Year 11 Knowledge organiser— Paper and board SOURCES ORIGINS & PROPERTIES

Sources of Papers and Boards

Papers and boards are made from a pulp which is a mixture of cellulose fibres and up to 99% water. The cellulose fibres are usually derived from finely shredded wood, but other types of fibres such as hemp, flax, bamboo, sugarcane and straw can also be used.

Pulp - a mechanical process converts debarked logs into fine chips which are then added to a chemical solution and cooked in large tanks under pressure to make the paper pulp. Depending on the desired colour of the finished product, the resulting fibrous liquid is then bleached or coloured.

Sizing - The liquid is then beaten with other chemicals or additives according to the required finish. This process is called sizing. Sizing stops the paper from being absorbent, thereby allowing it to be printed, photocopied or painted. Paper with little sizing is very absorbent, such as toilet tissue or kitchen

Converting pulp to paper - The pulp is fed onto a mesh conveyor belt which allows much of the water to drain away. It then passes onto a series of rollers which squeeze out any excess water. Next, it goes through a series of drying rollers and onto a final set of rollers called calender rollers. These give the paper a desired finish, for example satin or matt.
Sometimes a final coating or sizing is added before the paper is cut.

Sustainable paper production

The UK uses 12 million tonnes of paper every year. It takes roughly 25 trees to produce one tonne of paper. Recycling paper and board is easy and the amount being recycled continues to rise.

Uses of common papers and boards

Name	Appearance	Characteristics	Uses
Tissue Paper	Available in many colours, sold in ply form as facial tissue and toilet roll	10-35gsm Soft, lightweight, highly absorbent	Packaging for cosmetics and gifts, arts and crafts, kitchen roll and toilet roll.
Newsprint paper	Off white, thin, slightly rough	45-55gsm Lightweight, low cost, uncoated paper	Commercial printing of newspapers and some advertising leaflets.
Photocopy paper	Usually brilliant white, smooth	70-150gsm Lightweight, low cost, good for laser printing toner	Photocopying, general use in home printers.
Photo quality paper	Brilliant white, often coated on one side only, very fine smooth finish	120-260gsm High quality, holds ink well, bright colours, quick drying, gloss, satin and matt finish	Photographics prints, presentation printing, greeting cards.
Carton board	Natural brown or white, coated or uncoated, can be layered and printed on one or both sides	200-1500 microns Thick to very thick when layered, can be coated or foil lined to hold food and liquids, full colour printing possible	Food containers, packaging, point of sales and advertising displays.
Mount Board	High quality finish usually to one side, available in many colours.	500-2500 microns Thick, rigid, fine finish, cuts well to produce frame mounts.	Mounting of art, photographs, artefacts in frames and cases, museum quality board has cotton fibre finish.

Key Questions

- **What are the negative effects of sending paper and board to landfill sites?**
- **Why is it encouraged to recycle paper and board?**
- **To help picture what 200kg of photocopy paper would look like, calculate how tall a stack would be if you stacked on ream on top of another. One ream (500 sheets) of 80gsm A4 photocopy paper weighs 2.5kg and is 75mm tall.**

Year 11 Knowledge organiser— Working with paper & boards

Selecting suitable papers and boards

Which type of paper or board to use for a product depends on the a number of factors including:

Aesthetics	Required finish
Size of product	Availability of stock
Where it will be used	Weight
Stability	Desired properties
Cost	Workability
Size available	How long it is to last

Standard material stock forms, types and sizes

Papers and boards are available in three main formats; rolls, sheets and ply.

Paper and board shaping, cutting and processing

Marking out and cutting tools

Steel rule	Paper shears
Maun safety rule	Rotary cutting wheel
Craft knife	Drawing aids
Scalpel	Cutting mat
Perforating tools	Rotary paper trimmer
Creasing tools	Creasing machine

Cutting scoring and perforating

Cutting and scoring lines on paper and board involve the same process but differ in the amount of pressure used.

Creasing and folding

A crease is a line or mark that remains present when a material has been folded. Creasing & folding involves crushing the fibres of the paper or board in order for it to remember a shape

Standard components; fasteners seals and bindings.

Common fasteners

Paper fastener - split pin	Treasury tag
Bulldog clip	Prong paper fastener
Binder clips	Paper clip Self-
adhesive foam pad	Staple Rachet
rivet	Slide binding

Common sealing methods

Self-adhesive envelope	Tamper-proof stickers
Easy open tear strip	Wax seal
String and button	Gummed envelope seal

Common binding methods

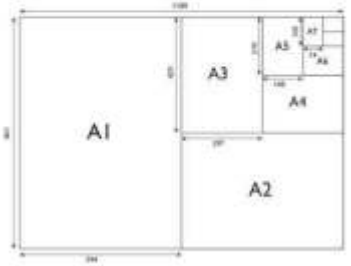
Perfect binding	Coil or spiral binding
Wire binding	Comb binding
Hardcover binding	Saddle stitch

Paper sizes

Paper is cut into a series of standard sizes. The standard sizes are set by ISO.

The series are A, B and C.

A series - main sizes for paper. B series - used more in industry C series - used for envelopes



Key Questions

- **Find images of the tools that are used to mark out and cut papers and boards.**
- **Find examples of products that are made from rolls of paper, sheets of paper and ply of paper.**
- **Why should you use a cutting mat when cutting and scoring with a blade?**
- **Draw a net for a cube that is 50mm on all sides. Add tabs in the appropriate places so that it can be joined together.**
- **Create a flowchart to show the stages of die cutting for non-industrial machines.**
- **What is laminating and encapsulation (school-based)?**
- **Find images of the standard components: fasteners, seals and bindings.**

Year 11 Knowledge organiser— Commercial manufacturing with paper & boards

Using papers and boards for commercial products

We come into contact with industrially produced paper and board products on a daily basis.

