Toynbee Curriculum
KS4 Knowledge Maps

DESIGN AND TECHNOLOGY

Toynbee School

AUTUMN TERM

- ALESSI KEY FOB LIGHT
- IPHONE STAND

YEAR 10 -AUTUMN

REVISION TOPICS

- Alessi
- CAD
- CAM
- Electronic Components (IPO)
- Flow Diagrams
- AI and Programming
- User Interfaces
- Material Properties
  - Working
  - Physical
- Consumer Choice
  - Market Pull
  - Technology Push
- Polymers
  - Thermoforming
  - Thermosetting
- Papers and Boards
  - Types
  - Stock forms and properties
  - Finishing techniques
- Designers
  - Philippe Starck
  - Matthew Williamson
  - Apple
  - Dyson
  - Airbus
- Life cycle assessment

YEAR 10 – KEY FOB	DESIGNER FOCUS - ALESSI

KEY QUESTIONS

1. WHAT ARE THE THEMES/STYLE OF ALESSI PRODUCTS?
2. WHAT COLOURS/FINISHES ARE MOST COMMONLY USED?
3. WHAT SHAPES/FEATURES ARE USED THROUGHOUT THE BRANDS DESIGNS?

YEAR 10 – KEY FOB

DESIGNER FOCUS - ALESSI

YEAR 10 – KEY FOB	COMPUTER AIDED DESIGN

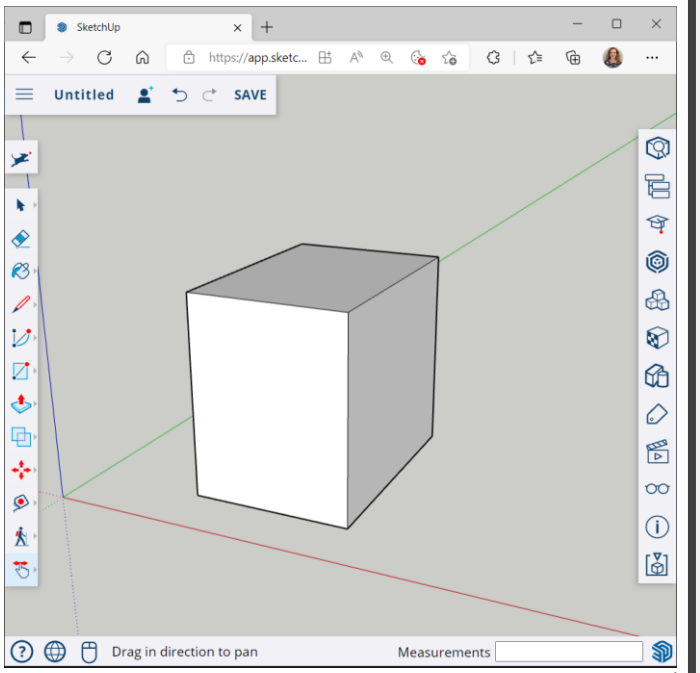
KEY QUESTIONS

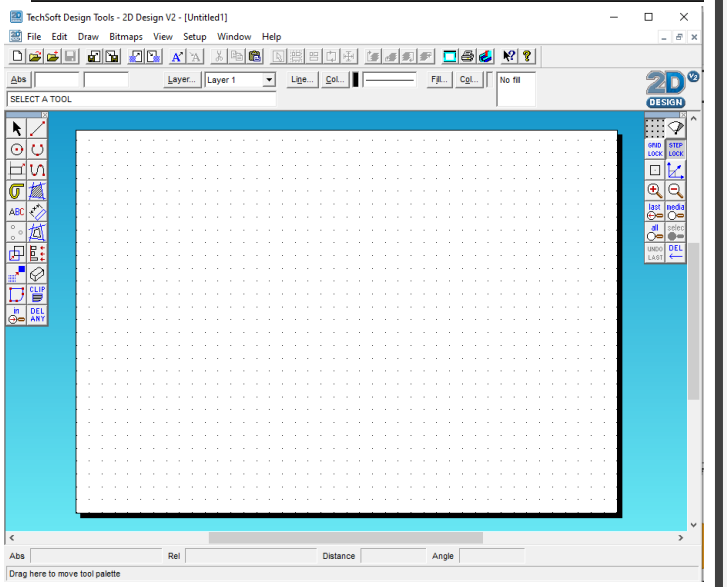
1. WHAT IS COMPUTER AIDED DESIGN?
2. WHAT ARE THE ADVANTAGES OF CAD?
3. WHAT ARE THE DISADVANTAGES OF CAD?
4. WHAT ARE SOME COMMON EXAMPLES OF CAD?

YEAR 10 – KEY FOB | COMPUTER AIDED DESIGN

COMPUTER AIDED DESIGN IS THE PROCESS OF USING SOFTWARE TO PRODUCE DRAWINGS –EITHER IN 2D OR 3D

Advantages	Disadvantages
Ideas can be drawn and developed quickly	Expensive to set up
Designs can be viewed from all angles and with a range of materials	Needs a skilled workforce
Some testing and consumer feedback can be done before costly production takes place	Difficult to keep up with constantly changing and improving technology
It becomes easier to design and test a range of ideas	Computers can fail





YEAR 10 – KEY FOB	COMPUTER AIDED MANUFACTURE

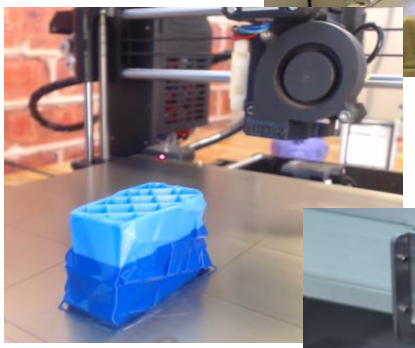
KEY QUESTIONS

1. WHAT IS COMPUTER AIDED MANUFACTURE?
2. WHAT ARE THE ADVANTAGES OF CAM?
3. WHAT ARE THE DISADVANTAGES OF CAM?
4. WHAT ARE SOME COMMON EXAMPLES OF CAM?

YEAR 10 – KEY FOB

COMPUTER AIDED MANUFACTURE

COMPUTER AIDED MANUFACTURING USES COMPUTERS TO CONTROL EQUIPMENT THAT MANUFACTURES.



Advantages of CAM	Disadvantages of CAM
Fast and accurate production	Expensive to set up
Machines can run constantly on repetitive tasks	Needs a skilled workforce of engineers
Good for producing on a mass/flow production line	Downtime required for maintenance
Less material wastage	Computers and machines can fail

YEAR 10 – KEY FOB	INPUTS AND OUTPUTS

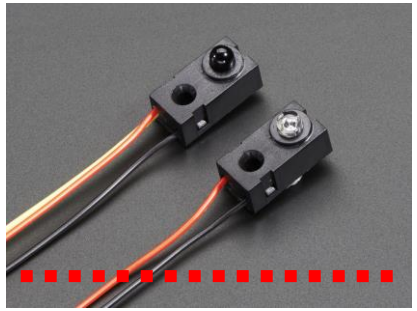
KEY QUESTIONS

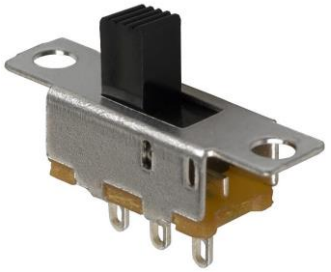
1. WHAT ARE INPUTS OR OUTPUTS?
2. WHAT DO INPUTS DO?
3. WHAT ARE SOME COMMON INPUTS AND OUTPUTS?

YEAR 10 – KEY FOB

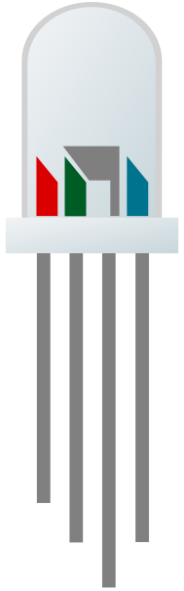
INPUTS AND OUTPUTS

Input: a place where, or a device through which, energy or information enters a system (often sensors or switches)





Output: a place where power or information leaves a system.



YEAR 10 – KEY FOB	FLOW DIAGRAMS

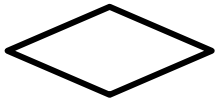
KEY QUESTIONS

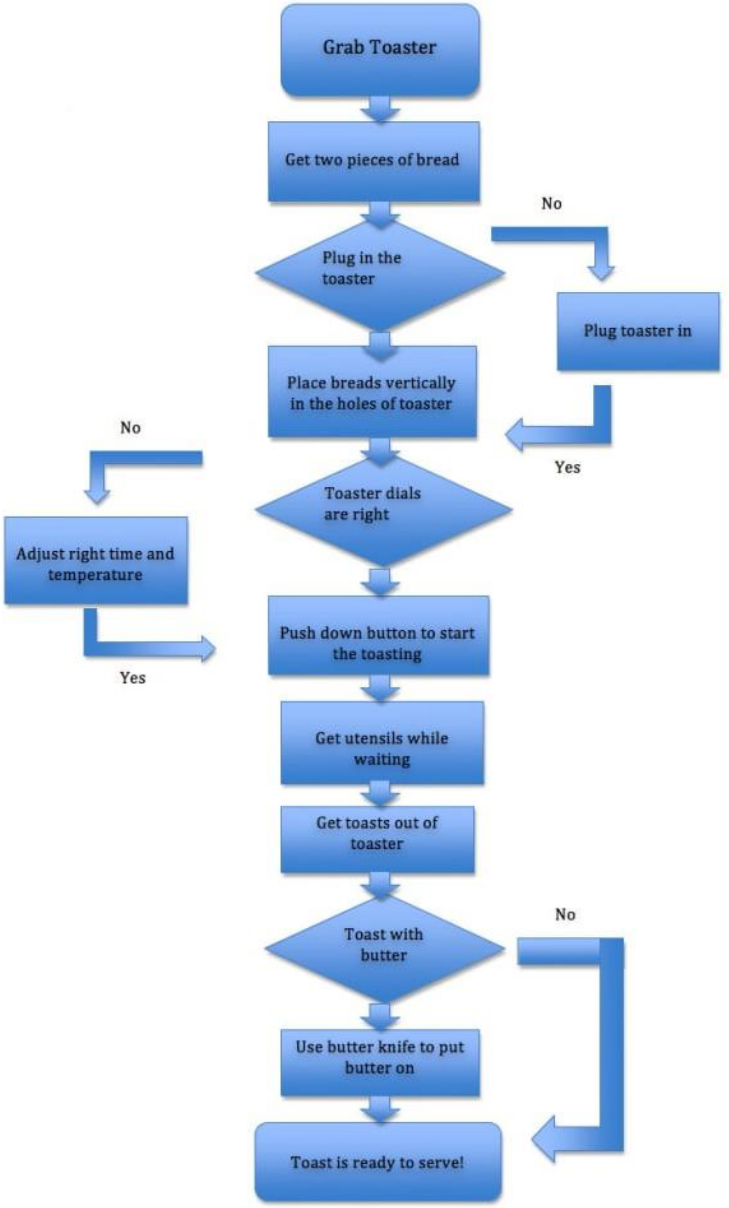
1. WHAT ARE FLOW DIAGRAMS USED FOR?
2. WHAT DO THE SHAPED BOXES MEAN?
3. WHAT ARE THE CONVENTIONS WHEN DRAWING FLOW DIAGRAMS?
4. WHAT ARE FEEDBACK LOOPS AND WHY ARE THEY IMPORTANT?

YEAR 10 – KEY FOB

FLOW DIAGRAMS

Flow diagrams can be used to document a process to understand it more clearly – and sometimes spot inefficiencies

Symbol	Name	Function
	Start/End	An oval or lozenge represents a start or end point
	Arrows	Line is a connector that shows relationships between the shapes
	Input/ Output	A parallelogram represents input or output
	Process	A rectangle represents a process
	Decision	A diamond indicates a decision (used to create feedback loops)



YEAR 10 – KEY FOB	AI / PROGRAMMING

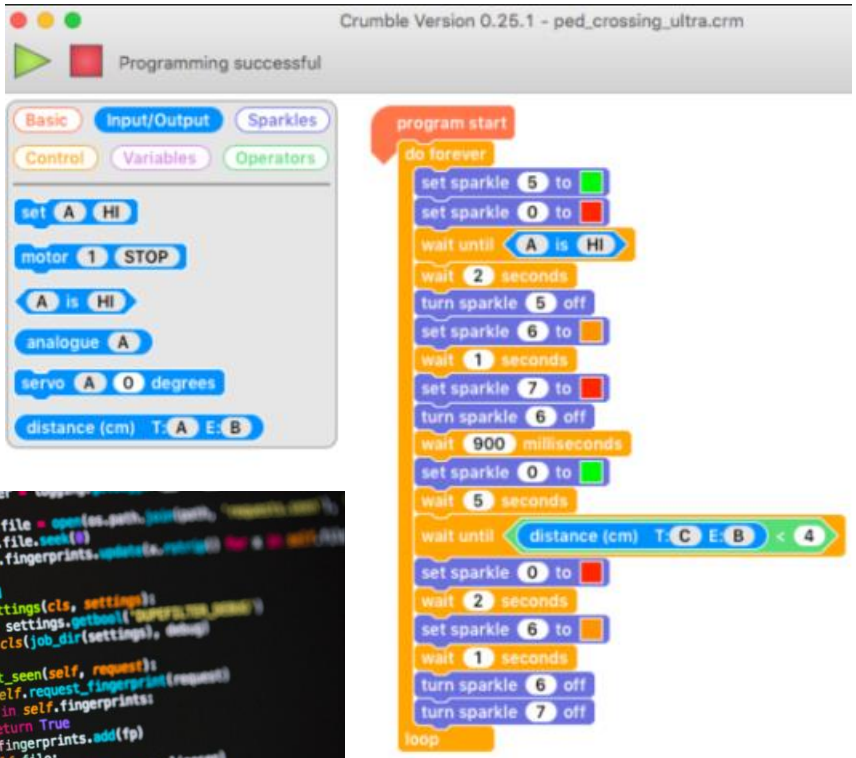
KEY QUESTIONS

1. WHAT IS “ARTIFICIAL INTELLIGENCE”?
2. WHAT IS PROGRAMMING?
3. HOW CAN YOU PROGRAMME A MICROPROCESSOR?

YEAR 10 – KEY FOB

AI / PROGRAMMING

Artificial Intelligence: the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.



