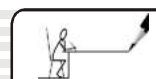


1

SYNTHETIC FIBRES AND PLASTICS

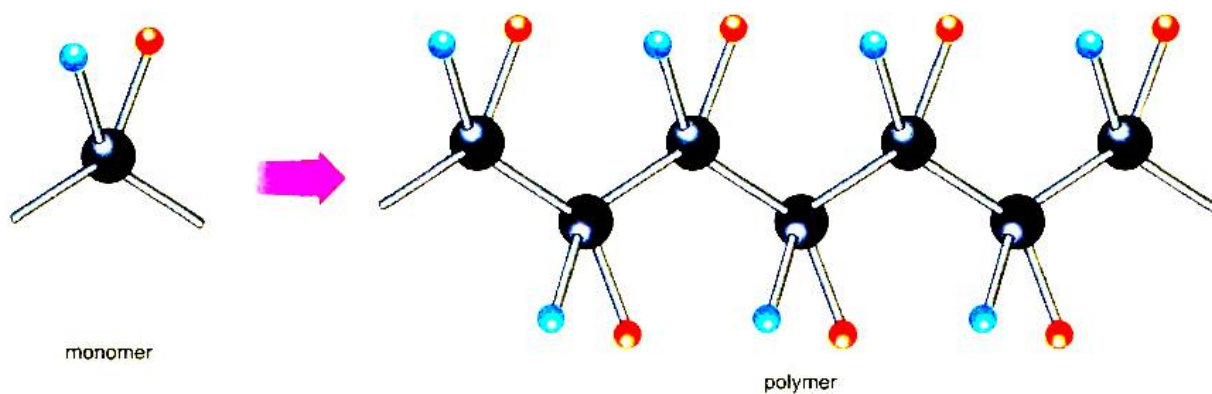


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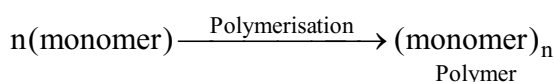
1.1 INTRODUCTION (POLYMERS)

A polymer is a large molecule composed of many repeated subunits, known as monomers. In Greek, *polloi* means 'many' and *meros* means 'part'.

The process by which monomers combine end-to-end to form a polymer is called polymerisation.



Polymerisation



Many of the substances in living organisms are polymers. For example, cellulose is a polymer of glucose, while haemoglobin is formed by amino acids, the building blocks of all proteins.

In order to fulfill his needs, man has been able to develop new materials from the materials already existing. This has become possible through the scientific knowledge and development of technology that has been achieved over the years. Scarcity and drawbacks of traditional natural materials has spurred development of new man made materials.

In this chapter, we will study synthetic fibres and plastics which, are polymers.

1.2 FIBRES

A **fibre** is a kind of thread which is strong and flexible enough to make clothes, nets, ropes, shirts, sarees, curtains, bedcover, towels, bags, etc. All these clothing materials are called **fabrics** and are woven out of fibres. Fibres are used for making a large variety of household articles.

Here is a quick glance at some of the terms and steps associated with fabrics.

1.2.1 Types of Fibres

Fibres may be of three types

- (1) Natural Fibres (2) Synthetic fibres (3) Semi synthetic fibres

1. Natural fibres: Fibres obtained from plants and animals are known as natural fibres. Natural fibres are usually short fibres.

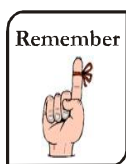
Example: Wool, cotton, silk (it can be obtained up to 1 km length), jute.

Table : Natural Fibres and their Sources

S.No.	Natural	Sources
1	Cotton	From the fruit of cotton plant
2	Linen	From the stem of flax plant
3	Hemp	From the stems of the marijuana plant
4	Jute	From the stem of the jute plant
5	Wool	From the soft hair of sheep, goat, rabbit and camel
6	Silk	From the cocoon of the silkworm

2. Synthetic fibres / Man made fibres : Fibres synthesized by human being are known as synthetic fibres. Synthetic fibres are continuous filament fibres.

Example : Nylon, Polyester, Acrylic, Spandex, etc.



All synthetic fibres are prepared from raw materials of petroleum origin called 'petrochemicals'.

3. Semi synthetic fibres: Modified natural fibres are known as semi-synthetic fibres.

Example: Rayon or Viscose.

Synthetic fibres are used for making clothes and many other useful things. They may be entirely synthetic or semisynthetic. Semisynthetic fibres, like rayons, are made by using natural polymers as the starting material. On the other hand, purely synthetic fibres are made from chemicals. Polyesters, nylons and acrylics are purely synthetic fibres.

(A) RAYON OR ARTIFICIAL SILK

Rayon is the first man-made (semi-synthetic) fibre. It is composed of regenerated cellulose, a component of green plants.

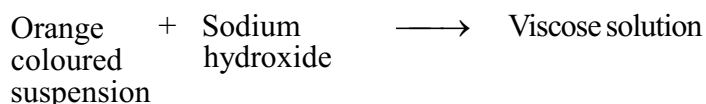
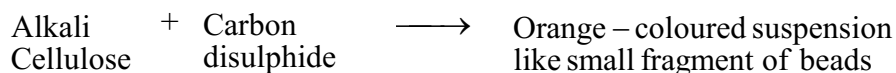
The artificial silk prepared from cellulose is called **rayon**. Rayon resembles silk in appearance, texture, shine and hence also called **artificial silk**. There are several varieties of rayon. Rayon is obtained from a natural source like wood pulp.

The process of making it in Europe is known as **viscose process**. The rayon thus obtained is known as **viscose** in Europe.

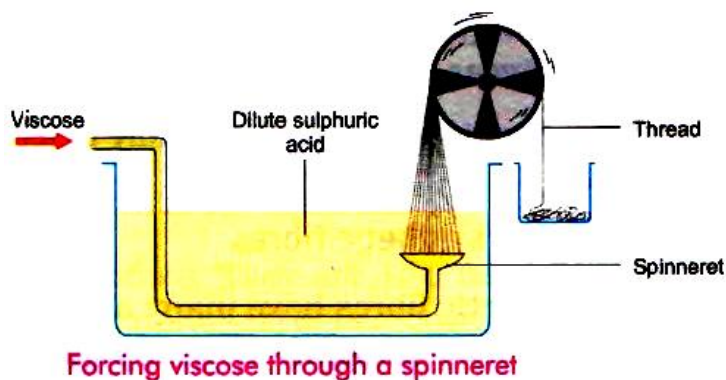
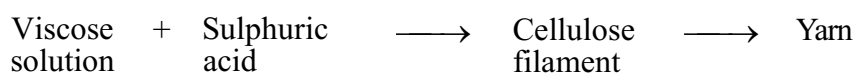
They are available in three different varieties Viscose, cuprammonium (or cupro) and acetate rayons.

Preparation of Rayon:

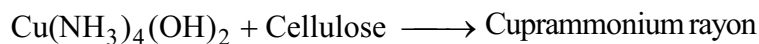
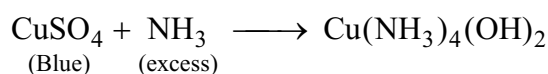
1. **Viscose Rayon :** The raw material for the preparation of rayon is wood. Wood is changed into wood pulp. The wood pulp is changed into a viscous solution, known as viscose, with the help of chemicals.



The viscose solution is then passed through the fine holes of a shower head of a spinneret into an acid bath. Finally, these cellulose filaments are spun into rayon yarn .

