

From crude oil to plastics and fibres

Grade 8 science (Year 9 · Class 8) · Lesson

Quick answer: Synthetic materials are substances made by people through chemical reactions, usually from natural resources such as crude oil. Plastics are the best-known example: small molecules called monomers join into long chains called polymers. Chemists choose the monomers to give properties such as flexibility, strength or low density.

Level: Grade 8 science (Year 9 · Class 8) · **Curriculum:** MS-PS1-3

What are synthetic materials?

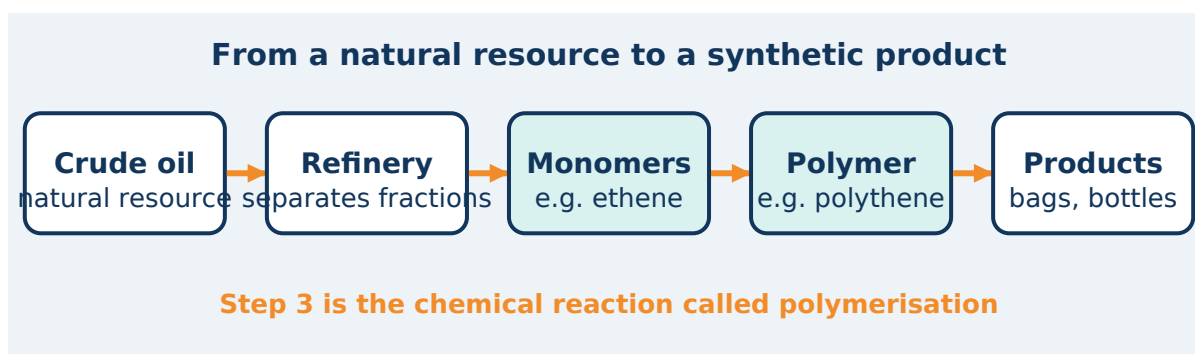
A natural material, such as cotton, wool or wood, comes from plants and animals. A synthetic material is made by people in factories using chemical reactions. Most start from natural resources. Crude oil, natural gas, coal, air and water are the commonest raw materials, so a synthetic product always begins with something from the Earth.

Definition

A **synthetic material** is a substance made by chemical reactions in industry. It may be a copy of a natural material, such as nylon in place of silk, or something new, such as a clear and flexible plastic film.

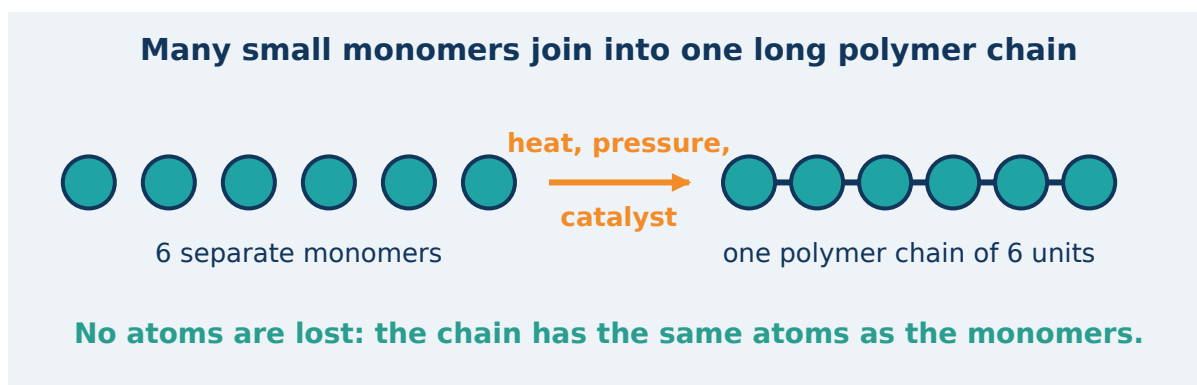
How are plastics made from crude oil?

Crude oil is a mixture. A refinery separates it into fractions, and one of them provides small molecules such as ethene. Chemists then join these molecules into long chains. A small molecule is a **monomer**, and the long chain is a **polymer**. The joining reaction is called **polymerisation**.



Natural resource to plastic product: five stages.

Ethene has the formula C_2H_4 . When thousands of ethene molecules join, the polymer is polythene. The change can be written as $n C_2H_4 \rightarrow (C_2H_4)_n$, where n is a very large number.



Polymerisation joins monomers into a long chain.

Key law

Mass is conserved in polymerisation. No atoms are made or destroyed, so the mass of the polymer equals the mass of the monomers that reacted.

Worked example

Kofi in Accra polymerises 84 g of ethene completely. What mass of polythene forms?

Mass of polymer = mass of monomer = **84 g**.

What properties make plastics so useful?

Changing the monomer changes the properties. Polythene is flexible and floats on water. PVC is stiff and does not conduct electricity. Nylon is strong and hard-wearing. Polyester dries quickly, and acrylic gives warm fabric. Plastics are also light, cheap to shape and do not rust.