Programming: giving a set of instructions to a computer to execute

Software such as **“crumble”** or **“scratch”** use blocks to control inputs/output.
Programming languages such as “**Python**” can be used for more complex projects

YEAR 10 – KEY FOB	USER INTERFACES/IOT

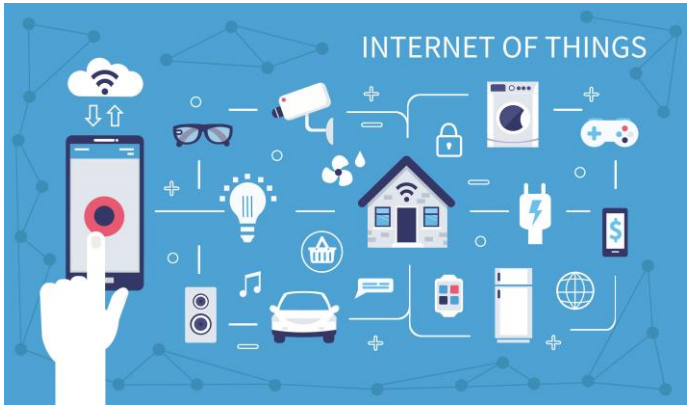
KEY QUESTIONS

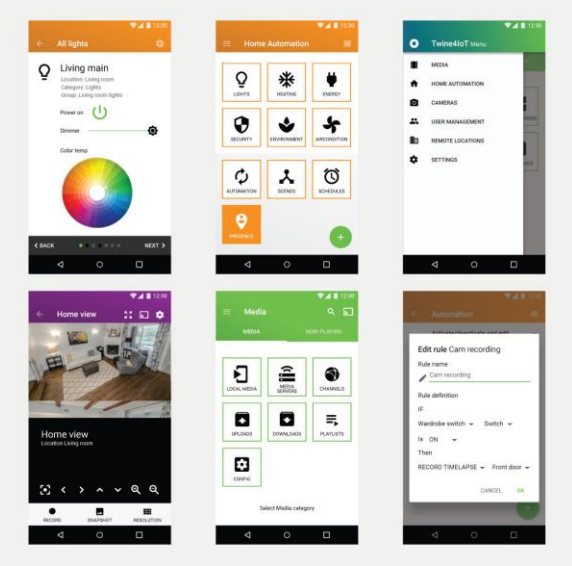
1. WHAT IS THE “INTERNET OF THINGS” (IOT)?
2. WHY ARE USER INTERFACES HELPFUL?
3. WHAT MAKES A GOOD USER INTERFACE?

YEAR 10 – KEY FOB

USER INTERFACES/IOT

INTERNET OF THINGS: the interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data:





USER INTERFACES: Allow users to control connected device, in a simple user friendly way. Removing the need to know programming, making devices intuitive to use.

YEAR 10 – KEY FOB	MATERIAL PROPERTIES

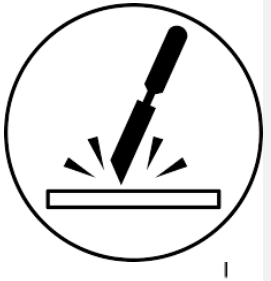
KEY QUESTIONS

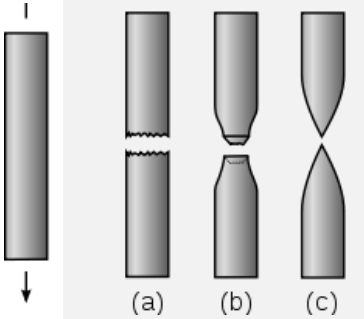
1. HOW ARE THE PHYSICAL PROPERTIES OF MATERIALS DESCRIBED?

YEAR 10 – KEY FOB | MATERIAL PROPERTIES

Physical properties are the traits a material has before it is used.

- **absorbency** - the ability to soak up moisture, light or heat, eg natural materials (such as cotton or paper) tend to be more absorbent than man-made materials (such as acrylic or polystyrene)
- **density** - how solid a material is. This is measured by dividing mass (grams) by volume (cm^3), eg lead is a dense material
- **fusibility** - the ability of a material to be heated and joined to another material when cooled, eg webbing is fusible and can be ironed onto fabrics
- **electrical conductivity** - the ability to conduct electricity, eg copper is a good conductor of electricity
- **thermal conductivity** - the ability to conduct heat, eg steel is a good heat conductor, whereas pine is not





YEAR 10 – KEY FOB	MATERIAL PROPERTIES

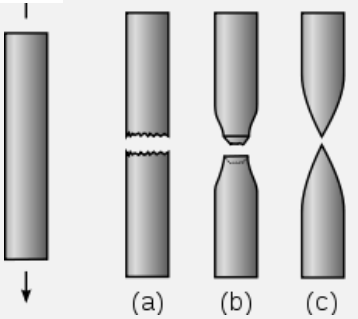
KEY QUESTIONS

1. HOW ARE THE WORKING PROPERTIES OF MATERIALS DESCRIBED?

YEAR 10 – KEY FOB | MATERIAL PROPERTIES

Working properties are how a material behaves when it is manipulated.

- **strength** - the ability of a material to withstand compression, tension and **shear**, eg in woven fabrics cotton isn't as strong as wool when pulled
- **hardness** - the ability to withstand **impact** without damage, eg pine is easier to dent with an impact than oak; therefore, oak is harder
- **toughness** - materials that are hard to break or snap are tough and can absorb shock, eg Kevlar in bulletproof vests is a very tough material
- **malleability** - being able to bend or shape easily would make a material easily malleable, eg sheet metal such as steel or silver is malleable and can be hammered into shape
- **ductility** - materials that can be stretched are ductile, eg pulling copper into wire shows it is ductile
- **elasticity** - the ability to be stretched and then return to its original shape, eg elastane in swimming costumes is a highly elastic material



YEAR 10 – KEY FOB	CONSUMER CHOICE

KEY QUESTIONS

1. WHAT IS TECHNOLOGY PUSH AND SOME PRODUCT EXAMPLES?
2. WHAT IS MARKET PULL AND SOME PRODUCT EXAMPLES?
3. WHAT IS THE “RIGHT TO REPAIR”?

YEAR 10 – KEY FOB

MATERIAL PROPERTIES

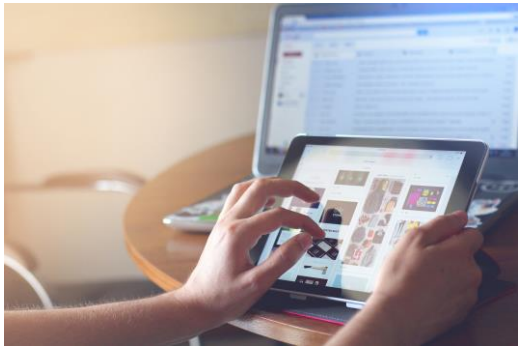
Technology push vs. Market pull

Technology push

Research & Developement → Production → Marketing → Need?

Market pull (demand pull)

Research & Developement → Production → Marketing → Expressed Market Need



YEAR 10 – KEY FOB	THERMOFORMING POLYMER

KEY QUESTIONS

1. WHAT ARE THERMOFORMING POLYMERS?
2. WHAT ARE SOME COMMON EXAMPLES AND THEIR USES?
3. WHAT ARE THE COMMON PROPERTIES?

YEAR 10 – KEY FOB | THERMOFORMING POLYMER

Thermoforming polymers can be heated and formed repeatedly. They are **pliable** and **recyclable**

Because…

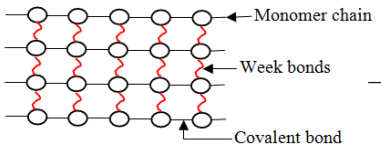


Figure 1. Thermoplastic polymer

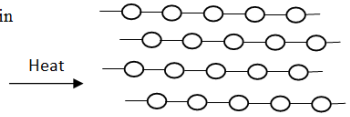


Figure 2. Thermoplastic softened state

Behaves like….

Thermoforming polymer	Properties	Uses
Acrylic (PMMA)	Hard with good plasticity when heated so can be folded well, resists weather well but is brittle and scratches easily, available in lots of colours	Car headlights, visors and baths
High density polythene (HDPE)	Stiff, strong but lightweight, good plasticity when heated with excellent chemical resistance	Washing-up bowls, pipes, chairs, buckets and bottles
Polypropylene (PP)	Lightweight but strong and tough, has good heat and chemical resistance	Computer game cases, chairs, children's toys and food packaging film
Polyvinyl chloride (PVC)	Can be matt or high gloss with both chemical and weather resistance, low in cost with good strength, can be made to be flexible or rigid	Window frames, building cladding, guttering

YEAR 10 – KEY FOB	THERMOSETTING POLYMER

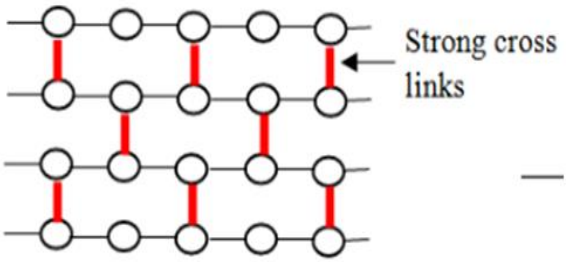
KEY QUESTIONS

1. WHAT ARE THERMOSETTING POLYMERS?
2. WHAT ARE SOME COMMON EXAMPLES AND THEIR USES?
3. WHAT ARE THE COMMON PROPERTIES?

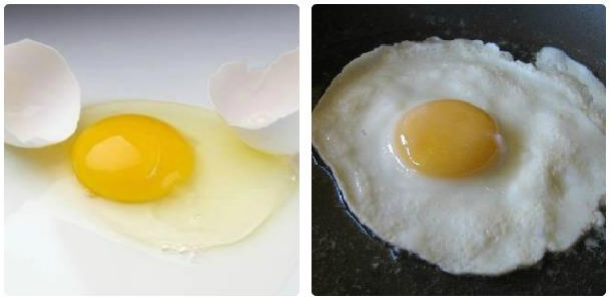
YEAR 10 – KEY FOB | THERMOSETTING POLYMER

Thermosetting polymers are **brittle** and can only be formed once. They are hard to recycle. They are good **insulators** and are resistant to heat and chemicals.

Because…



Behaves like….



Thermosetting polymer	Properties	Uses
Epoxy resin (ER)	Supplied as two parts, one resin and one hardener (see image) - the resin and hardener combine to create an extra-strong adhesive, good chemical and heat resistance and an excellent thermal insulator, can be brittle	Bonds materials and can be used for waterproof coatings and lamination
Melamine formaldehyde (MF)	Excellent heat resistance as well as being resistant to scratching and staining, hard and strong	Laminates for worktops, food safe so used for picnic tableware
Urea formaldehyde (UF)	A hard and stiff polymer with excellent thermal insulation	Electrical fittings, toilet seats, holding the wood chips together in the making of medium-density fibreboard (MDF)

YEAR 10 – KEY FOB	PHILIPPE STARCK

KEY QUESTIONS

1. WHAT IS PHILLIPPE STARCK KNOWN FOR?
2. HOW HAS HE INFLUENCED INDUSTRY?
3. WHAT PRODUCTS DID HE DESIGN?

YEAR 10 – KEY FOB

PHILIPPE STARCK

Starck has worked across a range of design disciplines, buildings, rooms, furniture, boat, lamp toothbrush, clothing, electronic device. His philosophy is to improve people's life both aesthetically and in quality.

He has collaborated with numerous companies: Flos, Alessi, Hansgrohe, Microsoft, Virgin and also creates independently. He promotes healthy lifestyle, ecological debate through material choices.

Notable designs: **Juicy Salif Lemon Squeezer** - Alessi (1990) , **Louis Ghost Chair -** Kartell (2002), **Hot Bertaa Kettle -** Alessi (1987)

YEAR 10 – KEY FOB	MATTHEW WILLIAMSON

KEY QUESTIONS

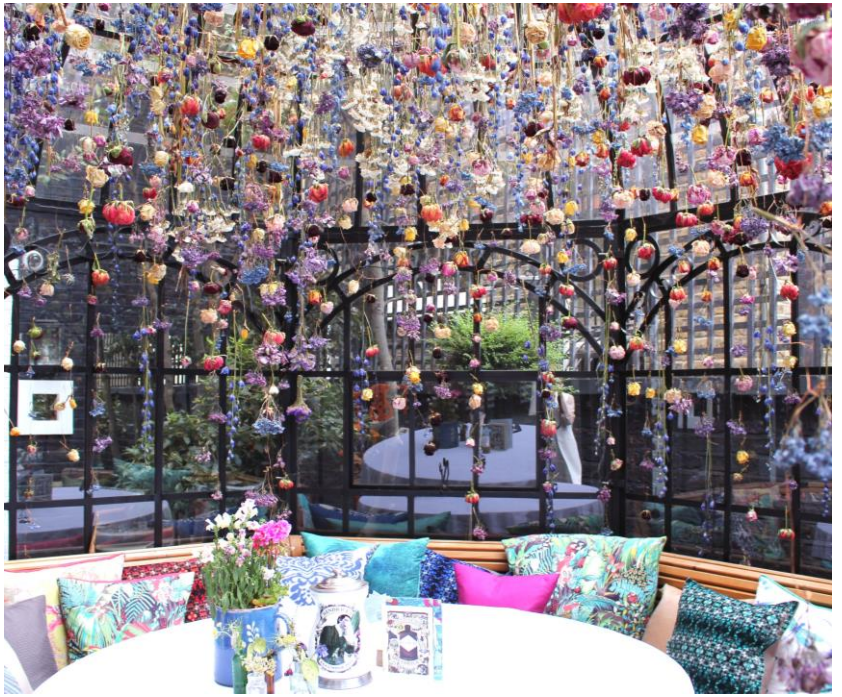
1. WHAT IS MATTHEW WILLIAMSON KNOWN FOR?
2. HOW HAS HE INFLUENCED INDUSTRY?
3. WHAT PRODUCTS DID HE DESIGN?

YEAR 10 – KEY FOB

MATTHEW WILLIAMSON

Matthew Williamson is an award-winning, British interior designer known predominantly for his unique and unrivalled use of pattern and colour. Having begun his illustrious career in fashion under his namesake brand for over 20 years, Matthew has drawn on his decades of experience and pivoted seamlessly into the world of interior design. He now develops several homeware collections to sit alongside his growing residential and commercial interior design portfolio.

Notable designs: **IKAT Pouffe, Peacock Lamp Base, range of maximalist wall papers.**



YEAR 10 – KEY FOB	DYSON

KEY QUESTIONS

1. WHAT IS DYSON KNOWN FOR?
2. HOW HAS THE COMPANY INFLUENCED INDUSTRY?
3. WHAT PRODUCTS DID DYSON MANUFACTURE?

YEAR 10 – KEY FOB

DYSON

Dyson has descried the company approach as “design is first and foremost an engineering company. Our main concern is developing and commercializing products that are more effective than those that are already on the market. Our motto remains fairly simple, we constantly question the things that exist and we think about how we could improve them. This process takes avenues that may seem illogical at first, but they do deliver results in the end. Our engineers enjoy solving problems that others have ignored. All this to say that technology comes ahead of design. Our desire to create beautiful objects is in no way essential. We are guided by practicality and not appearance.”