Flyers - was the cheapest way to promote or sell a product or a service. Made from cheap low grade paper with one colour printing.

Leaflets - This would have used a higher grade paper suitable for full colour printing. Leaflet would be more likely to be kept.

Card based food packaging - Most takeaway food and drinks packaging is either plastic or card based. Paper and board based products are fully biodegradable and recyclable. Problem with card, is that it's absorbent if not treated. An example of this is Tetra pak.

Die Cutting (industry-based)

Commercial products like food cartons, are commercially die-cut. The die consists of special steel rules that either cut, crease or perforate the material that are being pressed into.

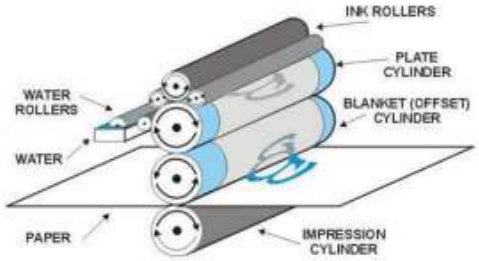
One of the most common die cut features that you will recognise is the euroslot.

Colour printing

Commercial colours are based on blending specific amounts of base colours to form required shade or tone. There are two main ways to form colour. RGB (red, green, blue) and CYMK (cyan, magenta, yellow and key [meaning black]).

Offset Lithography

Mass produced printing and very long print runs tend to use offset lithography, aka offset printing.



Using additives

Many different coatings can be applied to paper to alter its functional properties.

The most common is sizing which is used to control the absorbency of the paper.

Printing paper is often coated (sized) with clay, chalk or other fine powder-based minerals which increases its smoothness and reduces absorbency.

Polymers or waxes are used as coatings to make material waterproof.

Embossing and debossing

Embossing - creates a raised profile or pattern on the surface of paper.

Debossing - creates a recessed profile or pattern on the surface of the paper.

The process involves two plates being created, the fibres are permanently compressed and

Printing

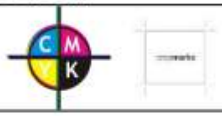
The most common surface finish applied to paper and board products is print.

There are many types of printing techniques and processes - in school and at home you'll probably use inkjet or laser printers.

Registration and crop marks - QC

As part of QC procedures commercially printed products need to checked to ensure that all the different coloured inks are aligned correctly (registration marks).

Crop marks show the printers where to trim the sheet.



UV Varnishing

This allows for all or part of the surface to be printed with a shiny transparent varnish.

Lamination

This is the application of a polymer film to the surface for the product. It protects the document to ensure it lasts longer

Key Questions

- **Create a moodboard of images that include; Flyers, leaflets, card based food packaging.**
- **Create a flowchart to explain the process of Die-Cutting (industry basd).**
- **Gather information explaining how offset lithography works.**
- **Explain the terms; registration marks, crop marks.**
- **Explain the terms and fins examples of printing, embossing, debossing, UV varnishing, lamination.**

Year 11 Knowledge organiser— Wood SOURCES ORIGINS & PROPERTIES

Timber conversion

After a tree is felled and cut into manageable lengths, it is then converted into planks at which point it is known as timber. Timber is supplied in two main types of finish: rough sawn or planed all round (PAR).

Seasoning

Once timber is converted into a workable form, it is seasoned in order to reduce the moisture content. Typically, a newly felled tree will have a moisture content of over 50%, and is known as green timber. The moisture content needs to be reduced below 20% for most exterior applications, below 15% for interior work and below 10% for interior areas that are constantly heated.

There are two methods of seasoning:

- Air drying
- Kiln drying

Key Questions

- **Which type of timber surface finish do you think is the most expensive to produce, PAR or rough sawn? Justify your answer.**
- **Why does timber for interior use need a lower moisture content?**
- **How is timber air dried?**
- **How is timber kiln dried?**
- **The end grain of timber planks is often covered with a sealant? Why do you think this is done?**
- **If you had the choice of two identical tables made from mahogany, one sustainably sourced which costs £200 and one from an unmanaged supply at £100, which would you choose, and why?**

Manufactured boards

Natural timber is combined with adhesive to make manufactured boards. They can be made from waste, low-grade and recycled timber and are usually produced in a pale brown natural finish.

Each board is produced in a slightly different way; the two main processes used are lamination and compression.

Lamination - examples include plywood and blockboard.
Compression - examples include MDF, chipboard and hardboard.

Advantages	Disadvantages
• Available in large sheets. • Very stable. • No defects such as warping, twisting, cupping and splitting. • Do not have knots or resin pockets. • Smooth finish which requires very little preparation. • Makes use of low grade, recycled and waste wood. • Available in many different finishes, veneers and laminates.	• Adhesives used bond can contain hazardous particles or VOCs • Machining and sanding causes very small particles of dust to be released. • Tools can blunt easily owing to the adhesives. • Many traditional wood joints cannot be used effectively. • Edges can be hard to finish. • Are prone to absorb moisture if not treated.


Blockboard


Hardboard


OSB

Veneer

Some boards are covered in a thin slice of natural timber called a veneer. This is applied to the surface of cheaper sheets of material to give them a high-quality appearance, making them aesthetically pleasing.

There are 2 methods of veneer production; rotary and knife cut. The image on the right shows the rotary method.

Sustainable timber production

Wood is considered to be a sustainable product, as new trees can be grown to replace those used for timber and fuel.

A main issue facing timber production is that in many parts of the world, it is being used at a far greater rate than it is being replanted. Some countries are suffering from desertification due to deforestation. This activity is also thought to be a contributing factor in global warming.

