Synthetic Fibres and Plastics

Synthetic Fibres

The clothes we wear and the furnishings we use are all made up of fabrics, which are obtained from natural or artificial sources. While cotton and jute fibres are obtained from plants, silk and wool are obtained from animals.

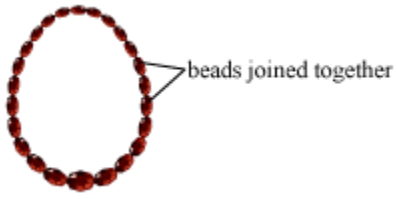
Apart from these fibres, nowadays many other fibres are being used for various purposes. **Can you name some of them?**

Different types of fibres are used to produce a wide variety of household goods. Natural fibres have been in use since a long time. Although, they are manufactured and used on a large scale even now, they have some drawbacks. Natural fibres are more prone to moth attacks. Fibres like cotton and jute get wrinkled easily, while silk and wool require delicate handling. To overcome these problems, artificial fibres such as Rayon, Nylon, Polyester, Acrylic etc. are being manufactured by various processes. These fibres are called **synthetic, man-made**, or **artificial** fibres.

The following table lists some articles and the type of fibre used in their manufacture.

Article	**Type of fibre used in manufacture**
Toothbrush bristles	Artificial
Ropes	Artificial
Sweaters	Natural
Towels	Natural

Do you know what synthetic fibres are made up of?



You must have seen a necklace made of beads. The necklace is made up of small beads, which are arranged together to form the necklace with the help of a thread.

Similarly, a synthetic fibre is made up of small units that are joined together (like the pattern in a necklace). Each small unit is a chemical compound. These small units join together to form a single large unit called **polymer.** Polyester fibres are made up of repeating units of chemical substances called **esters**.

The word **Polymer** comes from two Greek words; *poly* meaning 'many' and *meros* meaning 'parts'. Thus, a polymer is made up of many repeating units.

Did you know that even natural fibres are polymers? Cellulose is a naturally occurring polymer found in the cell wall of all plant cells. It is made up of glucose units. Cotton is a cellulosic fibre.

Synthetic polymers: They are classified as follows:

Addition polymers: In such polymers several small units called monomers combine together to form a giant molecule known as the polymer. No molecule is eliminated during formation of addition polymers. Examples of addition polymer are polythene, polyvinyl chloride etc.

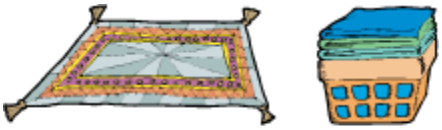
Condensation polymers: In such polymers several small units of monomers combine with each other, along with elimination of simple molecule like water to form polymer unit. Examples of condensation polymer are nylon-66, terylene etc.

In the table given below are listed some of the polymers with their monomers:

S.No	Monomer	Polymer	Type of polymer
1	Ethene	Polyethene	Addition
2	Caprolactum	Nylon-6	Condensation
3	Esters	Polyesters	Condensation
4	Vinyl chloride	Polyvinyl chloride	Addition
5	Tetrafluoroethane	Teflon	Addition
6	Chloroprene	Neoprene	Addition
7	Ethylene chloride and sodium polysulphide	Thiokol	Condensation

Properties And Uses Of Rayon

You must have seen carpets and clothes made up of artificial silk. **Do you know what artificial silk is?**



Uses of Rayon fibre

Silk is obtained from the cocoon of silk worms. A number of steps are involved in obtaining silk from silk worms. Thus, natural silk is quite expensive. Also, silk is a very delicate fibre, which requires delicate handling and a lot of care. For this reason, attempts were made by scientists to make something equally beautiful. Their attempts bore fruit at the end of the nineteenth century, when they obtained rayon, having similar properties as silk. Hence, rayon is commercially known as **Artificial Silk** or **Art Silk.** It is cheaper, resistant to moths, and does not require delicate handling. Due to these properties, rayon has become a very popular fabric.

Do you know how Rayon is obtained?

Rayon is obtained by the chemical treatment of wood pulp. Wood pulp is a natural raw material, but since it has to undergo various chemical processes, rayon is considered as a **man-made** or **synthetic** fibre.

Rayon is a manufactured and regenerated cellulosic fibre. Cellulose is a structural component of green plants. Cotton is also a cellulosic fibre.

