

Lesson

Do Materials Get Tired? How Long will a Paperclip Last?

Suggested Grade Level

9-12

Run Time

Approximately 90 minutes

PDE Standards

- 3.1.12 C: Assess and apply recurring patterns in science and technology
- 3.6.10 C: Apply physical technologies of structural design, analysis and engineering, personnel relations, financial affairs, structural production, marketing, research and design to real world problems
- 3.8.10 B: Analyze how human ingenuity and technological resources satisfy specific human needs and improve the quality of life.

Content Objectives

1. Students will conduct an experiment mimicking a torsion test.
2. Students will determine the shear stress on a paperclip.
3. Students will infer reasons for the quantitative shear stress for various paperclips.

Process Objectives

1. Students will calculate the shear stress on various paperclips.
2. Students will compare the shear stress on various paper clips.

Assessment Strategies

1. Completion of the “Do Materials Get Tired? How Long will a Paperclip Last?” Lab

Materials

- Computer with Internet access
- Video clips (online)
 1. "Do Materials Get Tired? Introduction" (2 minutes 21 seconds)
 2. "Do Materials Get Tired? Fatigue" (2 min 11 seconds)
 3. "Fracture Surfaces of Paper Clips" (10 seconds)
- 4 different paper clips, for example:
 - 1 Small metal paperclip
 - 1 Large metal paper clip
 - 1 Small plastic paperclip
 - 1 Large plastic paperclip
- Metric ruler

Procedure

PART 1:

1. Students should view video clip "Do Materials Get Tired? Introduction" (2 minutes 21 seconds) and video clip "Do Materials Get Tired? Fatigue" (2 minutes 11 seconds).
2. Teacher should lead a discussion on how to test the fatigue of various objects. What are some products students would want to make sure were tested for fatigue? Have any students ever had a product just suddenly break due to fatigue?
3. Teacher should inform the students that they will test the fatigue for a variety of paperclips.
4. Students should create the three hypotheses listed in the lab.
5. Students should collect data for the laboratory experiment. This can be done with groups of students testing just one variable (two groups can test the same paper clips, but each group would change the rotation angle) and then share the data between the groups, or each group can test all of the variables including type of paperclip and rotation angle.

PART 2:

1. Students should graph the number of cycles vs the angle of rotation. Multiple graphs may need to be completed, one for each type of paper clip.
2. Students should complete the analysis questions.
3. Students should watch video clip "Fracture Surfaces of Paper Clips" (10 seconds).
4. Teacher should readdress the discussion around various objects that may have failed under stress forces. Teacher should also discuss the various careers in which the experiment pertains and the importance of such careers to society and today's lifestyles.

Extension

1. Using the 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.
2. Groups of students can test only one type of paper clip. After the tests have been conducted, the various data can be recorded and averaged.
3. Some of the paper clips can be frozen or heated and same experiment conducted. This can show how changes in temperature can affect the strength of metals.