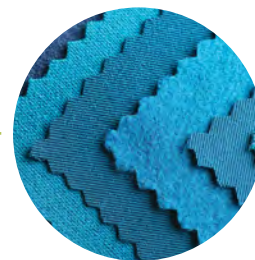


Origin and Properties of Synthetic and Natural Fibers

A Carolina Essentials™ Activity



Overview

Students begin this activity by using a set of guiding questions to research the source, processing requirements, and final properties of natural and synthetic fibers. After the research is complete, students investigate properties such as absorbency, stretch, shrinkage, and ability to take a dye of at least one natural and synthetic fiber. Natural fibers for research include cotton, linen, silk, and wool; synthetic fibers include polyester, rayon, spandex, and acrylic. Students are also asked to survey their own clothes and record and tally the fiber content of what they wear.

Physical Science
Grades: 6–8

Phenomenon

A definitive test for separating synthetic and natural fabrics is the burn test. How the fabric responds to the heat of a flame, the color of smoke produced, the odor, and properties of the ash or residue remaining identifies the base unit of the fabric—cellulose, protein, or a man-made monomer. Make observations from the burn test demonstration your teacher performs or watch the 4-minute video “[Textile Fibers Burning Test](#)” with numerous examples.

What are your observations?

Essential Question

How do synthetic and natural fibers compare in composition, properties, natural resource use, and impact on society?

Investigation Objectives

1. Complete research to identify the properties, source, and manufacturing processes for natural and synthetic fibers.
2. Collect data on properties of natural and synthetic fibers through investigations and compare lab findings to research.



Continued on the next page.

TIME REQUIREMENTS



PREP | **ACTIVITY**
1–2 hr | 4–6.5 hr

Teacher Prep: 1–2 hr

Student Research: 3–5 hours
(May be completed independently)

Student Lab Investigation:
60–90 minutes, depending on the number of samples

SAFETY REQUIREMENTS



MATERIALS

Teacher Demonstration
(Optional)

Fabric sample of a natural fiber fabric, 2 cm × 8 cm

Fabric sample of a synthetic fiber fabric, 2 cm × 8 cm

Votive candle

[Matches](#) or lighter

[Aluminum pie pan](#)

[Tongs](#) or long [tweezers](#)

Student Investigation

(Per group or individual)

1 or 2 natural fiber fabric squares, 10 cm × 10 cm

1 or 2 synthetic fiber fabric squares, 10 cm × 10 cm

[Electronic balance](#)

[Ruler](#)

[Plastic beaker](#), 250 mL

Hair dryer or [heat lamp](#)

Blue or red [food coloring](#)

[Wash bottle](#)

Tap water

HELPFUL LINKS

[Colorful Dyes from the Natural World](#)

[Shaving Cream and Food Coloring Chemistry](#)

[Kool Aid Chromatography](#)

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Next Generation Science Standards* (NGSS)

PE MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information <ul style="list-style-type: none">Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.	PS1.A: Structure and Properties of Matter <ul style="list-style-type: none">Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. PS1.B: Chemical Reactions <ul style="list-style-type: none">Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	Structure and Function <ul style="list-style-type: none">Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Safety Procedures and Precautions

Food coloring will stain your hands and clothing so keep your work space clean and clear. Hair dryers or heat lamps can burn your skin if exposed for too long.

Teacher Demonstration

Work in a well-ventilated space and wear gloves and goggles.

Student Activity

Exercise caution using the hair dryer or heat lamp.

Teacher Preparation and Disposal

For the fabric burn test demonstration, gather a 2 cm × 8 cm sample of cotton or silk and polyester or spandex; a votive type candle; matches; tongs or long tweezers; and an aluminum pie pan or large square of aluminum foil.

Gather and cut 10 cm × 10 cm fabric samples for the student investigation. You will need 1 or 2 samples per fiber type, natural or synthetic, per group. There should be 4 natural and 4 synthetic fabrics to choose from. Natural fibers that are easy to find include 100% cotton, linen, silk, and wool. Synthetic fibers that are easy to locate include 100% polyester, rayon, nylon, acrylic, and spandex. Avoid fabric blends. All fabric samples can be disposed of in the classroom trash.

Upload or print the student activity guide. Arrange research time in the media center if needed.

Continued on the next page.

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Student Procedure

Student Research

1. Complete student research assignment. See attached student research guide.

Investigation of Fiber Properties

1. Measure the length and width of the fabric samples in centimeters. Record your answers in the data table.
2. Weigh the fabric samples in grams.
3. Record the weights in the data table.

