



Design Technology

Y11 Week 5

Polymers

• Objectives –

- to be able to answer questions on a range of plastics and their categories with good examples & explanations.
- Prepare revision materials for this topic (Q-cards , mind maps, diagrams)
- Organise a revision timetable so that all topics are revised every 3 weeks
- Self test and Quiz at home / with a revision group / get others to test you.

• Activities

- Read and highlight all the information – research un known vocabulary
- **Tasks**
 1. Slide 3. Make a Q-Card for Categories of plastic
 2. Slide 4. Research the production life cycle of a PET disposable drinks bottle
 3. Slide 5. Create flash cards to learn the key thermo plastics Names or letters . This must include examples for their uses
 4. Slide 6. Create flash cards to learn the key thermoset plastics Names. This must include examples for their uses
 5. Slide 7. draw you own simplified diagram for the production life cycle of a bio plastic product.
 6. Slide 8. Research injection moulding and blow moulding – create your own diagrams to help learn how to explain the key steps for each one.
 7. Slide 9. Answer the questions on plastics.

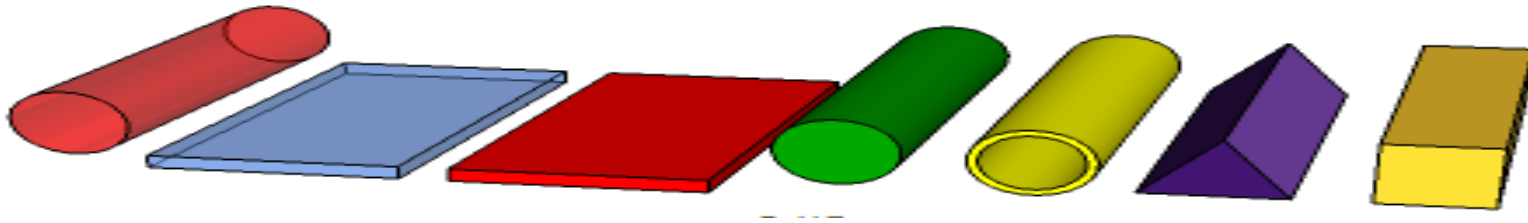
Categories of plastic

Thermosetting, thermoforming polymers & Bio Plastic

Plastics are versatile and flexible materials and they may be very suitable for use in your project. This may be an area of materials research that you need to investigate in detail. It is important that you read the information below and consider the type of plastic that will best suit your project.

All plastics are based on **polymers** and they are created by bonding molecules together.

The terms **monomer** and **polymer** are very important in the plastics industry. A monomer is a relatively small molecule that can chemically bond to other monomers, forming a polymer. Remember, all plastics are polymers.



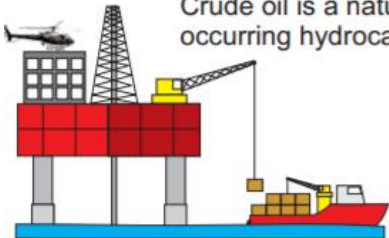
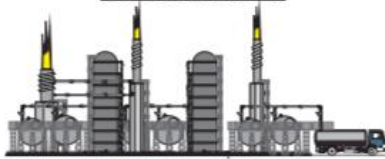
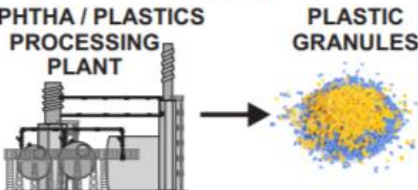

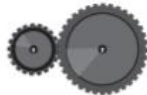





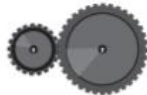





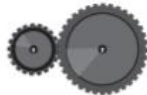




Thermoforming plastics These plastics can be re-heated and therefore shaped in various ways. They become mouldable after reheating as they do not undergo significant chemical change. Reheating and shaping can be repeated. The bond between the molecules is weak and become weaker when reheated, allowing reshaping. Thermoplastics tend to be composed of 'long chain monomers'. These types of plastics can be recycled.

Thermoset Plastics Once 'set' these plastics cannot be reheated to soften, shape and mould. The molecules of these plastics are cross linked in three dimensions and this is why they cannot be reshaped or recycled. The bond between the molecules is very strong.