FSC® PEFC™

To ensure that timber comes from a reputable source, it is vital to know the provenance of the wood. This means that the supplier or retailer should be able to prove that it has been sustainably harvested.

The symbols on the left are of 2 organisations that make the process much easier and are both dedicated to ensuring that timber supply is regulated.

Year 11 Knowledge organiser— Working with Wood /Manufactured wood

Key Questions

- How many square metres of material are there in a standard full size board of 2440mm x 1220mm?
- Why is it good practice to drill a pilot hole?
- Why are the Allen key and Torx screws less prone to slipping when being driven in?
- How can steel hinges be modified to protect them from rust?
- What is the most essential piece of PPE to be worn when using a pillar drill?
- Do some research on saw blades and explain the following terms: a) tooth pitch, b) Kerf.
- When sanding a rough piece of timber to a smooth finish, would you start with a high number frit and work lower, or a low number and work higher?

Boards and plank sizes

- Manufactured boards come in a series of standard sizes. Thicknesses tend to start at 3mm and 4mm. From 6mm thicknesses rise in 3mm steps.
- Single veneer thicknesses vary from 0.4mm to 4.5mm , but are commonly 1.5mm thick.
- A full size sheet of manufactured board is 2440mm long by 1220mm wide.
- Plank widths are of standard sizes and generally increase in 25mm stages. A common size is 50mm x 25mm used for frame and carcase construction.
- PAR sizes tend to be 2-3mm less per side in width and thickness than rough sawn.
- Plank lengths vary and can often be bought by the metre. Common lengths are 1.2m, 1.5m, 1.8m, 2.4m, 3m and 3.6m, normally increasing to a maximum of 4.8m.

Mouldings - specially shaped sections of wood, most common variety can be seen around door frames (architrave) and ornate skirting boards.
Dowel rods - circular sections of timber that come in different diameters.
Knock-down fittings - Flat pack furniture relies on KDF. They are a form of temporary fitting that joins 2 or 3 pieces of material together. Easily dismantled for transportation or storage.
Hinges - Used to attach doors, windows and other openings to frames and carcases. Most commonly made from metal. Must be carefully aligned to ensure accurate operation.
Woodscrews - To fix two pieces of wood together. They are available in many different lengths and diameters. Screws come with different driving methods, most common being slotted, phillips and Pozidriv.
Nails and Pins - Threadless versions of screws and are either hammered into position or a powered nail gun can be used.

Drilling - drilling a hole into a piece of wood seems a simple task but there are a number of factors to consider (drill bit, speed, depth).
Cutting and sawing - Saws are used to cut materials and joints to size. Saws you may come across; tenon saw, rip saw, cross-cut saw, coping saw.
Sanding - *This is to give the wood a smooth finish, it can be performed with machines or by hand. Hand sanding uses glass paper.*
Wood turning - Wood lathes are used to turn bowls and spindles. Size of the material is important (speed is adjusted as the diameter gets larger).
Laminating - this involves bonding strips of material together in layers.
Bending - To achieve ornate curves and shapes you soak the wood in water until it softens.

Key Task

For each of the following tasks, you need to create a table with the following headings; name, characteristics and image.

1. Common types of nails and pins.
   a. Round wire nail
   b. Panel pin
   c. Clout nail
   d. Oval wire nail
   e. Tack
   f. Lost head nail
2. Common types of hinge.
   a. Butt hinge
   b. Flush hinge
   c. Butterfly hinge
   d. Piano hinge
   e. Concealed hinge
   f. Tee hinge
3. Common drill bits with wood based materials.
   a. Wood drill bit
   b. Twist drill bit
   c. Countersink bit
   d. Hole saw
   e. Flat bit
   f. Forstner bit
4. Wasting tools
   a. Smoothing plane
   b. Chisel
5. Abrading tools
   a. Rasp
   b. Surform
6. Common wood joints
   a. Butt joint
   b. Dowelled joint
   c. Mitre joint
   d. Housing joint
   e. Mortise and tenon joint.

Year 11 Knowledge organiser— Commercial manufacturing of wood & manufactured wood

Commercial products

They are nearly always aimed at a certain price point and this often determines the quality of the chosen construction material.

If a manufacturer wanted to save production costs, they could decide to use a softwood such as pine or spruce. The result would have slightly different aesthetics, being yellower with a more pronounced grain.

Commercial routing and turning

Most machining and shaping of furniture, etc is now done by CNC routers for flat materials and CNC lathes for cylindrical objects. This gives great repetitive accuracy and level of details that would be difficult to do by hand.

Surface treatments and finishes

Most woods perform better if they have a finish applied to them.
Reasons for applying a finish are:
Aesthetics - colouring or staining to; match or contrast with existing materials, enhance the natural grain, give it a sheen or shine or even a matt finish.
Protection - can mean making it: waterproof, less prone to fungal or insect attack, tougher so it resists knocks and bumps, easy to wipe clean and disinfect.

Quality Control

When products are made, checking that they are being produced correctly is an essential stage. This is known as Quality Control (QC) and ensures dimensional accuracy is consistent or that the product is safe.
To save checking every vital measurement, specials tools known as go/no go gauges are used.

These tools are set to specific minimum or maximum tolerances allowed for a particular component. It is then a simple task of placing a the fixture onto the part of the workpiece being measured. The gauge will check and if needed the par can be easily rejected.