Uses of Rayon

Rayon is a versatile fibre. It has the same comfort properties as silk. However, it is cheaper than silk, making it a material of choice. Rayon can be dyed in a variety of colours; it can be mixed with cotton, wool, and linen to make apparel (e.g. dresses, jackets, suits, ties, etc.) and furnishings (e.g. bed sheets, blankets, carpets, etc.).

Did you know that the Grasim Textiles of India are the world's largest producer of rayon? They have plants in Nagda (M.P), Harihar (Karnataka), and Kharach (Gujarat).

Properties And Uses Of Nylon

Things like toothbrush, socks, ropes, tents, seat belts etc. are used by us in our daily lives. **But do you know what materials are used in making them and what is the nature of the material used-strong, light, or elastic?** All these articles are made up of nylon. Like rayon, nylon is also a man-made or synthetic fibre.

Manufacturing Nylon

Nylon was produced in 1931. Unlike Rayon, which is made using wood pulp, nylon is completely made from petrochemicals. It is prepared from coal, water, and air. Hence, Nylon is regarded as the first fully synthetic fibre.

Do You Know:

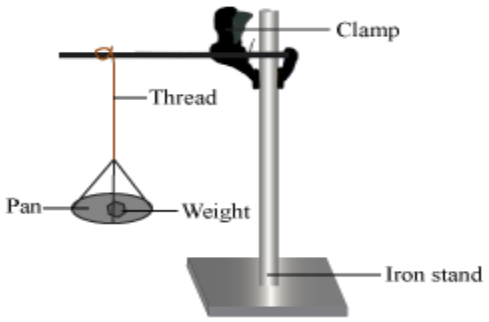
In September 1931, Wallace Carothers (an American chemist) discovered a 'miracle fibre' and named it '**nylon**' or simply '**66**'. The number '**66**' came from each repeat unit of the polymer chain.

Uses of Nylon

Nylon is one of the first synthetic fabric. It is strong, lustrous, and flexible. Nylon is mainly used for manufacturing women hosiery, ropes for mountain climbing, tents, flags, strings of many instruments, squash and tennis racquet strings, heads of drumsticks etc. Though it is soft and lustrous, it is strong enough to be used in making ropes and parachutes. In fact, a nylon thread is stronger than a steel wire. The strength of a nylon thread can be observed by performing the following activity.

Activity:

Take an iron stand with a clamp. Now, take four threads (about 60 cm in length) of different fibres such as cotton, wool, silk, and nylon. These threads are to be tied one by one, so that each one hangs freely. Firstly, a cotton thread is tied, and at the free end, a pan is suspended in air to place the weights in it. Weights are kept one by one in the pan. Note the total weight required to break the threads.



It will be observed that the nylon thread requires the maximum weight to break. This suggests that Nylon is a stronger thread than the other three threads. The increasing order of strength of these threads can be represented as:

Cotton < Wool < Silk < Nylon

Polyester and Acrylic

PET jars and PET bottles have become a part of every household for storing food items. Similarly, wrinkle free fabrics have added a new dimension to the clothing industry.

Have you ever wondered what these Pet bottles, jars, and wrinkle free clothing made up of?

These items are made up of **Polyester.** Like rayon and nylon, polyester is also a man-made fibre. Fabric made from this fibre does not get wrinkled easily. Also, it remains crisp and is easy to wash.

What is Polyester made up of?

Polyester is made up of repeating units of a chemical substance called **ester**. Esters are sweet smelling compounds, which are primarily made of carbon, hydrogen, and oxygen.

Uses of Polyester

Being crisp and easy to wash, polyester is perfect for making clothes. Shirts made from polyester look very fine. Terylene, a kind of polyester, can be drawn into very fine fibres that can be woven easily into yarns.

Most of our outdoor gears like flysheets, tents, ropes etc. are made of polyester. This is because, polyester is hydrophobic in nature, i.e., polyester does not absorb water. Though nylon is comparatively stronger than polyester, the hydrophobic nature of polyester makes it a preferred material of choice for making these products.

Another most commonly used form of polyester is **PET**. It is used for making bottles, jars, wires, films, and many other useful products.

Do You Know:

PET is the abbreviated form of **Polyethylene terephthalate.** In textile applications, PET is simply referred as "polyester". However, PET is also used most often to refer to packaging applications.

Polyester is mixed with other fibres such as cotton and wool to form polycot and polywool respectively. Terrycot is also a mixture of two fibres i.e. terrylene and cotton.

