ROBERT C. WILLIAMS MUSEUM of PAPERMAKING

# The Properties of Paper: Tear Resistance

**Grade Level:** Science grades 2, 4, 8

**Time:** 45 min

**Objectives:** Students will be able to plan and carry out investigations to observe and record results using the strength test so they can learn how the pull on the paper can cause tearing displaying the different tear resistance of the paper

**I Can Statements**: I can: (1) complete a tear resistance test for 6 different paper samples; (2) record observations; (3) investigate how unbalanced force pulling on the paper causes it to tear; (3) draw conclusion regarding paper from observations; (4) use accurate vocabulary

**Georgia Standards of Excellence:**
*Science*
2nd: S2P1.1 S2P2.a
4th: S4P3.a
8th S8P5.a

**Vocabulary:**

Tear resistance (or tear strength): an engineering measurement of how well a material can withstand tearing. The test is useful for a wide variety of materials by many different test methods. For paper, tear resistance is the force required to tear a single ply of paper after the tear has been started.

**Materials:** 1 large metal paper clip, 1 pen, 1 ruler, masking tape or scotch tape, 1 roll of transparent tape, scissors, 35 washers ½ inch or ¾ inch, Sets of 2" x 5" strips of each of the following seven papers: notebook paper, newsprint, paper towel, copy paper, magazine paper, toilet tissue, and paper grocery bag

**Preparations:** Prepare 1 strip of the 7 paper samples per measurements above for each student or group. Tape pieces can also be pre-prepared.

**Essential Questions:** (1) What is meant by the "quality" of a product? (2) How can the quality of different products be compared? (3) How does adding unbalanced weight pulling on one tab of the paper from the paper clip and washers cause it to tear? (4) How can you be sure the test you are doing is fair?

**Introduction:** One way to learn more about the properties of a product is to test it. In this lesson, students will perform a tear-resistance test on six paper samples. Then they will predict how each paper sample will perform in the test and record their observations during the tests. Instructors will demonstrate how to complete the tear test and record results with one of the paper samples. Instructor will demonstrate how to fold paper sample in half, measure 1" from each end of the paper sample and cut 1" along center fold from the end of the paper. Instructor will demonstrate folding 1" tab down, unfolding paperclip and poking hole in center of tab with paper clip. Then instructor will show how to thread paperclip, tape edges of paper, and attach paper sample to table. Instructor will then demonstrate adding washers to unfolded paperclip until the paper tears. Then instructor will mark point on paper at which paper tore to. Please refer to diagram at the bottom of the page for assistance.

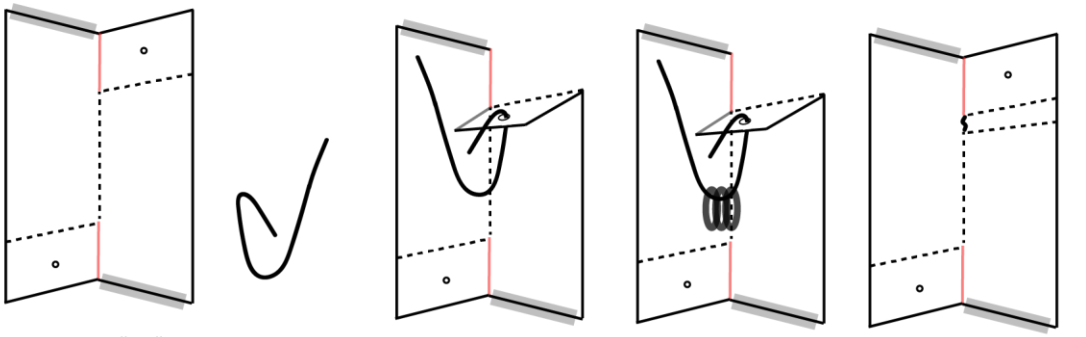
## Procedure:

1. Make predictions for which paper sample will be least resistant and which will be most resistant to tearing. Record prediction on data sheet
2. Fold all paper samples in half vertically (long ways, or "hot dog" style).
3. Using a ruler, measure 1" down from both short edges along the paper fold for each paper sample and mark.
4. Cut 1" slit along paper fold from each end to mark and fold down tab.
5. Unfold paperclip and then use the straight end of the clip to poke hole in center of each tab.
6. Using tape, secure paper sample to desk or table. Tape unfolded side of the top and bottom of the paper to a vertical surface, being sure to allow the folded sides to be accessible for the activity.
7. Hang paper clip hook through hole in upper flap. Bend the tab down gently so the hook dangles freely.
8. Gently add washers, one at a time, until the paper begins to tear. Record on datasheet the number of washers added, and mark point at which paper tore with line across the paper strip.
9. Flip paper upside down and repeat trial with same paper sample. After completing two trials for each sample, students will average results.
10. Repeat process for each of the remaining paper samples and record results.

## Wrap Up (can be used in discussion or written format)

1. Which paper was the most resistant to tearing? The least?
2. Were you surprised by the results? Why or why not? How did the results compare with your predictions?
3. How do unbalanced force pulling on the paper causes it to tear?
4. Based on what you observed about each paper sample, what properties of the strongest paper do you think contributed to its strength? What properties contributed to the weakest?
5. Think about the uses of each paper type you tested. Which samples need to resist tearing? Why? For which ones is tear resistance less important?
6. In what ways do you think paper tests can be helpful? To whom?

**Sample:**



Paper size 2″x5″
Dashed line = fold
Red line = cut
Circle = hole in paper
Grey Block = tape

Unfold large paperclip

Cut along red line and thread paper-clip

Add 1/2″ to 3/4″ washers

Mark line at point where paper ripped

Flip paper and repeat test

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**Name: _____**

## The Properties of Paper: Tear Resistance

Prediction 1:_____ will be the least resistant to tearing.

Prediction 2: _____ will be the most resistant to tearing.

| Paper Type | Test 1 | Test 2 | Average |
|---|---|---|---|
| Notebook Paper | | | |
| Newsprint | | | |
| Paper Towel | | | |
| Copy Paper | | | |
| Magazine | | | |
| Toilet Paper | | | |
| Paper Bag | | | |

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