Engineered Fabric Constructions

Unit: Science of Textiles and Manufacturing

Problem Area: Fabric Construction

Lesson: Engineered Fabric Constructions

Student Learning Objectives.

Instruction in this lesson should result in students achieving the following objectives:

1. **Summarize specialty fabric constructions.**
2. **Describe the uses and attributes of engineered fabrics.**

Resources.

The following resources may be useful in teaching this lesson:

E-unit(s) corresponding to this lesson plan. CAERT, Inc. http://www.mycaert.com.

Birdair. Accessed June 23, 2016. http://www.birdair.com.

Fabric Architecture. Accessed June 23, 2016. http://fabricarchitecturemag.com/.

Fabric Images.com. http://www.fabricimages.com/. Accessed June 23, 2016.

Geosynthetics. Accessed June 23, 2016. http://geosyntheticsmagazine.com/.

Humphreys Textile Products. Accessed June 23, 2016. http://www.humphrys.biz/.

"Individual Equipment Decontamination Mitt™," *Integrated Textile Solutions*. Accessed June 23, 2016. http://intextile.com/products_decon.html.

Industrial Fabrics Association International. Accessed June 23, 2016. http://www.ifai.com.

"Manufactured Fiber Uses," *Fibersource*. Accessed June 23, 2016. http://www.fibersource.com/f-tutor/uses.htm.

"Nonwoven Fabric," *Wikipedia*. Accessed June 23, 2016. https://en.wikipedia.org/wiki/Nonwoven_fabric.

Specialty Fabrics Review. Accessed June 23, 2016. http://specialtyfabricsreview.com/.

Weber, Jeanette. *Clothing: Fashion, Fabric, & Construction*, 5th ed. Glencoe/McGraw-Hill, 2008.

Equipment, Tools, Supplies, and Facilities

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials

Key Terms.

The following terms are presented in this lesson (shown in bold italics):

- engineered fabrics
- fabric architecture
- fade resistance
- faux suede
- felted fabric
- filmed fabric
- flame retardant
- flocking
- foils
- geomembranes
- geotextiles
- hydrophobicity
- interfacing
- laminated vinyl
- light block
- nano fabric
- nanometer
- pleather
- polyester
- scrim
- tensile strength
- UV protection
- vinyl

Interest Approach.

Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

> *Ask small student groups to think about and list fabrics used for items other than clothing. To begin the small group discussions, show a few pictures of architectural fabric, banners, military fabrics (e.g., a Kevlar® vest), and outdoor*

fabrics. You may project VM–A for examples. Ask students what types of fabrics were used for VM–A and for the image examples you provided.

Then provide a mini-explanation of engineered fabrics (e.g., geotextiles, bulletproof, and water resistant) versus natural fabrics (e.g., cotton, wool, and silk), just enough to peak their interest. In their small groups, let students explore and learn more about engineered fabrics using the Internet and/or publications and texts. Assign each group to collect five facts they learned about engineered fabrics in their research. Compile a list of information that is viewable by all. Refer back to this list strategically as you conduct the lesson.

CONTENT SUMMARY AND TEACHING STRATEGIES

Objective 1: Summarize specialty fabric constructions.

Anticipated Problem: What are engineered fabrics? How are they constructed?

I. Engineered fabric constructions

A. ***Engineered fabrics*** are materials made from two or more components: a strong fiber for tensile strength and a resin to bind the two component fibers together. Strong fibers include fiberglass, Kevlar®, and carbon. Resins (sometimes called a matrix) are typically made from polyester or epoxy. This combination of fiber and resin is crucial for performance garments (e.g., bulletproof, fire-retardant, and heat-resistant items), fabric architecture, and geotextiles to enhance the material's durability and to resist the elements (water, wind, sun, and fire). ***Tensile strength*** is the resistance shown by a fiber, yarn, or fabric to withstand breaking or tearing under pressure.

B. Human-made fabrics first made an appearance in the 1950s. Rayon was the first human-made fabric. Today, polyester is the most commonly manufactured human-made polymer fabric in the marketplace worldwide. It is also the most recycled. [NOTE: Flame-resistant rayon and wool blends are used for airline seats, as they are durable and colorful.]

1. ***Polyester*** is a fiber and a fabric made from synthetic resins (synthetic linear polymer) usually produced with staple fiber and a spun yarn. Polyester has a high strength-to-weight ratio that makes it a good choice for the following uses:
   a. Carpet
   b. Clothing

c. Fiberfill insulation (high-performance outdoor wear such as clothing, parkas, and boots)
d. Home goods (e.g., linens, window coverings, and furniture)
e. Reinforcing fiber (e.g., tires, hoses, and belts)

2. Polypropylene is another common component of engineered fabrics due to its high abrasion resistance. It is a thermoplastic polymer resin used for structural and fabric applications. Many food containers use polypropylene because the resin has a high melting point (320°F) that means it can be used in microwave ovens and cleaned in dishwashers. In addition, it does not contain bisphenol A (BPA). BPA may be transported to food and is linked to diabetes, heart disease, brain development, and other cancer-related and sexual problems. It also transports rather than absorbs moisture, is lightweight, and has high tensile strength. Uses include:
   a. Indoor-outdoor carpet
   b. Upholstery
   c. Lawn furniture
   d. Active wear
   e. Technology (loud speaker components)
   f. Toy and automobile parts
3. ***Interfacing*** is webbed woven or nonwoven fabric used to support, reinforce, and give shape to products: garments, upholstery, geotextiles, and fabric architecture. Forms include woven (e.g., canvas and haircloth), non-woven, and knitted. Interfacing is constructed by layering fibers and filaments in an open weave (e.g., few fibers or filaments) or a heavy weave (e.g., many fibers or filaments placed closely together).
   a. Heavy weave interfacing is part of the structure of many reusable shopping bags.
   b. Some interfacings are fusible (iron-on), which allows the fabric to be bonded to other fabrics via heat.
4. Polyvinylchloride (PVC) or ***vinyl*** is a material created from ethylene (found in crude oil) and chlorine (found in salts), with a wind-resistant fabric backing. The fabric was developed in the 1950s. Today, vinyl is produced in many colors as well as a translucent fabric. Vinyl can be purchased in thick or thin varieties and in matte or shiny finishes. It is easily recycled, has a long life span, and is produced in 16-foot rolls.
   a. Uses:
      (1) Billboards
      (2) Signs
      (3) Banners
      (4) Indoor and outdoor upholstery
      (5) Garments
      (6) Luggage

b. ***Laminated vinyl*** is a fabric composed of a reinforcing polyester scrim pressed between two layers of unsupported PVC film. ***Scrim*** is mesh. Laminated vinyl has a high tensile level.

c. Vinyl is becoming more environmentally friendly. Some vinyl alternatives do not leach when temperatures rise. While environmentally friendly, these alternative products are two to four times more costly to produce than traditional vinyl fabric.