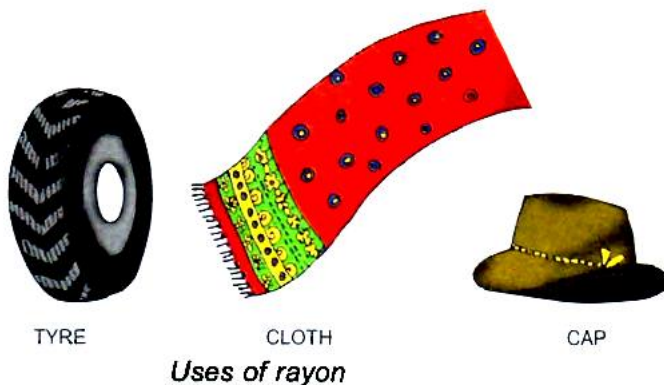


2. **Cuprammonium rayon (or cupro) :** A copper sulphate solution (blue), on treatment with an excess of an ammonia solution, gives a deep blue solution of a compound, cuprammonium hydroxide. Cellulose is dissolved in this solution. The resulting solution is forced through spinnerets into an acid bath to give the filaments of cuprammonium rayon.



3. **Acetate rayon :** In this case, cellulose is dissolved in a mixture of acetic acid, sulphuric acid and some other chemicals. The solution is forced through spinnerets to obtain filaments of acetate rayon.

- **Properties :**
- The fibres of rayon are long, smooth and shiny.
 - It sheds dirt easily.
 - It is a good conductor of heat and cool to wear. It does not melt.
 - It has tendency to absorb moisture. Because of its tendency to absorb moisture, rayon can absorb sweat. Therefore, it is generally preferred over other synthetic fabrics in summer.
 - It is shiny and lustrous and resembles to silk in appearance. So, it is also called artificial silk.
 - It wrinkles easily and may stretch or shrink when washed.
- **Uses :**
- It is used in the manufacturing of fabrics for sarees.
 - It is used for making dresses, aprons and caps, when mixed with cotton (50% – 50%)



- It is used in medical field for making gauze (for making bandages) and lint (for dressing wounds).
- It is used for making tyre cord.
- It is used for making carpets, when mixed with wool.

(B) NYLON (POLYAMIDE)

- Nylon is a fully synthetic polymer developed simultaneously in 1931 in New York and London. (Name is derived from the names of these two cities.) It was prepared from coal, water and air.
 - Nylon 6 and nylon 6, 6 are the most important fibres of this class. Nylon 6 is made of an organic compound which contains six carbon atoms. Nylon 6, 6 is made of a more complicated monomer.
- **Properties :**
- Chemically nylon is a polyamide like that of natural silk but these fibres are strong, tough, hard and water resistant.
 - It is elastic and so does not lose strength even after repeated use.
 - It is light synthetic fabrics. It is lustrous and easy to wash.

- **Uses :**
- It is used in making sarees, socks, stockings etc.
 - It is blended with wool to increase the strength of wool.
 - It is used for making tents, umbrellas, parachutes and tarpaulins.
 - It's fibers are used for making tooth brush bristles.
 - Due to their high strength and elasticity, nylon threads are used to make fishing nets, climbing ropes, seat belts, sleeping bags and strings in badminton and tennis racquets.

(C) **POLYESTERS**

It is made of repeating units of a chemical called ester, which has fruit like smell. Polyester made from petroleum products.

➤ **Properties :**

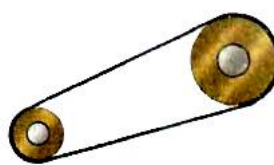
- It is strong and wrinkle resistant.
- It retains creases.
- It is not attacked by moths and moulds.
- It absorbs very little water, so clothes dry out quickly.
- It is not so elastic and is, therefore, unsuitable for stockings.
- It is quite resistant to the action of chemicals.

➤ **Uses :**

- It is widely used for making fabrics for suits, jackets, shirts, trousers, sarees and other dress materials.
- It is used for making sails for boats.
- It is used for making protective clothing for the workers in chemical industries.
- It is used for making fire hoses and conveyor belts.
- PET is used for making bottles, utensils, films, wires, etc.



CLOTHES



CONVEYOR BELT



SAIL

Uses of terylene

BLENDED FIBRE : Mixing of two different fibres results in the formation of blended fibres. More often, a synthetic fibre is mixed with a natural fibre. Two similar fibres, for example, both natural fibres, may also be mixed to form blended fibre.

Table : Examples of blended fibres:

Fibres	Blended fibres
Polyester and cotton	Polycot
Polyester and wool	Terry wool
Cotton and wool	Cotswool

These blends :

- are less lustrous than pure synthetic fibres,
- are more comfortable as they absorb sweat,
- have heat-setting properties,
- develop less electrical charge on them (so cause less irritation of skin) than synthetic fibres do, and
- are more durable than natural fibres.

(D) TERRYWOOL & TERRYCOT

- **Terrywool**, a blend of Terylene (a type of polyester) and wool is used for making suits.
- **Terrycot**, a blend of Terylene and cotton is commonly used for making skirts, shirts and other dress materials.
- It is light weight and strong. This property makes it suitable for making light weight sails.
- Terylene is used for making conveyor belts as it is very elastic.
- Polyester films (commonly known as mylar) are also used for making magnetic recording tapes in audio cassettes, video cassettes and floppy discs.
- Terylene is also called Dacron or Mylar.

(E) ACRYLICS / ORLON / ACRILAN

Acrylic fibres are a substitute for natural wool. These polymers decompose without melting. So, they are dissolved in a suitable solvent and the solution is forced through spinnerets to obtain filaments. The filaments can be cut into staples and the staples spun into yarns.

Acrylic fibre is obtained by the polymerisation of **acrylonitrile** monomer. The clothes made from this fibre are relatively cheap and are available in a variety of colours. It resembles closely with wool in its properties.

Some of the well-known acrylic fibres are **orlon**, **acrilon** and **cashmilon**.

➤ **Properties :**

- Acrylic fibres are crimped (i.e., wavy) and not straight like polyester or nylon fibres. So acrylic yarns appear to be bulky and compete with wool.
- It is warm, soft, light and flexible fibre. Acrylic yarn can be easily knitted. It is cheaper than natural wool.
- Acrylic fibres are not easily acted upon by moisture, chemicals or bacteria.

➤ **Uses :**

- Acrylic fabric is used for making sweaters, socks and shawls.
- It is used for making carpets and blankets.

(F) SPANDEX / LYCRA

These fabrics have excellent elasticity. The high elasticity of these fabrics make them suitable for use in clothes that require snug fitting, for example swimming costumes, T-shirts and caps.

1.2.2 Advantages and Disadvantages of synthetic fabrics

➤ Advantages :

Synthetic fibres have many advantages over natural fibres.

1. Synthetic fibres do not depend either on an agricultural crop as cotton, flax and jute do, or on animal farming as silk and wool do.
2. The fabrics made of synthetic fibres like polyester and nylon are easily heat-set, i.e., they retain the fold or pleat made on them by ironing even after washing. Thus it is easier to maintain clothes made of synthetic fibres than those made of natural fibres.
3. Synthetic fibres are much stronger, and hence more durable than natural fibres. They dry easily and have faster colours.
4. Synthetic fibres are not easily acted upon by moisture, chemicals or bacteria.
5. They are generally cheaper than natural fibres .
6. Can handle heavy loads without breaking (high tensile strength).