Dyson’s focus on function followed by form has yielded a range of exceptionally effective, consistently Styled products, aimed at making life Easier.

Notable designs:

Dyson DA001/DC01 (1993),
Dyson Airblade (2006),
Dyson Zone (2022)

YEAR 10 – KEY FOB	APPLE

KEY QUESTIONS

1. WHAT IS APPLE KNOWN FOR?
2. HOW HAS THE COMPANY INFLUENCED INDUSTRY?
3. WHAT PRODUCTS DID APPLE MANUFACTURE?

YEAR 10 – KEY FOB

APPLE

The following statements sum up the Apple approach to design – most of these relate to when Jony Ive was the primary designer for the company:

Design takes depth
Good design is revolutionary
Complex simplicity
The pain of “no”
Inspiration not imitation
Sweat the detail

Notable designs:
iPhone (2007)
MacBook Air (2008)
AirPods Max (2020)

YEAR 10 – KEY FOB	AIRBUS

KEY QUESTIONS

1. WHAT IS AIRBUS KNOWN FOR?
2. HOW HAS THE COMPANY INFLUENCED INDUSTRY?
3. WHAT PRODUCTS/SERVICES IS AIRBUS KNOWN FOR?

YEAR 10 – KEY FOB

AIRBUS

In the **feasibility** and **concept** phases, market expectations and requirements are explored. Different options are combined to come up with an overall aircraft concept with the latest technologies, structural concepts and systems architectures. The result is a product specification to start detailed design of parts and the specification of system elements from equipment suppliers. The characteristics of the product are simulated in extensive detail.

During the **design** phase, the definition and dimensioning of all elementary parts and their interfaces are performed, and the equipment, engines and landing gear are developed by the supply chain.

In the **integration** and **qualification** phases, parts are produced and assembled – both for test specimens on test benches and for the first aircraft that will serve the flight test programme. The tests are organised as a pyramid, going from lab tests at a small scale (via integration tests for checking the behaviour of complete systems) to full-scale structural tests and flight tests. The goal of all these tests is to verify predicted behaviour of the systems, structure and aircraft and to demonstrate their ability to sustain conditions well exceeding what is expected during the life of the aircraft – including also all conceivable failure cases.

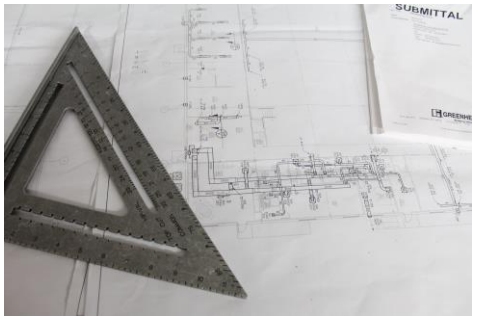
YEAR 10 – KEY FOB	PAPERS AND BOARD

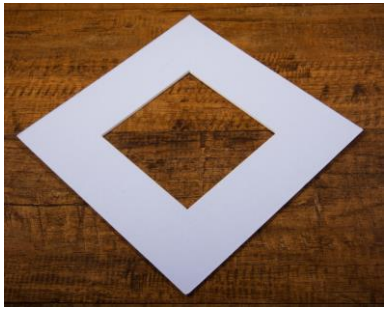
KEY QUESTIONS

1. WHAT ARE THE MOST COMMON TYPES OF PAPERS AND BOARDS?
2. WHAT ARE SOME COMMON USES FOR EACH TYPE OF PAPER?

YEAR 10 – KEY FOB

PAPERS AND BOARD





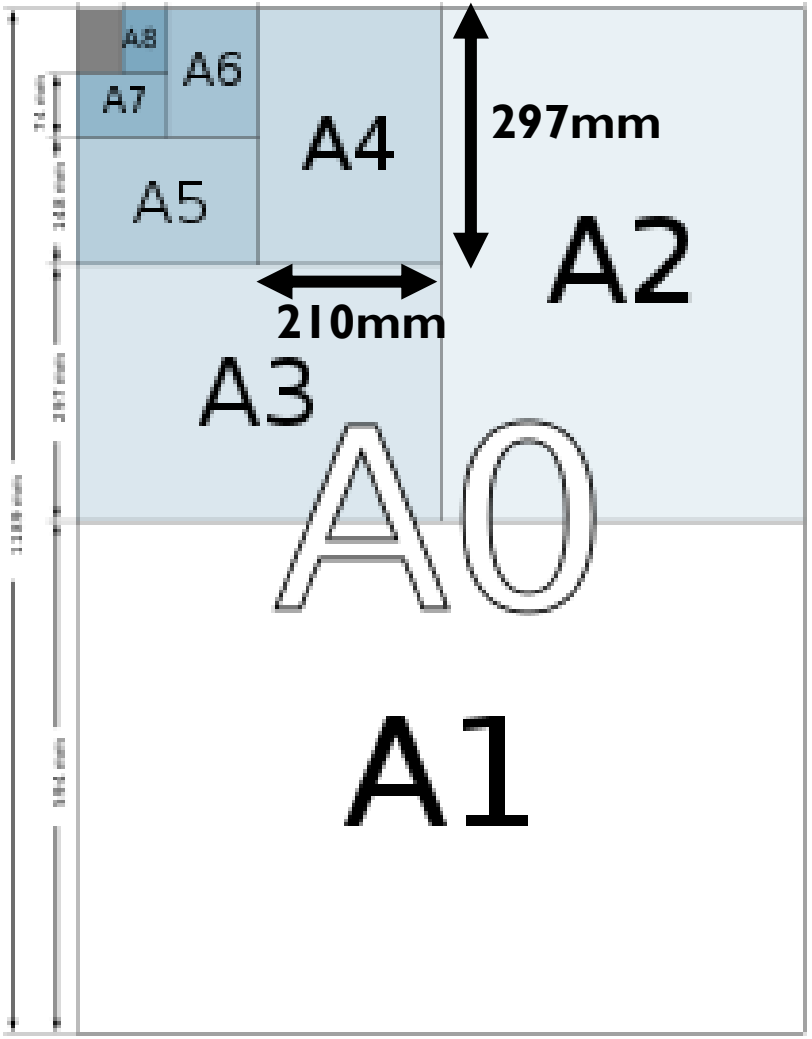
YEAR 10 – KEY FOB	PAPERS AND BOARD

KEY QUESTIONS

1. HOW ARE PAPERS AND BOARD SOLD? (STOCK FORMS)
2. WHAT ARE THE USEFUL MEASUREMENTS RELATING TO PAPERS AND BOARDS

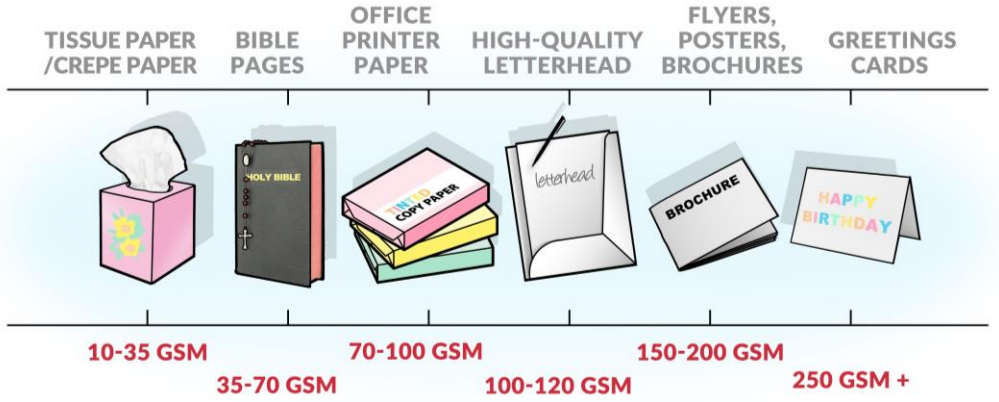
YEAR 10 – KEY FOB

PAPERS AND BOARD



STANDARD DIMENSIONS

WEIGHT – GRAMS PER SQUARE METRE (GSM)



THICKNESS - MICRONS

SOLD BY ROLL/ SHEET

YEAR 10 – KEY FOB	PAPERS AND BOARD

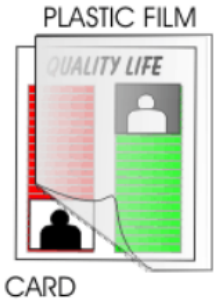
KEY QUESTIONS

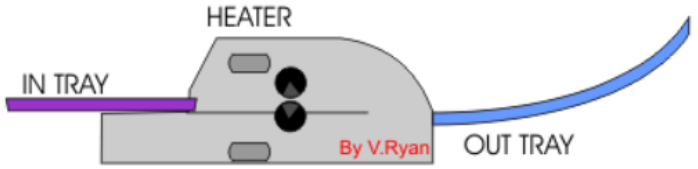
1. HOW CAN YOU IMPROVE THE PERFORMANCE OF PAPER AND BOARDS?
2. WHAT FINISHING TECHNIQUES CAN BE APPLIED?

