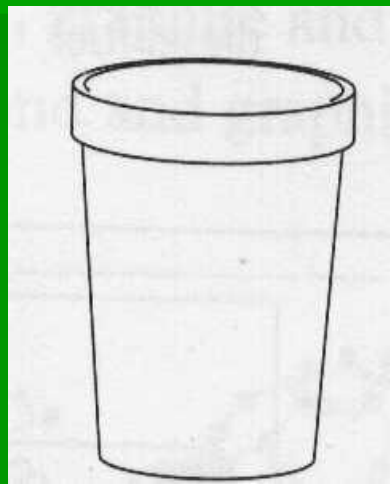
C2 - Material Choices Revision

Material Choices (C2) Revision for Exams

Properties of Materials

- When we decide which material to **use**, we have to think about the **properties** of the material.
- Polystyrene is **used** for hot drink containers because it is **waterproof**, **low density** and a **poor thermal conductor**.



Property Words

Strong	This means that it is hard to break a material.
Strong under tension	The material needs a big load to break it when stretched.
Strong under compression	The material needs a big load to make it break when squashed.
Hard	The material is difficult to dent or scratch.
Soft	The material can be scratched or dented easily.
Flexible	The material will bend easily and without breaking.
Stiff	This means that a material is difficult to bend or stretch.
High density	This means that a material has a big mass for its size.
High melting point	The material will turn into a liquid at a high temperature.

Testing Materials

2 ropes from the same factory were tested by the quality control department.

The length of rope used was the same to make it a **fair test.**

	Is there a real difference?	
	Rope 1 Force needed to break it (N)	Rope 2 Force needed to break it (N)
1	200	240
2	210	250
3	240	
4	230	
5	100	

Rope 2: **Mean** is 232. **Range** is 220-250.

There is **no real difference** because the **ranges** overlap.

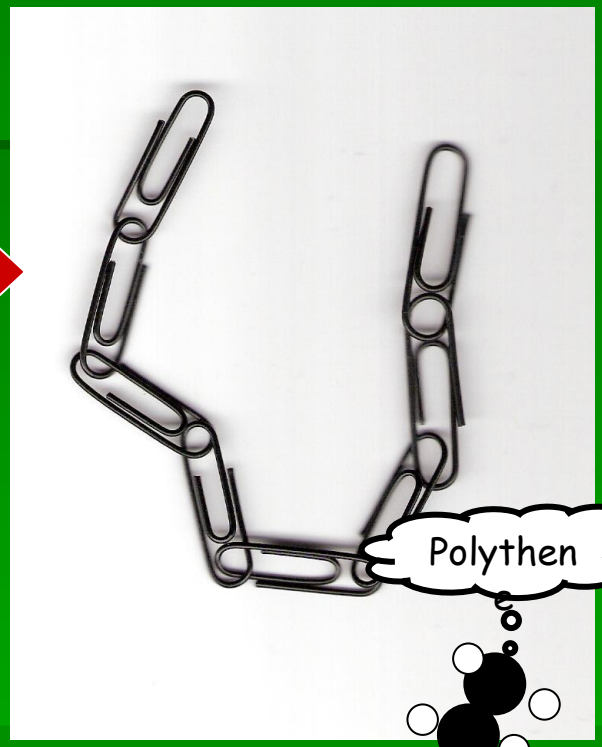
For rope 1, Mean is 220N. **Range** is 200-240 (**Outlier** not included)

For rope 1, 100 was an **outlier** because it was very different to the other results.

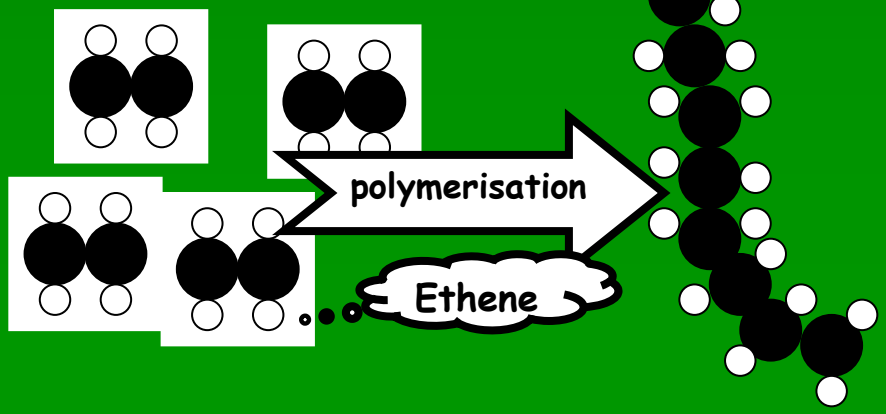
For some uses, materials need to have a **high tensile strength.** You don't want ropes or thread holding your clothes together to **break when stretched.**