Bio Plastic Are new plastics that are currently being developed using plant starch as the key source material. Once used and no longer needed they will rot in the ground like any other plant material which can help feed new growth which is very good for the environment

Crude Oil is one of the key sources of materials for making plastic

You will need to be able to explain the key stages of plastic production - you should know a good example (A PET drinks / water bottle is often used in exams as an example)

Source	Processing	Manufacture						
<p><u>OIL RIG - CRUDE OIL</u></p> <p>Crude oil is a naturally occurring hydrocarbon.</p>  <p>Crude oil is found deep underground. Oil reserves are extracted by oil rigs on land and on the oceans / seas. On land, 'crude oil' is piped directly to refineries. Huge oil tankers often transport crude oil from oil rigs at sea, to refineries.</p> <p>Crude oil is a valuable commodity, as it can be refined (distilled) into fuels, chemicals and processed into plastics. Crude oil is difficult to find and expensive to extract.</p>	<p><u>CRUDE OIL REFINERY AND DISTILLATION</u></p>  <p>Refineries 'distil' (distillation) crude oil, manufacturing gas, petrol, diesel, heating oils, naphtha (important for plastics), ethylene and polyethylene. Bitumen / asphalt is also produced. Naphtha is processed into 'plastic' granules, in a processing plant.</p> <p>NAPHTHA / PLASTICS PROCESSING PLANT → PLASTIC GRANULES</p> 	<p><u>FACTORY MANUFACTURED PRODUCTS</u></p> <p>Many types of plastic granules are manufactured. They are used in turn, to manufacture a vast range of products.</p> <table><tr><td><p>PVC POLYVINYLCHLORIDE</p></td><td><p>NYLON</p></td></tr><tr><td><p>POLYESTER</p></td><td><p>POLYSTYRENE</p></td></tr><tr><td><p>POLYURETHANE FOAM</p></td><td><p>POLYPROPYLENE</p></td></tr></table>	<p>PVC POLYVINYLCHLORIDE</p> 	<p>NYLON</p> 	<p>POLYESTER</p> 	<p>POLYSTYRENE</p> 	<p>POLYURETHANE FOAM</p> 	<p>POLYPROPYLENE</p> 
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<p>POLYURETHANE FOAM</p> 	<p>POLYPROPYLENE</p> 							

QUESTIONS

1 How is crude oil extracted from underneath the ground and transported to refineries?

3 marks.

.....

2 Why is crude oil a valuable commodity ?

2 marks

.....

3 What is the name of the process used to convert crude oil, into useful chemicals and fuels ?

1 marks.

.....

4 What happens at an oil refinery ?

2 marks

.....

Thermo Plastics & Thermo-set plastics

Thermo plastics can be re-heated and re-shaped



PETE

polyethylene terephthalate

soft drink bottles, mineral water, fruit juice container, cooking oil



HDPE

high-density polyethylene

milk jugs, cleaning agents, laundry detergents, bleaching agents, shampoo bottles, washing and shower soaps



PVC

polyvinyl chloride

trays for sweets, fruit, plastic packing (bubble foil) and food foils to wrap the foodstuff



LDPE

low-density polyethylene

crushed bottles, shopping bags, highly-resistant sacks and most of the wrappings



PP

polypropylene

furniture, consumers, luggage, toys as well as bumpers, lining and external borders of the cars



PS

polystyrene

toys, hard packing, refrigerator trays, cosmetic bags, costume jewellery, CD cases, vending cups



OTHER

other plastics, including acrylic, polycarbonate, polyactic fibers, nylon, fiberglass

These symbols represent how easy these plastics are to recycle 1= easy 7 =Hard



Memorise – examples of their names, number and uses

Thermosetting plastics

WHAT ARE THERMOSETTING PLASTICS ?



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Once heated and moulded, these plastics **cannot be reheated and remoulded**. The molecules of these plastics are cross linked in three dimensions and this is why they cannot be reshaped or recycled. The bond between the molecules is very strong.

THERMOSETTING PLASTICS 4

Urea Formaldehyde has physical properties of high hardness and high toughness, making it suitable for strong, knock-resistant electrical fittings. It is also scratch resistant and a very good electrical insulator. Electrical fittings manufactured from this polymer are safe to use.



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THERMOSETTING PLASTICS 1

Many **adhesives (glues)** are thermosetting plastics. For example, Araldite. Composed of two tubes (one is resin, the other a catalyst). They are mixed to form the glue.



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THERMOSETTING PLASTICS 2

Polyurethane. This forms the basis of many paints and varnishes. Tough, water resistant.



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THERMOSETTING PLASTICS 3

Melamine Formaldehyde. Because of its smooth surface and hygienic qualities, used for kitchen laminates surfaces. Also used for electrical plugs and sockets, because it can be cast and it is an excellent insulator.

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THE DIFFERENCE BETWEEN THERMOSETTING PLASTICS AND THERMOPLASTICS

Thermosetting plastics once heated and formed to a shape, **cannot be reheated and reformed**. Consequently, they tend to be difficult to recycle.