YEAR 10 – KEY FOB

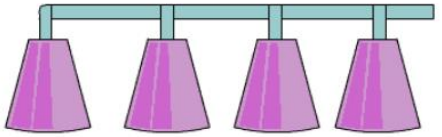
PAPERS AND BOARD

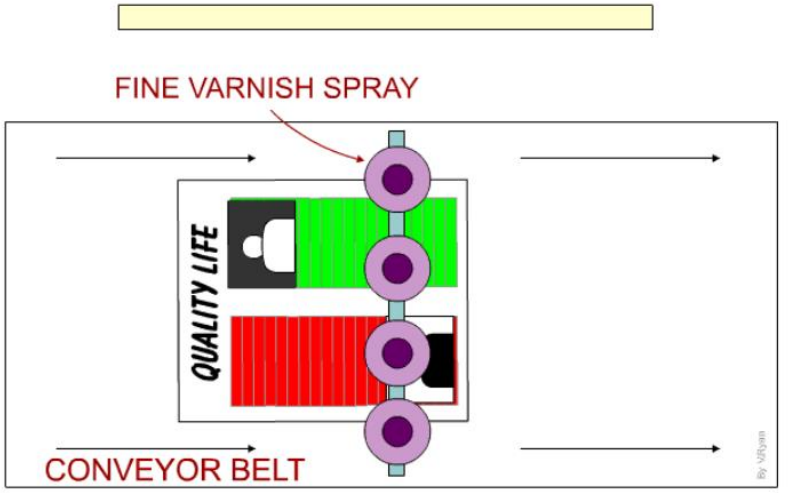
LAMINATION/ ENCAPSULATION



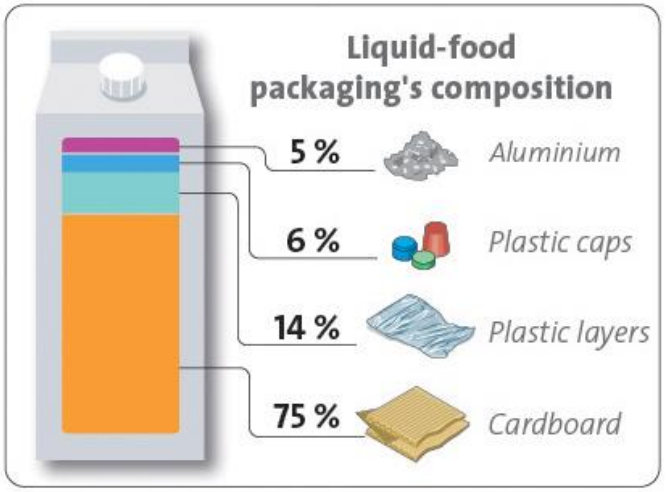


PRINTING AND VARNISHING





TETRA PAK



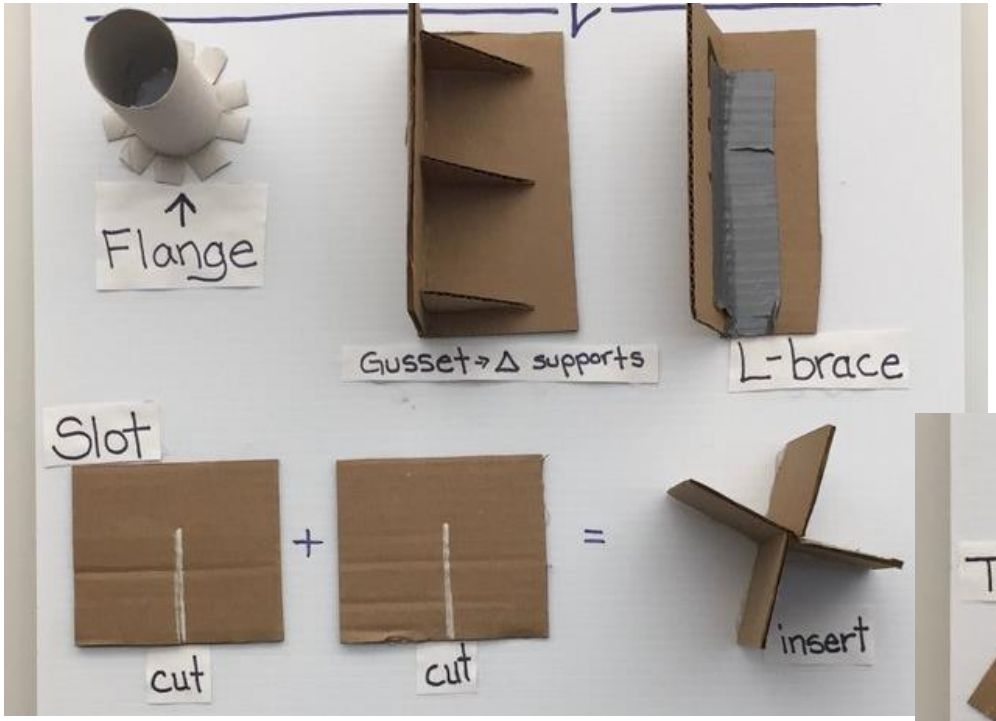
YEAR 10 – KEY FOB	PAPERS AND BOARD

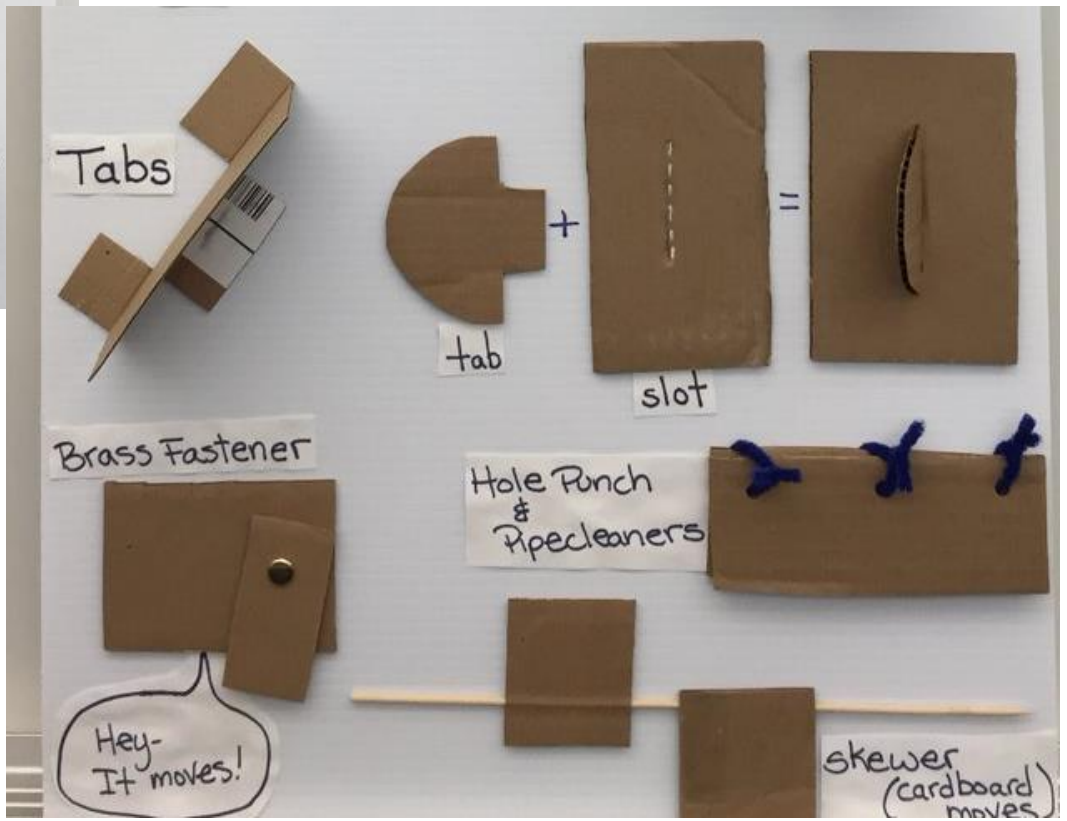
KEY QUESTIONS

1. WHAT METHODS ARE THERE FOR JOINING PAPER BASED MATERIALS?

YEAR 10 – KEY FOB

PAPERS AND BOARD





SPRING TERM

- Group Design & Make – Mechanical Toys
- Smart and Modern Materials

YEAR 10 - SPRING

REVISION TOPICS

- Types of motion
- Mechanical Devices
  - Levers
  - Pulleys
  - Gears
  - Cams
- Energy Generation
- Energy Sources
  - Renewable
  - Non Renewable
- Timber – Trees to Timber
- Timber Life Cycle
- Material Properties
- Metals – Categories
- Metal – Specific materials (properties & uses)
- Smart Materials – Stimuli
- Smart/Modern Materials – Specific materials (properties & uses)

YEAR 10 – SPRING	TYPE OF MOTION

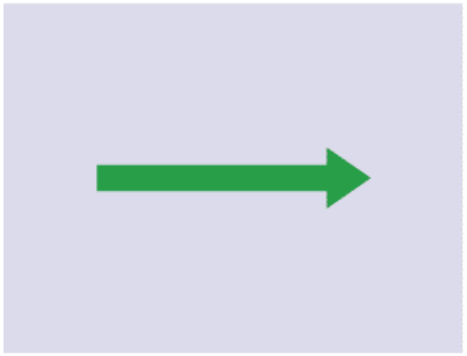
KEY QUESTIONS

1. WHAT ARE THE DIFFERENT TYPES OF MOTION?
2. WHAT ARE SOME COMMON EXAMPLES WHERE YOU CAN SEE THE DIFFERENT TYPES OF MOTION?

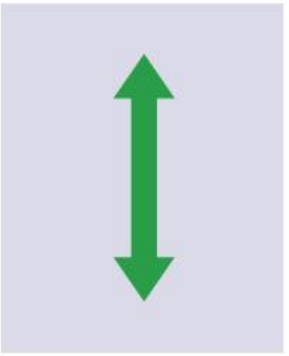
YEAR 10 – SPRING

TYPE OF MOTION

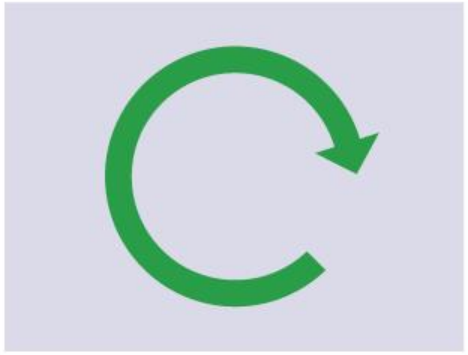
Linear motion moves something in a straight line, eg a train moving down a track:



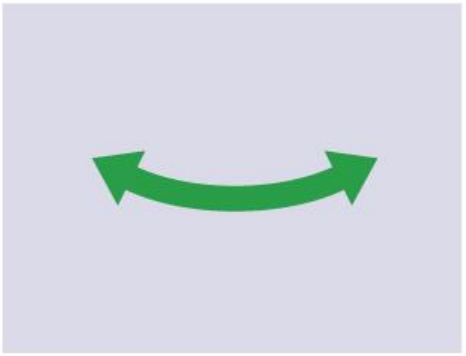
Reciprocating motion has a repeated up and down motion or back-and-forth motion, eg a piston or pump:



Rotary motion is where something moves around an axis or pivot point, eg a wheel:



Oscillating motion has a curved backwards and forwards movement that swings on an axis or pivot point, eg a swing or a clock pendulum:

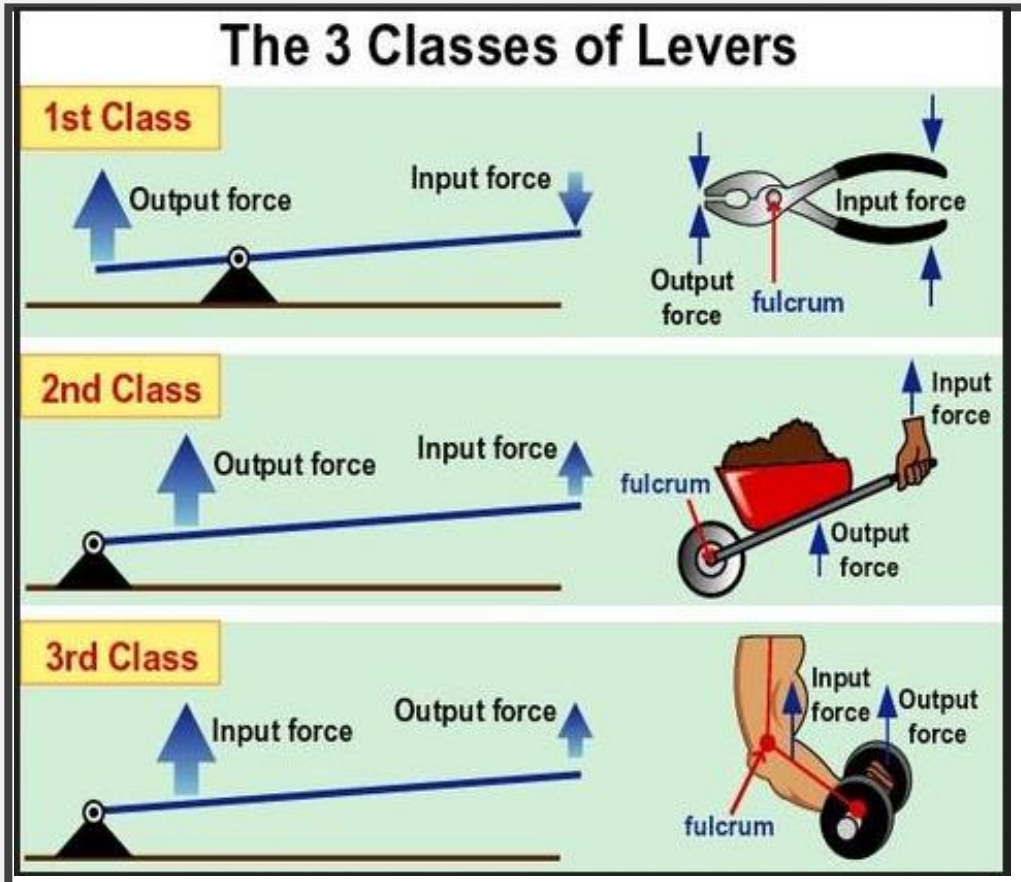


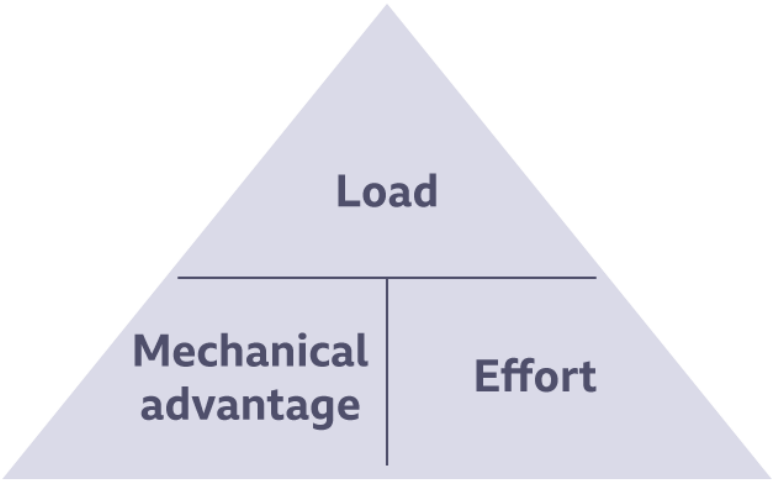
KEY QUESTIONS

1. WHAT ARE THE DIFFERENT CLASSES OF LEVER?
2. WHAT ARE SOME COMMON APPLICATIONS FOR EACH CLASS OF LEVER?
3. HOW DO YOU CALCULATE THE MECHANICAL ADVANTAGE OF A LEVER?

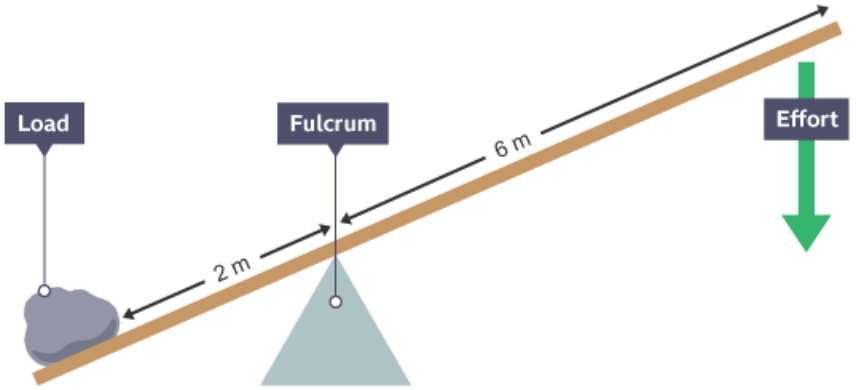
YEAR 10 – SPRING

MECHANICAL DEVICES - LEVERS





- mechanical advantage = load ÷ effort
- load = mechanical advantage × effort
- effort = load ÷ mechanical advantage



Therefore, the mechanical advantage = 6 ÷ 2 = **3** or **3:1**

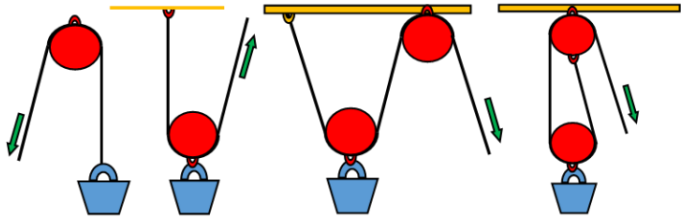
KEY QUESTIONS

1. WHAT ARE THE DIFFERENT CONFIGURATIONS OF PULLEYS
2. WHAT ARE SOME COMMON APPLICATIONS OF PULLEYS?
3. HOW DO YOU CALCULATE THE MECHANICAL ADVANTAGE OF A PULLEY?

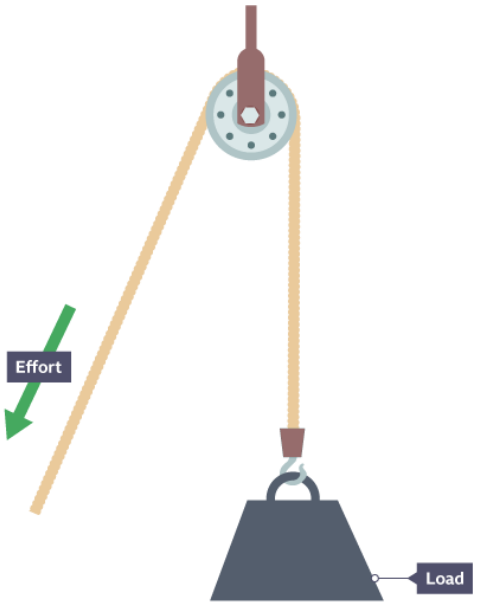
YEAR 10 – SPRING

MECHANICAL DEVICES - PULLEYS

Types of Pulleys

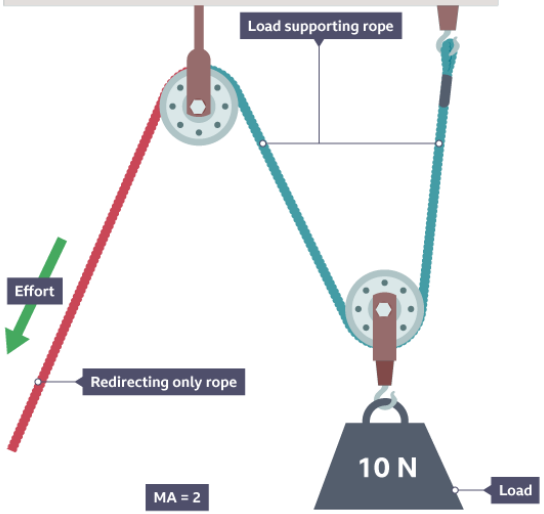


Fixed	Moveable	Compound	Block & Tackle



A single fixed pulley has a mechanical advantage of one

The 10 N load below would require half of the force to lift. There are two sections of rope taking the strain, so 5 N of force would be needed to lift it. The mechanical advantage would be 2.



The mechanical advantage is equal to the number of sections of rope pulling up on the object.

Belts can be attached around different-sized pulleys to drive shafts to change speed. As with gears, the bigger the wheel, the slower the speed. The **velocity ratio** between two pulleys can be calculated.

