

Twists in the Fibres

Introduction

Has anybody in your family bought silk or wool and found later that it was not pure silk or wool? Although we use bags, ropes, clothes, and items made from different fabrics, it is difficult to ascertain the purity of the fabric by touch, texture, or weight alone. A fibre or yarn may look like cotton but it may be synthetic. One cannot trust appearance alone.

Would you like to learn simple ways to identify fibres? In this learning unit, you can explore this through two techniques: burning test and microscopy.

Did you know?

A thread is not a fibre but a bundle of fibres. You can see this in Figure 1.

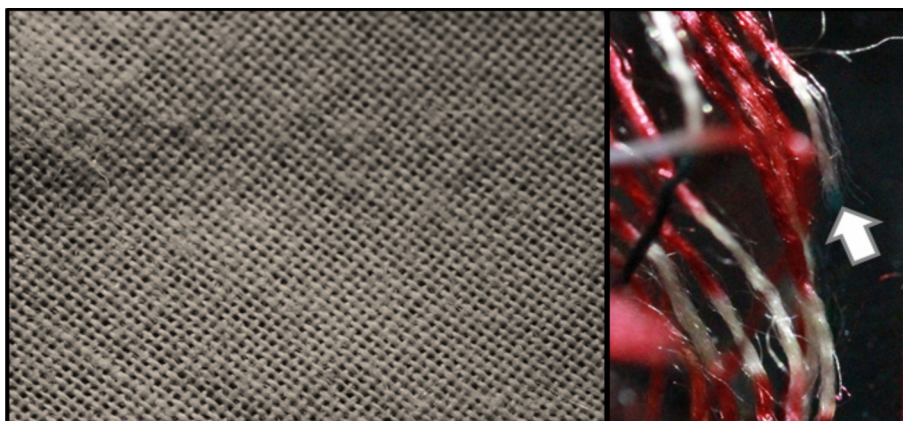


Figure 1: (Left) A cloth is made of threads. (Right) Each thread is made of several fibres (indicated by arrow).

Materials required

- Threads: cotton, polyester (or any other synthetic thread), wool (if you don't get real wool, a broken hair can also be used), and a thread made of unknown fibre. The fibres should be clean, so that any other substance sticking to them does not affect the observations.
- Candle, match stick, beaker, forceps, watch glass, water.
- Microscope, glass slide, and cover slip.

Burning test for fibres

There is a popular saying in Hindi "*Rassi jal gai, par bal nahin gaye.*", meaning "the rope got burnt, but the twists in the rope have remained (in the form of ash). This is a property of ropes that are made of plant fibres, which on burning produce ash in which twists can still be seen. Figuratively, it also refers to someone's personality traits that did not change even after facing a lot of difficulties in life.

Textile experts across the world have been using burning tests to identify fibres. Plant fibers burn slowly producing ash, which glows for few seconds (known as afterglow) before cooling down. The ash roughly retains the shape of fibres but can be easily crushed to powder.

Animal-based fibres such as silk and wool also burn to give ash but in much lesser quantity. Sometimes they burn producing a small bead which gets crushed easily. Moreover they burn with a very unpleasant odour, similar to that of burning meat.

Synthetic fibres usually burn much faster than plant or animal fibres. When exposed to flame, they melt and then decompose, producing a lot of heat. These do not form any ash

but form a bead which is not easy to crush.

Safety: Be very careful while doing the burning tests. Do not be too close to the flame or the burning fibre and do not throw burnt threads around. Some fibers burn very vigorously and their melts can also cause burns or damage to surrounding objects. Keep water in a watch glass or a container nearby, and put the burnt fibres in the water.

Fibres under microscope

Different fibres have different shapes and surface features that can be seen under a microscope. Depending on the conditions in which the fibre has formed (shape of original plant cell or animal cell(s) and how the fibre was dried), it can have a circular, elongated, or irregular cross section. Cotton fibres, in particular, have a non-circular cross-section due to which the twists in the fibres can be easily observed under a microscope. Plant fibres generally have rough surfaces. In a bundle of natural fibres, fibre thickness may also vary from one fibre to another.

Synthetic fibres usually have circular cross-sections and smooth surfaces because they are formed by passing molten polymer through circular holes, similar to the way noodles are made. Thickness of a synthetic fibre is uniform along the length of a fibre, and is also the same for different fibres in a thread.

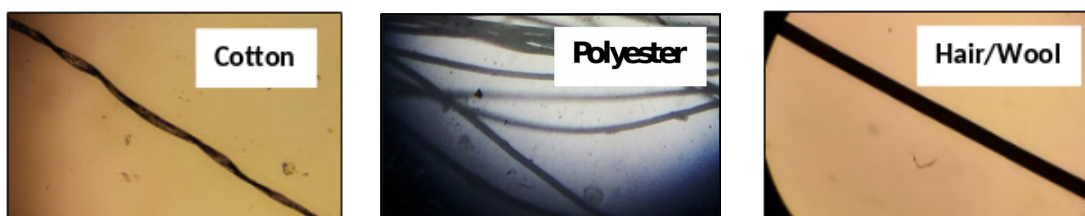


Figure 2: Fibres under microscope

Animal fibres such as wool and silk have circular cross-sections and surfaces smoother than plant fibres but rougher than synthetic fibres. Wool/hair also have scales of the surface (which may not be observed if the wool/hair has been treated with strong bleaches, dyes, or chemicals that damage the hair scales).