Flat-pack furniture

Manufactured boards are most often seen commercially in flat-pack furniture

Advantages	Disadvantages
• Compact for ease for transportation • Low cost compared to traditional furniture • A large choice of styles and finishes • Easy to assemble with limited tools and experience • Can be disassembled for storage/moving.	• Needs to be constructed yourself or by someone else at an additional cost • Not as robust as traditional furniture • Can be complex to construct for some • Prone to damage by moisture • Can chip and break more easily

As manufactured board is so dimensionally stable it can be processed, transported, stored and assembled without risk of developing the faults of natural timbers. Although it can be prone to absorbing moisture in damp and humid conditions.

Common protections and finishes

Most finishes for woods are available with a range of different base liquids. 3 categories are: oil, solvent and water.

Name	Characteristics
Wood Preservative	Painted on to protect wood from fungal or insect attack, and prevent rot and decay.
Varnish	Protects from moisture, can be coloured with stain. Enhances the grain.
Oil	Similar effect to varnish but soaks into the timber rather than sitting on the surface.
Paint	Painted with brush or roller, usually needs primer and undercoat on bare wood.
Stain	Permanently colours wood, does not protect it.
Wax	Rubbed into the wood with cloth or wire wool, enhances natural grain, needs regular application.

Key Questions

- **What are the advantages to manufacturers of producing a range of flat-pack furniture?**
- **What factors make flat-pack furniture cheaper than traditional pre-assembled furniture?**
- **What are the benefits of using go/no go fixtures in product manufacture?**
- **Why should you reapply surface treatments and finishes in accordance with the manufacturer's instructions, or when signs of wear occur?**

Year 11 Knowledge organiser— Metals sources, origins & properties

Metals are found in the earth's crust and are obtained through mining. There are two main types of mining for metal and ore, they are:

Surface mining

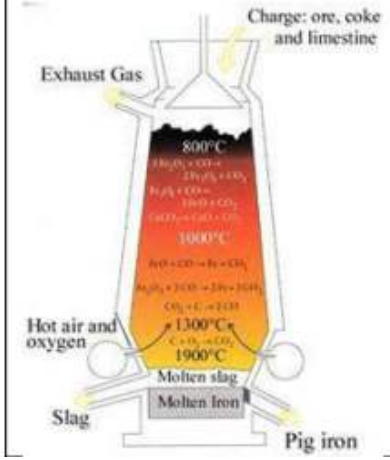
Underground mining

Both methods cause some destruction to the natural environment but surface mining creates much more a visible scar.

Extraction of metals

Once the raw material has been mined, the metal is separated from any waste material. This tends to be done in a furnace although different metals are processed in different ways.

The process of extracting iron from iron ore involves a blast furnace that can reach temperatures of around 1,700°C. Iron melts at 1,538°C and therefore starts to become a liquid as it descends through the furnace,

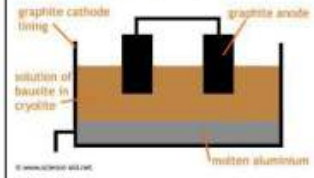


eventually running free from the rest of the ore, which becomes waste product known as slag.

The molten iron is heavier than the slag and therefore sinks below it to be collected at the bottom of the furnace where it is drained off.

Bauxite

Aluminium is extracted from bauxite which is the most abundant *(having plenty of)* ore on the planet. Once the bauxite is mined it is washed to remove clay minerals and other impurities. The resulting aluminum oxide is then extracted using electrolysis (expensive process).



The aluminium, in its liquid form, is separated from any unwanted elements and cast into required forms. It takes 4kg bauxite to make 1kg of aluminium.

The process of refining metals simply means purifying them to improve the quality and functionality. Different processes are used to refine different metals and the level of purity obtained also vaires.

Worth knowing

Duralumin - light grey, finishes like aluminium - greater hardness and tensile strength that pure aluminium - aircraft components, sports car wheels, casings.

Sustainability of metals

Almost all metals are recyclable. When metal is recycled and melted down the resulting recycled metal is of the same quality as the original. This in contrast with other materials, they will tend to be of a lower quality.

Metals are considered as a finite resource. Designers must therefore consider the amount of metal needed in a product and how easily recyclable it will be when the product reaches the end of its life.

Metals must be separated into their pure form when been recycled, as small amounts of other metals in the recycling process can degrade the quality of the recycled metal.

Ferrous metals are picked up by a giant magnet at a scrapyard

All metals require vast amounts of energy to produce and to recycle, but metal products tend to last a long time, thus reducing the need to replace parts or products so frequently.

Metals that are thrown into landfill, harmful metals can leak into the soil and water contaminating it.

Key Questions

- **Explain the factors that make metal such an energy hungry material to produce.**
- **Which physical properties can be gained by reducing the carbon content of pig iron through further processing?**
- **Why is duralumin a better choice than aluminium for certain aircraft?**
- **What are the implications of metal being considered a finite resource?**
- **What are the positive impacts of recycling metals?**

Year 11 Knowledge organiser— Working with Metals

Selecting suitable metals
Which type of metal-based material to use for a product depends on the a number of factors including:

Aesthetics	Required finish
Size of product	Availability of stock
Where it will be used	Weight
Stability	Desired properties
Cost	Workability
Size available	How long it is to last

Machine screws differ from wood screws by having a finer thread and a parallel shank with no point on the end.

Nuts and bolts are available in many different lengths, diameters and thread pitches. Bolts come fully threaded or partially threaded; the unthreaded part is called the shank The shank has 2 uses; firstly, it may support a moving or rotating part. Secondly the length of the shank reduces the elasticity of the bolt.

Key Questions

- **Explain the difference between bars, tubes and rods.**
- **Why should nylon nuts only be used once?**
- **Which type of turning techniques would be used to create a grip on a bar?**
- **What could potentially happen if no flux was added to a joint before brazing?**

Rivets are used to join two or more pieces of metal together, and are often used on sheet metals to create a very strong semi-permanent fixing. They are heavily used in aircraft, shipbuilding and automobile industries as they avoid the need for welding.

