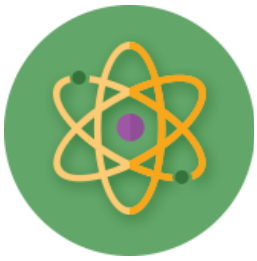
KEY

Synthetic Materials



Glossary

TERM	DEFINITION
synthetic material	*a material made by people that has properties that are different from any material found in nature*
plastic	*a synthetic polymer made using oil and natural gas as the starting materials*
ceramic	**hard, strong and brittle material made by heating substances such as clay and sand; examples are tableware and glass**
steel	*an alloy made from raw iron and carbon in the form of coke*
composite	**material that has two or more materials next to each other; examples are plywood and concrete**
polymer	**material made of long molecules called polymer chains; examples are cellulose, plastic, nylon, and rayon**
alloy	**metallic material made by heating a mixture that has a metal as its main component; examples are steel and bronze**

Objective

In this lesson, you will

describe the properties and uses of synthetic materials and how they affect society.

What Are Synthetic Materials?

Natural Materials

- Used to make: buildings, **clothing**, containers, and **tools**
- Examples include:
  - *stone*
  - **wicker**
  - **wood**
  - **bone**
  - **cotton**
  - **leather**
  - **silk**

Synthetic Materials (human-made materials)

- ○ are ◉ are not available in nature
- we use natural resources to make them
- The four main types of synthetic materials are:
  1. *polymers*
  2. **ceramics**
  3. **alloys**
  4. **composites**

The study of how to develop and process synthetic materials is called **materials science**, a branch of physical science.

Polymers

Polymers are substances with relatively large molecules.

There are two kinds of polymers—

1. Natural polymers:
   - come from living organisms
   - some synthetic materials are made by processing natural polymers

   ⇒ For example: paper products are made from processed cellulose, a natural plant polymer

   ⇒ For example: *rayon is made from processed cellulose*

2. Synthetic polymers can be made by:
   - Polymers that are made from chemical reactions using oil and natural gas (two nonrenewable resources)

   ⇒ For example: plastics and fabrics such as nylon and polyester

There are many reasons we use plastic to make so many items.

Characteristics of plastic:

- ✓ it can be shaped into any form or texture
- ✓ it is lightweight, strong, and durable
- ✓ it repels water, so it can be used outdoors and to wrap food items
- ✓ it is a good insulator, which means it doesn't conduct heat or electricity

  ⇒ For example: Most pans have plastic handles. In electric cords and electronic devices, plastic insulates wires and small circuits and protects people.

- ✓ different kinds of plastic vary in terms of density, flexibility, elasticity, and hardness

  ⇒ For example, we wrap food items with soft, stretchy plastic. Hard, strong plastic is used to make chairs.

- ✓ it has a relatively low cost

Ceramics

Different types of ceramics are used in many items:

⇒ dishes, bricks, tiles, and glass

⇒ *bone and tooth replacements and strong cutting tools*

⇒ ceramic coatings used on metals

★ People make ceramics by heating natural materials such as clay and sand at very high temperatures.

Characteristics of ceramics:

- ✓ Some are the hardest materials in the world.
- ✓ Ceramics are generally light, durable (lasts a long time), brittle (can break or shatter), and often slippery.
- ✓ Some dishes are microwave- and oven-safe because they can withstand high heat.
- ✓ Most are good insulators, so they ○ do ◉ do not conduct heat and electricity.
- ✓ One kind of ceramic is even magnetic, which is a very rare property.

Alloys

Pure metals are very soft. To make a pure metal more useful, we heat it and mix in other elements. This process is called alloying, and the product is a metal alloy.

Characteristics of alloys:

- ✓ harder and less reactive than a pure metal
- ✓ good conductors of heat and electricity

An alloy has:

1. a base metal
2. one or more alloying components, which are metallic or nonmetallic elements that are usually present in very small quantities

Types of Alloys

	Steel	Brass	Bronze
Made of	*Raw iron and carbon, which is heated to remove impurities then mixed with other elements.*	**Copper and zinc are combined to produce brass.**	**Copper and tin are combined to produce bronze.**
Used in	⇒ *construction components* ⇒ *heavy machinery* ⇒ **rails** ⇒ **ships** ⇒ **utensils**	⇒ **plumbing fittings such as pipes, elbows, and faucets** ⇒ *various musical instruments*	⇒ *sculptures* ⇒ **coins** ⇒ **utensils**

Composites

Composites are **combinations** of **different** materials. A composite blends the **desirable** **properties** of each of its components. Sometimes, a composite even has **new** properties not seen in any of its components.