➤ Disadvantages :

Synthetic fibres suffer from the following disadvantages.

1. Clothes made of pure synthetic fibres are garishly lustrous.
2. Synthetic fibres melt before burning. So clothes made of such fibres stick to the skin when in contact with a flame, causing burns. Therefore, they should not be worn in the kitchen or while setting off fireworks.
3. Synthetic fibres are generally **hydrophobic**, i.e., they repel moisture (e.g., sweat) and do not absorb it. They also do not allow enough circulation of air . So clothes made of synthetic fibres are not comfortable to wear as they do not allow sweat to evaporate easily. Natural fibres are **hydrophilic**, i.e., they absorb moisture. They also allow the circulation of air. Therefore, clothes made of natural fibres are comfortable to wear as they allow sweat to evaporate.
4. Some electrical charge accumulates on synthetic fibres due to which they cling together as well as to the skin. The electrical charge irritates the skin.

1.3 PLASTIC

Plastics are synthetic materials that can be moulded into a permanent shape.

They can be moulded into different shapes, this property is known as **plasticity**. They are not generally attacked by chemicals.

1.3.1 Types of Plastic

(A) ON BASIS OF STRUCTURE THEY ARE CLASSIFIED AS :

- (i) **Linear plastics** : The monomer units are joined together to form long straight chains of polymer molecules. These chains are stacked over one another to give a well packed structure. **e.g.** HDPE, PVC, polythene ,etc.



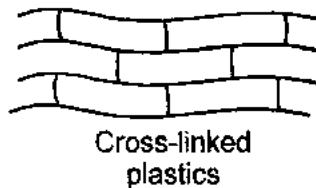
Linear plastic

- (ii) **Branched chain plastics** : The monomer units not only combine to produce the linear chain but also form branches of different length along the main chain. **e.g.** LDPE, etc.

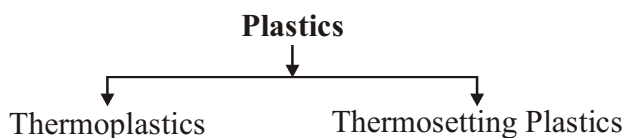


Branched chain .
plastic

- (iii) **Cross-linked or three dimensional network plastics** : The initially formed linear polymer chains are joined together to form a three -dimensional network structure. These polymers are hard and rigid. e.g. Bakelite, melamine-formaldehyde etc.



(B) **ON THE BASIS OF THEIR BEHAVIOUR TO HEAT :**



- (i) **Thermoplastics** retain their plasticity even after repeated heating and cooling. So they can be moulded over and over again.
- Plastics which get deformed easily on heating and can be bent easily are known as Thermoplastics. Polythene and PVC are some examples of thermoplastics. These are used for manufacturing toys, combs and various types of containers
 - Polythene (poly + ethene) is a plastic which is used for making commonly used polythene bags.
- (ii) **Thermosetting plastics**, once set after being melted, cannot be moulded again.
- Plastics which when moulded once cannot be softened by heating are called Thermosetting plastics. **Bakelite** and **Melanine** are the examples of Thermosetting plastics.

1.3.2 Some Common Thermoplastics and their Uses

- (A) **Polythene (or Polyethylene)** : Polythene is obtained by the polymerisation of ethylene monomers. It is a thermoplastic polymer. It is unbreakable, corrosion resistant, tough and flexible. It is resistant to chemical actions by acids, alkalis and other organic solvents. It is an insulator.

➤ **Uses :**

- (i) It is used as a waterproofing material.
- (ii) It is used for making containers and pipes for storing and transporting water, oil and other materials.
- (iii) It is used for making bags and for wrapping food and other eatables.



Polythene bags

(B) Polyvinyl Chloride (PVC) : It is also a thermoplastic. It is obtained by the polymerisation of vinyl chloride. It is tougher than polythene.

➤ **Uses :**

- (i) It is used as insulating covering for electrical wires
- (ii) It is rolled between rollers to produce PVC sheets.
- (iii) It is used for making hand bags, rain coats and floor covering materials and covering for suitcases.



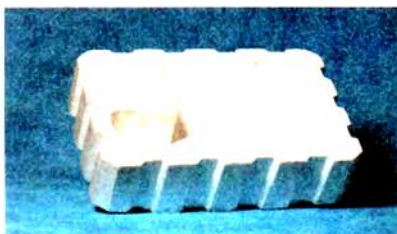
Electric wires are coated with PVC

- (iv) It is used to cover motor car seats and furniture.
- (v) It is used for making gramophone records and refrigerator linings.
- (vi) It is also used for making shoes and shoe soles.

(C) Polystyrene : It is a thermoplastic and is obtained by the polymerisation of styrene monomers. It is one of the cheapest plastics and is lighter than polythene. It is hard and brittle. It can be blown-up into a very large foam containing air bubbles. In this form, it is called **styrofoam** or **thermocole**.

➤ **Uses :**

- (i) It is used as packing material for expensive items such as refrigerators, TVs, cellphones and other fragile objects.



Thermocole used for packing

- (ii) It is used as a thermal insulator in the hollow walls of refrigerators and coolers.
- (iii) It is used for making toys, lamp shades and thermos flasks.

(D) Perspex : Perspex is a substitute for glass. It is transparent and unbreakable.

➤ **Uses**

- (i) It is used for making the windscreens of cars and windows in aircrafts.
- (ii) It is also used in street light fittings and telephones.



Perspex is a transparent plastic

(E) **Polypropylene** : It is a thermoplastic and is obtained by the polymerisation of propene monomer. It is a rigid and tough plastic.

➤ **Uses**

- (i) It is used for making gloves used by surgeons, while they perform operations.
- (ii) It is used for making fishing nets.
- (iii) It is used for making different kinds of brushes.

(F) **Teflon or Polytetrafluoroethylene** : It is a thermoplastic and is a polymer of tetrafluoroethylene. It is one of the best plastic polymers. It has a much higher melting point, very low friction (non-stick) and is quite inert. Its monomer unit is $\text{CF}_2 = \text{CF}_2$

➤ **Uses**

- (i) It is used for making non-stick cookwares.



A non-stick frying pan is coated with teflon

- (ii) It is used as lubricants in ball-bearings, chains, brakes, etc. in bicycles and motor vehicles.
- (iii) It is used as a fabric protector as any liquid spilled on the fabric rolls off its surface and stains are easily released during cleaning.
- (iv) It is also used as a lens coating.
- (v) It is used for coating industrial parts to increase their durability.

1.3.3 Some Common Thermosetting Plastics and their Uses

(A) **Bakelite** : It is a thermosetting polymer. It is made by reacting phenol with formaldehyde in the presence of a catalyst. It is hard, stiff and a good electrical insulator.

➤ **Uses :**

- (i) It is used for making plugs, switches, telephone cases and other electrical fittings.
- (ii) It is used for making radio and television casings.
- (iii) It is used for making handles of tea-kettles, sauce pans and pressure cookers.
- (iv) It is used for making artificial leather.

Note : Bakelite, the first completely synthesized substance. It was created by Leo Baekeland in 1907 in Yonkers, New York.