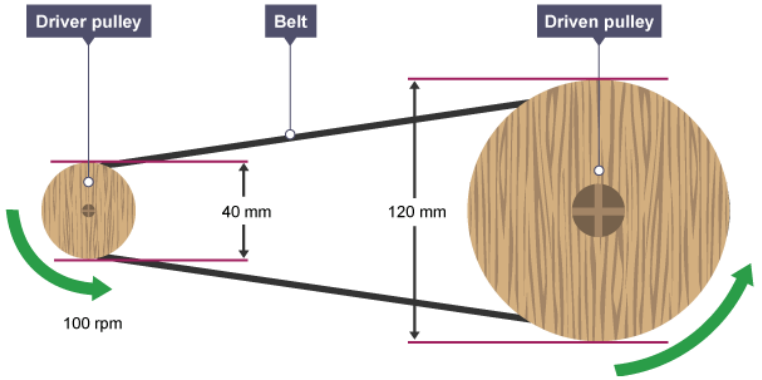
Velocity ratio = diameter of the driven pulley ÷ diameter of the driver pulley

This can then be used to calculate the output speed.

Output speed = input speed ÷ velocity ratio

Example

A driven pulley has a diameter of 120 mm and a driver pulley has a diameter of 40 mm.



Velocity ratio = diameter of the driven pulley ÷ diameter of the driver pulley

= 120 ÷ 40 = **3** or **3:1**

YEAR 10 – SPRING	MECHANICAL DEVICES - GEARS

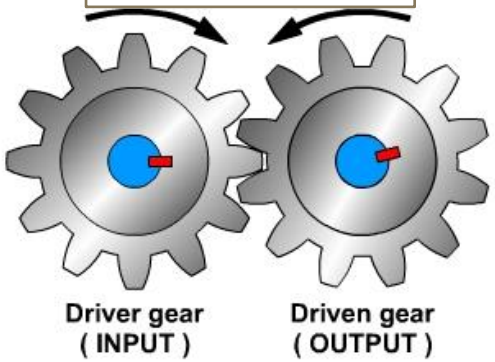
KEY QUESTIONS

1. WHAT ARE THE DIFFERENT TYPES OF GEARS?
2. WHAT ARE SOME COMMON APPLICATIONS OF GEARS?
3. WHAT ARE THE DIFFERENT WAYS GEARS CAN TRANSFER/TRANSFORM MOTION?

YEAR 10 – SPRING

MECHANICAL DEVICES - GEARS

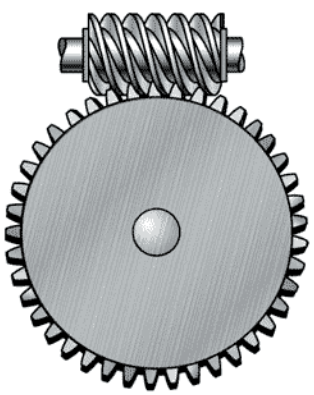
Spur Gears



Velocity ratio = $\frac{\text{distance moved by the effort (driver gear}}{\text{distance moved by load (driven gear)}}$

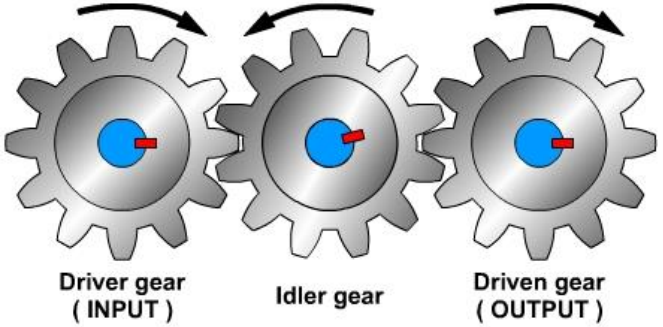
Velocity ratio = $\frac{\text{number of teeth on the driven gear}}{\text{number of teeth on the driver gear}}$

Worm Gears



Rack and Pinion

Idler Gears



Bevel Gears

Application of Different Types of Gears

Gearboxes, which are devices made up of gears housed within an enclosure or housing, are one of the most common applications for gears. These devices use a variety of gear types, such as worm gears, bevel gears, helical gears, and spur gears, and are designed to perform a specific motion or power transmission operation inside the machine system, such as altering the speed and torque or changing the direction of the output shaft.

Gearboxes, like most gear systems, have a range of applications, such as Conveyors, Agitators, Ball Mills, etc.

YEAR 10 – SPRING	MECHANICAL DEVICES - CAMS

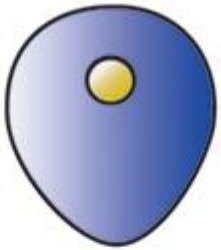
KEY QUESTIONS

1. WHAT ARE THE DIFFERENT TYPES OF CAMS?
2. WHAT ARE SOME COMMON APPLICATIONS OF CAMS? HOW DO THEY TRANSFORM MOTION?
3. HOW CAN YOU REPRESENT THE “FOLLOWER MOTION” OVER TIME?

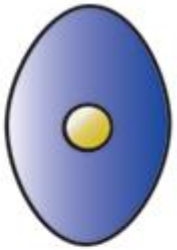
YEAR 10 – SPRING

MECHANICAL DEVICES - CAMS

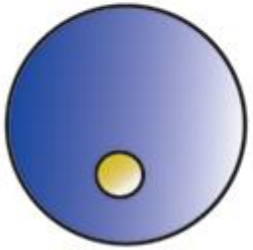
ROUND



EGG-SHAPED



ELLIPSE



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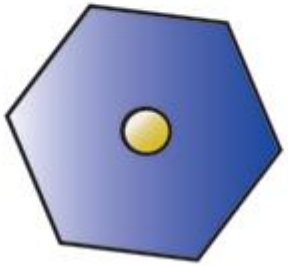
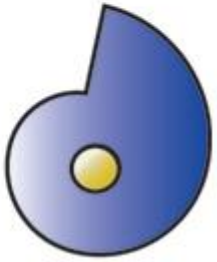
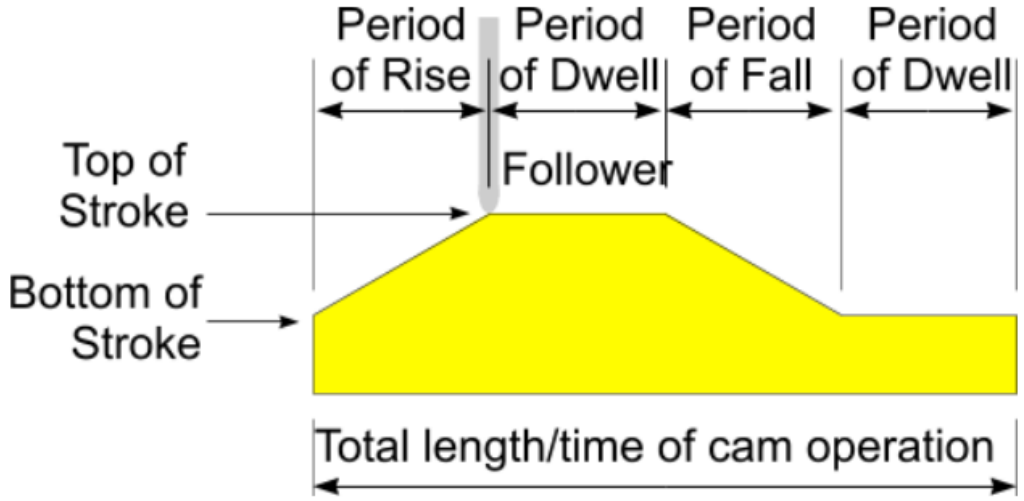


HEXAGON



SNAIL



Cams are used in a number of different applications both in industry. and everyday objects, some of the most common are:

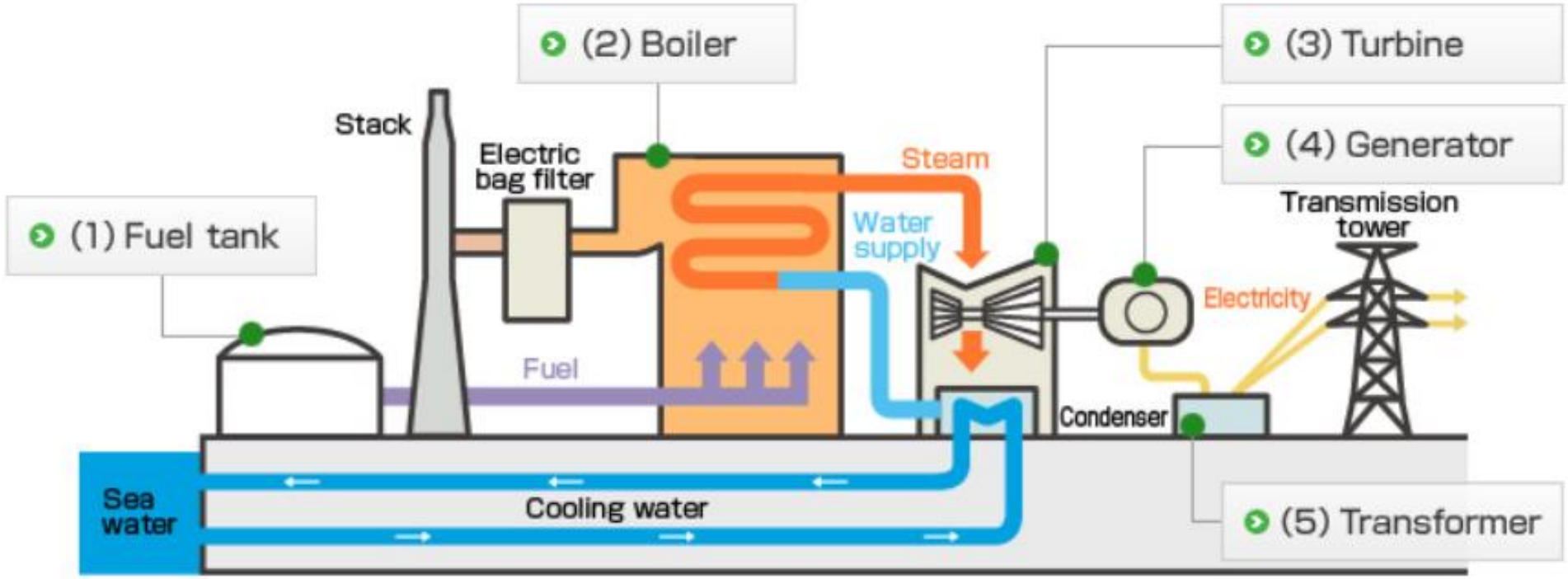
Door lock mechanisms
Stamping machines
Vehicle transmission
Hammering machines
Sewing machines
Dishwashers
Washing machines
Reciprocating saws
Sequential transmission

KEY QUESTIONS

1. HOW IS ELECTRICITY GENERATED?

YEAR 10 – SPRING

ENERGY GENERATION - BASIC



KEY QUESTIONS

1. WHAT ARE THE DIFFERENT FINITE (NON RENEWABLE) SOURCES USED TO GENERATE ELECTRICITY?
2. WHAT ARE THE ADVANTAGES OF FINITE ENERGY SOURCES?
3. WHAT ARE THE DISADVANTAGES OF FINITE ENERGY SOURCES?

YEAR 10 – SPRING

ENERGY GENERATION - FINITE

Coal

- Comes from the remains of plants that died hundreds of millions of years ago
- Has the highest level of carbon of all fossil fuels

Oil

- Comes from the remains of plants that died hundreds of millions of years ago
- Can be extracted and refined to make gasoline, diesel and jet fuel

YEAR 10 – SPRING

ENERGY GENERATION - FINITE

Natural Gas

- Formed from the remains of tiny sea plants and animals that died millions of years ago
- Mainly composed of methane

Nuclear Energy

- Energy released when atoms' nuclei are fused together (fusion) or split apart (fission)
- Nuclear power plants produce electricity through nuclear fission

KEY QUESTIONS

1. WHAT DIFFERENT METHODS ARE THERE FOR GENERATING ELECTRICAL ENERGY FROM RENEWABLE SOURCES?
2. WHAT ARE THE ADVANTAGES OF RENEWABLE ENERGY SOURCES?
3. WHAT ARE THE DISADVANTAGES OF RENEWABLE ENERGY SOURCES?

YEAR 10 – SPRING

ENERGY GENERATION - RENEWABLES

Wind Energy

- Energy in moving air, harnessed by wind turbines
- Used to produce electricity

Solar Energy

- Energy that comes from the sun
- Converted into heat, light and electricity

YEAR 10 – SPRING

ENERGY GENERATION - RENEWABLES

Hydropower

- Energy in the force of moving water
- Captured by dams in hydropower plants and converted to electricity

Biomass

- Energy contained in organic matter
- Used to generate electricity

YEAR 10 – SPRING

ENERGY GENERATION - RENEWABLES

Geothermal Energy

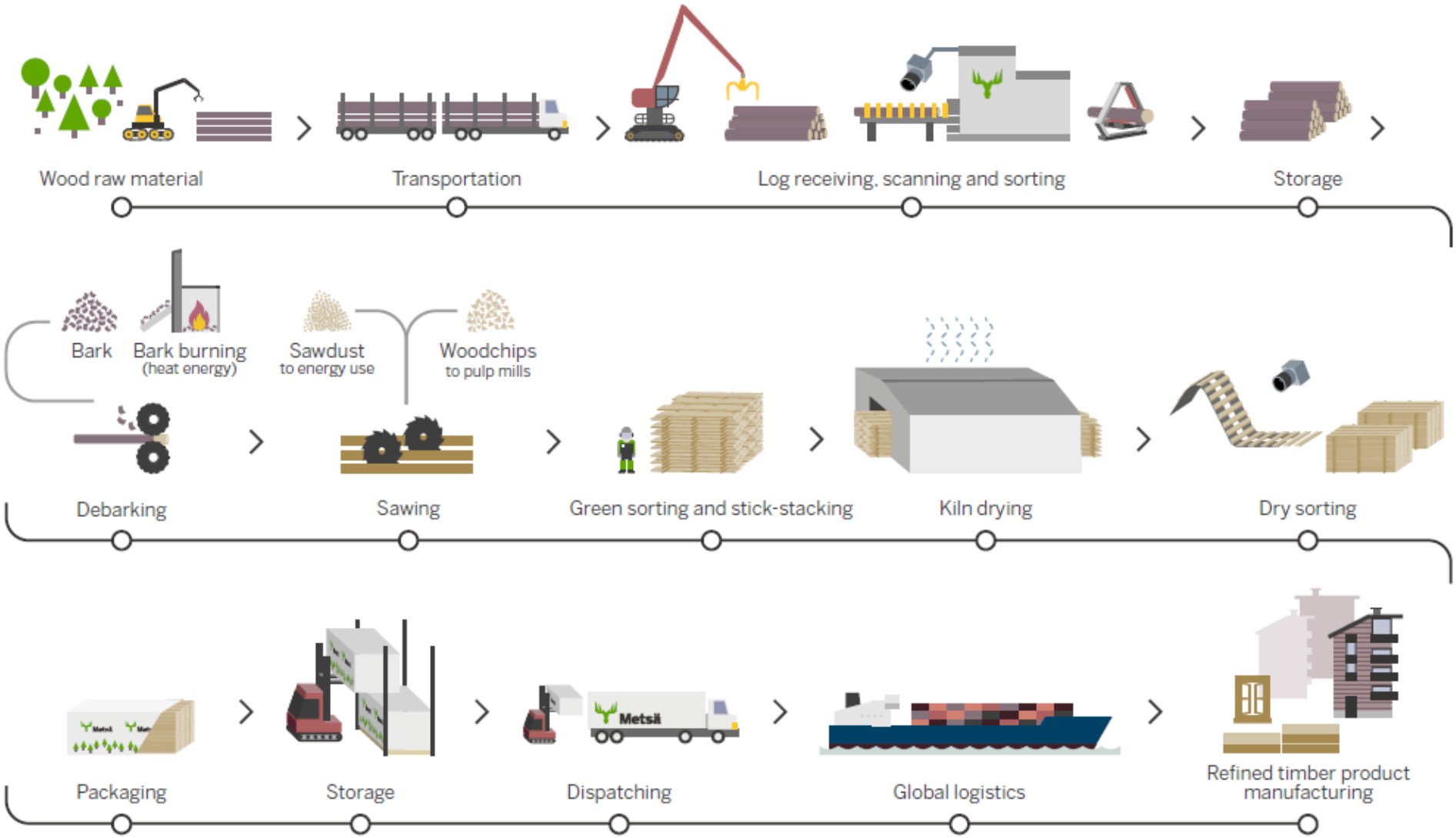
- Energy that comes from heat generated by the Earth
- Used to produce electricity and can provide heat and hot water

KEY QUESTIONS

1. WHAT IS THE PROCESS USED TO TRANSFORM TREES INTO A RAW MATERIAL FOR MANUFACTURING?

YEAR 10 – SPRING

TIMBER – MATERIAL PRODUCTION



KEY QUESTIONS

1. WHAT ARE THE ETHICAL AND SOCIAL CONSIDERATIONS OF USING TIMBER?
2. WHAT ARE THE ENVIRONMENTAL IMPACTS OF USING TIMBER?