Thermoplastics once heated and formed to a shape, **can be reheated and reshaped**. Every time they are reshaped, the quality of the thermoplastic tends to be reduced. They are recyclable.

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Questions

All these symbols are for thermoplastic, **what** do the numbers tell us?

.....

PP stands for polypropylene, what number is it?

.....

What is the difference between a thermoplastic and a thermosetting plastic?

.....

Which is the best plastic for a drinks bottle **and why**?

.....

..... Which is the best plastic for a detergent bottle **and why**?

.....

.....

BIOPOL (is a vegetable based plastic)

PHYSICAL PROPERTIES

Biopol can be produced through 'renewable' raw materials such as and corn starch. Starch is extracted from corn but the process produces carbon dioxide (a greenhouse gas). To some extent, the CO₂ can be encouraged to bind to the soil produced in the composting process.

Biopol is insoluble in water and will sink unlike the majority of 'plastics'. Over time it will degrade harmlessly as it is non-toxic. It has a similar tensile strength to that of polypropylene. With a high melting point of 175 degrees centigrade, it can withstand most use, that requires resistance to hot liquids, such as beverages.

Biopol PHB, can be injection moulded and vacuum formed. It has a range of uses such as, packaging, shampoo bottles, disposable razors, disposable cups, surgical stitches, surgical pins, disposable knives and forks, woven medical patches and nappy linings

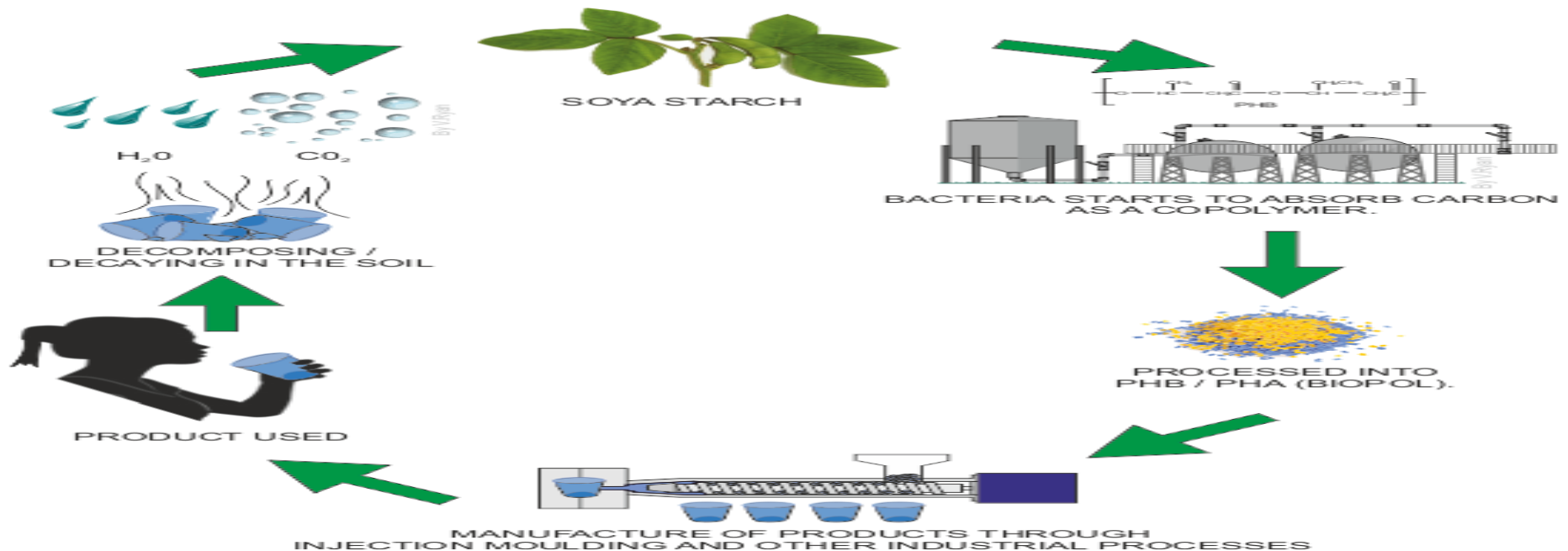
DISADVANTAGES

The main disadvantage, is that it more expensive to produce biopol than fossil fuel plastics.