Standard material stock forms, types and sizes

- They come in a range of standard sizes and shapes including sheets, rods, bars and tubes.
- Standardisation enables materials to be interchangeable and for the manufacturers of tools to be aware of the materials they will need to deal with.
- Standard dimensions for metal-based materials are given as *length* x *width* x *thickness* for sheet and flat bar.
- For box sections and many other shaped profiles, you will need the profile shape, and the *diameter* x *length*.
- Threaded rod - known as studding needs *diameter* x *length*. The pitch of the thread may need to be considered if fine or coarse threads are required.
- Metric is the standard measuring system for metal material forms.
- Wall thickness is often measured in millimetres; this thickness is known as gauge.

Name	Characteristics	Name	Characteristics
Nut	Usually a hexagonal profile used on bolts and machine screws to apply pressure.	Nyloc	Single use vibration resistant nut that stays in position, nylon insert tightens up on thread.
Bolt	Usually hexagonal profile used with a nut to apply pressure.	Grub screw	Headless screw with sharp point used to secure items such as a door handle to a shaft.
Machine Screw	Many different driving methods and profiles, very versatile.	Snap rivet	Semi-permanent joining of two or more metal parts, access to both sides needed.
Pop rivet	Semi-permanent joining of two or more pieces of metal, only one-sided access needed	Washer	Used with machine screws, nuts and bolts to spread the load, some prevent loosening.

Year 11 Knowledge organiser— Commercial manufacturing with Metals

Hardening and Tempering
Hardening is done through heating to a predetermined temperature, and quenching it in water or oil. This makes the steel harder but makes it more brittle.
Tempering is used to make steel less brittle. It is heated once again to a specific temperature between 230°C and 300°C. The metal is then quenched again. The exact temperature will depend on how tough or hard it needs to be.

Commercial casting Foundries form metal into a multitude of different shapes, sizes, components and parts. Workers are highly skilled and able to cast items ranging from small artefacts to huge parts.

Each casting needs to have a pattern made to precise measurements. This will mostly be done by CNC machines, but in the past pattern-makers have traditionally handmade the patterns to cast.

Commercial milling and turning
Machining and shaping metal artefacts and components are frequently done using CNC milling machines or CNC lathes. They allow for great repetitive accuracy.
Modern CNC milling machines are able to use multiple cutting tools with automated head changes. They are also able to cut along 5 axes, making complete 3D parts in one process.

Quality Control
QC checks ensure dimensional accuracy is consistent.
A depth stop can be found on most pillar drills. This allows for all holes being drilled are the same depth in the material.

Other quality control tools known as go/no go fixtures are available to ensure accuracy and consistency. These tools are set to the specific tolerance allowed for that particular component.

Common protections and finishes for metal-based products

Name	Characteristics	Name	Characteristics
Plastic dip coating	Metal is heated and dipped in powdered plastic that bonds, protects, insulates and adds grip and aesthetics.	Powder coating	Electrostatically applied dry powder paint that is cured by heat and bonds to metal, tough, even finish.
Metal lacquer	A clear varnish-like finish, applied to metal (often sprayed) to protect and create a sheen, gloss to matt finish available.	Metal primer and pain	Special primer and paint used to protect metal from the elements.
Hot blackening	A black oxide finish is obtained by dipping into heated tanks of chemicals and oil.	Electroplating and anodising	Both use an electric current. Plating adds a layer of another metal to the surface. Anodising changes the surface structure.
Polishing and brushing	A natural finish for aesthetics, the surface is buffed to a mirror finish or uniformly scratched.	Galvanizing	Zinc is coated over steel products to protect from corrosion. Hot-dipped or electroplated.
Rust stabiliser	A liquid painted on to rusty steel to harden any corrosion and prevent further occurrence.	Shot/ sand blasting	Particles of sand or lead shot are fired under pressure to remove layers of paint or to create an aesthetic effect.

Key Questions

- **Why is stainless steel used for kitchen utensils and not mild steel?**
- **What are the advantages and disadvantages of using aluminium over stainless steel for kitchen utensils?**
- **Explain why the blade of a chisel needs to be hardened and tempered.**
- **Explain how the use of a depth stop on a drill speeds up production and reduces labour costs for quality control inspection of batch produced products.**

Year 11 Knowledge organiser— Polymers Sources, origins and properties

Polymers.
Polymers can be created from 3 different sources. Most are made from petrochemical resources such as oil, gas and coal.
Some are made from natural materials such as amber and rubber.

Biopolymers
Are natural polymers made from starchy vegetables such as corn or plants containing lots of fibre, fat or carbohydrate.

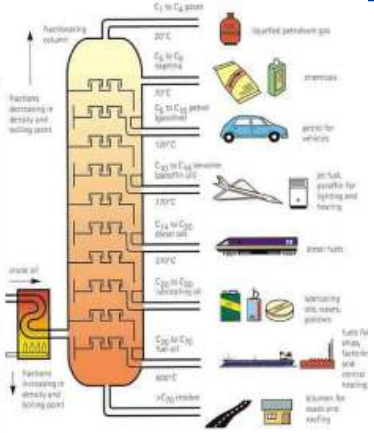
Cracking
The oil that has now been split into different fuel products is now unstable and contains large hydrocarbon molecules. These do not flow well and are not suitable to be converted into plastics. Cracking is the process of converting these large molecules into smaller more useful ones.
Heat is used to achieve the correct molecules for use in plastic production. The 2 most significant products gained from this are ethane and propane.

Categories -
There are 2 main types of plastics. These are :

Thermoplastic
Flexible when heated.
Formed and reformed into shapes when heated multiple times.
Easy to recycle.