Acrylic

We know that wool is obtained from animals such as sheep and goat. The process involved in obtaining wool is quite expensive. Also, natural wool fibres are delicate and require careful handling. Keeping this in mind, scientists made a fibre that resembled wool in its properties, and called it '**Acrylic'.**

Acrylic is much cheaper than wool. Also, it does not require delicate handing as in the case of wool. Also, acrylic can be easily dyed and is more durable.

The manufacture of polyester and acrylic fibres coined a new '**wash and wear**' era. Electric dryers replaced clotheslines as the 'wash and wear' garments dried quickly and emerged wrinkle free. Ironing began to disappear as a daily activity. The new fabrics were more durable and colour permanent.

MERITS AND DEMERITS OF SYNTHETIC FIBRES

All synthetic fibres are more durable, affordable, and stronger than natural fibres. They are easy to maintain and are available in a wide range of colours and mixed blends.

Synthetic fibres absorb less water and dry quickly. This can be observed by performing the following activity.

Take equal pieces of polyester and cotton fibres. Soak them in different mugs, containing the same amount of water. After a few minutes, take out the pieces and spread them under the sun.

On comparing the volume of water remaining in each mug, it will be observed that the cotton piece has absorbed more water as compared to the polyester cloth. Also, the polyester cloth dries up faster than the cotton piece.

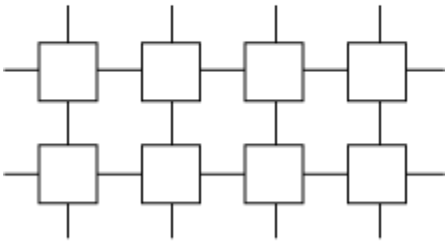
All these qualities make synthetic fibres more popular than natural fibres. However, there are some disadvantages associated with the use of synthetic fibres. We know that synthetic fibres are prepared using petrochemicals. Therefore, they can catch fire easily and stick to the body of the person wearing this fibre, causing severe burns. Hence, it is advisable not to wear synthetic clothes while working in the kitchen, or laboratory, or near any source of fire.

Types Of Plastics

You must have observed a variety of articles available in all shapes and sizes, which are made up of plastic. Bottles, mugs, polythene bags, plastic chairs, clips, handles of kitchen wares, doctor's gloves etc. are all made from plastic.

Plastic, being a polymer, comprises of several small units having different arrangements. While some have a linear arrangement, others have cross linked arrangements as shown below:

(a) Linear arrangement



(b) Cross-linked arrangement

Are all plastics of the same kind or are there different types of plastics, having different properties? Let us see.

Take a normal plastic bottle (made of PVC) and a melamine jar. Add hot water to both. **What do you observe?**

It will be observed that when hot water is poured in the plastic bottle, it gets deformed, while no deformation occurs in case of a melamine jar. Hence, it can be concluded that both PVC and melamine are different forms of plastics.

Plastics can be broadly classified into two categories, depending on their interaction with heat.

Plastics that get deformed easily on heating are known as **thermoplastics**. PVC is an example of such plastics. On the other hand, plastics that once molded cannot be deformed or bent on heating are known as **thermosetting** plastics**.** Melamine is an example of thermosetting plastics.

Do You Know:

There is one more form of polymer known as **Elastomers.** This is a small group of polymers, which can be stretched and deformed at room temperature. Elastic and rubber are examples of elastomers.

Articles made of thermoplastics and thermosetting plastics:

PVC and polythene are two widely used thermoplastics. They are used for manufacturing toys, combs, bottles, and various types of containers. Polythene is mostly used in making the commonly used polythene bags.

The two most common examples of thermosetting plastics are bakelite and melamine. Since these plastics are resistant to heat, bakelite and melamine are largely used in making electrical switches, floor tiles, kitchenware, handles of various utensils etc.

Articles made of thermosetting plastics

Articles made of thermoplastics

Properties And Uses Of Plastic

Most of the things that we use in our daily lives are either made up of plastic or have plastic as one of the components in them. Plastic has become a material of choice because of its extraordinary properties such as less weight, easy handling, lower price, durability, and strength. It is pliable, can be easily formed, and moulded. Also, it comes in an endless range of colours and finishes. Being strong and light in nature, it is preferred over metals in cars, aircrafts, and spacecrafts.

Let us now explore the characteristics of plastic, which are responsible for its popularity and large usage.

