Twists in the Fibres

Have you or your family ever purchased a cloth thinking it to be cotton or wool and later found it to be a synthetic fibre cloth? There are variety of fibres we use in our lives for clothing, making ropes, bags and containers, and cleaning materials. Usually by looks, touch, texture, sense of weight we try to identify them. But sometime we can be easily cheated by just looks. For example, a thread may look like cotton but may be synthetic or it may look synthetic but may be a natural fibre.

Do you think an understanding of material properties and microscopic shape of fibres can help us in their identification? Here we will explore this.

Before that we must remember that threads are not fibres but any thread is made by combining several fibres together. In the pictures of fabric below, you can see bundles of fibres within each thread.

Materials Required

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

Burning Test for Fibres

Careful combustion can be an important way to identify materials. Textile experts have been using burning tests to identify fibres. This identification is based on the following observations:

(i) 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 burnt fibre glows red like burning coal —a phenomena known as afterglow. As the burnt fibre/ash cools down, the afterglow disappears and fine ash is obtained. This ash retains the form or shape of the fibres, a property popular as the 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)".

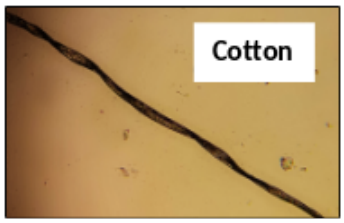
(ii) Synthetic fibres usually do not have silica or metals. These are often produced from polymers made of non-metallic elements such as carbon, nitrogen, oxygen, and hydrogen. These fibres have low melting temperatures. When exposed to flame, they melt and then decompose producing a lot of heat. They do not form any ash, but may form a bead, which is not easily crushable. They may or may not form smoke

(depending on percentage of carbon). The above Hindi saying is not true for synthetic fibres as the shape of the fibre is lost after burning.

(iii) Animal based fibres (wool, silk) are predominantly made of proteins (such as keratins) which burn with a very unpleasant smell, like that of burning meat/flesh. These usually do not leave much of ash, but form a bead which can be easily crushed to fine ash.

Fibres under Microscope

Different fibres have different microscopic shapes and surface features. Depending on the conditions in which fibre has formed, a fibre can have a circular, elongated, or irregular cross section. Cotton fibres, in particular, have non-circular cross-section due to which twists in the fibres can be easily observed in a microscope. Plant fibres, in general also have rough surfaces.



Synthetic fibres are usually circular in cross-section and have very smooth surfaces because they are formed by passing of a molten polymer through circular holes (like noodles are made). Thickness of a synthetic fibre is uniform along the length of a fibre, and is also same for different fibres in a thread. On the other hand, natural fibres may have varying thickness for different fibres in a thread.

Animal fibres such as wool and silk have circular cross-sections and look smooth on surface. Wool/hair may have some scaly appearance on surface. Used fibres (even synthetic fibres) usually develop surface roughness due to wear and tear.

Q 1. What differences do you observe between cotton and polyester fibres in the image above?

Task 1: Known Fibres

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

1. Observe the fibres in each thread with naked eye. Note its physical properties such as shiny, rough texture by looks and if it is smooth or rough by touch.

Fibre	Observations (Shiny/ rough/smooth texture)

2. Take a tray, and fix a candle in 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. Observe if the thread catch fire, it melts, there is any foul smell, or if there is ash formation, any afterglow or a bead is formed. Collect the ash/bead formed on a watch glass.

Safety: Be very careful while doing this activity. Do not be too close to the flame or burning fiber and do not throw burnt threads anywhere. Some fibers may burn very vigorously and their melts can also cause burns or damage to surrounding objects. Keep a watch glass or a container having water in it and put the burnt fibers in this water.

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. Add one drop of water to ash/bead on the watch glass. Wait for 1-2 minutes and check with a litmus papers (red and blue), or a drop of phenolphthalein solution, or a pinch of turmeric. Find if this water has become acidic or basic on contact with the ash/bead (Ash or bead will not completely dissolve in water).

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 seller and had discovered microscope to observe fibres only).

Pull out a fibre from the cotton thread. A thread usually has several fibres bundled together. So using a pin or forceps, loosen out the fibres in a thread. Put the fibre on a glass slide and cover it with a cover slip. Observe it under 10 X 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 lens tip and the cover-slip is~ 0.5 cm).

Note the features of the fibres. Then, put 3-4 fibres together on the slide and observe variation in thickness between different fibres.

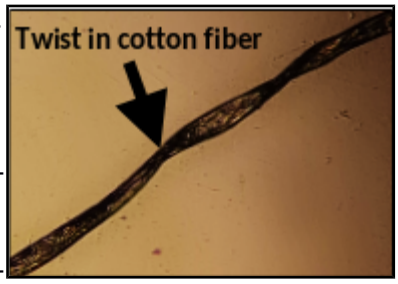
Q 2. Are they uniform in thickness along length or it is different across the length?

_____

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

Q 4. Do observe fold in the cotton fibre? _____

Q 5. Is the thickness of fibres same in all the fibres? _____



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

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

See sketches of your classmates and copy here at least one different sketches of cotton and polyester drawn by your classmate in their sheets.

Cotton:	Polyster:

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 did ash obtained from burning cotton change the (acidic/basic) nature of water, and bead from polyester did not?

_____

_____

_____

_____

Task 2: Wool/hair (Animal Fibre)

Take a woolen thread or human hair (because real wool is also 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.

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

Task 3: Unknown Fibre

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

Sr. No.	Observations	Natural/Synthetic

2. By burning test as done in Task 1, identify if it is natural or synthetic.

3. Separate fibres out of the thread, as done in Task 1 and observe the fibres under 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 how the livelihoods of millions of people depend on the fibres that we choose to use.

Q 1. For each of the fibres you identified, list the people who are involved in production of this fibre till you purchase the fibres or clothes made of those fibres?

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 tell if wicks for candles and oil lamps can be made using synthetic fibres? Why?

Q 4. Use in wicks continues to be an important reason for sale of cotton. Name the professions which depends on use of cotton in wicks?