Matter

4. Elements

CONCEPT 3

LESSON GUIDE

CERAMICS, POLYMERS AND COMPOSITES

PRECISE LEARNING POINTS

KNOW

I know what ceramics, polymers and composites are, and can describe their basic structure.

APPLY

I can apply my knowledge to describe uses for ceramics, polymers and composite.

EXTEND

I can extend my knowledge of ceramics, polymers and composites to explain how their structure is linked to their function.

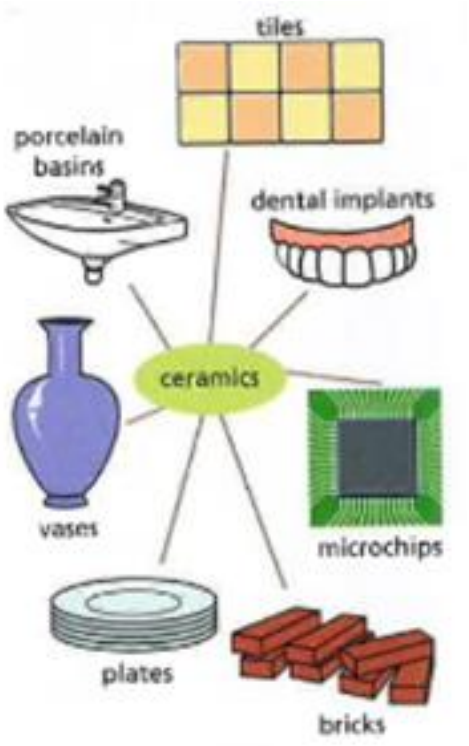
NOTES

Polymers can be found in nature and have been around since the start of life itself. They are cemicals made of long chains of repeating chemical units – the repeating molecule is called a **monomer**.
One of the most familiar natural polymers is **starch**, which is how plants store **glucose**. Glucose is the monomer and starch is the polymer. Glucose is a small and soluble molecule. When it is joined together to make starch, the properties change and it becomes large and insoluble. This means the plant can store starch for when it is needed. **Cellulose** is another polymer formed by glucose molecules and is found in plant cell walls. **Proteins** are one of the most important natural polymers and are made from **amino acid monomers**.

Synthetic polymers were first developed in the 1900's and were formed by heating monomers under great pressure. Catalysts were added and polymers were created – a discovery almost by chance! **Polythene** - a synthetic polymer – is a type of **plastic** which has many uses.
Synthetic polymers are made from monomers that come from crude oil and are mostly made of carbon and hydrogen. See the table below for ueses of polymers.

	Name of polymer	Uses of polymer
Natural polymers	starch	storage of glucose in plants
	cellulose	strengthening of cells wall in plant cells
	protein	many uses, for example, enzymes, muscle fibres, haemoglobin in red blood cells.
Synthetic polymers	polythene	plastic bags, plastic containers, cling film, plastic milk bottles
	polystyrene	packaging, model kits, containers
	acrylics	aircraft canopies, covers for car lights
	nylon	ropes, fabrics, gear wheels
	polypropene	ropes, containers
	polychloroethene	water pipes

Ceramics and other **composite materials** have been in use for centuries and is probably the most widespread materials in use today.
A **ceramic** is an inorganic (non-carbon based), non-metallic solid that is prepared by heating, followed by cooling. Clay and sand were used in early ceramics, but nowadays advanced ceramics are based on oxides and carbides, such as aluminium oxide and boron carbide.



The diagram below shows a variety of uses of ceramics.

Properties of ceramics generally include:

- Hard and resistant
- Light
- Brittle (can break easily if a force is applied)
- Thermal insulators
- Electrical insulators
- Non-magnetic
- Chemically stable (they do not break down in air)
- Non-toxic (used for food and drink)
- Non-ductile (cannot be drawn out into wire)

Composites are made up of two or more materials that are combined. The composite material is normally stronger than, more durable than, or has other desirable properties not found in the original materials. The materials involved or often not chemically combined within the composite. Examples of composites are concrete, carbon fibres and a natural composite is bone. Many composites are combinations of plastic, ceramic and metal materials, which are added to make the composite stronger, to **reinforce**, such as glass and carbon fibres.

Linking structure to function
Polymers have very large molecules and their structure has a particular shape that provides them with particular properties. It is the arrangement of particles within a polymer defines this shape.
Natural polymers are strong because of the number of chemical bonds within their structure. Some are elastic, like muscle fibres.
Scientists have found ways to improve the properties of synthetic polymers. For example, by adding small amounts of sulfur to natural rubber makes the polymer stronger and this can be used to make tyres.

Advanced applications of ceramics have been challenging metal materials in the use of high temperature parts required for aeroplane engines, turbo-jet engine blades and missile nose cones.
Composites such as carbon fibre are used in making car, aircraft and spacecraft bodies and in the manufacture of bikes, as they are munch stronger and much lighter than metals used previously.