(a) Handle of pressure cooker



(b) A telephone case

Articles made of thermosetting plastics

- (B) **Melamine** : It is also a thermosetting polymer. It is hard. It resists fire and can tolerate heat better than other plastics.
- **Uses :**
- (i) It is used for making unbreakable dinner ware and decoration pieces.
 - (ii) It is used for making floor tiles.
 - (iii) It is used for making fire proof fabrics, flame resistant.
- **Properties of Plastics**
- They are cheap, light and available in different colours.
 - They are strong, durable and resistant to corrosion.
 - They can be moulded to any shape when hot.
 - They are sensitive towards heat and melt quickly on heating.
 - They are bad conductors of heat and electricity.
 - They may be transparent, translucent or opaque.

1.3.4 Plastic and the Environment

- **Biodegradable** is a material which gets decomposed through natural processes such as action by bacteria and other microbes like fungi.
- **Non-biodegradable** is a material which is not easily decomposed by natural processes.
- **Hazard Related to Plastic** : The problems associated with the excessive use of plastics are given below.
1. Plastic materials when thrown out destroy the natural beauty of a place and provide homes for many pathogens.
 2. Plastic bags choke the drains which results in overflowing of waste water. This provides a good breeding place for mosquitoes.
 3. Plastic bags sometimes eaten by stray animals along with leftover food results in their death (Figure).



Feeding on plastic bags can cause illness in domestic animals

4. Use of recycled plastic bags to keep food items is harmful for health.
5. Burning of plastic releases poisonous gases into the atmosphere causing air pollution.
6. It reduces the percolation of water into the soil and prevents replenishment of groundwater.
7. Dumping of plastic goods in waterbodies poses a threat to aquatic life.
8. It causes soil pollution.

- **Measures to Tackle Plastic Pollution :** The environmental problem caused by plastic has become so alarming that people are advised to use following methods to prevent health hazards.
1. Reduce your dependence on plastic bags and other items made of plastics.
 2. Carry your own cloth bag or jute bag for shopping.
 3. Never burn plastic bags and other plastic items in the open.
 4. Don't throw plastic articles here and there after use.
 5. Say 'No' to plastics to save the future generation.
 6. Keep plastic bags clean and dry for reusing.
 7. Keep separate garbage bins in your home for biodegradable (green bins) and non-biodegradable wastes (blue bins).
 8. Recycle thermoplastic goods for reuse.
 9. Avoid the use of plastic as far as possible.
 10. Use biodegradable plastic instead of non-biodegradable plastic.
 11. Follow and practice the 4-R principle of **reduce, reuse, recycle** and **recover** to minimise environmental pollution.



Monomer	Plastic (Polymers)	Uses
Ethylene glycol and terephthalic acid	PET (Poly Ethylene terephthalate)	Containers for microwave cooking, carbonated beverage bottles and other food containers.
Ethylene or Ethene (C ₂ H ₄)	HDPE (High Density PolyEthylene)	For packaging strong and corrosive household and industrial chemicals like bleaches, acids and liquid detergents.
Vinyl Chloride (CH ₂ = CH – Cl)	PVC (PolyVinyl Chloride)	PVC pipes for sanitary fittings (such as water pipes).
Ethylene or Ethene (C ₂ H ₄)	LDPE (Low Density PolyEthylene)	Polybags, grocery bags and packages of frozen foods and bread.
Propylene or Propene (CH ₂ = CH – CH ₃)	PP (PolyPropylene)	Ketchup bottles, yogurt containers, medicine bottles, automobile battery casings.
Styrene or Vinyl benzene (CH ₂ = CH – C ₆ H ₅)	PS (Polystyrene)	Thermocol, a form of PS, is used for making disposable cups and packaging material for fragile items like computers and televisions.

1.4 RUBBER

Natural rubber is obtained from the latex of the rubber plant. However, rubbers like neoprene, vinyl rubber and poly(butadiene-styrene) are synthesised.

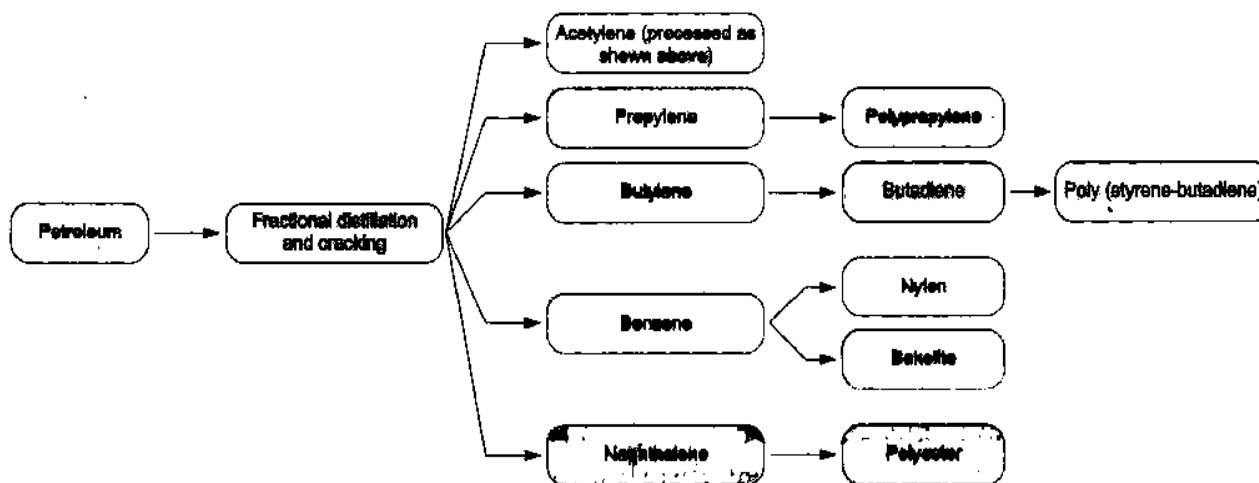
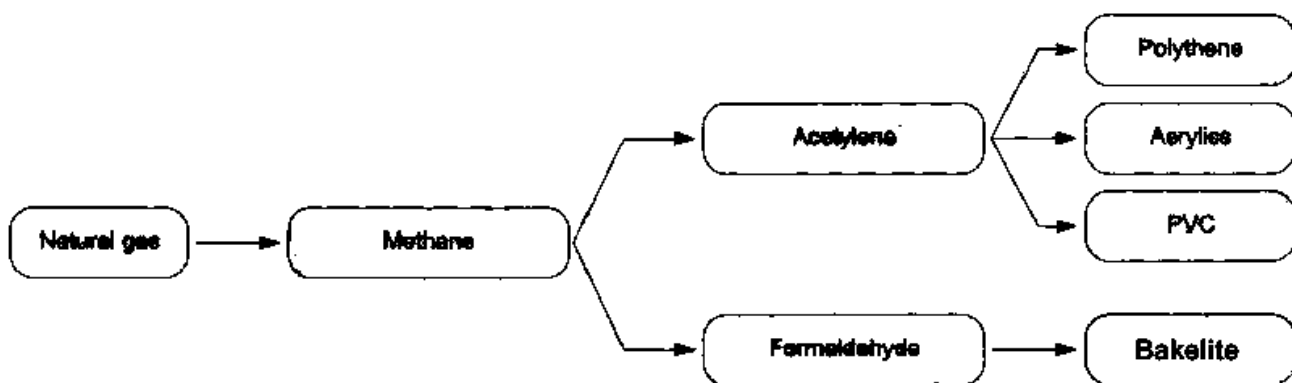
1.5 ADHESIVES AND LUBRICANTS

Previously, we used some plant and animal extracts as adhesives (glue) and lubricants. But now we use synthetic polymers like silicones and epoxy resins for the purpose. Silicones are also used as shoe-shines.

