensory words (rough, orange, brown, bumpy). They could also write a creative "story" from the perspective of a nail explaining how it became rusty over time.
3. Social Studies - Engineering and Builders: Connect to how engineers and construction workers must choose rust-resistant materials (like stainless steel or galvanized coatings) when building structures that will be outdoors. Students can research why certain bridges or buildings last longer than others.
4. Art - Texture and Color Study: Use the photo as inspiration for a mixed-media art project where students create textured artwork using actual rusty objects, rust-colored paints, and natural materials to explore how artists use weathering and age as design elements.

### STEM Career Connection

1. **Materials Engineer:** Materials engineers design and test different metals and materials to figure out which ones work best for specific jobs. They test how quickly materials like steel rust and develop special coatings to protect them. These engineers help create stronger, longer-lasting tools, vehicles, and buildings. Average Salary: \$100,000 per year
2. **Corrosion Control Specialist:** These scientists and engineers study how and why metal corrodes, and they develop ways to prevent rust and corrosion. They work on projects like protecting ships, oil pipelines, and bridges from rusting. They might apply protective coatings, design new materials, or test how long materials last in harsh conditions. Average Salary: \$72,000 per year
3. **Structural Inspector:** Structural inspectors examine buildings, bridges, and other structures to check for rust, corrosion, and damage. They use their knowledge of how materials change over time to ensure buildings and bridges are still safe for people to use. When they spot rust or corrosion problems, they recommend repairs. Average Salary: \$68,000 per year

### NGSS Connections

Performance Expectation: 5-PS1-4: Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Disciplinary Core Ideas:

- 5-PS1.B: Chemical reactions produce new substances with different properties
- 2-PS1.A: Different materials have different observable properties

Crosscutting Concepts:

- Patterns: Observable patterns in how materials change over time
- Cause and Effect: Environmental conditions cause predictable changes in materials

### Science Vocabulary

- \* **Corrosion:** The process where metals are slowly destroyed by chemical reactions with their environment.
- \* **Oxidation:** A chemical reaction where a substance combines with oxygen to form new compounds.
- \* **Chemical change:** When substances react to form completely new materials with different properties.
- \* **Weathering:** The breaking down of materials due to exposure to weather and environmental conditions.
- \* **Properties:** The characteristics of materials that we can observe or measure, like color, hardness, or texture.

### External Resources

Children's Books:

- "Chemical and Physical Changes" by David Dreier
- "Rusting and Oxidation" by David Dreier
- "What Is Chemistry?" by Robin Johnson