

# Industrial Standards and Testing

## Introduction

**ASTM. SAE. USS. ANSI. UL. RoHS. AACC. TAPPI. IEC.** Are you familiar with these acronyms? If so, you're likely in the minority. Each is associated in some way with industrial standards, specifications and



testing. It's probably safe to say that for the general public, and for middle and high school science students, this area is something of a blank. Yet these very things are extremely important to the successful functioning of industrial/technological societies like ours that are intimately related to science and engineering.



From the faulty bolts in the new Bay Bridge to an ad for a vacuum cleaner to the viscosity of motor oil, to buying a 10-24 machine screw you will find industrial standards and test methods involved. The vacuum cleaner ad shown is from the New York Times, Sunday, July 21, 2013. The text at the bottom of the ad (enlarged in the two paragraphs immediately below) says that the claim of superior suction is based on **ASTM F558**. The official title of this standard is **Standard Test Method for Measuring Air Performance Characteristics of Vacuum Cleaners**. Also cited is **IEC 60312-1**, the title of which is **Vacuum cleaners for household use - Part1: Dry vacuum cleaners - Methods for measuring the performance**.

**Suction power is measured in Air Watts and, as you can see, DC41 has twice as much suction of the cleaner head than any other vacuum.\* Its cleaner head self-adjusts to seal in that suction across carpets and hard floors. And, its Dyson cyclone technology captures more microscopic dust than any other.**

**\* Machine representation relative to Air Watts. Suction tested against upright market to ASTM F558 at cleaner head, dust loaded as per IEC 60312-1.**

The two activities that follow provide an opportunity to design, describe carry out and discuss simple standardized tests on properties of two common everyday items that many people would likely not perceive as having any relation to science or engineering -- toilet paper and pasta.

It should be recognized that the tests developed here will in all likelihood be very basic and straightforward, whereas actual operative standardized tests for the same properties may be far more extensive and sophisticated, and rely on scientific and technical knowledge at a level significantly beyond many middle school or high school students. But things have to start somewhere, and it is hoped that the effort here can bring to students the beginning of an awareness of the existence of and importance of technical standards and testing in our society.

# Tear Strength and Puncture Strength of Toilet Paper

It is common knowledge, gained through everyday experience, that various properties of toilet paper differ from brand to brand. It is probably not common knowledge that toilet paper manufacturers and high volume sellers (think Costco and Walmart as examples) have a high enough economic stake in toilet paper sales that they conduct their own technical testing of toilet paper, in some cases using very simple qualitative tests that require little or no instrumentation, and in other cases using highly specialized engineering test instruments. Some actual test-related items from Consumer reports and Tinius Olsen (a well known maker of test equipment) are shown below. Selected items that relate to tear strength, puncture strength and wet strength have been marked with arrows.



## Consumer Reports Ratings for Best Toilet Paper

### Which toilet paper performed best in our tests?

We tested 25 toilet papers to determine the best-performing models. Our expert lab technicians tested each toilet paper based on the following criteria:

**Strength:** resistance to puncturing. ←

**Disintegration:** amount of time needed for a sheet to break up in swirling water.

**Softness:** judgment of trained panelists

**Tearing ease:** separation of sheets at their perforation ←



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### Paper - Typical Calculations

Click the icons below for more info

- Compression
- Puncture ←
- Tensile
- Peel ←
- Tear ←
- Friction ←

### Which Machine Do I Need?

**Paper**

- Tear strength of envelopes
- Tensile strength of paper
- Wet strength of paper
- Folding endurance of paper and cardboard
- [Tear strength of tissue paper \(pdf\)](#)
- [Puncture strength of tissue paper \(pdf\)](#)
- Tear strength of toilet paper
- Tensile strength of cigarette paper
- Tear strength of newspaper
- Peel strength of labels

This activity involves devising, describing and carrying out a "standard test method" that will measure some particular aspect of the "strength" of toilet paper. In conclusion, groups will be asked to briefly share their test and results with each other. A variety of materials will be provided and you can ask for additional materials if they are conveniently obtainable, but to

some extent this will be an "Apollo 13" experience, where you will have to create your solution from the materials available.