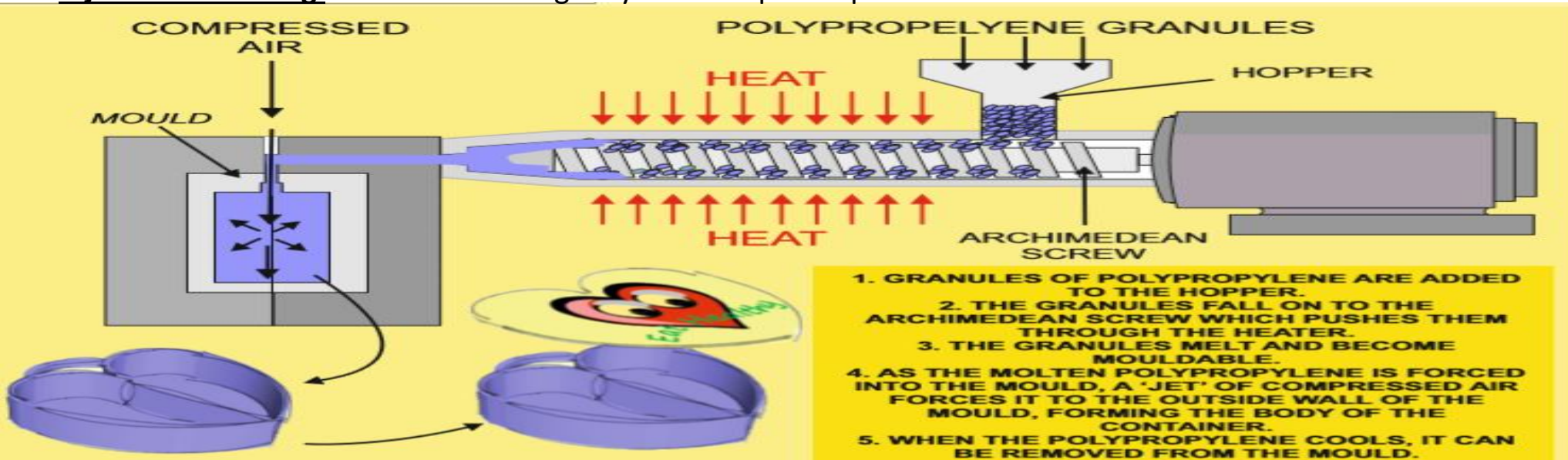
Biopol has a low resistance to acids and bases, including bleach. This restricts its use as 'plastic' packaging.

Biopol does not resist impact as well as fossil fuel based plastics and cannot be used in situations such as containers, that could potentially be dropped or knocked.

The fermentation process is longer, when compared to plastics processed from fossil fuels such as oil.



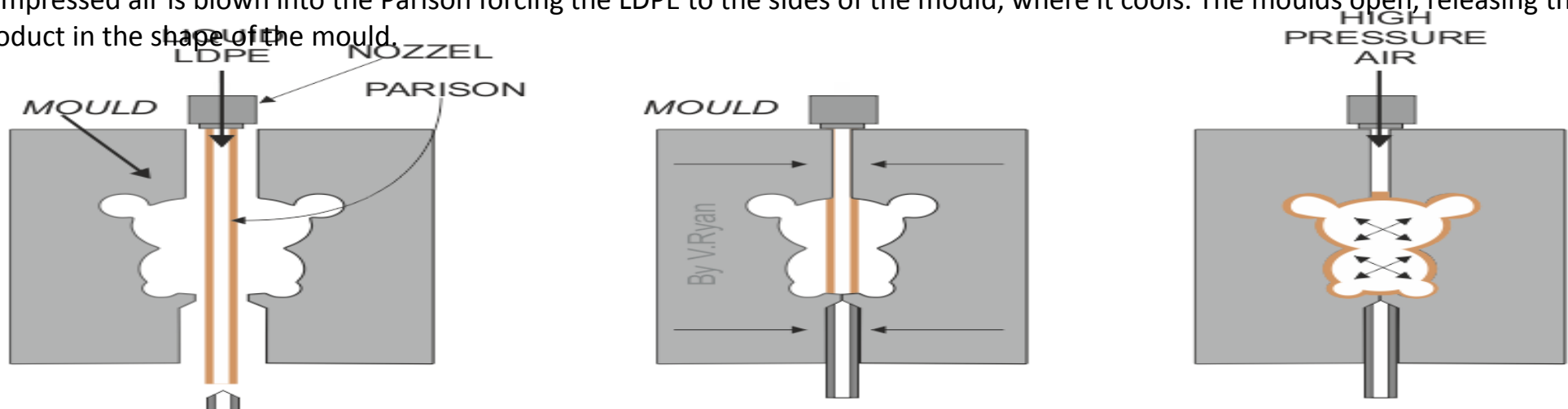
Injection Moulding – Used for making very detailed plastic products



Blow Moulding- used to make hollow shapes like bottles

LDPE granules are heated and made into a molten state. The liquid is extruded through a nozzle in the form of a tube called a 'Parison'. The two halves of the mould close on the 'Parison' / tube and shut tight.

