

# Do Materials Get Tired - How Long Will a Paperclip Last?

## Lesson

The lesson “Do Materials Get Tired - How Long Will a Paperclip Last?” will allow students to determine the amount of stress that a paperclip can handle.

## Suggested Grade Level

6-8

## Approximate Run Time

60 -90 minutes (approximately 2-3 class periods)

## PDE Standards

- 3.2.7 A: Explain and apply technological knowledge.
- 3.2.7 B: Apply process knowledge to make and interpret observations.
- 3.2.7 C: Identify and use elements of scientific inquiry to solve problems.
- 3.2.7 D: Know and use technological design process to solve problems.
- 3.4.7 A: Describe concepts about the structure and properties of matter.
- 3.4.7 C: Identify and explain the principles of force and motion.
- 3.6.7 C: Explain physical technologies of structural design, analysis and engineering, financial affairs, structural production, marketing, research and design.
- 3.7.7. A: Describe the safe and appropriate use of tools, materials, and techniques to answer questions and solve problems.
- 3.7.7. B: Use appropriate instruments and apparatus to study materials.
- 3.8.7 A: Explain how sciences and technologies are limited in their effects and influences on society.

## National Standards

- NS 5-8.1: Science as inquiry
  - Abilities necessary to do scientific inquiry.
  - Understandings about scientific inquiry.
- NS 5-8.2: Physical science
  - Properties and changes of properties in matter.
  - Motions and forces.
  - Transfer of energy.
- NS 5-8.5: Science and technology.
  - Abilities of technological design.
  - Understandings about science and technology.

## Content Objectives

1. Students will predict how paperclips will fatigue based on prior experiences.
2. Students will be able to measure, compare and contrast the fatigue of the paperclip based on its angle and the material (whether metal or plastic).

3. Students will compare and contrast how differing angles change the outcome of how a material will fatigue.
4. Students will predict and measure how different sizes or materials will affect the failure of materials.

### **Process Objectives**

1. Students will be able to determine the fatigue of paperclips using quantitative data.
2. Students will make observations of paperclips fatigue while bending the paperclips in different angles.
3. Students will be able to determine how the angle affects the fatigue of paperclips.
4. Students will compare and contrast how different variables affect the fatigue such as materials, size and angle.

### **Assessment Strategies**

1. Completion of the hypothesis.
2. Completion of the lab questions.
3. Informal evaluation of participation in group discussion.

### **Materials**

- Do Materials Get Tired – How Long Will a Paperclip Last Lab, questions and data tables.
- Paperclips: 4 for each group or set of lab partners, for example:
  - 4 small metal paperclips
  - 4 large metal paper clips
  - 4 small plastic paper clips
  - 4 large plastic paper clips
- Video clips (online)
  1. "Do Materials Get Tired? Introduction" 2 minutes 21 seconds
  2. "Do Materials Get Tired? Fatigue" 2 minutes 11 seconds
  3. "Fracture Surfaces of Paper Clips" 10 seconds

### **Procedure**

#### **Part 1: Strain of Materials**

1. Introduce lesson by asking students to view video clips "Do Materials Get Tired? Introduction" (2 minutes 21 seconds) and "Do Materials Get Tired? Fatigue" (2 minutes 11 seconds).
2. After viewing videos, ask the students to share their ideas about the fatigue of materials. What happens to an object when bent or twisted? Does it retain its shape? Does the object break? Use examples of different materials such as rubber, plastic, metal, etc.
3. Ask the students how they could devise a plan to test how each of these objects break? Would they all break in the same way or would they break in different ways?

4. Now, introduce other factors that may affect how an object breaks. Does the age of a material affect how easily the object breaks? Give some examples.
5. Talk to the students about how useful it is for people to test how a material breaks. Engineers are scientists that construct objects, buildings, airplanes, etc. out of materials that have specific properties. How would it be useful to know how an object fatigues before you build with it?
6. Complete the lab and when the lab is over, use data from the lab to reiterate parts 1-4 above. Draw on real-life experiences and objects used in everyday life.

### **Part 2: Other Examples**

1. Teacher-led discussion about how an object fatigues is useful.
2. What are the advantages and disadvantages of a material that does not fatigue easily? Are there any advantages of a material that would fatigue easily? Explain.

### **Extension**

1. Try the experiment again and compare the results to the first time. Were they similar or different?
2. Try adding different materials to this experiment, such as different quality plastic and metal paperclips.
3. Students may view video "Fracture Surfaces of Paper Clips" (10 seconds) as an introduction. After downloading a virtual microscope, (<http://virtual.itg.uiuc.edu/downloads/#interface>), students can view various paperclips and their fatigue surfaces (find links to data at <http://www.wpsu.org/nano/>). Discussions as well as activity questions can be designed based around the images and the experiment.