Polymerization

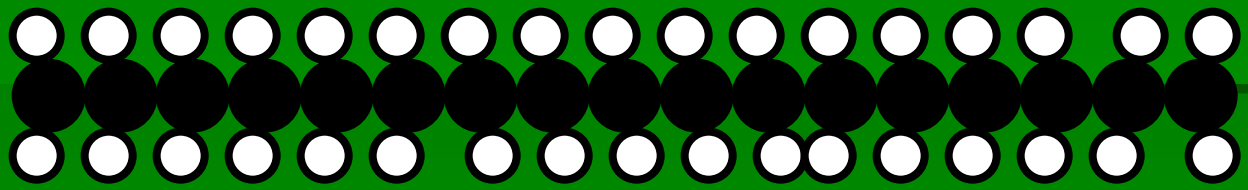
Polymerization



Polymers are very large molecules made when many **small** molecules join together. The small molecules are called **monomers**. **Polymerization** is making a polymer from many monomers.

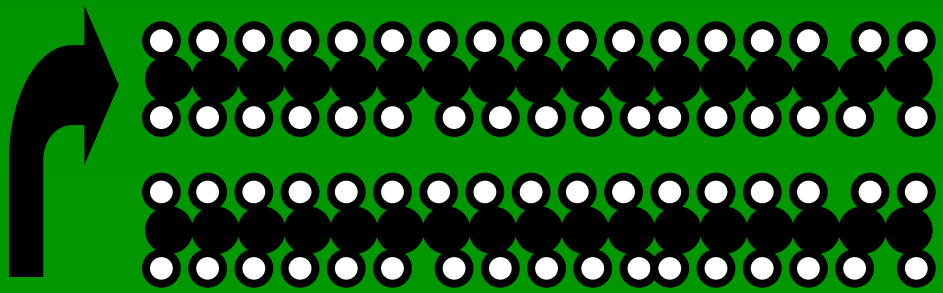


May the force be with you

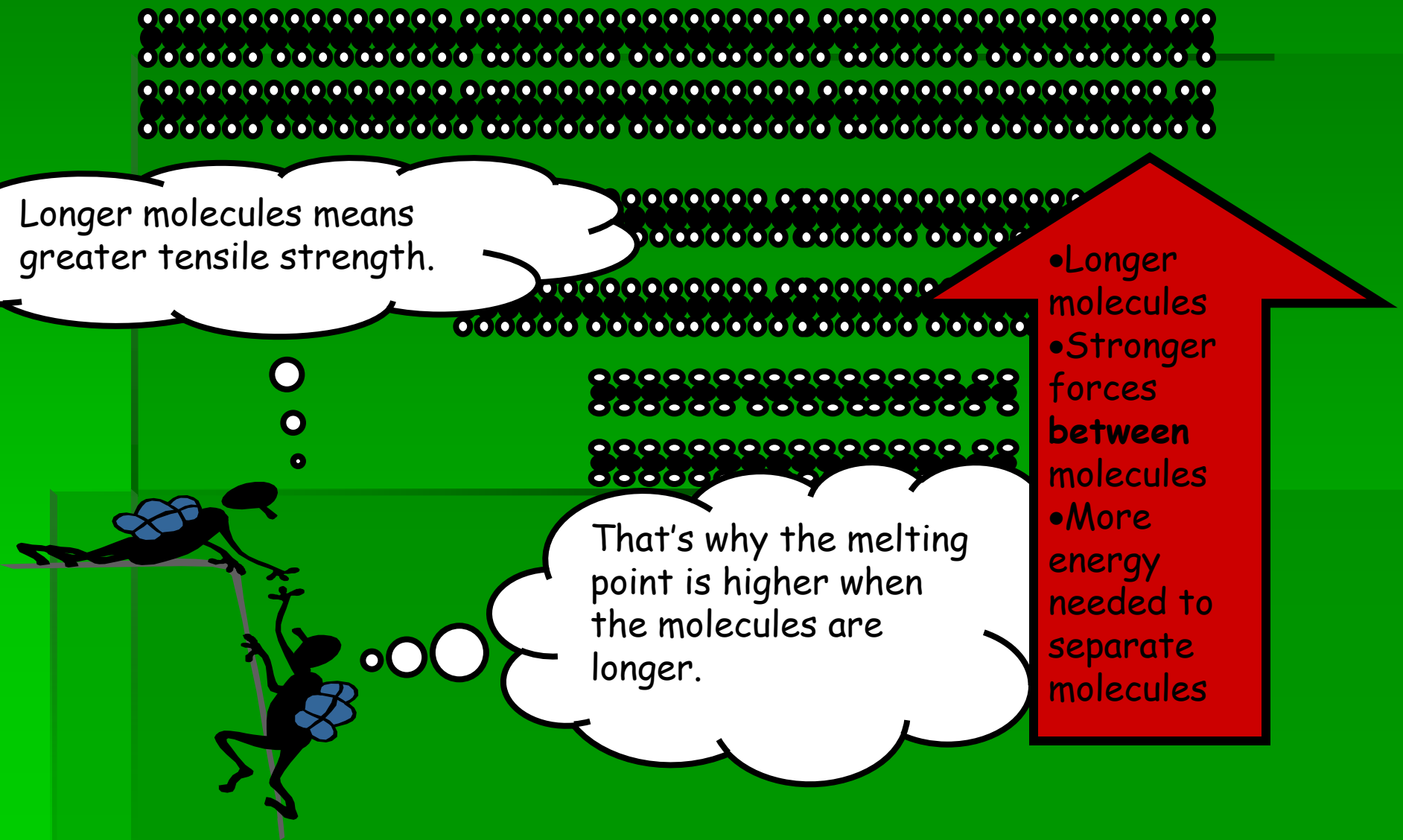


The **atoms** in a polymer are held together by **strong covalent bonds.** A lot of **energy** is needed to break them. Heating with a Bunsen burner or pulling won't break these bonds.

There are **weaker forces between** the molecules. They don't need so much **energy** to break them. When a rope snaps, it is because these forces are broken. When a plastic melts, it is these forces which are broken.