Table : Some common synthetic polymers not used as textiles

Polymer	Used to make
Polythene	Packaging material, carrybags, bottles
Polypropene	Bottles, crates
Polyvinyl chloride (PVC)	Pipes, insulation
Teflon	Nonstick kitchenware
Polystyrene	Foam, Thermocol
Bakelite	Electrical insulation, buttons
Lexan	Bulletproof glass
Melamine	Crockery
Perspex	Windows for cars, trains and aircraft
Vinyl rubber	Rubber, erasers
Neoprene	Rubber
Poly styrene-butadiene	Rubber, bubblegums

Raw materials for synthetic polymers

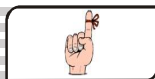


1.6 SOME IMPORTANT PROPERTIES OF SYNTHETIC MATERIAL

1. **Chemical resistance:** Synthetic plastics are hardly affected by strong chemicals such as acids and alkalis. Contrary to it, all natural fibres such as cotton, wool, jute, silk, wood cellulose, etc. are affected by acids and alkalis.
2. **Weather resistance :** Synthetic plastics are non biodegradable, i.e., they do not get affected by weather unlike natural fibres, such as cotton, wool, etc.
3. **Light weight:** Synthetic plastic materials weigh far less as compared to natural fibres materials, such as wool, jute, etc.
4. **Toughness or Tensile strength:** Synthetic plastics can withstand lot of force without getting broken. For example, a thread of synthetic plastic can withstand a lot of weight as compared to a thread of cotton of same thickness.
5. **Insulation:** Synthetic plastic materials are far better for heat and electrical insulation. It is for the same reason that electric wires are covered with plastic insulation rather than cotton or silk insulation.
6. **Appearance:** Synthetic plastic material can be made as transparent as glass. Furthermore, they can be used for making large variety of household products.

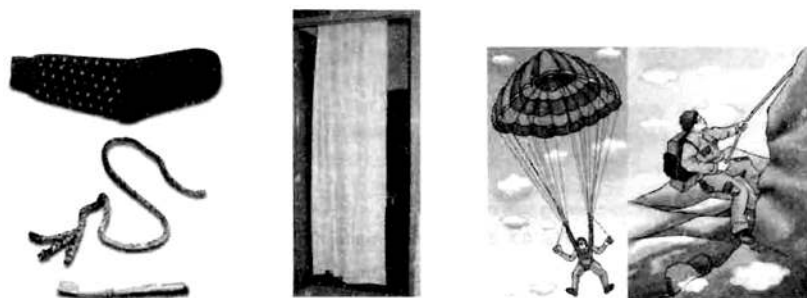
KEY WORDS

- **Synthetic materials** : man-made or manufactured materials.
- **Monomer** : a single unit in a chain of polymer.
- **Polymer** : the product formed by the combination of large number of monomers.
- **Polymerisation** : the process of linking large number of monomers to form polymers.
- **Plastics** : a material which can be easily moulded into various shapes and sizes.
- **Thermoplastic** : plastic that can be moulded upon reheating again and again.
- **Thermosetting** : plastic that can be moulded only once.
- **Nylon** : a polyamide fibre which is strong, elastic and light.
- **Acrylic** : a synthetic fibre obtained by polymerisation of acrylonitrile.
- **Polyethene** : a plastic material obtained by the polymerisation of ethylene.
- **Rayon** : artificial silk man made fiber made from wood pulp.
- **Terylene** : can be drawn into very fine fibres that can be woven like any other yarn.



POINTS TO REMEMBER

- **Fibre :** A fibre is a kind of thread which is strong and flexible enough to woven into fabrics. Fibres are of two types -natural fibres and man-made fibres.
- We get natural fibres either by plants or by animals. Synthetic or man-made fibres are made by various chemical process. These fibres are obtained from coal, petroleum and natural gases.
- Synthetic fibre is a polymer made from the molecules of a monomer joined together to form very long chains. There are four types of synthetic fibres. These are Rayon, Nylon, Polyester and Acrylic.
- **Rayon or Artificial Silk**
 - (i) It is a man-made fibre obtained from a natural source wood pulp.
 - (ii) It can be dyed in a wide variety of colours.
 - (iii) Rayon is mixed with cotton to make bedsheets or mixed with wool to make carpets.
- **Nylon**
 - (i) It was the first fully synthetic fibre. It was prepared from coal water and air.
 - (ii) Nylon fibres are strong elastic and light, lusturous and easy to wash.



Various articles made from nylon

- (iii) It is used to make many items like socks, ropes, tents, toothbrushes, car seat belts, sleeping bags, curtains etc.
 - (iv) Nylon is also used for making parachutes and ropes for rock climbing.
- **Polyester**
 - (i) It remains crisp, wrinkle free and easy to wash, so it is quite suitable for making dressing material.
 - (ii) **Terylene**, can be drawn into very fine fibres that can be woven like any other yarn.
 - (iii) **PET**, is used for making bottles, utensils, films, wires and many other useful products.
 - **Acrylic** is an artificial wool.
 - **Characteristics of Synthetic Fibres :** They dry up soon, are durable, less expensive, readily available and easy to maintain.
 - **Plastics** are polymers having large number of monomers units repeated into long chain.
 - (i) Plastics can be easily moulded into any shape.
 - (ii) Plastics can be recycles, reused, coloured melted, rolled into sheets or made into wires.
 - (iii) Some of the plastic has linear arrangement while some has crosslinked.
 - (iv) **Thermoplastic** is a plastic which gets deformed easily on heating and can be bent easily e.g., Polythene and PVC. These are used for manufacturing toys, combs, carginills and various types of containers.

- (v) **Thermosetting Plastics:** There are some plastics which when moulded once cannot be softened by heating. These are called thermosetting plastics e.g., bakelite and melamine. Bakelite is used for making electrical switches, handles of various utensils etc. Melamine is used for making floor tiles, kitchenware etc.
- Plastics are very useful to us but excessive use of plastic has led to certain environmental hazards.
 - Polythene, PVC, polystyrene, bakelite, perspex and celluloid are some commonly used plastics.
 - **Petrochemicals:** All the synthetic fibres are prepared by a number of processes using raw materials of petroleum origin, called petrochemicals.
 - **Biodegradable:** Materials which get decomposed through natural processes are called biodegradable.
 - **Non-biodegradable:** Those materials which are not easily decomposed by natural process are called non-biodegradable.
 - Follow the 4-R principle of '**Reduce, Reuse, Recycle and Recover**' to prevent plastic pollution.

CONCEPT APPLICATION LEVEL - I [NCERT Questions]

Q.1 Explain why some fibres are called synthetic.

Ans. Some fibres are called synthetic because they are made by human beings.

Q.2 Mark (✓) the correct answer.

Rayon is different from synthetic fibres because

- (a) it has a silk like appearance
- (b) it is obtained from wood pulp
- (c) its fibres can also be woven like those of natural fibres

Ans. (b), It is obtained from wood pulp.