5. ***Felted fabric*** is matted fiber or fur produced by using heat, moisture, and pressure to create the material. Felted fabric was some of the first engineered fabric but is infrequently used today.
6. Pleather and faux suede
   a. ***Pleather*** (slang for "plastic leather") is an imitation leather fabric made of polyurethane or PVC. Polyurethane fabric is able to breath, and PVC fabric does not. Pleather has a controlled stretch and can be made with a silicon coating that allows no moisture penetration. Today's pleather is softer, more flexible, more durable, and more stain resistant than the original fabric. With some stain-resistant versions (those with a suitable coating), a person is able to use an alcohol rub to remove ink and other marks. Uses include:
      (1) Clothing
      (2) Furnishings (e.g., chairs and couches)
      (3) Handbags and luggage
   b. ***Faux suede*** is a synthetic material made of 100 percent polyester that looks and feels like real suede: nappy to the touch and thick. It is easier to clean, is more water resistant, and typically is half the cost of real suede. The uses are similar to those for pleather.
7. ***Filmed fabric*** is material bonded or sealed with thermoplastic material. This category of specialty fabric uses several terms: foil, film, and light block. Each category has a different process and a different outcome. Films are typically constructed from a polyester base with the film and the last layer flocked to bond all layers.
   a. ***Flocking*** is the process of mechanically or electrostatically (or a combination) depositing many small fibers onto a product or surface. Flocking may produce an overall effect or a raised textural and/or decorative effect. For example, flocked fabrics may produce a "bumpy, nappy" series of dots or lines that increase the appeal of the fabric (e.g., dotted Swiss). Other uses are:
      (1) Racecar dashboards (to prevent glare)
      (2) Water-repellant finishes
      (3) Acoustical tiles and walls
   b. ***Foils*** are high-gloss mylars generally laminated onto spandex fabrics that allow a wide variety of finished appearances. Foil types are metallic, holographic, and pearl finish fabric transfers (typically via heat) for use in:
      (1) Costumes

(2) Clothing (e.g., T-shirts, jewelry, handbags, and scarves)
(3) Graphic arts industry advertising and marketing (including toothpaste tubes, greeting cards, and labels)

c. ***Light block*** is a tightly woven opaque fabric sandwiched between other fabric layers to block light, such as blackout shades and curtains and solar screen shades. These options open a whole new world in decorating with fabric. The finishes are great, and the availability of colors and effects improves daily. Uses include:
(1) Glare control
(2) Light and heat management
(3) UV protection

Teaching Strategy: *Many techniques can be used to help students master this objective. Use VM–A through VM–G to review. Facilitate a class discussion about the types of engineered fabrics students have used, including clothing, outdoor furniture, etc. Then have students list types of fabric finishes. (You may need to prompt the discussion by beginning with examples, such as water repellant, mosquito repellant, and sun-resistant.) Move the discussion from the obvious use of specialty finishes (e.g., fireproof clothing) to less obvious purposes (concert venues that use fire-retardant curtains and venue, office, or arena area dividers).*

Objective 2: Describe the uses and attributes of engineered fabrics.

Anticipated Problem: What are the uses and attributes of engineered fabrics?

II. Engineered fabric uses and attributes

A. ***Fabric architecture*** is the use of engineered fabrics to create three-dimensional tensioned, sculptural, and shade structures. It is lightweight, visually interesting, and often more economical than traditional indoor and outdoor structures. PVC-coated polyester is a typical choice for fabric architecture because of its strength, flexibility, and translucency. It also has a life expectancy of 15 to 20 years.

1. Outdoor living and dining spaces are increasingly common in homes and commercial businesses.
   a. Uses: Outdoors furniture, rugs, awnings, tents, and tarps
   b. Attributes: Fade-resistant or fade-retardant, water-repellant, and stain-resistant items
   c. ***Fade resistance*** is the ability to retain brightness and color. Fade-resistant fabrics are made with high UV-resistant pigments added to the fibers prior to fabric creation. Some fade-resistant fabrics have a 5- to 10-year guarantee against fading.
2. Indoor and outdoor and conference and convention venues use architecture systems and engineered fabrics that can be assembled quickly, disassembled,

and used repeatedly. Engineered fabrics have made displays of all types more reasonably priced.

a. Uses: Concert venue structures, display booths, flags, pull-up banner stands, booth furnishing, dividers, etc.
b. Attributes: Fade-resistant, wrinkle-resistant, and water-repellant treatments as well as limited wind penetration [NOTE: Fabrics that can be exposed to high or continual winds without destruction is an important attribute. Engineered fabrics have more tensile strength than natural fabrics.]

3. Faux fabrics are popular engineered constructions.
   a. Uses: Roofing, office partitions, chain link-like fences, and much more (Common names for faux fabrics are PTFE fiberglass, which is a Teflon-coated non-woven fiberglass fabric with high weather resistance, and ETFE film that has a high transparency rating and is lightweight. ETFE is comparable to using glass.)
   b. Attributes
      (1) Arena roofing system attributes include 150 to 200 yard product, 25-year guarantee, high tensile strength, fire-retardant coating, insulation level options, stretch capability, and UV protection. The fabric is connected to supporting beams that span enormous areas.
      (2) Offices partitions, while not requiring all of the attributes of a large span roof, have wide variety of designs and textures. Engineered fabric dividers are lightweight, easy to arrange (and rearrange), acoustically beneficial, and cost effective with a designer look.

B. ***Geotextiles*** are permeable fabrics that, when in contact with soils, have the ability to separate, filter, protect, and/or drain. Geotextiles can be woven or non-woven fabrics; most are non-woven.

1. Non-woven geotextiles are filter fabrics produced by mechanical entangling. Fibers or filaments are bonded using barbed needles. Then the fabric is heat set. Many non-woven geotextiles are made from recycled materials and are engineered for a single use and a short life (e.g., production costs make them disposable products); surgical gowns are an example of a single-use geotextile. The Industrial Fabric Association International (IFAI) is a resource for information about geotextiles and other engineered fabrics.
2. Geotextile finishes are added to fabrics for the following characteristics: stretch, flame retardant, and water retention. ***Flame retardant*** is the application of chemical(s) to fabric fibers at construction to significantly reduce the fabric flammability. An example of a geotextile fabric and finish use is modern camping and hiking equipment. While the super hydrophobicity of geomembranes is not required, many of these fabrics are used to decrease the dampness of tents and tarps. Camping equipment and clothing is available with UV protection, antimicrobial coatings, and water and insect repellency. With advances in geotextiles, campers are offered better equipment and clothing at reasonable prices.