Thermosetting Plastic
Rigid once heated and formed.
Cannot be reformed.
Excellent electrical insulators and have a good resistance to heat and chemicals.
Hard but brittle.
Cannot be easily recycled.

Fractional Distillation
Refining the black 'sticky' crude oil allows for it to be used for other purposes for example if your look at the chart you can see how it can be refined for petrol for aircraft or cars, or even bitumen for roads.
Oil is heated in the CDU (crude oil distillation unit) as the oil is heated it allows for it to split. Each product has a different boiling point and condenses at a different temperature this allows for it to be drawn off at different points.



Additives
Polymers (plastics) can be further enhanced through the introduction of additives.
Plasticisers - make the plastic soft and flexible e.g. PVC.
Pigments - add or change the colour of the plastic.
Stabilisers - help to make the plastic resist UV light damage which is useful for products that are used outside - ***see image of chairs below.*** **Fillers** - increases the bulk of the polymer which helps improve its resistance in an impact.
Fragrance - Fragrance can be added to plastics, this is for air fresheners and some childrens toys.

Melamine
Found in picnic crockery, melamine resists scratching and enables it to keep its aesthetic appeal, it can be easily cleaned after use. It is more durable than glass or ceramic

Key Questions

- **Describe how polymerisation is used to make plastics.**
- **Which plant based materials can be used to make sustainable plastics?**
- **Define the term thermoforming plastic.**
- **Define the term thermosetting plastic.**
- **Why are plastics so good at helping designers solve technical problems?**
- **What factors make plastic a value-for-money material?**
- **How can thermosetting plastics be recycled?**
- **Why does biodegradable plastic break down so readily when incontact with soil?**
- **Why should biodegradable plastics not be recycled?**

Year 11 Knowledge organiser— Polymer commercial manufacturing

Working properties

Stock forms

Metric is the standard measuring system for plastics.
Sheet's starts at 1mm thick and increases to 20mm thick, length and width will vary depending on requirements.
Rod is available from 2mm to well over 100 mm in diameter.
Tube is available from 5 mm to around 1meter in diameter.

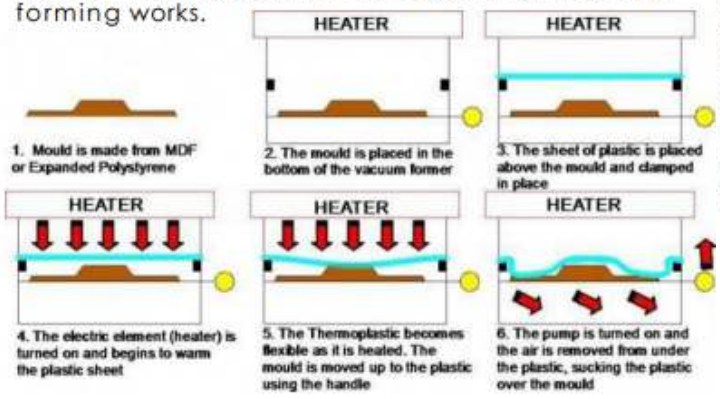
Tubes are a little more complicated to measure as you will need to decide on the wall thickness.

Gauge

Wall thickness is measured in mm however this is known as the gauge. Tubes may still be sold in this way. As the gauge number increases the wall thickness decreases.

Vacuum forming

Look at the image below to explain how vacuum forming works.



Plastic powder and granules.

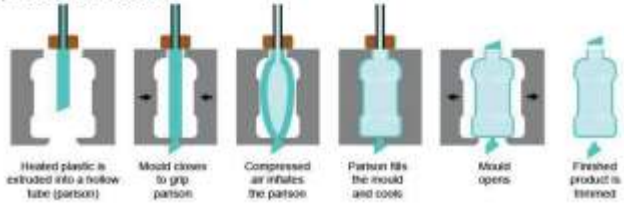
Plastic granules are mainly used in plastic processing such as plastic dip coating, injection moulding and extrusion.
Powders tend to be used by bonding them to a surface of a hot item for example metal.
Both are available in a wide range of colours.

Film and foam

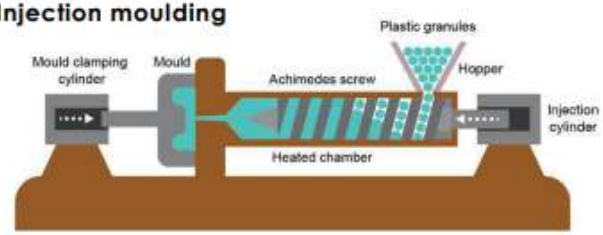
Mainly used for food packaging, films can be heat sealed to make them airtight and tamper proof. Expanded foam for example polystyrene. It is incredibly lightweight and protects the contents of a packet or box. They are used in car dashboards and bumpers to help sorten impacts. You can also use them in the furniture industry to soften seating and beds.

Blow moulding

Blow moulding starts off with a blank which is injection moulded. This is placed into the mould (see image).
The mould is heated and air is introduced to force the warm plastic into the bottle form. Once complete the bottle is released and cooled.
Trimming of all extra Plastic then occurs.

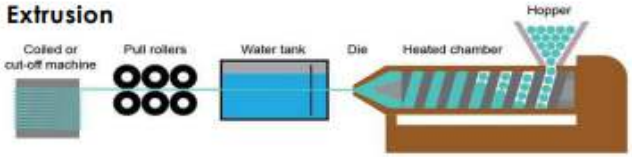


Injection moulding



Granules or pellets are fed into the **hopper** the hopper feeds the **Archimedes screw** that drags the granules past a heater, where they melt the plastic is **softened** as it reaches the end of the screw, where it collects until there is enough to fill the mould at this point an **injection cylinder** forces the molten plastic into the mould under pressure, filling it up the plastic sets quickly, the mould is separated and the **clamping cylinder** releases the moulding.