However, all fibres on use (even synthetic fibres) usually develop surface roughness due to wear and tear.

Q 1. What differences do you observe between the microscopic images of cotton and polyester fibres in Figure 2? Are there any other different features of these fibres that you can infer from these observations?

Task 1: Known fibres

Take a cotton and a polyester or synthetic thread (like nylon or acrylic).

1. Observe the fibres in each thread with the naked eye. Note their physical properties such as shiny, rough appearance, and if they are smooth or rough to touch.

Fibre	Observations (Shiny/ rough/smooth texture)

2. Take a tray, and fix a candle in the middle of it. Fill the tray slightly with water. Light the candle.

Hold the thread with a pair of forceps or tongs and bring one end of it close to the flame. Note your observations about the thread burning in the following table. Collect the ash/bead formed on a watch glass. [Caution: Keep your head/body parts away from flame as some fibers burn very vigorously. Extinguish flames of any burning fibres in water; do not throw them anywhere else.]

Note the following observations for each fibre.

Sr. No.	Did it melt? (Yes/No)	Any smoke? (Yes/No)	Smell (like burning paper or plastic)	Ash/ Bead formed	Afterglow? (Yes/No)

3. Take some water in a glass. Check if it is acidic or basic with a litmus paper. Add one drop of water to the ash/bead on the watch glass. Wait for 1-2 minutes and check with litmus papers (red and blue), a drop of phenolphthalein solution, or a pinch of turmeric. Has the water become acidic or basic on contact with the ash/bead? Note: Ash or bead will not completely dissolve in water; some solid will remain in both cases.

Sr. No.	Thread burnt	Ash + Water (Neutral/Basic/Acidic)

4. Now observe the thread under a microscope as described below. (Did you know that Antonie van Leeuwenhoek was a cloth merchant and had invented the microscope to observe fibres?).

A thread usually has several fibres bundled together. Using a pin or forceps, loosen out the fibres in a thread and pull out a fibre. Put the fibre on a glass slide and cover it with a cover slip. Observe it under 10X objective. If you are not able to focus on the fibre, make sure that the fibre is under the objective lens and while focusing, the distance between the lens tip and the cover-slip is around 0.5 cm.

Note the features of the fibre. Next put 3-4 fibres together on the slide and observe the variation in the thickness of different fibres.



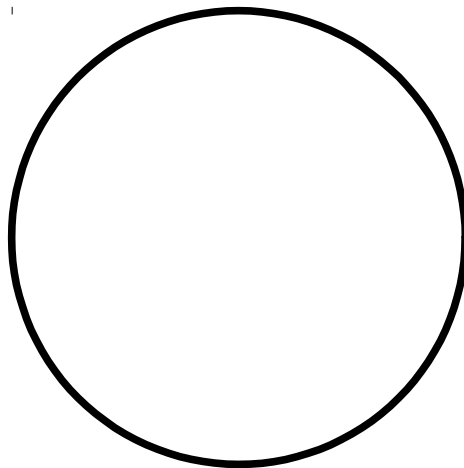
Q 2. Is the fibre that you observe uniform in thickness along the length or is the thickness different at middle and ends of the fibre (To see this, you may have to move the slide on the stage to see it from one end to another end)?

Q 3. Do you observe twists in the cotton fibres? _____

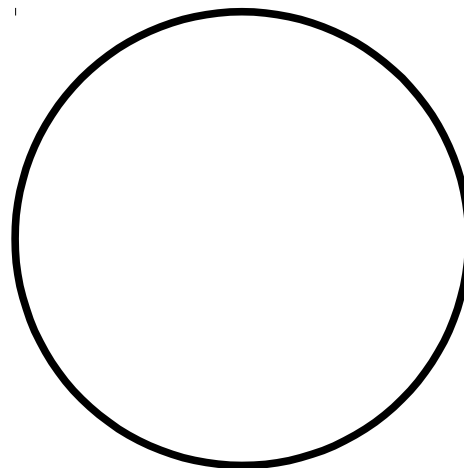
Q 4. Do you observe folds in the cotton fibre? _____

Q 5. What can you say about the thickness of various fibres? _____

Now sketch the shape of the fibre observed under microscope, and write its features:



Cotton
Magnification _____X



Polyester
Magnification _____X

Fibre	Fibre description (straight or twisted, transparent or opaque, uniform or variable thickness along length)	Are all the fibres same or different in shape?
Cotton		
Polyester		

See the sketches done by your classmates and copy here at least one different sketch of cotton and polyester as drawn by one of your classmates .

Cotton:	Polyester:
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Q 6. Based on your observations, what features/properties can you conclude about the features of cotton (a plant-based fibre), and polyester (a synthetic fibre).

Q 7. Why do you think the ash obtained from burning cotton changes the (acidic/basic) nature of water, and the bead from polyester did not?