Q.3 Fill in the blanks with appropriate words:

- (a) Synthetic fibres are also called _____ or _____ fibres.
- (b) Synthetic fibres are synthesised from raw material called _____ .
- (c) Like synthetic fibres, plastic is also a _____ .

Ans. (a) artificial, man-made.
 (b) petrochemicals
 (c) artificial sources.

Q.4 Give examples which indicate that nylon fibres are very strong.

Ans. Nylon fibres are used for making parachutes and ropes for rock climbing.

Q.5 Explain why plastic containers are favoured for storing food.

Ans. Three main advantages of using plastic containers for storing food are:
 (i) They do not react with food items.
 (ii) They do not get rusted.
 (iii) They are light, strong and durable.

Q.6 Explain the difference between thermoplastic and thermosetting plastics.

Ans. Thermoplastics can be softened on heating and can be bent easily whereas thermosetting plastics cannot be softened on heating and it breaks when forced to bend.

Q.7 Explain why the following are made of thermosetting plastics.

- (a) Saucepan handles
- (b) Electric plugs / switches / plug boards.

Ans. Above articles are made up of bakelite (a thermosetting plastic) because it is
 (i) poor conductor of electricity
 (ii) heat resistant.

**Q.8 Categorise the materials of the following products into 'can be recycled' and 'cannot be recycled':
*Telephone instruments, plastic toys, cooker handles, carry bags, ball point pens, plastic bowls, plastic covering on electrical wires, plastic chairs, electrical switches.***

Can be recycled	Cannot be recycled
Toys, carry bags, plastic bowls, electric wire covering, plastic chairs.	Telephone instruments, cooker handles, ball point pens, electrical switches.

Q.9 Rana wants to buy shirts for summer. Should he buy cotton shirts or shirts made from synthetic material? Advise Rana, giving your reason.

Ans. The absorbing capacity of synthetic fibres is less than cotton fibres, so the synthetic fabric soaks less water than cotton fabric. In summers we have extensive sweating which must be soaked up by our clothings. Since synthetic fabric is poor in this property we prefer cotton clothes in summers.

Q.10 Give examples to show that plastics are noncorrosive in nature.

Ans. (i) It does not react with the chemical or other items stored in the containers made of it.
(ii) It does not get rusted when exposed to moisture and air.
(iii) It does not decompose when left in open for a long period.

Q.11 Should the handle and bristles of a toothbrush be made of the same material? Explain your answer.

Ans. The bristles of the toothbrush is more flexible than the handle. As per the use of toothbrush, both must made up of different materials.

Q.12 'Avoid plastics as far as possible.' Comment on this advice.

Ans. Since plastic takes several years to decompose, it is not environment friendly. It causes environmental pollution. Besides, when the synthetic material is burnt it takes a long time to get completely burnt. In the process it releases a lot of poisonous fumes into the atmosphere causing air pollution.

Q.13 Match the terms of Column A correctly with the phrases given in Column B.

Column A	Column B
(i) Polyester	(a) Prepared by using wood pulp
(ii) Teflon	(b) Used for making parachutes and stockings
(iii) Rayon	(c) Used to make non-stick cookwares
(iv) Nylon	(d) Fabrics do not wrinkle easily

Ans. (i)-d; (ii)-c; (iii)-a; (iv)-b

Q.14 'Manufacturing synthetic fibres is actually helping conservation of forests.' Comment.

Ans. In the manufacturing of synthetic fibres we use no material from natural sources thus in turn we conserve forests which may otherwise been destroyed. When we use articles made of plastics we also save thousands of trees which otherwise have to be cut if we used articles made of wood or natural fibres.

Q.15 Describe an activity to show that thermoplastic is a poor conductor of electricity.

Ans. A thermoplastic (or plastic) is poor conductor of electricity. It can be shown by using a plastic wire as a connecting wire in a circuit. In this condition the bulb will not glow.

CONCEPT APPLICATION LEVEL - II

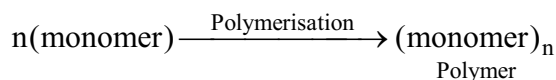
SECTION-A

Q.1 What is polymer? What do you mean by polymerisation?

Ans. A polymer is a large molecule composed of many repeated subunits, known as monomers.

In Greek, *polloi* means 'many' and *meros* means 'part'.

The process by which monomers combine end-to-end to form a polymer is called polymerisation.



Q.2 What are fibers? Explain different type of fibers?

Ans. A **fibre** is a kind of thread which is strong and flexible enough to make clothes, nets, ropes, shirts, sarees, curtains, bedcover, towels, bags, etc. All these clothing materials are called **fabrics** and are woven out of fibres. Fibres are used for making a large variety of household articles.

Fibres may be of three types

(1) Natural Fibres (2) Synthetic fibres (3) Semi synthetic fibres

1. Natural fibres: Fibres obtained from plants and animals are known as natural fibres. Natural fibres are usually short fibres.

Example: Wool, cotton, silk (it can be obtained up to 1 km length), jute.

2. Synthetic fibres / Man made fibres : Fibres synthesized by human being are known as synthetic fibres. Synthetic fibres are continuous filament fibres.

Example : Nylon, Polyester, Acrylic, Spandex, etc.

3. Semi synthetic fibres: Modified natural fibres are known as semi-synthetic fibres.

Example: Rayon or Viscose.

Q.3 What is rayon? Why is it called an artificial silk?

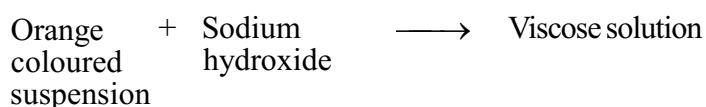
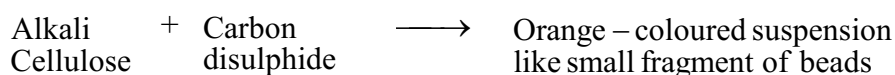
Ans. Rayon is the first man-made (semi-synthetic) fibre. It is composed of regenerated cellulose, a component of green plants.

The artificial silk prepared from cellulose is called **rayon**. Rayon resembles silk in appearance, texture, shine and hence the name **artificial silk**. There are several varieties of rayon. Rayon is obtained from a natural source like wood pulp.

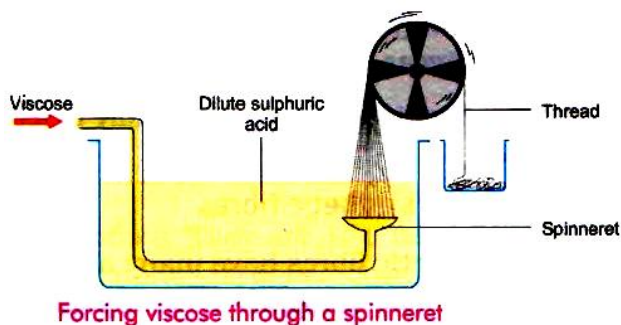
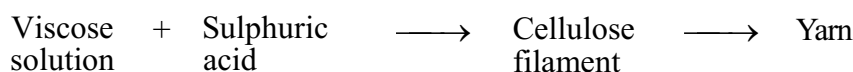
They are available in three different varieties Viscose, cuprammonium (or cupro) and acetate rayons.

Q.4 Describe Preparation of Viscose Rayon.

Ans. Preparation Viscose Rayon : The raw material for the preparation of rayon is wood. Wood is changed into wood pulp. The wood pulp is changed into a viscous solution, known as viscose, with the help of chemicals.