- **Plastic is less reactive**

  You must have noticed how an iron nail develops a reddish brown layer on its surface when left in the open for some days. This is because metals are quite reactive and react with air and water easily. Plastics, on the other hand, do not react with air and water. They do not corrode easily. Therefore, they are used to store various kinds of materials, food items and many chemicals. Unlike metals, plastic being non-reactive does not react with the chemicals placed in it.

- **Plastic is inexpensive, light, strong, and durable**

Plastic has replaced metal in the manufacture of several articles such as containers, jars, buckets, mugs, etc. It is light in weight, strong, durable, and can be moulded (and remoulded) into various shapes and sizes. Plastic is generally cheaper than metal. It is widely used in various industries and for making a variety of household articles. Plastic is also used for the storage of various articles.

Plastics are extensively used in health care industry for making syringes, threads for stitching wounds, doctor's gloves, and other such medical instruments. Microwave ovens are coated with a special kind of plastic, which allows the cooking of food without affecting the vessel. The famous non-stick cookwares are made of Teflon, a plastic that is resistant to oil and water.

- **Plastics are poor conductors of heat**

  Let us watch the following animation to understand how this property of plastics makes our lives simpler and safe.

  We know that all synthetic fibres catch fire easily. However, there are some fire resisting plastics such as melamine, which are coated on the uniforms of firemen, to make them flame resistant.

  Plastic And The Environment

  A lot is talked about plastic and its effects on the environment. You must have heard about the idea of banning plastics completely.

  Do you know why efforts are being made to ban plastics? What are its harmful effects on the environment?

  Many difficulties are being faced in the disposal of plastics. Plastic waste keeps on accumulating in the form of polythene bags, which we use for wrapping food items, jars, and containers. Disposal of this waste is a major problem.

  Depending on whether a substance degrades or not when thrown directly in nature, materials are classified as biodegradable and non-biodegradable. A substance that gets decomposed easily by natural processes such as the action of bacteria is known as a **biodegradable** substance, while a substance that does not decompose easily by natural processes is called a **non-biodegradable** substance.

  The following table lists some waste materials along with their nature, based upon the approximate time required for their decomposition.

Type of waste	Approximate time taken for decomposition	Nature of material
Peels of vegetables and fruits, leftover food items etc.	1-2 weeks	Biodegradable
Paper	10-30 days	Biodegradable
Tin, aluminium, and other metal cans	100-500 years	Non-biodegradable
Plastic bags	Several years	Non-biodegradable

As listed in the table, plastic is non-biodegradable because its decomposition is not possible by natural processes. Also, there is no estimated figure of the time required for its decomposition. Such non-biodegradable substances are hazardous for our environment. Though Plastic is an essential part of our day-to-day life, it is very harmful to our environment. It causes environmental pollution. Since natural processes do not decompose plastic easily, burning this waste is an option for its disposal. However, the burning process of plastic (and all other synthetic materials) is quite slow and incomplete as well. Also, the process of burning involves the release of various poisonous gases causing air pollution. Hence, the problem of plastic disposal remains unsolved.

Plastic is also harmful for animals like cows who generally swallow materials such as polythene bags and food wrappers from garbage dumps for food. This plastic material can choke their respiratory tract or form a lining in the stomach, which can even result in their death.

How can this problem be solved?

Attempts are being made to find out an environment friendly method for disposal of plastic wastes. But for now, the only solution we have to the problem is to avoid the use of plastics as much as possible. We should use bags made of cotton or jute (natural fibres) for shopping than using polythene bags.

However, certain measures have been put in place to check the disposal of plastic. The government has placed separate garbage bins for biodegradable and non-biodegradable

wastes. We should take responsibility for collecting such wastes separately and discarding them properly.

Also, we should be careful in the usage of fibre and follow the **4R** principle, i.e., Reduce, Reuse, Recycle, and Recover**.** Recycling is a good option for the disposal of plastic wastes. Most thermoplastics can be recycled and reused. However, the addition of colouring agents during the recycling process, limits its usage for food storage.

It has been observed that plastics and additives can easily transfer into food. Even a low concentration of these substances can upset reproduction, release, transport, metabolism, binding, action, or elimination of natural hormones in the body responsible for maintaining internal balance and the regulation of developmental processes.

Therefore, we need to act wisely and develop environment friendly habits to obtain a safer and healthier environment.