Stretch Test

1. Hold the fabric at the center top.
2. Pull the fabric from the center bottom and measure the stretched length in centimeters.
3. Repeat the procedure for the width.
4. Hold the fabric at the upper left corner and pull the lower right corner. Measure the stretched length.
5. Repeat the procedure with all fabric samples. Record your answers in the data table.

Wrinkle Test

1. Make a fist around a tightly balled up fabric sample for 45–60 seconds.
2. Release the fabric and count the number of wrinkles and creases. Record your answers in the data table.
3. Repeat for all the fabric samples. Record your answers in the data table.

Absorbency Test

1. Put about 100–125 mL of tap water in the plastic beaker.
2. Submerge all the fabric swatches in the water for 3–4 minutes.
3. Pull out a swatch and let it drip over the beaker until no more water is running out of the fabric.
4. Weigh the fabric swatch and subtract the dry weight of the fabric. Record the amount of water absorbed by the fabric in the data table.
5. Repeat for all the fabric samples. Record your answers in the data table.

Shrinkage Test

1. Place the wet fabric swatches on the desk. Use a hair dryer or heat lamp to completely dry the fabric swatches.
2. Measure the length and width of all samples.
3. Subtract the dried measurements of length and width from the original measurements of length and width to calculate shrinkage. Record your answers in the data table.
4. Optional: Calculate the area of fabric shrinkage in units of cm^2 .

Dye Test

1. Fill the wash bottle with tap water.
2. Place the fabric swatches on a flat surface. Make sure they are dry.
3. Place a drop of food coloring on the fabric in 3 different places. Do not let the spots run together.
4. Let the dye sit for 5 minutes.
5. Hold a swatch by a corner, over the beaker. Use the wash bottle to rinse off any excess dye into the plastic beaker.
6. Record the diameter of the stains and the depth of the color in the data table.

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Teacher Preparation and Tips

Student Research

Assign each student or pair of students 1–2 natural fiber fabric swatches and 1–2 synthetic fiber fabric swatches to research. The students will test the properties of the SAME fibers in the investigation section.

Investigation of Fiber Properties

Have fabric swatches pre-cut to save time.

Review centimeter and millimeter measurements with students.

Wrinkle Test

Have a classroom clock or smartphone available for students to time the 45–60 seconds.

In step 1, students need to squeeze the fabric samples tightly for the entire time.

In step 2, tell students not to smooth out the fabric.

Absorbency Test

Tell students not to wring out the fabric samples, just let them drip.

Dry the scale before and after weighing each sample.

Shrinkage Test

Position the hair dryer perpendicular to the fabric samples so they don't blow away. If necessary, the fabric samples can be taped on one corner to the desk.

Make certain the samples are completely dry.

Area is length \times width.

Dye Test

Students are rinsing excess dye from the cloth. They are not trying to remove the stain.

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Data and Observations

Student answers will vary.

Data Table

		Sample 1	Sample 2	Sample 3	Sample 4
Investigation of Fiber Properties	Fiber				
	Natural or Synthetic				
	Length (cm)				
	Width (cm)				
	Initial Weight (g)				
Stretch Test	Vertical Stretch Length (cm)				
	Horizontal Stretch Width (cm)				
	Diagonal Stretch Length (cm)				
Wrinkle Test	# of Wrinkles and Creases				
Absorbency Test	Water Absorbed (g) (Saturated Weight – Initial Weight)				
Shrinkage Test	Dried Length (cm)				
	Dried Width (cm)				
	Shrinkage Length (cm) (Original Length – Dry Length)				
	Shrinkage Width (cm) (Original Width – Dry Width)				
	Shrinkage Area (cm ²) (Length × Width)				
Dye Test	Dye Spot Diameter (cm)				
	Dye Spot Color				

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Analysis and Discussion

1. Add your data to a class data table.

Make an online, paper, or white board class data table for each individual or group to share answers. If fabric samples are repeated, those values should be averaged.

2. Summarize the properties of natural and synthetic fibers.

Natural fibers tend to wrinkle more, be more absorbent, shrink, and take more vivid dyes. Synthetic fibers wrinkle less, are less absorbent, don't shrink, and can be hard to dye. If you completed the burn test, natural fibers produce ash, while synthetic fibers melt. Rayon is the exception since it is made of processed cellulose.

3. How does the manufacturing and processing of fibers and fabrics impact natural resources and society?

All the fibers and fabrics require natural resources. Natural fibers tend to come from renewable resources, while many of the synthetic fibers and fabrics require petroleum, a non-renewable resource. Most natural fibers will biodegrade faster than most synthetic fibers.

4. How did your investigation results compare to your research findings?

Lab data should support research findings.

TEACHER NOTES