The viscose solution is then passed through the fine holes of a shower head of a spinneret into an acid bath. Finally, these cellulose filaments are spun into rayon yarn.



Q.5 Give two properties and two uses of Rayon?

Ans. Properties :

- It is a good conductor of heat and cool to wear. It does not melt.
- It has tendency to absorb moisture. Because of its tendency to absorb moisture, rayon can absorb sweat. Therefore, it is generally preferred over other synthetic fabrics in summer.

Uses :

- It is used in the manufacturing of fabrics for sarees.
- It is used for making dresses, aprons and caps, when mixed with cotton (50% – 50%)

Q.6 Write properties and uses of Nylon?

Ans. Properties :

- It is very strong and fairly elastic.
- It absorbs very little water, hence dries up rapidly.
- It resists wrinkles and keeps permanent creases.
- It is not attacked by moths and moulds.
- It is fine, light and durable.

Uses :

- Because of its high tensile strength, it is used for making fishing nets, tyre cords, climbing ropes, parachute fabrics, bristles for tooth brushes and paint brushes.
- It is used in the production of textiles like sarees, shirts, neck-ties, socks and other garments.

Q.7 Explain with the help of an activity that nylon thread is stronger than cotton, wool, silk.

Ans. Take an iron stand with a clamp. Take a cotton thread of about 60 cm length. Tie it to the clamp so that it hangs freely from it as shown in figure. At the free end suspend a pan so that weight can be placed in it. Add weight one by one till the thread breaks. Note the total weight required to break the thread. Repeat the same activity with threads of wool, silk and nylon. We observe that more weight is required to break the nylon thread in comparison to other threads. So we can say that nylon is much stronger than other threads.



An iron stand with a thread hanging from the clamp.

Q.8 Why polyester is quite suitable for making dress materials? Name any two types of polyesters and their uses.

Ans. Fabric made from polyester does not get wrinkled easily. It remains crisp and is easy to wash. So, it is quite suitable for making dress material. You must have seen people wearing nice polyester shirts and other dresses. Terylene is a type of popular polyester. It can be drawn into very fine fibres that can be woven like any other yarn.

PET is a very familiar form of polyester. It is used for making bottles, utensils, films, wires and many other useful products.

Q.9 What are polysters and write their properties?

Ans. It is made of repeating units of a chemical called ester which has fruit like smell. Polyester made from petroleum products.

Properties :

- It is strong and wrinkle resistant.
- It retains creases.
- It is not attacked by moths and moulds.
- It absorbs very little water, so clothes dry out quickly.
- It is not so elastic and is, therefore, unsuitable for stockings.
- It is quite resistant to the action of chemicals.

Q.10 Define Blended fibers.

Ans. Mixing of two different fibres results in the formation of **blended fibres**. More often, a synthetic fibre is mixed with a natural fibre. Two similar fibres, for example, both natural fibres, may also be mixed to form blended fabric.

Table : Examples of blended fibres:

Fibres	Blended fibres
Polyester and cotton	Polycot
Polyester and wool	Terry wool
Cotton and wool	Cotswool

These blends :

- are less lustrous than pure synthetic fibres,
- are more comfortable as they absorb sweat,
- have heat-setting properties,
- develop less electrical charge on them (so cause less irritation of the skin) than synthetic fibres do, and
- are more durable than natural fibres.

Q.11 By which material artificial wool is formed? Why artificial wool has become more popular than natural wool?

Ans. Artificial wool is prepared from another type of synthetic fibre called acrylic. The wool obtained from natural sources is quite expensive whereas materials made from acrylic are relatively cheap. They are available in a variety of colours. Synthetic fibres are more durable and affordable which makes them more popular than natural fibres.

Q.12 Give properties and uses of Acrylic fibre?

Ans. **Acrylic fibres** are a substitute for natural wool. These polymers decompose without melting. So, they are dissolved in a suitable solvent and the solution is forced through spinnerets to obtain filaments. The filaments can be cut into staples and the staples spun into yarns.

Acrylic fibre is obtained by the polymerisation of **acrylonitrile** monomer. The clothes made from this fibre are relatively cheap and are available in a variety of colours. It resembles closely with wool in its properties.

Some of the well-known acrylic fibres are **orlon**, **acrilon** and **cashmilon**.

Properties :

- Acrylic fibres are crimped (i.e., wavy) and not straight like polyester or nylon fibres. So acrylic yarns appear to be bulky and compete with wool.
- It is warm, soft, light and flexible fibre. Acrylic yarn can be easily knitted. It is cheaper than natural wool.
- Acrylic fibres are not easily acted upon by moisture, chemicals or bacteria.

Uses :

- Acrylic fabric is used for making sweaters, socks and shawls.
- It is used for making carpets and blankets.

Q.13 What are advantage and disadvantage of Synthetic Fibres?

Ans. Advantages of Synthetic Fibres

1. They are strong and cheaper.
2. They are crease resistant.
3. They are not attacked by moths and moulds.
4. They are easy to wash and maintain.
5. They dry up quickly.
6. They can be dyed in attractive colours and shapes.
7. They are light, durable and easy to maintain.

Disadvantages of Synthetic Fibres

1. They do not allow air to pass freely through them and hence are not good for summer.
2. They do not absorb sweat as well as natural fibres do.
3. They get damaged by high temperature when ironed.
4. They catch fire more easily than cotton or wool.

Q.14 Write some characteristics of synthetic fibres which make them popular dress materials.

Ans. Synthetic fibres possess unique characteristics which make them popular dress materials. They dry up soon, are durable, less expensive, readily available and easy to maintain.

Q.15 Why is it advised not to wear synthetic clothes when working in a laboratory or working with fire in the kitchen?

Ans. The synthetic fibres melt on heating. This is actually a disadvantage with synthetic fibres. If the cloth catches fire it can be very disastrous. The fabric melts and sticks to the body of the person wearing it. It is therefore advised not to wear synthetic clothes while working in a laboratory or working with fire in the kitchen.

Q.16 What is plastic? Why is it used in a variety?

Ans. Plastic is a polymer. The plastic can be moulded in any shape. It can be shaped in any form. Plastic can be recycled, reused, coloured, melted, rolled into sheets or made into wires. That is why it finds such a variety of uses.

Q.17 Why is it convenient to store plastic containers than metals?

Ans. Plastic containers seem most convenient than metal containers. This is because of their light weight, lower price, good strength and easy handling. Being lighter as compared to metals, plastics are used in cars, aircrafts and spacecrafts also.

Q.18 Why are plastics used widely in the industries and household articles?

Ans. Plastic is very light, strong, durable and can be moulded into different shapes and sizes. It is used in various purposes. Plastics are generally cheaper than metals. This is because they are widely used in industries and household articles.

Q.19 Write the uses of plastics in health care industry.

Ans. Plastics find extensive uses in health care industry. Some examples of their uses are the packaging of tablets, threads used for stitching wounds, syringes, doctor's gloves and a number of medical instruments.

Q.20 Write some uses of plastics based on the poor conductivity of heat and electricity.

Ans. Plastics are poor conductors of heat and electricity. That is why electrical wires have plastic covering, and handles of screw drivers are made of plastics. Handles of frying pans are also made of plastics.

Q.21 Describe different type of plastics on the basis of structure.