3. ***Geomembranes*** are a category of geotextiles produced as an impermeable (impervious) synthetic liner to control fluids and erosion. Sandbags are a common example of a geomembrane engineered fabric product. These fabrics stabilize soil and are minimally affected by weather. Railroads use geomembrane mats placed beneath the tracks to spread the force of a train over a greater area, to provide drainage when track is laid, and to protect the subgrade under the rails. Dams, rivers, and waterway projects use them for their water-retention capability. Hazardous waste sites worldwide are lined with geomembrane liners. Many have a mesh fabric liner placed below the geomembrane liner. The mesh liner allows gases to escape while keeping the waste site safer. [NOTE: Life expectancy has yet to be determined due to the exceptionally slow decomposition rate.]
4. Geotextiles are a type of ***nano fabric***, which is a textile made from nanoscopic (a scale stated in nanometers) fibers formed by applying a solution containing nanoparticles to fabric. A ***nanometer*** is one-billionth of a meter. Both the construction method and/or the application process create a finished product that has super ***hydrophobicity*** (extreme water-retention abilities). This attribute—the ability to retain water—is one of the reasons geotextiles are used in the construction of many water-related projects.
    a. Uses: Construction projects and tasks (holding soil in place, filtering soils, and retaining or resisting water); roadwork and railroad tasks; water retention (e.g., pond and waterway liners), sandbagging flood-prone or flash flood areas; hazardous waste site liners; as well as camping and hiking clothing, tents, and tarps (e.g., UV protection, antimicrobial and insect-repellant clothing, and shoe finishes)
    b. Attributes:
        (1) Geotextiles: High tensile strength, high tear-resistance, good anchor strength, high puncture resistance, low cost, environmentally friendly, water and insect repellant, and UV protection
        (2) Nano fabrics: Hydrophobicity, high elasticity, high tensile strength, and bacterial resistance

C. Military, law enforcement, and emergency response textiles

1. Safety: Performance textiles (including military, law enforcement, and emergency response) have unique characteristics from other engineered fabrics. They require high-performance gear suited to the situation. Finding products that make life safer and easier (e.g., lighter, camouflaged, and bulletproof body armor) for people serving in the military, as police officers, firefighters, and emergency response teams is the goal of researchers, fiber and finish scientists, and manufacturers.
2. Climate: Engineered fabrics also provide clothing customized for the area of the world and climate in which these people are located. Extremely hot and/or humid climates require cooler, lighter weight, and safer fabrics. For example, ***UV protection*** is a safeguard against ultraviolet radiation. Extremely cold climates require heat trapping and protection from the elements.

a. Uses: Water-resistant housing (e.g., geomembrane tents and tarps); construction and water-retention projects (e.g., geotextile and geomembrane products for roadway, rail, and waterway constructions); protective yet flexible body armor (e.g., Kevlar® vests, gloves, helmets, flak jackets, and other armor-piercing technologies for shoe and clothing items); engineered tank and ground vehicle, ship, and aircraft fabrics; and domestic armor-clad vehicles (e.g., vehicles and air transport for heads of state) are possible uses.

b. Attributes: In addition to the attributes named for other geotextile and geomembrane construction and water-related projects, the fabrics for high-performance careers are constructed to be bulletproof, fire-and heat-resistant, water-resistant, breathable, wick sweat capable, flexible, and fast drying.

Teaching Strategy: *Many techniques can be used to help students master this objective. Use VM–H through VM–P. Discuss each picture. Ask: "Would you have known that these images were fabric if you had not been told? What properties must the fabric in each picture have to complete the design?" Allow the students to use their class notes while viewing the visual masters to review the information from the lesson through the pictures with the question-and-answer technique. Use VM–Q to review body armor images. Then consider showing a short DuPont video: "What Keeps You Safe?" that describes high-performance military, law enforcement, fire and emergency response gear at http://www.dupont.com/products-and-services/personal-protective-equipment/body-armor/videos/wkys-1.html. Assign LS–A.*

Review/Summary.

Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. If a textbook is being used, questions at the ends of chapters may be included in the Review/Summary.

Application.

Use the included visual master(s) and lab sheet(s) to apply the information presented in the lesson.

Evaluation.

Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

Answers to Sample Test:

Part One: Matching

1. c
2. e
3. b

4. d
5. a
6. f

Part Two: Completion

1. tensile strength
2. fade resistance
3. fire retardant
4. hydrophobicity
5. UV protection
6. body armor

Part Three: Short Answer

Answers will vary but should be similar to the following: Fabric architecture is the use of engineered fabrics to create three-dimensional tensioned, sculptural, and shade structures. It is lightweight, visually interesting, and often more economical than traditional indoor and outdoor structures. PVC-coated polyester is a typical choice for fabric architecture because of its strength, flexibility, and translucency. It also has a life expectancy of 15 to 20 years. People see fabric architecture installations at museums, concert and sports venues, outdoor living and public areas, flags, marketing, etc.

Sample Test

Name _____

Engineered Fabric Constructions

Part One: Matching

Instructions: **Match the term with the correct definition.**

a. vinyl
b. filmed
c. polyester
d. fabric architecture
e. geotextiles
f. engineered fabrics

_____1. A fiber and a fabric made from synthetic resins usually produced with staple fiber and a spun yarn

_____2. Permeable fabrics that, when in contact with soils, have the ability to separate, filter, protect, or drain

_____3. Materials that are bonded or sealed with thermoplastic materials

_____4. The use of engineered fabrics to create three-dimensional tensioned, sculptural, and shade structures

_____5. A material created from ethylene and chlorine with a wind-resistant fabric backing

_____6. Materials made from two or more components: a strong fiber for tensile strength and a resin to bind the two component fibers together

Part Two: Completion

Instructions: **Provide the word or words to complete the following statements.**

1. The resistance shown by a fiber, yarn, or fabric to withstand breaking or tearing under pressure is termed _____.

2. An attribute of outdoor fabrics is to retain brightness and color. The term used to describe the retention is _____.

3. Concert venues that value safety and fire prevention use construction fabrics and materials that are _____.

4. Fabrics that have extreme water retention abilities are said to have the attribute _____.

5. Fabrics that are used to filter the sun's destructive rays have the attribute of _____.

6. A fabric product that makes life safer and easier for people serving in the military, as police officers, firefighters, and emergency response teams is _____.