Extrusion



Same as above however A continuous flow of molten plastic passes through the die at just the right temperature to hold the shape the extruded plastic then passes onto a cooling table or cooling trough where it fully solidifies.

Quality Control

Quality Control (QC) checks are carried out to ensure that each product is being produced to the correct specification.QC checks are made to make sure that each product meets a specific standard and is safe to use.

Year 11 Knowledge organiser— working with polymers

Selecting suitable polymers
Which type of polymer-based material to use for a product depends on the a number of factors including:

Aesthetics	Required finish
Size of product	Availability of
stock Where it will be used	Weight
Stability	Desired properties
Cost	Workability
Size available	How long it is to last

Stock forms, types and sizes
Most plastics come in a wide range of standard shapes and sizes.

Standard dimensions
Sheet - length x width x thickness Rods - length x diameter
Tubes - length x diameter x wall (material) thickness.

Metric is the standard measuring system for plastic forms.

The standard forms of polymers are:

- Sheet
- Rods
- Tubes
- Powder
- Granules
- Foam
- Films

Standard components
To temporarily attach plastic to itself or other materials a few different methods can be used.
Machine screws have a finer thread than self tapping screws and the have no point on the end. Plastic can be internally tapped with a screw thread, allowing machine screws to be inserted, but the internal thread can easily strip if too much torque is applied.
Hinges are often used to attach doors, windows and othe opening to frames and carcasses. They can be made from many materials but are most commonly made from plastic and metal.
Plastic hinges can be welded, glued, screwed or bolted to other plastics. If attached using screws or bolts, they will need to be countersunk so that they lay flat or flush, meaning the hinge can completely close.

Common types of hinges for use with plastics

Name	Characteristics
Plastic butt hinge	Standard hinge for openings, can be glued, welded or bolted to the product.
Plastic fold hinge	Extruded profile, holds two sheets of plastic, single centre layer allows flexing.
Butterfly hinge	Decorative version of the butt hinge, can be mounted on plastic with countersunk nuts and bolts.
Piano style hinge	Long plastic butt-style hinge, cut to required length.
Plastic or glass door hinge	Allows sheet materials to be held with clamping grub screw.
Flush hinge	Thin profile, mounted with small countersunk nuts and bolts.

Shaping, processing and machining Drilling - requires careful speed control. The larger the diameter of the drill bit the slower the drill should be rotating.
Cutting/sawing - Hacksaw, junior hacksaw and coping saw are common saws for cutting plastic.
Abrading - Abrading can be done either by machine or by hand. If you are to do it by hand you'd use a file and wet & dry paper.
Line bending - Strip heaters are used for line-bending which is a good way to create a permanent fold in a piece of thermoplastic.
Vacuum forming - Vacuum formed products include items such as chocolate trays and bath tubs.
3D printing - it enables physical objects to be formed from reels of thermoplastic. They use special CAD files (STL or VRML).
Resin casting - Thermosetting polymers can be used to cast into a mould where it sets and permanently takes the shape of the mould.
Welding - Plastics can be heat welded or chemically welded.

Key Questions

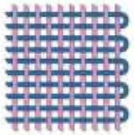
- **Why is plastic an ideal material for large outdoor children's toys such as slides or sit-in cars?**
- **What are the advantages and disadvantages of using thermoplastics for kitchen utensils?**
- **Suggest 3 objects other than bottle lids that are commonly injection moulded?**
- **A material is being engraved using a laser cutter. The settings read 100% power and 100% speed. Which setting would you change in order to make a deeper engraving?**

Year 11 Knowledge organiser— Textiles Sources, origins and properties

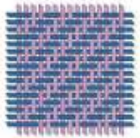
Textiles can be made from either natural or synthetic fibres, but frequently the two are combined to produce a number of modern textiles that have improved functionality.

Fibres
Fibres, whether natural or synthetic, usually need to be spun or twisted to make a yarn. There are 2 types of fibre:
Filament - long and make a smoother yarn.
Staple - short and make fluffy/hairy yarn.

Weaving
There are many types of weave, the most commonly used are plain weave and twill weave.



Plain weave



Twill weave

Twill weave is a more complicated technique, as the weft goes over 2 or more warp yarns to create a diagonal striping on the fabric.

Twill weave can create a number of interesting patterns such as houndstooth and herringbone.

Flame retardants
Most homes are furnished with textile based products which all have the potential to burn. In order to reduce fabric combustion and potential fire hazards, flame retardants are used.The two labels below tend to be attached to textile products highlighting the fire precautions.

Flame retardants are designed to produce a chemical reaction that slows down and even stops ignition taking place. The two types of flame retardant used on textiles are halogenated and phosphorus.

Sustainability of textiles
Almost all textiles are recyclable or biodegradable. Some textiles are reused in crafting activities such as applique and patchwork quilting or simply altered, reshaped or repaired.

Many people take old clothes to charity shops where they maybe sold. When items are no longer fit for purpose, they can be physically recycled.

Other textiles

Plant based natural fibres and textiles	
Name	**Uses**
Linen (flax) 	Lightweight summer clothing, tablecloths, tea towels, bed sheets, upholstery.
Blended and mixed fibre textiles	
Name	**Uses**
Cotton and elastane blend 	Socks, underwear, sportswear, stretch denim and other stretch clothing
Synthetic fibre textiles	
Name	**Uses**
Acrylic 	Clothing, faux fur products, soft toys, upholstery, carpets.