Task 2: Wool/hair (animal fibre)

Take a woollen thread or human hair (because real wool is also the hair of some animal) and perform the following steps.

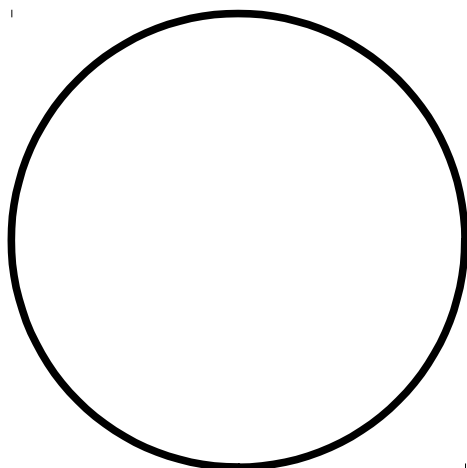
1. By burning test as done in Task 1, check if it is natural or synthetic.
(If it is synthetic, then try finding a real wool/hair sample.)

How did it melt (smell, smoke, afterglow, ash/bead formed?)

Ash/bead + water: Acidic or basic or neutral?

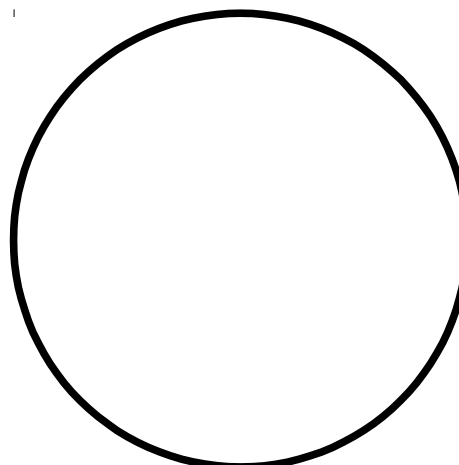
Crushable?

2. Separate fibres out of the thread, as done in Task 1 and observe the fibres under microscope.



Fibre: _____

Magnification ____X



Fibre: _____

Magnification ____X

Fibre description (straight or twisted, transparent or opaque, uniform or variable thickness along length)

Are all fibres same or different in shape?

The science behind the burning tests

Now that you have done some burning tests, let us try to understand why plant-based, animal-based, and synthetic fibres burn differently.

- Plant-based fibres (cotton, linen, hemp, sugarcane, jute) have high amount of cellulose which burns easily. However, these also have some amount of silica and metals (~0.1-0.6% by mass) which lead to ash formation (~0.5 - 1.2% by mass). These fibres burn slowly with a flame. When the flame goes off, the remaining silica and metal compounds glow red like burning coal. As the burnt fibre/ash cools down, the afterglow disappears and

fine ash is obtained.

- Synthetic fibres usually do not have silica or metals. These are often produced from polymers made of non-metallic elements such as carbon, nitrogen, oxygen, and hydrogen. These fibres have low melting temperatures. Therefore when exposed to flame, these melt and then decompose. Burning a synthetic fibre produces a lot of heat but may or may not form smoke (Smoke formation depends on percentage of carbon in the polymer. If carbon percentage is high, then all of carbon is not able to get enough oxygen to form carbon dioxide, and hence particles of unburnt carbon and related substances are formed which become smoke).
- Animal-based fibres (wool, silk) are predominantly made of proteins (such as keratins) which burn with a very unpleasant smell, similar to obtain from burning of other proteins such as meat.

Task 3: Unknown fibre

1. Take a thread of unknown material. By observing this thread with the naked eye, guess if it is a natural or a synthetic fibre.

Sr. No.	Observations	Natural/Synthetic

2. Conduct the burning test for the thread as done in Task 1, identify if it is natural or synthetic. [Remember the precautions of keeping your head/body parts away from flame as some fibers burn very vigorously. Extinguish flames of any burning fibers in water; do not throw them anywhere else.]
3. Separate the fibres out of the thread, as done in Task 1, and observe the fibres under a microscope.

Sketch	Describe a single fibre	Variation in a bunch of fibres

Note: Do check if the thread you have is not mixed (i.e., if it consists of more than one kind of fibres) and hence may give properties of both kinds of fibre, such as giving both ash and bead on burning.

Based on the above tests, try to identify the fibre: The observed fibre is

_____ because _____

4. Paste/staple a sample of the thread here.

Task 4: Fibres and Society

As a customer, the nature of fibres is important to us. But have you thought about how the livelihoods of millions of people depend on the fibres that we choose to use?

Q 1. For each of the fibres that you identified, list the people who are involved from the production stage of this fibre to the sale of final product (fabric, threads or garments) when you buy them?

Q 2. Do you know of any fibres that are produced in your locality and are used for making textiles, ropes, or any other materials? If yes, briefly describe the process used to prepare the threads from the fibres.

Q 3. Based on what you have learned above, can you say if the wicks for candles and oil lamps can be made using synthetic fibres? Why?

Q 4. Use in wick-making continues to be an important reason for the sale of cotton. Name the professions that depend on the use of cotton in wicks.