Part Three: Short Answer

Instructions: **Answer the following.**

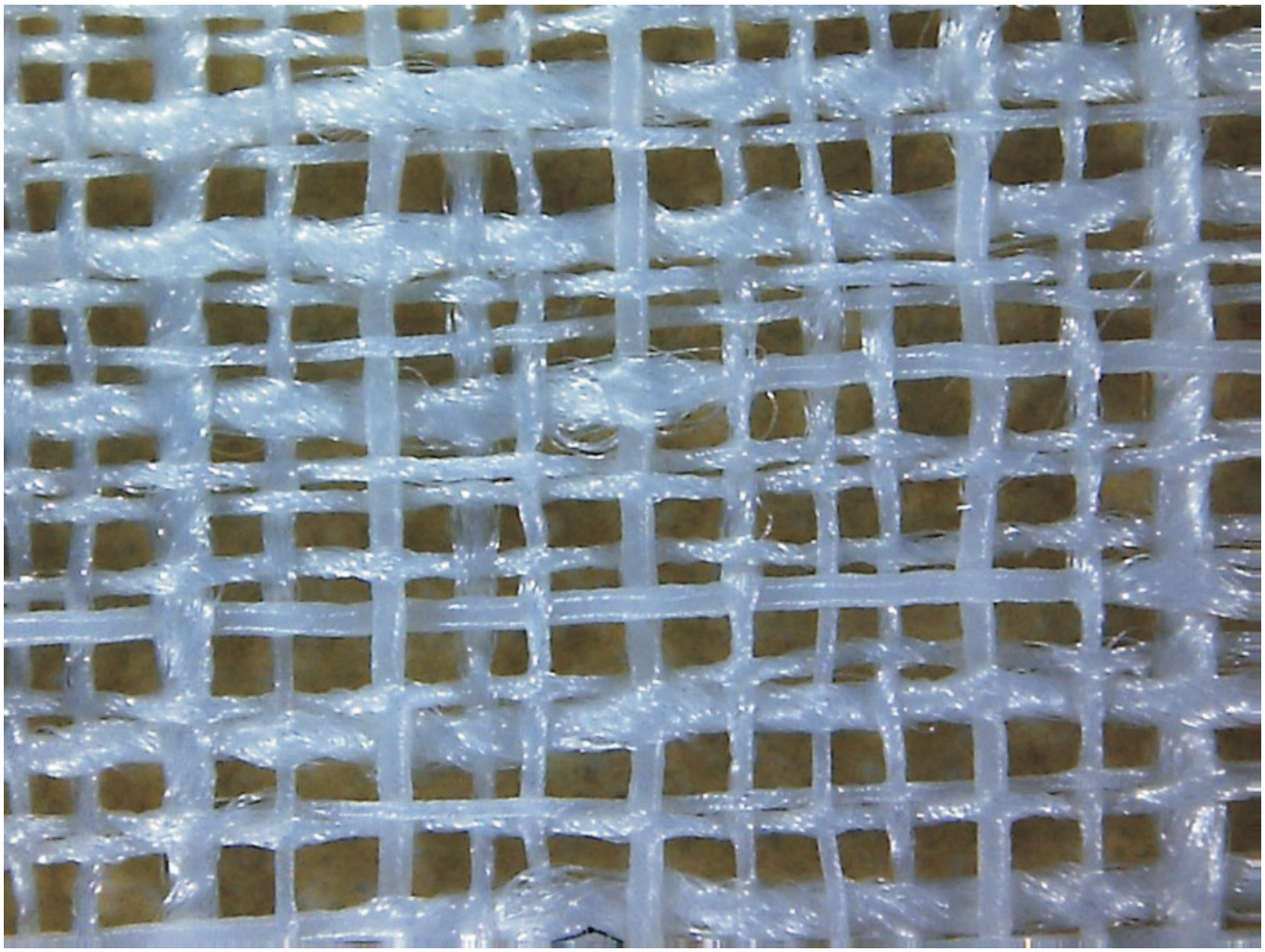
Describe fabric architecture in your own words. Where can you find examples of fabric architecture?

WHICH FABRICS ARE USED?

VM–B

POLYESTER WOVEN

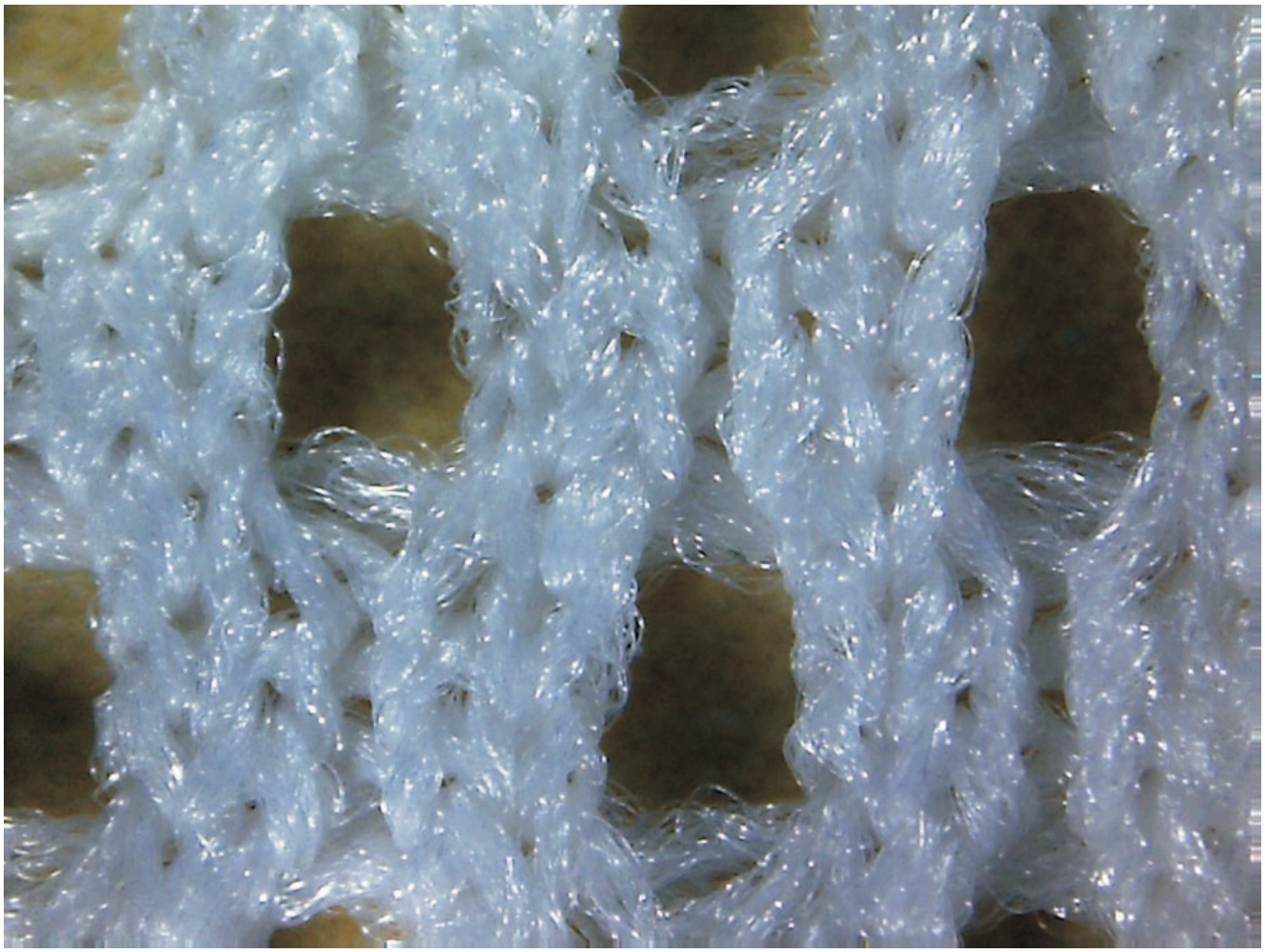
This is a microscopic view of an engineered woven polyester fabric. Describe what you see. What are the differences between this fabric and typical garment fabric?