Key Questions

- **Why is twisting used as the main method to create yarn?**
- **Why do you think nightclothes are specifically covered by flammability guidelines?**
- **Why is donating usable clothes to charity shops more environmentally friendly than sending them for recycling into recycled yarn?**
- **How does halogenated and phosphorus flame retardants stop textiles becoming alight by a flame.**

Year 11 Knowledge organiser— working with Textiles

Key Questions

- **What factors make reels of yarn the most appropriate for manufacturing by machine?**
- **How do pinking shears reduce the chance of a material fraying?**
- **What factors make batik dyeing techniques a labour intensive process?**
- **Explain which stitch would be the best to use on lycra?**

Selecting suitable papers and boards

Which type of paper or board to use for a product depends on the a number of factors including:

Aesthetics	Required finish
Size of product	Availability of stock
Where it will be used	Weight
Stability	Desired properties
Cost	Workability
Size available	How long it is to last

Standard material stock forms, types and sizes

Standard practice when measuring fabrics is length x width. Another factor to consider is the weight of the fabric.

Fabrics are mostly available by roll and are cut to length as required.

Common fasteners used with textiles

Button Velcro Hook & Eye Buckle

Eyelet Press Stud Zip Toggle

Layered and laminated textiles

Some technical textiles are available where two or more layers of the same or different fabrics are bonded together. This is usually to improve its physical properties. The different layers, sometimes known as ply, can be sewn together or bonded using heat or adhesive.

Cutting

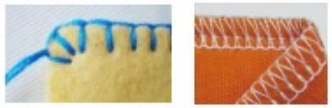
Cutting techniques vary depending on the material being used and the quantity required. Common cutting tools are listed below. ***Find an image of each piece of equipment and list their characteristics.***

Shears or tailors shears	Electric rotary cutting wheel
Rotary cutting wheel	Embroidery scissors
Seam ripper	Thread snips
Textile band saw	Pinking shears

Types of stitch

There are many different types of stitch which can be used depending on the task and finish required. ***For each of the stitches below list the characteristics of it.***

Running Stitch Back Stitch Chain Stitch ZigZag



Blanket Overlock

To ensure that the product is of a high quality, the length of the stitches and gaps should be kept as consistent as possible.

Different textile techniques

For each of the techniques below, gather information explaining the technique and images of products that use the technique.

Batik

Pleating

Gathering

Quilting

Piping

Year 11 Knowledge organiser— Commercial manufacturing Textiles

Textiles for commercial products

Commercial textile production has developed significantly over the last 50 years owing to new materials being invented as well as industrial manufacturing methods and high levels of computer driven automation.
Both 'technology push', in the form of new materials and 'market pull' with demand for greater fabrics, have contributed to a huge and expanding industry.

The introduction of stretch fabrics has transformed aerodynamics, especially seen in cycling and swimming, enabling items of clothing to fit tightly thus reducing drag yet allowing freedom of movement by the wearer.

Commercial development in the area of the home and business furnishings have led to a greater range of choice through colours, styles and levels of quality. Furnishings cover a multitude of interior, and increasingly, exterior quality textiles, including carpets, rugs, upholstery fabrics, curtains, cushions and many more.

Commercial printing

There are various commercial textile printing techniques available.
Commercial printing techniques include: **roller printing**, **screen printing**, **digital printing**.
There are a number of different techniques used to transfer designs to the fabric, these include: **Digital printing**, **mordant printing**, **discharge printing**, **resist printing**.

Surface treatments and finishes

Most textiles are given a surface finish so that they perform more efficiently. The reasons they are applied, are as follows:
Aesthetics - can mean manipulating the surface of the fabric to: make the surface smooth to improve sheen and lustre, receive embossed patterns, make the surface fluffy.
Functionality - can mean: resistance to water, resistance to staining, flame retardancy, ability to retain heat more efficiently, adding smart finishes such as insect repellent and anti-bacterial properties.

Key Questions

- **How have developments in commercial textiles helped to improve comfort and safety in motorsport apparel?**
- **Why do you think pressure and heat are used in some dyeing processes?**
- **Which method of dyeing uses a similar technique to resist printing?**

Commercial weaving

Many modern textiles are produced on large scale industrial looms which are often computer controlled. This automation allows the fabric designs to be created in special CAD software. Industrial looms can take a very long time to set up, but once running they can produce fabrics very quickly and accurately.

Commercial dyeing

There are a number of methods of dyeing yarns and textiles: ***Stock dyeing*** - in advance of being woven, separate fibres can be coloured
Piece dyeing - woven or knitted cloth, made first then dyed. ***Garment dyeing*** - whole garments are made from white fabric and then dyed.
Batch dyeing - uses tanks or vessels, yarn or fabric is added.

Quality Control

Quality control is vital to ensure dimensional and visual accuracy are consistent.
One of the main areas for quality control within textiles is checking a repeating print against an original sample. This ensures it repeats correctly both vertically and horizontally. It is not possible to get everything aligned perfectly, but it should look as good as possible

Common textile finishing techniques

Name	Characteristic
Flame retardancy	Flame retardant chemicals are applied to the fabric to reduce its ability to burn.
Stain Protection	Fabric is coated with an invisible stain resisting substance that prevents absorption into the fibres.
Waterproofing	Fabric is coated with a waterproofing substance that forms a seal.
Crease resistance	A resinous liquid is applied to the fabric which makes it quick drying and easy to iron.
Heat transfer printing	Inkjet printed design on special transfer paper is heat pressed onto fabric surface
Distressing	Including; bleaching, stone washing, spray painting, cutting, slashing scraping, filling and patching.
Calendering	Fabric is fed through rollers to smooth the cloth and/or permanently emboss designs.
Brushing	Fabric is passed through rough rollers that lift fibres to form a nap making it soft and more insulative.