Social and ecological issues

When considering the ecological and social implications of using timber, the term **'deforestation'** is often used. Deforestation is when a **clearing** is made by chopping down trees. This can often bring jobs and money into a local area but can also push out communities and wildlife. Without responsible management of deforestation, accompanying environmental issues can occur, such as:

•soil **erosion** that can lead to landslides

•an increase in global warming

If more trees are planted than are cut, it is possible to minimise the environmental impact. Hardwood trees take a long time to grow in comparison to softwood trees so are more commonly planted in managed forests.

Supply and demand can cause issues for forest management. If the customer demands more timber due to an increase in purchasing, a forest management organisation could struggle as trees will take time to mature.

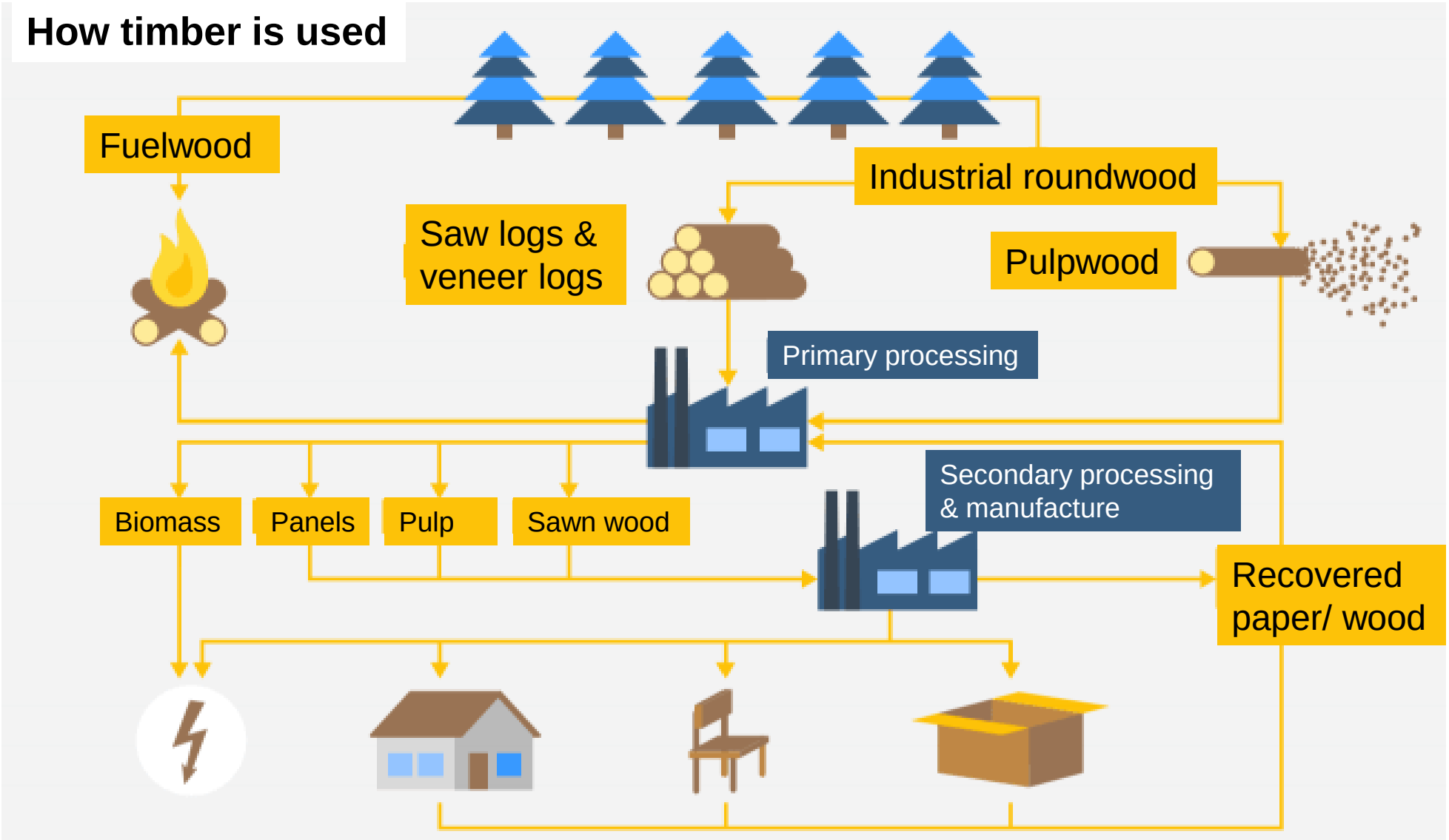
KEY QUESTIONS

1. WHAT IS THE LIFE CYCLE OF TIMBER?
2. WHAT ARE THE FOUR OUTPUTS FROM THE TIMBER LIFE CYCLE?

YEAR 10 – SPRING

TIMBER – MATERIAL LIFE CYCLE

How timber is used



KEY QUESTIONS

1. WHAT ARE THE MOST COMMON ADJECTIVES USED TO DESCRIBE MATERIAL PROPERTIES?
2. WHAT IS THE DIFFERENCE BETWEEN PHYSICAL AND WORKING PROPERTIES OF MATERIALS?

YEAR 10 – SPRING

DESCRIBING MATERIALS

Physical properties are the traits a material has before it is used.

Physical properties:

- **absorbency** - the ability to soak up moisture, light or heat, eg natural materials (such as cotton or paper) tend to be more absorbent than man-made materials (such as acrylic or polystyrene)
- **density** - how solid a material is. This is measured by dividing mass (grams) by volume (cm^3), eg lead is a dense material
- **fusibility** - the ability of a material to be heated and joined to another material when cooled, eg webbing is fusible and can be ironed onto fabrics
- **electrical conductivity** - the ability to conduct electricity, eg copper is a good conductor of electricity
- **thermal conductivity** - the ability to conduct heat, eg steel is a good heat conductor, whereas pine is not

Working properties are how a material behaves when it is manipulated.

Working properties:

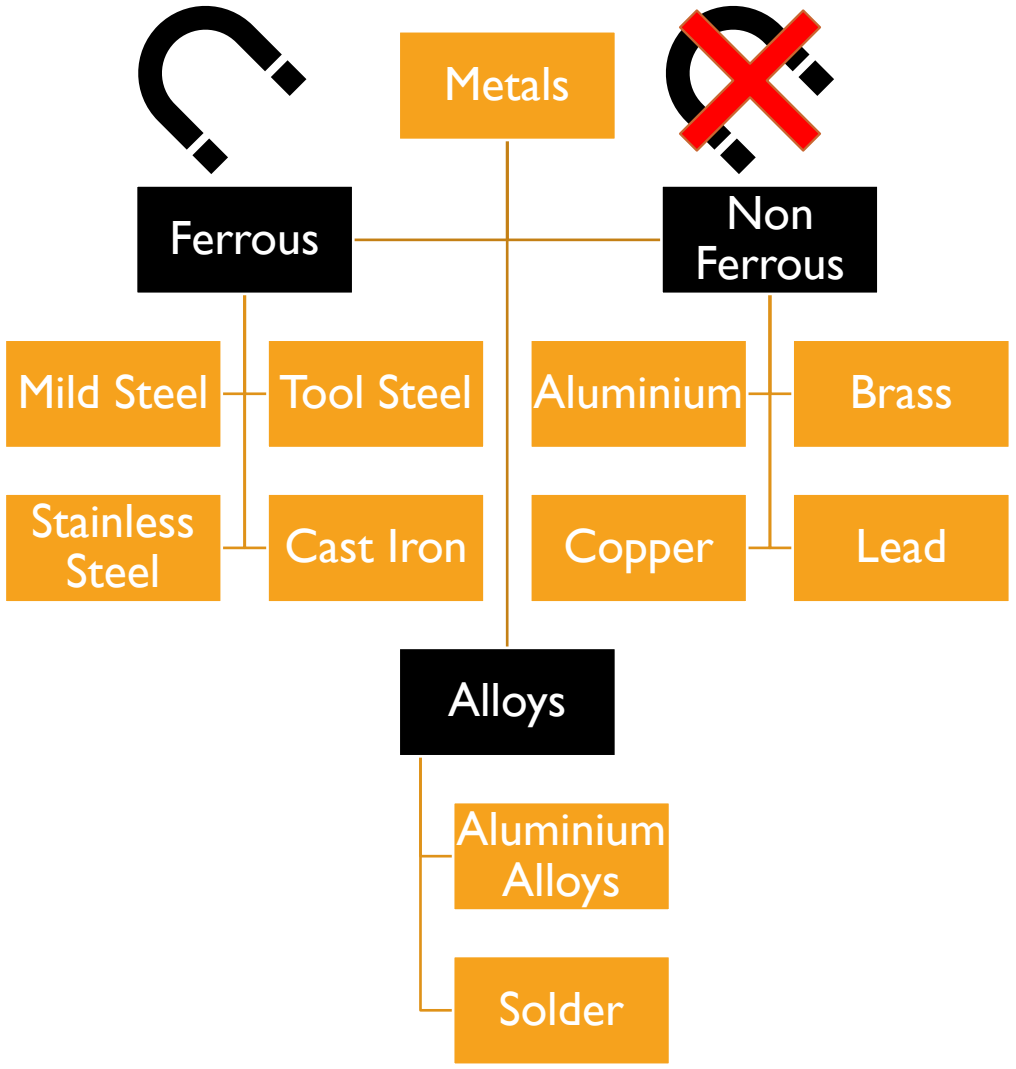
- **strength** - the ability of a material to withstand compression, tension and **shear**, eg in woven fabrics cotton isn't as strong as wool when pulled
- **hardness** - the ability to withstand **impact** without damage, eg pine is easier to dent with an impact than oak; therefore, oak is harder
- **toughness** - materials that are hard to break or snap are tough and can absorb shock, eg Kevlar in bulletproof vests is a very tough material
- **malleability** - being able to bend or shape easily would make a material easily malleable, eg sheet metal such as steel or silver is malleable and can be hammered into shape
- **ductility** - materials that can be stretched are ductile, eg pulling copper into wire shows it is ductile
- **elasticity** - the ability to be stretched and then return to its original shape, eg elastane in swimming costumes is a highly elastic material

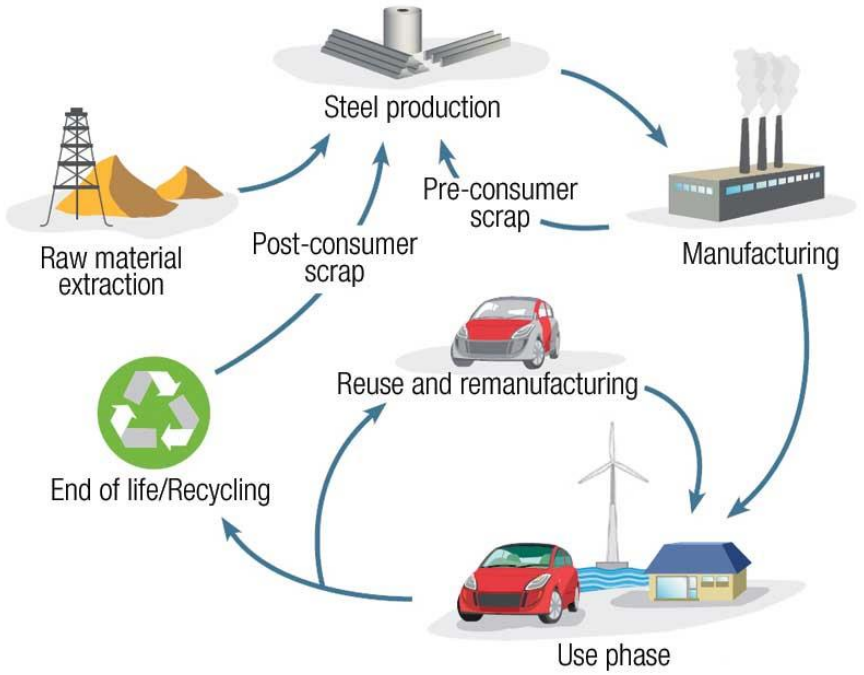
KEY QUESTIONS

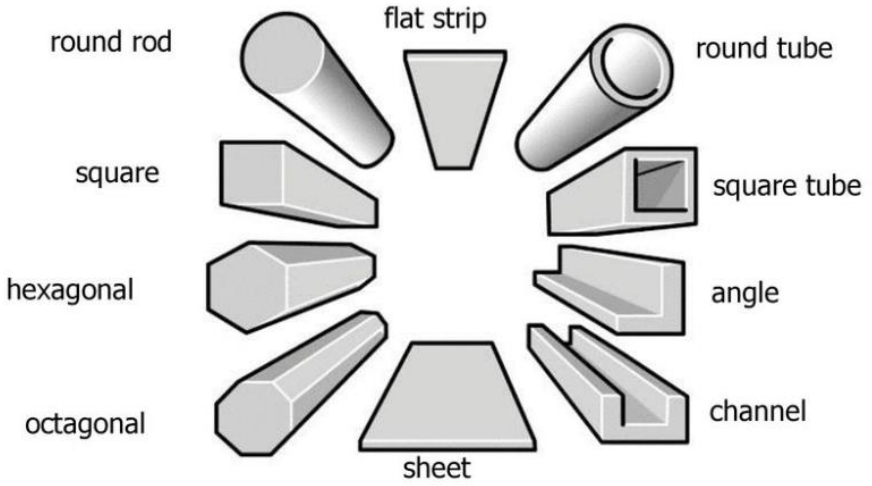
1. WHAT ARE THE THREE COMMON CATEGORIES OF METAL BASED MATERIALS?
2. WHAT ARE THE PRIMARY DIFFERENCES BETWEEN THE THREE MAIN CATEGORIES?
3. WHAT ARE SOME COMMON STOCK FORMS FOR METAL BASED MATERIALS?