(Courtesy, Fabric Images, Inc., Elgin, IL)

POLYESTER MESH

This is a microscopic view of an engineered polyester mesh fabric. Describe what you see. What, if any, differences are visible between this engineered polyester mesh and the polyester woven (VM–B)?



(Courtesy, Fabric Images, Inc., Elgin, IL)

STRETCHED FABRIC DESIGN

This fabric is stretched to divide the room around the displays. The stretch-ability of this fabric is due to fabric engineering. What is the term stretching strength?

(Courtesy, Fabric Images, Inc., Elgin, IL)

VM–E

VINYL FILM OVER FABRIC

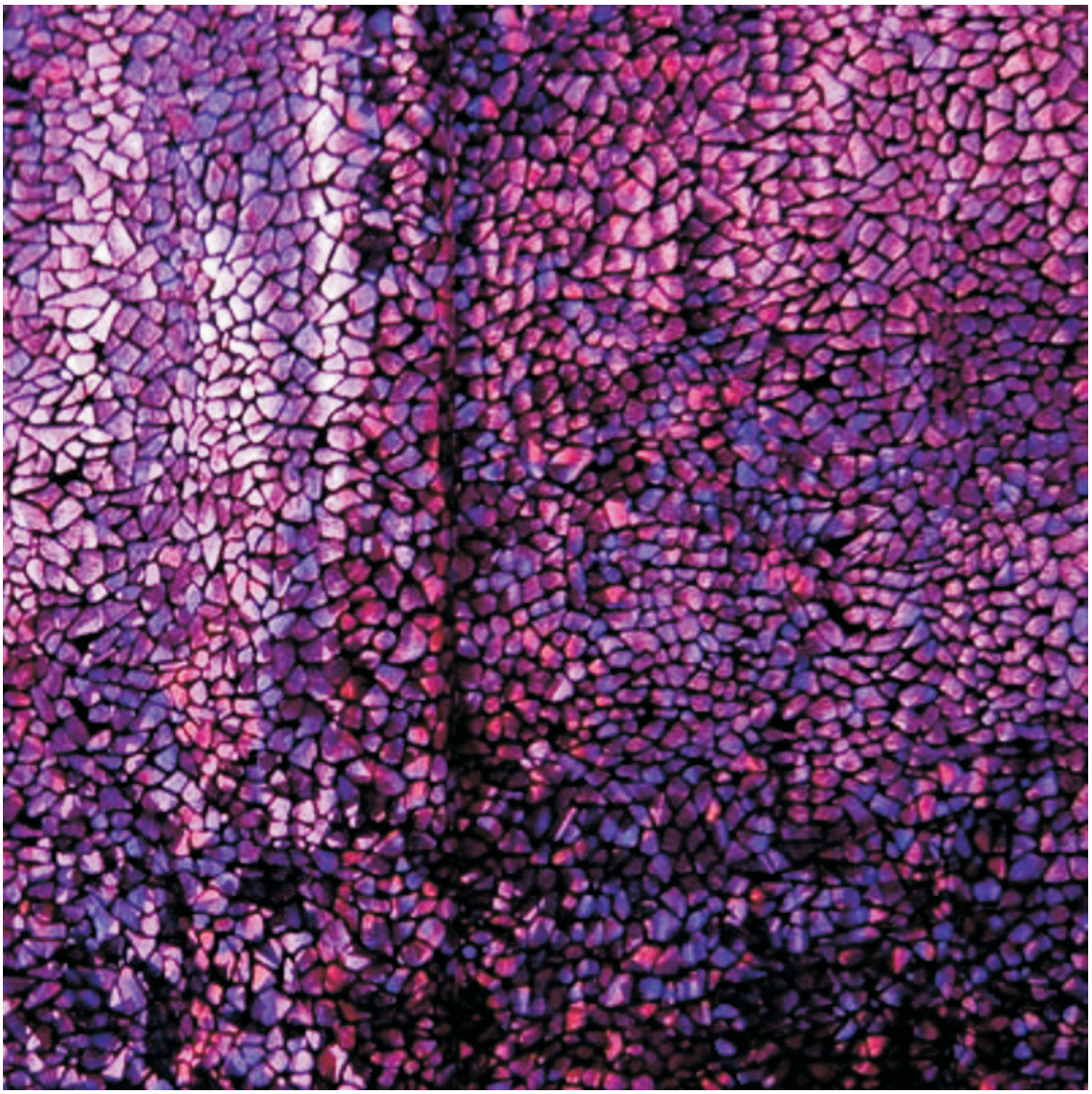
Fabrics that have been bonded or sealed with thermoplastic materials are known as filmed fabrics. They have a wide variety of attributes from decorative to water repellency.