Examples of composites:

- ⇒ Concrete: **a mixture of sand, cement, and other granular additives**
- ⇒ Plywood: **a combination of thin wooden sheets glued together**
- ⇒ Fiberglass: *a combination of plastic and fine glass fibers*

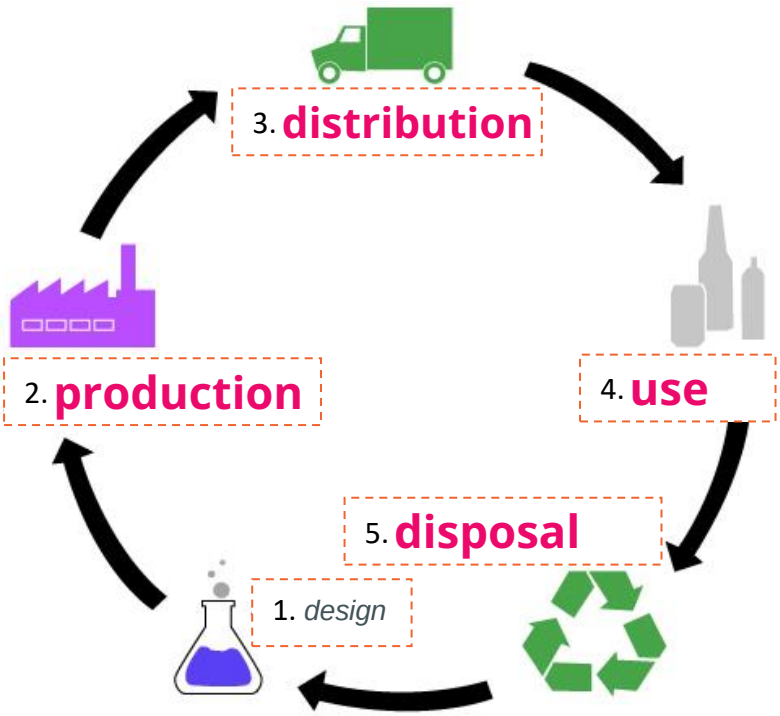
Impact of Synthetic Materials

In many cases, people find that synthetic materials are much more effective than natural materials.

However, people are now concerned that synthetic materials, especially plastics, are harming our environment:

- ⛔ Because plastics don't **break down**, they're accumulating around us.
- ⛔ **Animals** on land and in water mistakenly **consume** plastic.
- ⛔ Some kinds of plastic release **toxic chemicals**.

Products go through a life cycle consisting of five steps.



Until recently, most people didn't think about using **sustainable** resources and how they'd **dispose** of products. Different methods of disposal include:

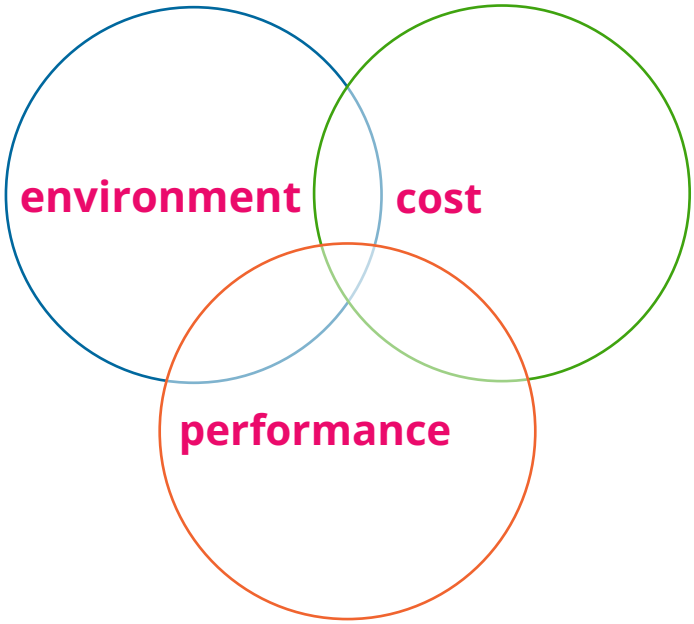
MOST PREFERRED
reuse
recycle/compost
energy recovery
landfill
LEAST PREFERRED

Human activities affect the environment. So, we need to consider the lives of **future** **generations**, not just our own.

Beyond Cost and Performance

The phrase “reduce, reuse, recycle” urges people to responsibly use and dispose of materials.

Reducing	Reusing	Recycling
→ using **fewer** materials → buy products that use less **packaging** → wait as **long** as possible to replace items	→ decreases the need for new products → For example, old clothes can be **donated** so that others can reuse them.	→ converting **waste** materials into new products → reduces the amount of **resources** and **energy** needed



Many product manufacturers now think about disposal during the design phase as well as cost and performance.

Everyone can do something to help protect our environment today and for future generations:

- *Manufacturers can make safer materials.*
- **Consumers can reduce, reuse, and recycle.**
- **Cities and towns can make it easier to recycle.**

Summary

Think of some products that you use or see every day that are made from synthetic materials. How do the characteristics of each material make the product effective? In what ways could each product be made more sustainably and how can you use it more responsibly?

Answers will vary.