YEAR 10 – SPRING

METAL - CATEGORIES







KEY QUESTIONS

1. WHAT ARE THE NAMES OF SOME COMMON FERROUS METALS?
2. WHAT ARE SOME COMMON USES FOR THESE METALS?

FERROUS METALS CONTAIN IRON AND ARE **MAGNETIC**. THEY ARE PRONE TO **RUST**.

Ferrous metal	Physical properties	Working properties
Low-carbon steel (mild steel)	An alloy that is grey and smooth, rusts if not protected	Ductile and tough, easy to form, braze and weld, versatile, useful for construction, nuts, bolts, bike frames
Cast iron	Dull grey, rusts easily	Brittle if thin, can be cast in a mould, used for manhole covers, pans and gates
High-carbon steel (tool steel)	An alloy that is grey, smooth and does not rust easily	Hard-wearing, harder than low-carbon steel so less ductile but good for making tools, sharpens well

KEY QUESTIONS

1. WHAT ARE THE NAMES OF SOME COMMON NON FERROUS METALS?
2. WHAT ARE SOME COMMON USES FOR THESE METALS?

NON-FERROUS METALS **DO NOT** CONTAIN IRON AND ARE **NOT MAGNETIC**. THEY DO NOT RUST.

Non-ferrous metal	Physical properties	Working properties
Aluminium	Light grey with a matt finish	Lightweight but strong and ductile, used for drink cans, kitchen utensils and some parts in transport
Copper	Rose coloured, polishes well but can oxidise to a green colour (Verdigris)	Good electrical conductor, can be polished, welds easily, used for plumbing parts and electrical cable
Tin	Silver coloured	Soft and malleable, easy to form, used to make food cans
Zinc	Silvery blue with a matt finish	Brittle with average malleability and conductivity, often used to galvanise steel

KEY QUESTIONS

1. WHAT ARE THE NAMES OF SOME COMMON METAL ALLOYS?
2. WHAT ARE SOME COMMON USES FOR THESE METALS?

YEAR 10 – SPRING

METAL – ALLOYS

ALLOYS ARE MIXTURES OF METAL WITH AN ELEMENT TO IMPROVE ITS PROPERTIES OR **AESTHETIC**. FOR EXAMPLE BRASS IS A MIXTURE OF COPPER AND ZINC. ALLOYS CAN ALSO BE CLASSIFIED AS FERROUS OR NON-FERROUS.

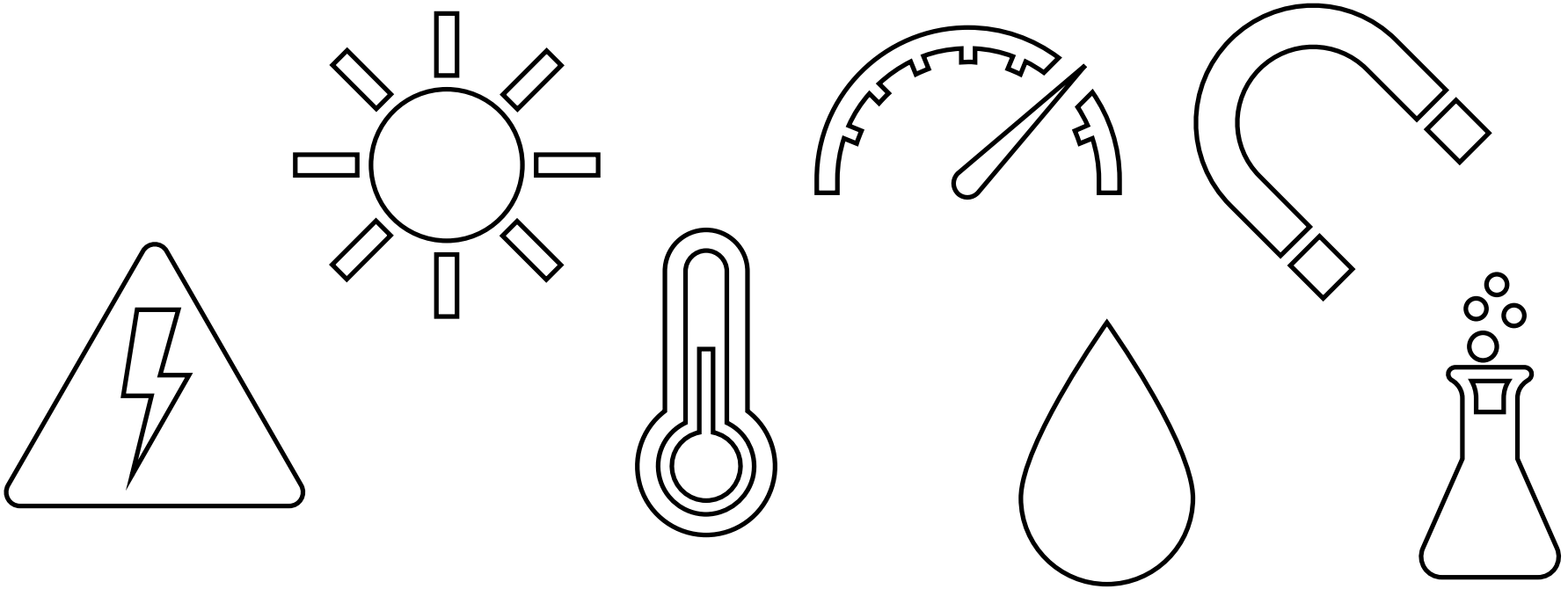
Alloy	Physical properties	Working properties
Brass	Non-ferrous metal that is gold coloured and darkens when oxidised with age	An alloy of copper and zinc, can be cast and machined, used for musical instruments and ornamental hardware
Stainless steel	Ferrous metal that is silver when polished, resists rust	An alloy of chromium, nickel and manganese, hard and smooth, used for cutlery and sinks
High-speed steel	Ferrous metal is dark grey when used for tool bits	Can be alloyed with a variety of materials for different properties, can withstand high temperatures, used for drill bits and saw blades

KEY QUESTIONS

1. WHAT ARE THE COMMON STIMULI THAT CAUSE SMART MATERIALS TO REACT AND CHANGE?
2. WHAT IS THE BEST WAY TO DESCRIBE THE CHANGE IN A SMART MATERIAL?

YEAR 10 – SPRING

SMART MATERIALS – STIMULI



WHAT ARE SMART MATERIALS?

Smart materials are materials that are **manipulated to respond in a controllable and reversible way, modifying some of their properties as a result of external stimuli** such as certain mechanical stress or a certain temperature, among others. Because of their responsiveness, smart materials are also known as responsive materials. These are usually translated as "active" materials although it would be more accurate to say "reactive" materials.

KEY QUESTIONS

1. WHAT STIMULI PROMPT THE MATERIALS TO CHANGE?
2. WHAT CHANGES OCCUR?
3. HOW ARE THESE MATERIALS USED?

YEAR 10 – SPRING

SMA AND NITINOL

Shape-memory alloys (SMA) are metal **alloys** that can remember their shape when heated. These alloys have been utilised on spectacle frames that spring back to shape if they are squashed.

Nickel titanium (**nitinol**) is a type of SMA, and it contracts when heated, whereas most metals expand. When braces are made from nitinol, they heat up in the mouth and 'pull' on the teeth, so they move with the nitinol.

Setting SMA into the desired shape

Step 1: Fix SMA into the shape you want – use metal mechanical fixings

Step 2: Heat it up to 400 degrees for 8-10min

Step 3: Quench in cold water

KEY QUESTIONS

1. WHAT ARE THE PROPERTIES OF EACH MATERIAL?
2. WHAT ARE THE COMMON APPLICATIONS FOR EACH MATERIAL?

Gore-Tex fabric

Properties:
- Waterproof
- Breathable (allows moisture out)
- Holes on fabric allow sweat out, but not rain in
- Can be combined well with insulation fabric (to keep you warm)

Kevlar fabric

Properties:
- Eight times stronger than steel wire
- Does not melt and can withstand up to 450c
- Can withstand very low temperatures :- 96c
- Resistant to many chemicals
- Very lightweight

Nomex fabric

Properties:
- Thickens when heated, offering more protection
- Flexible fabric
- Lightweight
- Flame resistant
- Breathable (allows moisture)
- Durable (hard wearing)
- Abrasion resistant (does not get worn out easily)

X-Static fabric

Properties:
- Anti odour (Does not hold smell)
- Made with pure silver
- Very flexible
- Soft
- Long lasting
- Stretchy
- The silver reacts with bacteria
- Has been proven to eliminate 99% bacteria within one hour

Shape memory alloys

Properties:

- If the material is bent or de-formed, it returns to its set shape when heated up
- Can come in a variety of thick-nesses
- Possibility to blend into fabrics

Thermochromic dyes

Properties:

- Can dye a fabric any colour
- The colour changes when heat or UV light reacts with the fabric
- The colour can change on a scale, depending on temperature or light(For example the colour may go more vibrant as the material is heated up more)

Microfibre fabric

Properties:
- Breathable (let sweat out)
- Durable (does not get worn out easily)
- Crease resistant
- Some variations can hold chemicals such as deodorants, insecticides and perfumes that are released when worn

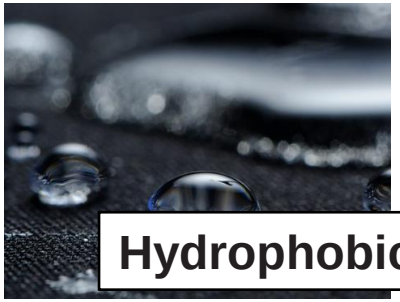
Coolmax fabric

Properties:
- Draws sweat from the skin
- The fabric dries quickly
- Breathable (Lets sweat out)
- Soft
- Comfortable
- Holds its shape

KEY QUESTIONS

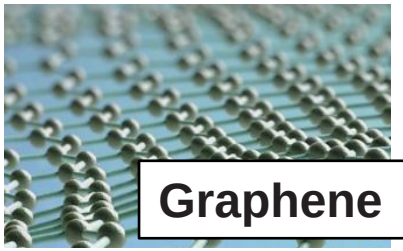
1. WHAT ARE THE PROPERTIES OF EACH MATERIAL?
2. WHAT ARE THE COMMON APPLICATIONS FOR EACH MATERIAL?

YEAR 10 – SPRING | COMPOSITES AND HIGH PERFORMANCE



Hydrophobic

Metal Foam



Graphene

Titanium

Composites

Fibre-based composite	Materials	Uses
Glass-reinforced plastic (GRP)	Glass fibres and resin	Boats, instrument cases
Carbon-reinforced plastic (CRP)	Carbon fibre and resin	Formula 1 car bodies, crash helmets, sports equipment
Glass-reinforced concrete (GRC)	Glass fibre and concrete	Street furniture, urban features

Particle-based composite	Materials	Uses
Concrete	Cement, sand and aggregate	Buildings, street furniture
Cermet	Ceramic (cer) and metal (met)	Electronic components that need to operate under very hot temperatures

SUMMER TERM

- MOISTURE SENSOR MINI NEA
- GCSE CORE KNOWLEDGE RECAP

YEAR 10 - SUMMER

REVISION TOPICS

- Maths in D&T
  - Visual representation of data
  - Percentages
  - Costings
- Product Life Cycle
- Sustainability
  - Life cycle analysis
  - Carbon footprint
  - 6R's
  - How to tackle waste
- Smart and Modern Materials
  - Smart Material Types and properties
  - Technical Textiles
- Electronics
  - Basic components
- Mechanical Devices
  - Levers
- Papers and Boards
  - Types
  - Stock forms and properties
  - Finishing techniques
- Polymers
  - Thermoforming
  - Thermosetting
- Metal Based materials
  - Specific materials (properties & uses)
- Timber based materials
  - Manufactured boards
  - Uses and properties
  - Finishes and Manufacturing Processes
- Textiles based materials
  - Natural fibres
- Design Approaches
  - Ergonomic design
  - User centred design
- Scales of Manufacturing

YEAR 10 – SUMMER	MATHS IN D&T

KEY QUESTIONS

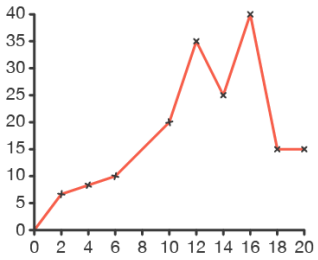
1. HOW CAN DATA BE REPRESENTED?
2. HOW DO YOU TAKE DATA AND CREATE GRAPHS?
3. HOW ARE PERCENTAGES CALCULATED?
4. HOW ARE PRODUCT “COSTS” CALCULATED?

YEAR 10 – KEY FOB

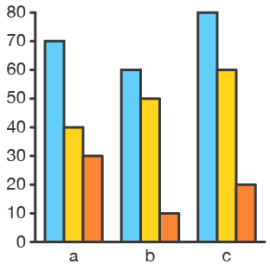
MATHS IN D&T

pie chart

line graph



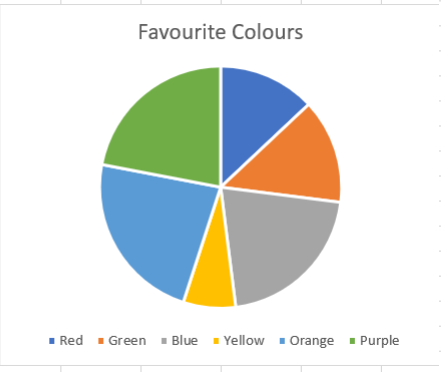
bar chart

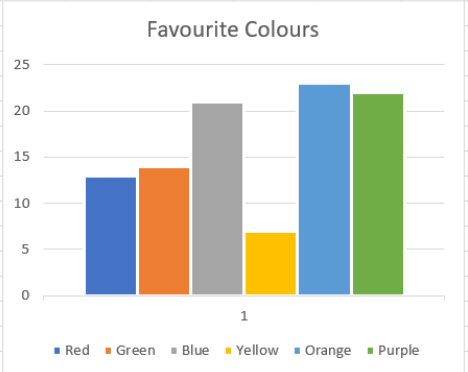


pictogram

category	frequency
A	
B	
C	
D	

Red	13
Green	14
Blue	21
Yellow	7
Orange	23
Purple	22
	100

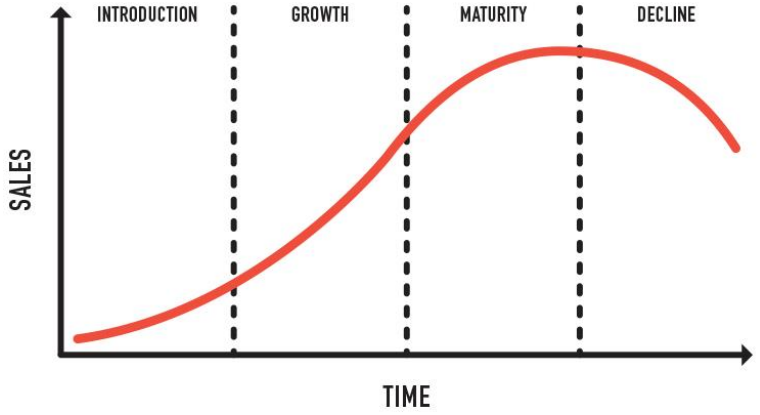




Depending upon the data set, different types of graphs will make the data easier to understand and interpret. Selecting the wrong type of graph will make the data difficult to understand.