(Courtesy, Fabric Images, Inc., Elgin, IL)

VM–F

HOLOGRAPHIC FOIL FABRIC

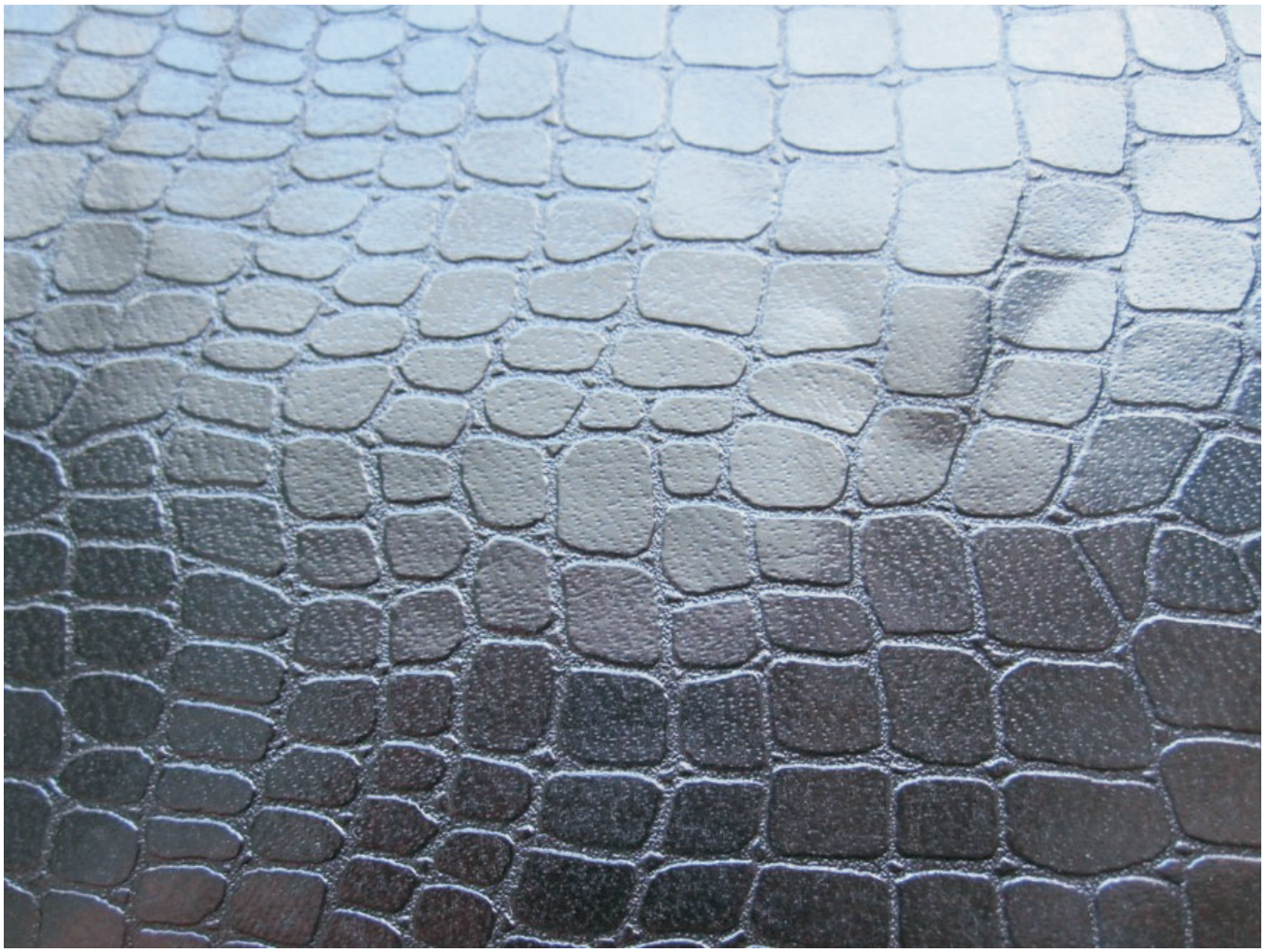
This holographic foil is an engineered fabric. Foils come in a variety of colors, finishes, and textures. Foils are often used for costumes.



(Courtesy, Fabric Images, Inc., Elgin, IL)

PLEATHER FABRIC

Pleather is an imitation leather fabric made of polyurethane. Today's pleather is softer, more flexible, more durable, and more stain resistant than the original fabric.



(Courtesy, Fabric Images, Inc., Elgin, IL)

LAMINATED EMBOSSED FABRIC

Laminated fabrics are typically composed of a reinforcing polyester scrim (mesh) pressed between two layers of unsupported PVC film. Laminated vinyl has a high tensile level. This image is laminated and embossed (marked, printed) with a basket-weave pattern. For what purposes would this fabric be appropriate?

(Courtesy, Fabric Images, Inc., Elgin, IL)

FABRIC ARCHITECTURE: CANDY

Fabric Images, Elgin, IL, produced the fabric architecture "kisses" for the Hershey's candy company. What fabric attributes were required to produce this display?

(Courtesy, Fabric Images, Inc., Elgin, IL)

FABRIC ARCHITECTURE: CUBE

Fabric Images, Elgin, IL, produced this fabric architecture booth display to promote its fabric architecture product line. What are other examples of fabric architecture you have seen? Where did you see them?

(Courtesy, Fabric Images, Inc., Elgin, IL)