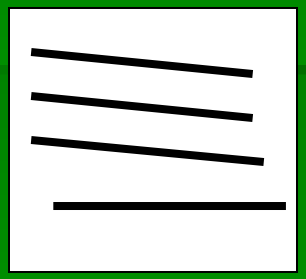


Polymers aren't always the same lengths

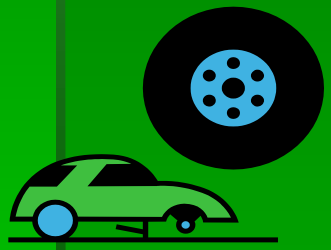


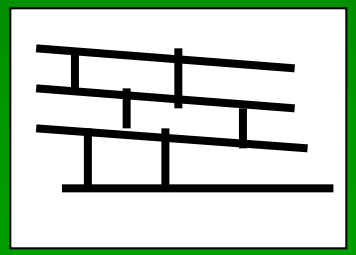
Cross-links and Plasticizers

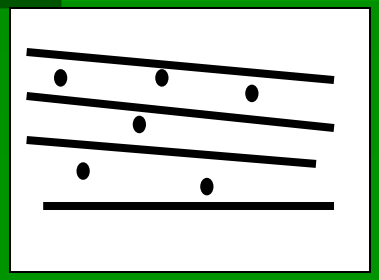
Natural rubber is very flexible because the forces between molecules are weak and they can slide over each other.



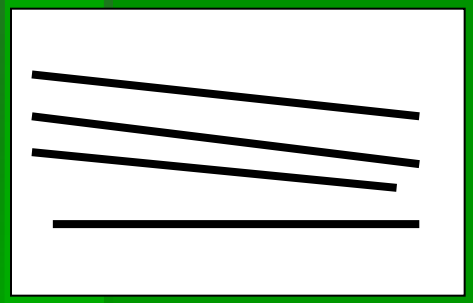
Vulcanised rubber is less flexible, harder and stronger if stretched. This is because the **cross-links** stop the chains from sliding over each other.







Plasticizers are small molecules which push the polymer chains apart. The force between them decreases and the chains can slide over each other. The polymer is softer and more flexible.