Ans. On basis of structure they are classified as :

- (i) **Linear plastics :** The monomer units are joined together to form long straight chains of polymer molecules. These chains are stacked over one another to give a well packed structure. **e.g.** HDPE, PVC, polythene ,etc.



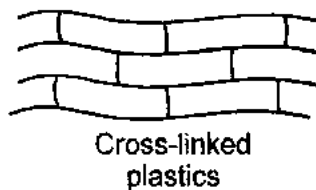
Linear plastic

- (ii) **Branched chain plastics :** The monomer units not only combine to produce the linear chain but also form branches of different length along the main chain. **e.g.** LDPE, etc.



Branched chain plastic

- (iii) **Cross-linked or three dimensional network plastics :** The initially formed linear polymer chains are joined together to form a three -dimensional network structure. These polymers are hard and rigid. e.g. Bakelite, melamine-formaldehyde etc.



Q.22 What are the different properties of plastics?

Ans. Properties of Plastics

- They are cheap, light and available in different colours.
- They are strong, durable and resistant to corrosion.
- They can be moulded to any shape when hot.
- They are sensitive towards heat and melt quickly on heating.
- They are bad conductors of heat and electricity.
- They may be transparent, translucent or opaque.

Q.23 State two uses of PVC.

Ans. Polyvinyl Chloride (PVC) : It is also a thermoplastic. It is obtained by the polymerisation of vinyl chloride. It is tougher than polythene.

Uses :

- (i) It is used as insulating covering for electrical wiring.
- (ii) It is rolled between rollers to produce PVC sheets.
- (iii) It is used for making hand bags, rain coats and floor covering materials and covering for suitcases.
- (iv) It is used to cover motor car seats and furniture.
- (v) It is used for making gramophone records and refrigerator linings.
- (vi) It is also used for making shoes and shoe soles.

Q.24 What are thermoplastics and thermosetting plastics? Give two uses and examples of each.

Ans. Thermoplastics retain their plasticity even after repeated heating and cooling. So they can be moulded over and over again.

- Plastics which get deformed easily on heating and can be bent easily are known as Thermoplastics. Polythene and PVC are some examples of thermoplastics. These are used for manufacturing toys, combs and various types of containers
- Polythene (poly + ethene) is a plastic which is used for making commonly used polythene bags.

Thermosetting plastics, once set after being melted, cannot be moulded again.

- Plastics which when moulded once cannot be softened by heating are called Thermosetting plastics. **Bakelite** and **Melanine** are the examples of Thermosetting plastics.

Q.25 Why are plastics considered as environmental hazards?

Ans. Hazard Related to Plastic : The problems associated with the excessive use of plastics are given below.

1. Plastic materials when thrown out destroy the natural beauty of a place and provide homes for many pathogens.
2. Plastic bags choke the drains which results in overflowing of waste water. This provides a good breeding place for mosquitoes.

3. Plastic bags sometimes eaten by stray animals along with leftover food results in their death.
4. Use of recycled plastic bags to keep food items is harmful for health.
5. Burning of plastic releases poisonous gases into the atmosphere causing air pollution.
6. It reduces the percolation of water into the soil and prevents replenishment of groundwater.
7. Dumping of plastic goods in waterbodies poses a threat to aquatic life.
8. It causes soil pollution.

Q.26 List five steps you would take to reduce the danger of plastic pollution.

Ans. Measures to Tackle Plastic Pollution : The environmental problem caused by plastic has become so alarming that people are advised to use following methods to prevent health hazards.

1. Reduce your dependence on plastic bags and other items made of plastics.
2. Carry your own cloth bag or jute bag for shopping.
3. Never burn plastic bags and other plastic items in the open.
4. Don't throw plastic articles here and there after use.
5. Say 'No' to plastics to save the future generation.
6. Keep plastic bags clean and dry for reusing.
7. Keep separate garbage bins in your home for biodegradable (green bins) and non-biodegradable wastes (blue bins).
8. Recycle thermoplastic goods for reuse.
9. Avoid the use of plastic as far as possible.
10. Use biodegradable plastic instead of non-biodegradable plastic.
11. Follow and practice the 4-R principle of **reduce, reuse, recycle** and **recover** to minimise environmental pollution.

Q.27 What are biodegradable and non-biodegradable materials? Explain with examples.

Ans. Biodegradable material: A material which gets decomposed through natural process, such as action by microorganisms, is called a biodegradable. For examples: paper, leaves, vegetable, fruits, etc.

Non-biodegradable material: A material which is not easily decomposed by natural processes, such as action of microorganisms is called a non-biodegradable material. For examples: Glass, copper, plastics and synthetic fibres, etc.

Q.28 Give two uses of

(i) Polyesterene (ii) Polythene (iii) Teflon

Ans. (i) Use of Polyesterene :

- (a) It is used as packing material for expensive items such as refrigerators, TVs, cellphones and other fragile objects.
- (b) It is used as a thermal insulator in the hollow walls of refrigerators and coolers.

(ii) Use of Polythene :

- (a) It is used as a waterproofing material.
- (b) It is used for making containers and pipes for storing and transporting water, oil and other materials.

(iii) Use of Teflon :

- (i) It is used for making non-stick cookwares.
- (ii) It is used as lubricants in ball-bearings, chains, brakes, etc. in bicycles and motor vehicles.

Q.29 Give some important properties and uses of Bakelite.

Ans. Bakelite : It is a thermosetting polymer. It is made by reacting phenol with formaldehyde in the presence of a catalyst. It is hard, stiff and a good electrical insulator.

Uses :

- (i) It is used for making plugs, switches, telephone cases and other electrical fittings.
- (ii) It is used for making radio and television casings.
- (iii) It is used for making handles of tea-kettles, sauce pans and pressure cookers.
- (iv) It is used for making artificial leather.

Q.30 What are the different properties and uses of Melamine?

Ans. Melamine : It is also a thermosetting polymer. It is hard. It resists fire and can tolerate heat better than other plastics.

Uses :

- (i) It is used for making unbreakable dinner ware and decoration pieces.
- (ii) It is used for making floor tiles.
- (iii) It is used for making fire proof fabrics, flame resistant.

Properties of Plastics

- (i) They are cheap, light and available in different colours.
- (ii) They are strong, durable and resistant to corrosion.
- (iii) They can be moulded to any shape when hot.
- (iv) They are sensitive towards heat and melt quickly on heating.
- (v) They are bad conductors of heat and electricity.
- (vi) They may be transparent, translucent or opaque.

Q.31 Make a table to show various types of wastes, time taken to degenerate and their nature.

Ans.

Types of Waste	Approximate Time taken to Degenerate	Nature of Material
Peels of vegetable and fruit, leftover foodstuff etc.	1 to 2 weeks	Biodegradable
Paper	10 to 30 days	Biodegradable
Cotton cloth	2 to 5 months	Biodegradable
Wood	10 to 15 years	Biodegradable
Woollen clothes	About a year	Biodegradable
Tin, aluminium, and other metal cans.	100 to 500 years	Non-biodegradable
Plastic bags	Several years	Non-biodegradable

Q.32 What is 4R principle?

Ans. 4R stands for:

- (i) Reduce the use of non-biodegradable things.
- (ii) We should use the thing again and again (Reuse).
- (iii) We should use the things which can be recycled (Recycle).
- (iv) Recover the lacking substances.