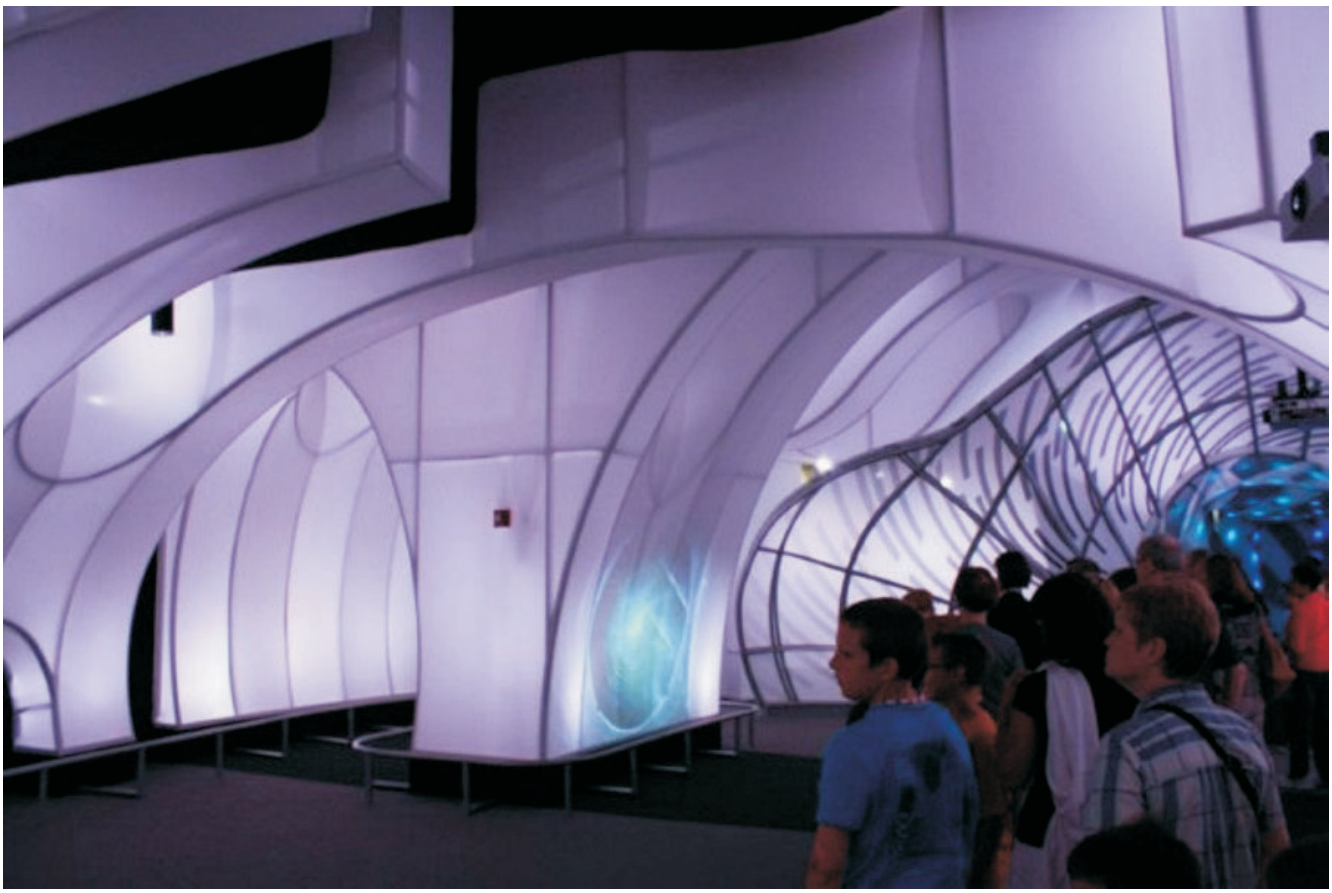
FABRIC ARCHITECTURE: DOME

Fabric Images, Elgin, IL, produced this fabric architecture dome. The dome illustrates some of the same techniques and technologies used in arena roofing systems. These roofing systems often use faux (artificial or non-natural) fabrics.

(Courtesy, Fabric Images, Inc., Elgin, IL)

FABRIC ARCHITECTURE: MUSEUM

This fabric architecture construction is inside a museum. It divides the museum's main passageway. Due to the way the fabric is staged, patrons intuitively know which path to take to the viewing area. Aside from being attractive and intuitive, the construction is an economical choice for the museum.



(Courtesy, Fabric Images, Inc., Elgin, IL)

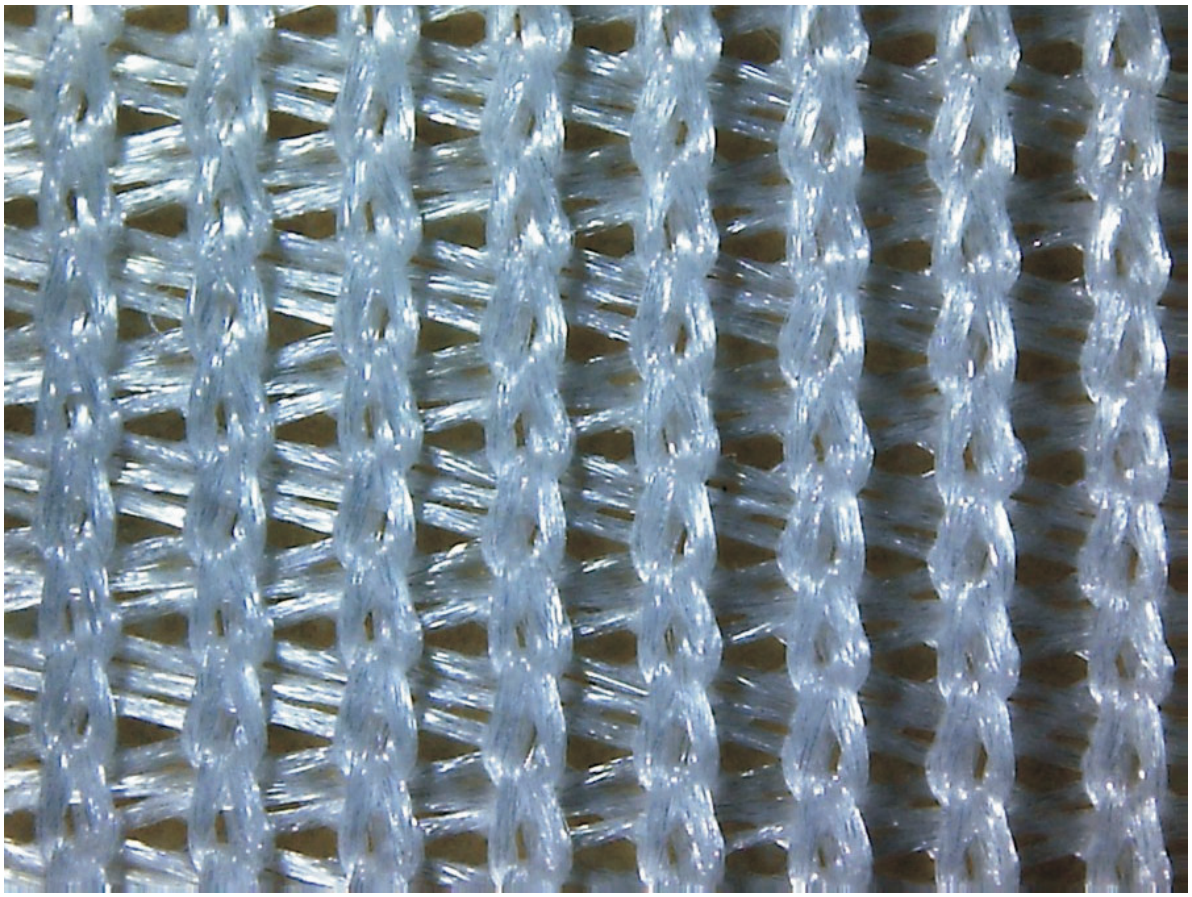
FABRIC ARCHITECTURE: AUTO SHOW DISPLAY

The fabric architecture display showcases the car and is a great way to draw a customer's attention.