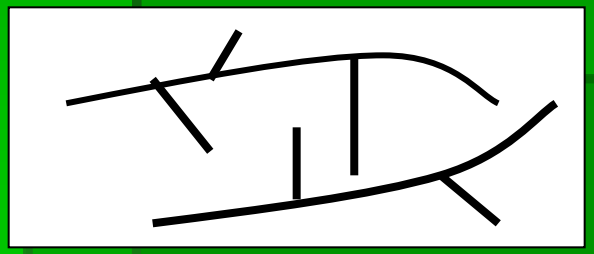


Crystallinity is crazy? (Higher only)

If we say a polymer is **crystalline** it means the long molecules line up close to each other.

High density polythene

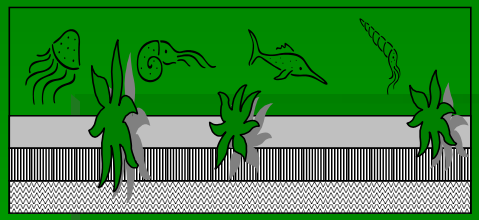
These polymer chains are close together. The polythene has a **higher density**, is **stronger** and has a **higher melting point**. Forces between molecules are stronger so more energy is needed to overcome the forces.



Low density polythene

In **low density** polythene, the molecules have **branches**. The branches keep the chains apart. It is not crystalline. The forces between molecules decrease because they are further apart.

Crude Oil



Millions of years ago, tiny sea creatures died. They became **crude oil**.

Millions of years

They drill for oil at an oil rig and then transport it by tanker, pipeline and lorries to the oil refinery.

Crude oil is a mixture of hydrocarbons. Hydrocarbons are molecules with only carbon and hydrogen in. E.g. CH_4 and $C_{20}H_{42}$ but not CO_2.

At the oil refinery, the mixture is separated into fuels, lubricants and the raw materials for making polymers. Most of the products are fuels.

Drilling, refining and making the plastic products require energy.

Transport requires energy.

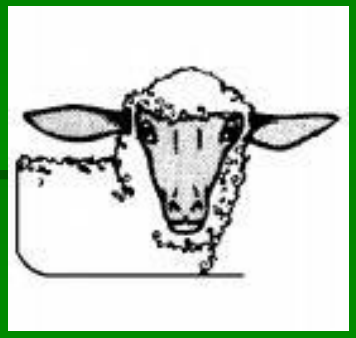
Oil spills harm wildlife.

Crude oil is running out.

Natural or Synthetic

Some materials are **natural**. They are made from plants or animals:

- Cotton is made from the cotton plant
- Silk is made by the silkworm
- Wool is made when a sheep is sheared
- Leather is made from the hide of cows
- Paper and wood are made from trees



Lots of materials are **synthetic** now. Synthetic means made by a chemical reaction. Anything with a name starting with poly is synthetic, for example polythene, polyester and pvc (**poly**vinyl**c**hloride). Other synthetic materials include acrylic, viscose and nylon. The raw material is usually crude oil.

Cradle to Grave

- By law, a **Life Cycle Assessment (LCA)** must be carried out on products.
- The purpose of an LCA is to make sure the product is made in the most **sustainable** way possible. **Sustainable** means meeting the needs of today but also making sure that future generations can meet their needs.

- Consider the raw materials needed to make the material you want e.g. crude oil for polythene
- Consider the energy needed to make the material from the raw material
- Consider the energy needed for manufacture of the product e.g. bag from polythene

Use

- Consider the energy needed to use it e.g. petrol for a car
- Consider the energy needed to maintain it e.g. car wash
- Consider the chemicals needed to maintain it e.g. lubricating oil at services

- Consider the energy needed to dispose of it
- Consider the space needed to dispose of it.

The problem with plastics – the grave

Plastics are **non-biodegradable** and crude oil is running out – don't just put plastic objects in the bin.

Landfill is such a waste.

Burning plastics makes CO_2, a greenhouse gas. The heat energy could be used to make electricity though.

You can **recycle** your plastic rubbish. It is sorted into type of plastic, melted and remoulded into new objects.

Try to **reuse** bottles, bags and containers. Give old toys to a friend or a charity shop.

No INCINERATOR
RE-USE RE-CYCLE RE-DUCE

Can we, should we?

Science can tell us if making a product is possible. For instance making cars completely from plastics is possible. It **can** be done. But **should** we do it?

They would be lighter – not good on windy days.

Crude oil is running out – I'd rather use it as a fuel.

How much would the cars cost to buy?

They might last longer – car manufacturers would lay people off.