Natural material	Synthetic replacement	Reason for the change
Silk	Nylon	Stronger, cheaper, easy to wash
Wool	Acrylic fleece	Light, dries quickly, cheaper
Latex rubber	Synthetic rubber	Steady supply, resists oil
Wood pipes	PVC pipes	Waterproof and does not rot

Plastics fall into two groups. A **thermoplastic**, such as polythene, softens when heated and can be remoulded. A **thermosetting plastic**, such as the type used for pan handles, stays rigid and chars instead of melting.

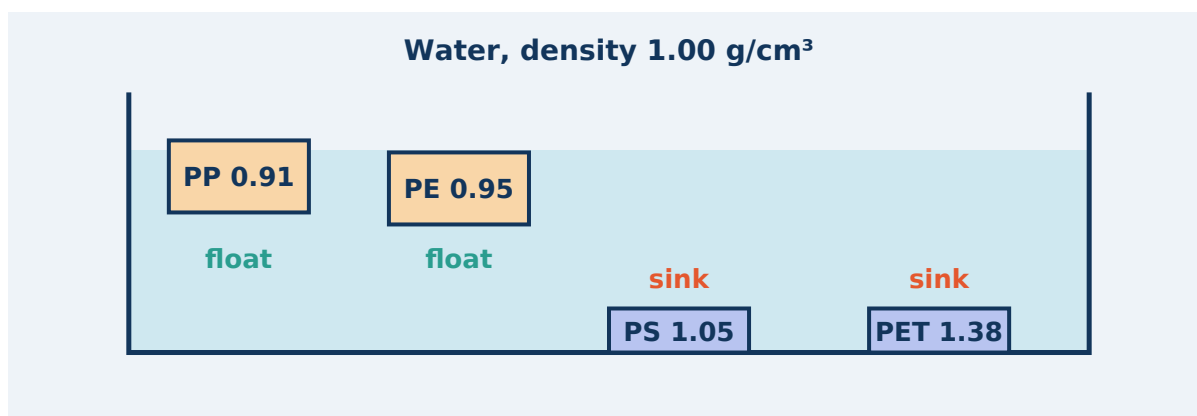
How can you tell plastics apart?

Density is a quick test. Plastics that are less dense than water float, and denser ones sink.

Formula

density = mass ÷ volume, $\rho = m \div V$

Mass m in grams (g), volume V in cm^3 , density ρ in g/cm^3 . Water has a density of 1.00 g/cm^3 .



Float or sink in water depends on density.

Worked example

A piece of plastic from a drinks bottle in Leeds has a mass of 6.9 g and a volume of 5.0 cm³.

$\rho = 6.9 \text{ g} \div 5.0 \text{ cm}^3 = \mathbf{1.38 \text{ g/cm}^3}$. This is more than 1.00 g/cm³, so it sinks in water.

Common mistake

A big piece of a plastic does not sink more than a small piece. Density does not depend on size: a tiny chip and a large block of the same plastic float or sink the same way. Do not say 'heavy things sink'.

Lina's tip

'Poly' means many and 'mer' means part. A polymer is many parts joined, so picture a chain of beads whenever you read the word.

What is the impact of plastics on society?

Plastics have saved lives and money. Sterile syringes, light helmets, food packaging that keeps food fresh and insulation on cables all depend on them. The problem is waste. Most plastics are not biodegradable, so a bottle can last for centuries. Pieces break into tiny fragments called microplastics, which spread through rivers and oceans.

Societies cut the harm in three ways: reduce what we use, reuse items such as bottles, and recycle plastic into new products. Recycling works best when the plastic is sorted, which is why density tests matter. Making plastics also uses fossil fuels, so a lower demand saves oil.

Worked example

A market in Lagos collects 1 250 kg of plastic and recycles 300 kg of it.

Percentage recycled = $300 \div 1250 \times 100 = \mathbf{24 \%}$.

Key points to remember

- Synthetic materials are made by chemical reactions, often from crude oil.

- Monomers join in polymerisation to make long polymer chains.
- Mass is conserved: polymer mass = monomer mass.
- Density = mass ÷ volume; plastics below 1.00 g/cm³ float on water.
- Most plastics persist in the environment, so reduce, reuse and recycle.

From crude oil to plastics and fibres: frequently asked questions

What is the difference between a natural and a synthetic material?

A natural material comes directly from living things or the ground. A synthetic material is made in a factory by chemical reactions, although its raw materials often come from nature.

What is a polymer?

A polymer is a very long molecule made by joining many small molecules called monomers. Polythene, nylon and PVC are all polymers.

Why do some plastics float and others sink?

It depends on density. Plastics with a density below 1.00 g/cm³, such as polythene and polypropylene, float on water. Denser ones, such as PET and PVC, sink.

Are all plastics made from crude oil?

Most are, but some are made from plant materials such as sugar cane. Making a plastic from a plant does not always make it biodegradable.

How can people reduce plastic waste?

Reduce single-use items, reuse containers and recycle sorted plastics. Good sorting and clear labels make recycling more effective.