All you need to know about ...

OCR 21st Century Science

Module

C2

MATERIAL CHOICES

Solid materials can differ in properties such as:

- melting points
- strength (in tension or compression)
- stiffness
- hardness
- density

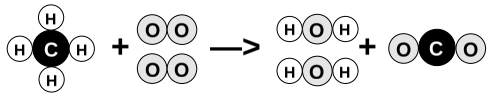
SYNTHETIC AND NATURAL MATERIALS

- materials are chemicals or mixtures of chemicals
- materials can be obtained or made from living things, e.g cotton, paper, silk and wool
- synthetic materials are 'man-made' and are alternatives to materials from living things

NATURAL	SYNTHETIC
COTTON	POLY(ETHENE)
WOOL	POLY(STYRENE)
WOOD	KEVLAR
PAPER	NEOPRENE
SILK	NYLON
LEATHER	POLYESTER

CHEMICAL REACTIONS

- atoms re-arrange during a chemical reaction
- the numbers of atoms of each element must be the same in the products as in the reactants;



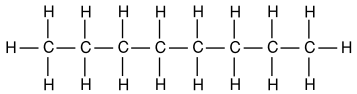
C	1	0	0	1
H	4	0	4	0
O	0	4	2	2

CRUDE OIL

- crude oil consists mainly of hydrocarbons
- hydrocarbons only contain carbon and hydrogen atoms
- the carbon atoms form chains of different lengths
- a small amount of crude oil is used for chemical synthesis
- the petrochemical industry refines crude oil to produce **fuels**, **lubricants** and **raw materials** for making chemicals
- substances are separated by fractional distillation
- separation is carried out because of different boiling points

longer chain = higher boiling and melting points

CH_4
gas

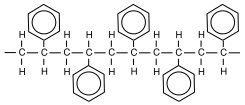


C_8H_{18}
liquid

POLYMERISATION

- when small molecules join together to make very long molecules called polymers

styrene
monomer



polystyrene
polymer

- polymerisation produces a wide range of materials... poly(ethene), Kevlar, polystyrene, nylon, pvc
- new materials are replacing older materials

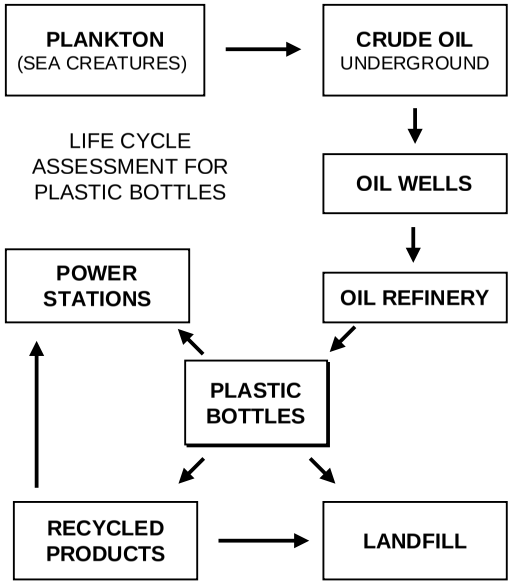
LIFE CYCLE ASSESSMENT (LCA)

'FROM THE CRADLE TO THE GRAVE'

RAW MATERIALS —> USE —> DISPOSAL

Key features of a life cycle assessment (LCA) include...

- the main requirements for **energy input**
- the environmental impact and **sustainability** of making the material from natural resources
- the environmental impact of **making the product**
- the environmental impact of **using the product**
- the environmental impact of **disposing of the product** by incineration, landfill or recycling;



PROPERTIES OF PLASTICS AND POLYMERS

The properties of solid materials depend on how the particles they are made from are arranged and held together;

The greater the strength of the forces between the particles to the greater amount of energy needed for them to break out of the solid structure, and the higher the melting point.

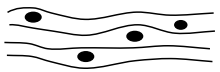
Modifying polymers produce changes to their properties...

- **increase the length of the carbon chain**
- **cross-linking the chains of atoms**
- **add plasticizers;**
- **increase crystallinity.**

Rubber is naturally flexible because the long chains of atoms can move around.

Cross linking by heating with sulphur atoms holds the chains together - it is stronger and harder

Plasticizers are small molecules which sit between the chains and weaken the forces between them, making them more flexible.



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