(Courtesy, Fabric Images, Inc., Elgin, IL)

POLYESTER ENGINEERED FABRIC FLAGS

This is a microscopic view of the fabric of flags you see on city streets, outside museum and sporting venue entrances, and at shopping malls. Again, these engineered fabrics have a higher tensile strength and are more resistant to moisture, wind, and sun than traditional decorative flag fabrics. They will "fly" longer.



(Courtesy, Fabric Images, Inc., Elgin, IL)

OFFICE PANEL

This reception area is divided from the office spaces by the red wall—a wall made of fire-retardant engineered fabric. Aside from the attractiveness of the fabric architecture wall, it is an example of a more economical way to divide space while providing more safety features to a client.

(Courtesy, Fabric Images, Inc., Elgin, IL)

OFFICE DIVIDER

An office divider can, at once, be functional (a barrier, acoustically effective), attractive, and "soften" the workspace. Using a variety of colors and textures allows the client to easily change the location of individual panels for a different look and/or to rearrange the workspace entirely.

(Courtesy, Fabric Images, Inc., Elgin, IL)

BODY AND VEHICLE ARMOR

LS–A

Name _____

Water Repellency Experiment

Purpose

The purpose of this activity is to predict, rate, and observe the ability of different fabrics to repel water.

Objectives

1. Predict the water repellency and absorbency of each item.
2. Conduct a water repellency experiment.
3. Rate each item as indicated on the Water Repellency Experiment table.
4. Summarize the findings from your table ratings and notes.
5. Analyze your findings to respond to debrief questions.
6. Participate in a class discussion of your findings.

Materials

- lab sheet
- five outdoor wear or use items
- one cup of water
- measuring teaspoon
- writing utensil
- class notes
- paper

Procedure

1. Work in pairs or small teams to complete this lab activity. [Alternatively, conduct the experiment as a whole class assignment. If the experiment would be whole class, you would each fill out a Water Repellency Experiment table.]
2. Review your notes about engineered fabric uses and attributes.
3. Collect and display the five outdoor items.
    a. Label each item with the fabric content.
    b. Gather a cup of water and a measuring teaspoon.
    c. Use the Water Repellant Experiment chart below to record information about each item in columns 1 through 4.
    d. Column 1: First, fill in the name of each item in Column 1. Below the name, describe the weave and/or finish.
    e. Column 2: Based only on the fabric content and your visual inspection and touching of each item, predict each item's water repellency. Circle the number to indicate your prediction for each item in Column 2.
    f. Columns 3 & 4: Begin with item 1 and make all notes and ratings for that item before moving to items 2, 3, 4, and 5.
        (1) Drop a teaspoon of water on item 1.
        (2) Observe and record how fast the water is absorbed in Column 4. Circle your rating. Notes may include such descriptions as "drop spreads quickly or drop beads up."
        (3) In Column 3, rate the item's water repellency. [NOTE: Before rating items simply as "beads-up when water is applied," try wiping the water away. If the water droplet is easily wiped away, what might that indicate?] Record whether or not you can simply wipe the water off the item.
    g. Repeat the protocol in Step "f" with the remaining items.

Table 1. Water Repellant Experiment

Item	Prediction	Result	Observation Description
1. Weave/finish	*Water repellency* Low 1 2 3 4 High	*Water repellency* Low 1 2 3 4 High	*Absorption rate* Fast 1 2 3 4 Slow *Notes:* *Water repellency* Low 1 2 3 4 High *Notes:*

Item	Prediction	Result	Observation Description
2. Weave/finish	*Water repellency* Low 1 2 3 4 High	*Water repellency* Low 1 2 3 4 High	*Absorption rate* Fast 1 2 3 4 Slow *Notes:* *Water repellency* Low 1 2 3 4 High *Notes:*
3. Weave/finish	*Water repellency* Low 1 2 3 4 High	*Water repellency* Low 1 2 3 4 High	*Absorption rate* Fast 1 2 3 4 Slow *Notes:* *Water repellency* Low 1 2 3 4 High *Notes:*
4. Weave/finish	*Water repellency* Low 1 2 3 4 High	*Water repellency* Low 1 2 3 4 High	*Absorption rate* Fast 1 2 3 4 Slow *Notes:* *Water repellency* Low 1 2 3 4 High *Notes:*
5. Weave/finish	*Water repellency* Low 1 2 3 4 High	*Water repellency* Low 1 2 3 4 High	*Absorption rate* Fast 1 2 3 4 Slow *Notes:* *Water repellency* Low 1 2 3 4 High *Notes:*

4. Summarize the findings from your table ratings and notes. Analyze your findings to respond to the following questions and statements:

    a. Which item(s) was/were the most water repellant?
    b. Which item(s) was/were the most absorbent?
    c. Describe your observations of the most water-repellant items.
    d. Describe your observations of the most absorbent items.
    e. Compare your predictions with the results. How accurate were your predictions? Describe.

5. Participate in a class discussion of your findings and conclusions.

6. Turn in your completed lab assignment to the instructor.

Water Repellency Experiment

Outdoor wear or use items for use in the water-repellency observation:

1. Five items to include: sweatshirt, backpack, wallet, gloves, umbrella, jacket, tent, tarp, shoes or boots, high-performance parka, pants, or shirt
2. One of the five items should be made of natural fabric (e.g., a cotton sweatshirt or a wool shirt). Other items should be examples of the new water- or sweat-resistant engineered fabric garments and equipment. (Consider borrowing some of the items. Students and colleagues who enjoy the outdoors may wish to volunteer some garments or equipment (e.g., tents, tarps, and backpacks) for the experiment.
3. An option to each team having five items to test is to conduct the experiment as a whole-class task with one team applying the water (and recording their observations) and the other teams observing and recording ratings and descriptions of the effect of water on each garment or item.