**Materials** (partial list -- additional things possibly available initially or upon request)

Toilet paper (several different brands)  
Masking tape  
Craft sticks, jumbo and regular  
Binder clips, various sizes  
String  
Steel washers, various sizes  
Glass marbles  
Pennies  
Paper clips, jumbo and regular  
Plastic cups  
PVC pipe and common fittings (elbows, T's, unions)  
PVC cutters  
Electronic balance  
Graph paper  
Rulers and meter stick

## Bending Strength of Pasta

What would be your reaction to opening a box of spaghetti and finding the strands broken into short pieces? For long-strand types of pasta such as spaghetti, linguini or fettuccini, the bending strength must be such that the pasta can withstand the processes of packaging, shipping and handling without significant breakage. This is economically important to pasta manufacturers, as are many other properties, and there are engineering test instruments used by them that are specifically designed to perform various tests, as shown below in an excerpt from an ad for a company that makes such instruments. Note that **bending strength** is listed as a test type.

# Pasta & Rice

The firmness, stickiness, elasticity and bending strength define the overall texture of cooked and uncooked pasta, noodles and rice. The breaking strength of uncooked spaghetti and lasagne sheets can be measured using the 3 point bend jig. Our unique spaghetti compression fixture measures the deflection of cooked spaghetti whilst under a fixed load for a specific time. This method is very effective in defining the correct cooking time.

| Test Type            |                                    |
|----------------------|------------------------------------|
| • Pasta stickiness   | • Spaghetti / noodle extensibility |
| • Pasta firmness     | • Bending strength                 |
| • Spaghetti firmness |                                    |



This activity involves devising, describing and carrying out a "standard test method" that will in some way measure the bending strength of long-strand pasta. In conclusion groups will be asked to briefly share their test and results with each other. A variety of materials will be provided and you can ask for additional materials if they are conveniently obtainable, but to some extent this will be an "Apollo 13" experience, where you will have to create your solution from the materials available.

**Materials** (partial list -- additional things possibly available initially or upon request)

Pasta (several different types & brands of long-strand pasta)

Masking tape

Craft sticks, jumbo and regular

Binder clips, various sizes

String

Steel washers, various sizes

Paper clips, jumbo and regular

Plastic cups

PVC pipe and common fittings (elbows, T's, unions)

PVC cutters

Electronic balance

Wood blocks

Graph paper

Rulers and meter sticks

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## Going Further

- Prepare a detailed written version of a test which other students will then attempt to implement. Follow this with a discussion and critique of the test and results.
- If not already discussed, look up the names and backgrounds of the various acronyms listed at the beginning of the Introduction section (ASTM, SAE, etc.)
- Try to find a written version of an actual test procedure from one of the organizations noted.

## Notes and Comments

If you have read this entire write-up, you are now aware of certain features. There are no instructions on how to set up tests, no diagrams, no definitions of terms, no sample calculations, etc. Having the students design the tests themselves is at the heart of things here, partly just so that they will have this experience. But it is also hoped that the variety of approaches and techniques they use and the results they obtain will provide the basis for a discussion that gets them to understand the necessity for widely accepted standards and testing methods, and exposes them to their existence and role.

It is recognized that there are existing activities that use everyday materials (e.g., structures built with pasta or newspapers) and that employ consumer testing (e.g., paper towel absorption). The activities here are not meant to replace those; they are valuable resources for inclusion of engineering ideas in the curriculum. This handout is an attempt to focus some attention on an area that has had little exposure -- the role and impact of standards and testing in our economy and in our lives. As mentioned in the Introduction it is just a start, and many practical issues (time available, level of students, etc.) remain to be addressed in determining whether or how it fits in a particular situation. It is hoped that it will at least provide some food for thought that ultimately proves useful in some way.