Compressed air is blown into the Parison forcing the LDPE to the sides of the mould, where it cools. The moulds open, releasing the product in the shape of the mould.



Research and revise **vacuum forming** – diagrams, uses, drawbacks

1. Complete the paragraph on thermosetting plastics, by adding the missing words.
heated - cannot be - cross linked - molecules - dimensions

Once _____ and moulded, these plastics _____ reheated and remoulded. The molecules of these plastics are _____ in three _____ and this is why they cannot be reshaped or recycled. The bond between the _____ is very strong.

2. Name a glue that is a thermosetting plastic and describe how it is mixed.

3. Name a plastic that is used as the basis of many paints and varnishes.

4. Why is Melamine Formaldehyde used for the manufacture of electrical plugs and sockets?

5. Urea Formaldehyde is also used for the manufacture of electrical plugs and sockets. Why ?

6. Complete the sentence about polyester resins, by adding the missing words.
fibre glass - resins - Reinforced - GRP

Polyester resins. If _____ are combined with a material such as _____, the result is a very tough material that can resist impact, known as Glass _____ Plastic (_____).

7. Why are polyester resins used in car body repairs, sailing boats and corrugated sheet.

8. What is the difference between thermosetting plastics and thermoplastics?

1. Explain the term ‘thermoset polymer’, with reference to molecular structure.

Once 'set' these plastics cannot be reheated to soften, shape and mould. The molecules of these plastics are cross linked in three dimensions and this is why they cannot be reshaped or recycled. The bond between the molecules is very strong.

2. Thermoset polymers are very useful in the manufacture of electrical fittings. Name a thermoset polymer used for this purpose

Urea Formaldehyde (UF)

3. Describe the properties of the polymer you have named above that make it suitable for electrical fittings.

Urea Formaldehyde has physical properties of high hardness and high toughness, making it suitable for strong, knock-resistant electrical fittings. It is also scratch resistant and a very good electrical insulator, making electrical fittings manufactured from this polymer safe to use.

THERMOPLASTICS

4. Explain the term ‘thermoplastic’, with reference to molecular structure.

These plastics can be re-heated and therefore shaped in various ways due being long chain monomers that are not inter- connected. They become mouldable after reheating as they do not undergo significant chemical change. Reheating and shaping can be repeated. The bond between the molecules is weak and become weaker when reheated, allowing reshaping. These types of plastics can be recycled.

5. Thermoplastics are very useful in the manufacture of mobile phone casings. Name a thermoplastic used for this purpose.

Polycarbonate

6. Describe the properties of the polymer you have named above that make it suitable for mobile phone casings.

Polycarbonate is a thermoplastic which means it can be shaped and formed through a number of manufacturing processes. It machines well and can be solvent bonded and welded. It is tough and resistant to damage which is an ideal property for a mobile phone. If dropped, a mobile phone with a polycarbonate casing is likely to survive undamaged. It is an insulator, often used to insulate electrical circuits. It is supplied in a range of colours.

7. List two more thermosetting plastics and describe practical applications of each one.

NAME 1: *Polyester Resins.*

PRACTICAL APPLICATION: *If resins are combined with a material such as fibre glass the result is a very tough material that can resist impact. This type of material is known as a glass reinforced plastic (GRP) and is used in car body repairs, sailing boats, corrugated sheet because of its lightness, toughness and resistance to water.*

NAME 2: *Melamine Formaldehyde.*

PRACTICAL APPLICATION: *Used in the production of plastic laminates because of its smooth surface and hygienic qualities. It is also used in electrical plugs and sockets because it can be cast and it is an excellent insulator.*

8. List two more thermoplastics and describe practical applications of each one.

NAME 1: *Polythene.*

PRACTICAL APPLICATION: *Can be moulded into almost any form due to its excellent moulding qualities. Used for the production of bottles, bowls, toys, tube etc... It is available in large sheets. There are two types: High density which is rigid and hard, and low density which is tough and flexible. Machine parts are generally made from high density polystyrene whilst bottles are made from the low density polystyrene.*

NAME 2: *Polyvinyl Chloride.*

PRACTICAL APPLICATION: *Better known as PVC. It is a tough material which can be purchased as a hard material or alternatively a flexible form. It can be welded or bonded with an adhesive. It has a range of uses including water pipes, raincoats, long play records, coating on electrical wires and many more.*