When designing products, it is important to track the costs. This can be done simply, using excel, or online calculators.

PRODUCT LIFECYCLE



#	description	material	qty	size/item	length	width	thickness	unit cost	total cost
1	Red	Acrylic	4	3.0 mm [sheet]	300mm	150mm	£13.00 per sq m		£2.34
2	Blue	Acrylic	4	3.0 mm [sheet]	200mm	50mm	£13.00 per sq m		£0.52
3		Battery Clip	1	PP3			£0.12 each		£0.12
4		Scots Pine	4	11mm x 150mm	200mm		£2.00 per m		£1.60
5		Buzzer	1	6v			£0.65 each		£0.65
									£5.23

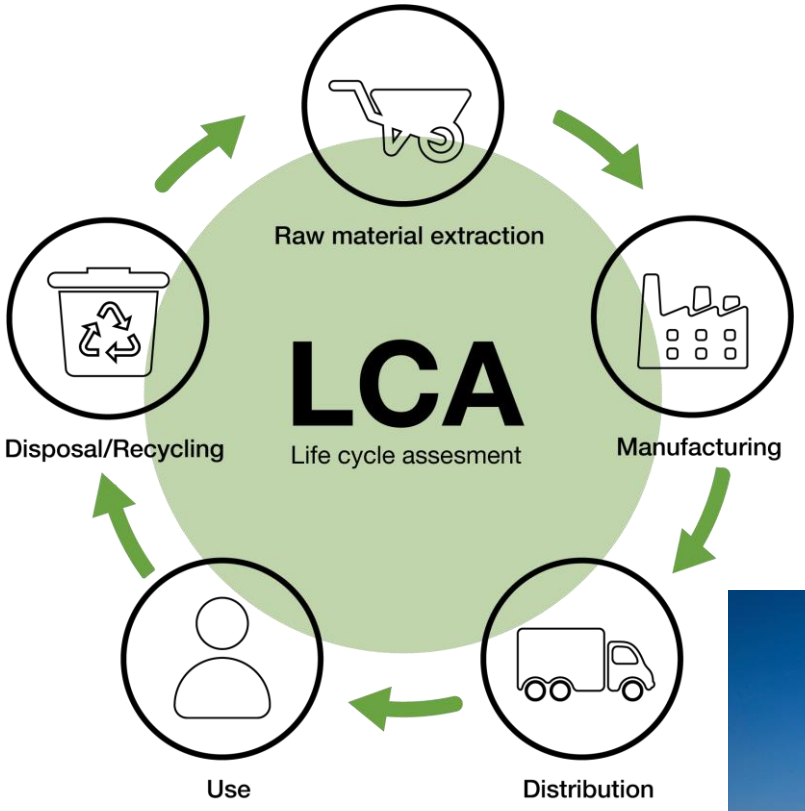
YEAR 10 – SUMMER	SUSTAINABILITY

KEY QUESTIONS

1. HOW CAN YOU ASSESS THE ENVIRONMENTAL IMPACT OF A PRODUCT?
2. WHAT IS A CARBON FOOTPRINT?
3. WHAT DO THE 6R'S DO? WHAT ARE THEY?
4. HOW IS WASTE ADDRESSED?

YEAR 10 – KEY FOB

SUSTAINABILITY

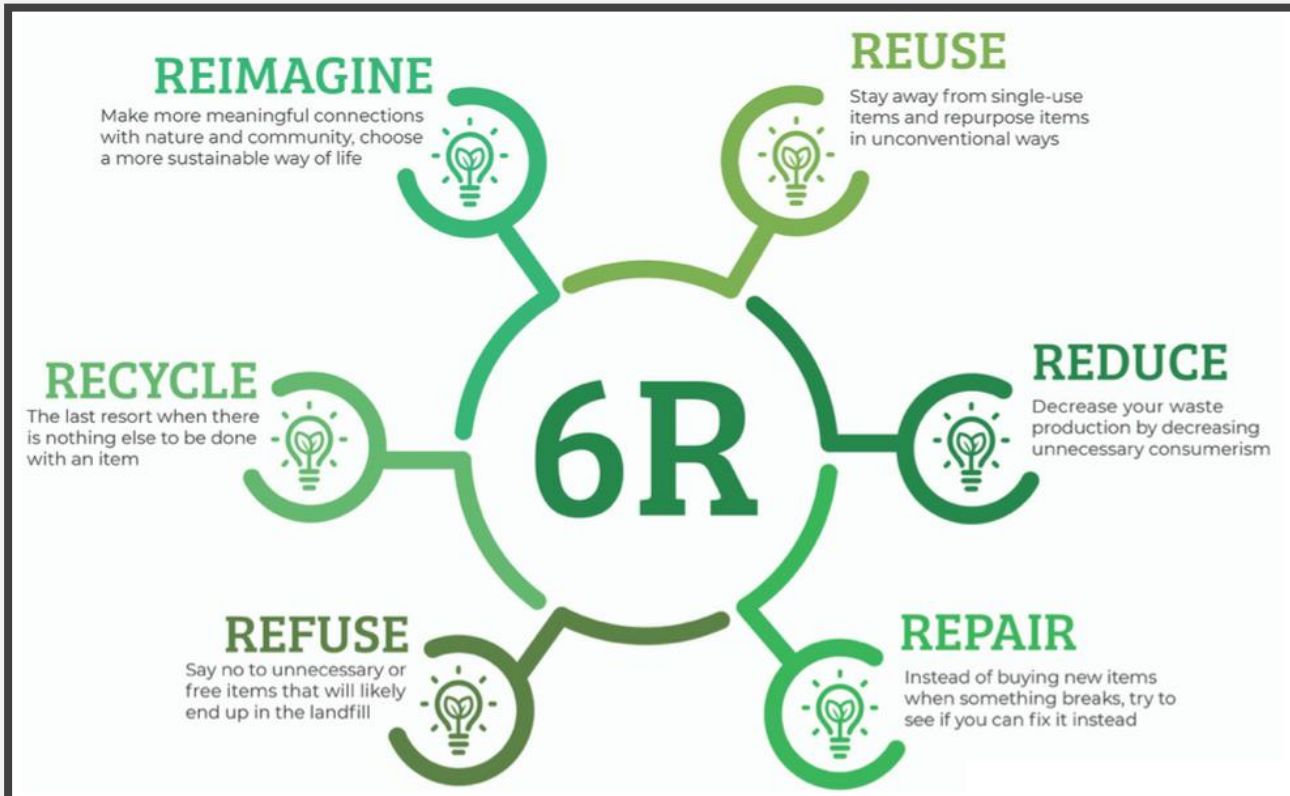


In the UK, the most common disposal method is landfill. Incineration, anaerobic digestion and some materials can be readily recycled.

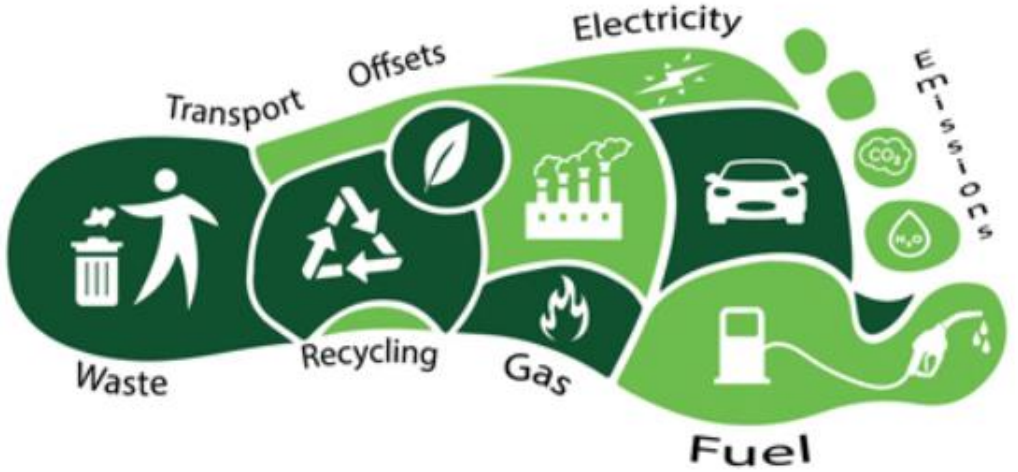
At each stage a life-cycle assessment considers:
use of raw materials (including water)
use of energy
release of waste substances into the environment

YEAR 10 – KEY FOB

SUSTAINABILITY



A carbon footprint is the total amount of greenhouse gas emissions that are released as a result of our individual actions. It measures the total volume of a number of greenhouse gases but is usually expressed in terms of the carbon dioxide equivalent.



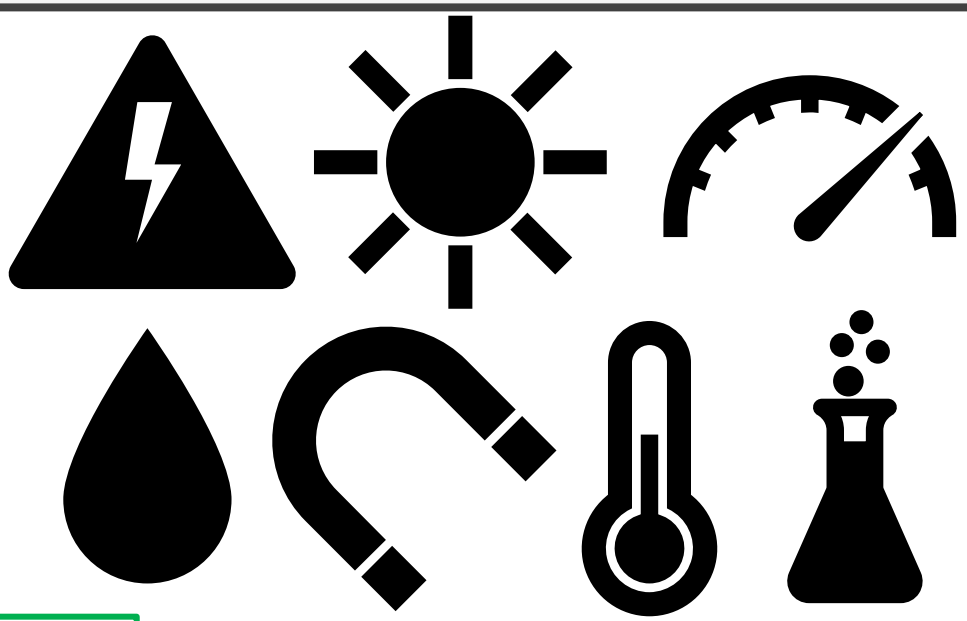
YEAR 10 – SUMMER	SMART AND MODERN MATERIALS

KEY QUESTIONS

1. WHAT STIMULI CAUSE THE PROPERTIES OF SMART MATERIALS TO CHANGE?
2. WHAT ARE SOME COMMON SMART MATERIALS?
3. WHAT ARE SOME COMMON TECHNICAL TEXTILES?

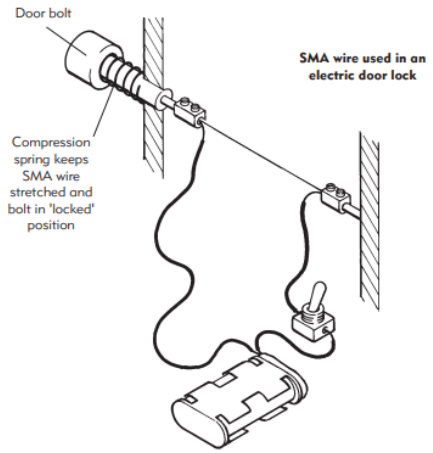
YEAR 10 – KEY FOB

SMART AND MODERN MATERIALS



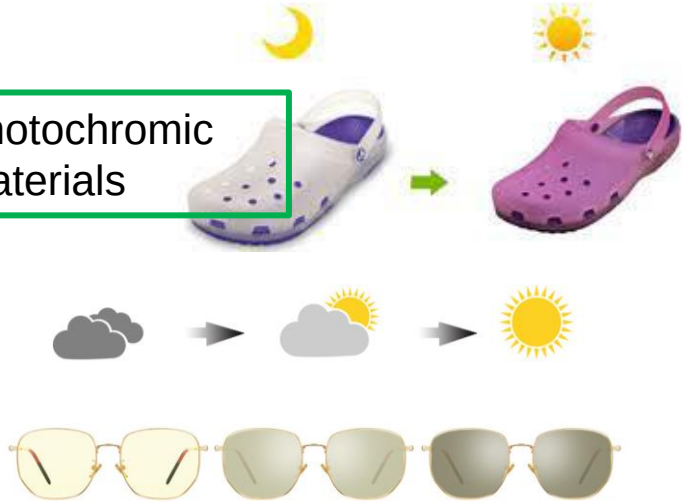
Thermochromic materials

Shape Memory Alloy (SMA)



Polymorph

Photochromic materials



YEAR 10 – KEY FOB

SMART AND MODERN MATERIALS

Gore-Tex fabric

Properties:
- Waterproof
- Breathable (allows moisture out)
- Holes on fabric allow sweat out, but not rain in
- Can be combined well with insulation fabric (to keep you warm)

Kevlar fabric

Properties:
- Eight times stronger than steel wire
- Does not melt and can withstand up to 450c
- Can withstand very low temperatures :- 96c
- Resistant to many chemicals
- Very lightweight

Nomex fabric

Properties:
- Thickens when heated, offering more protection
- Flexible fabric
- Lightweight
- Flame resistant
- Breathable (allows moisture)
- Durable (hard wearing)
- Abrasion resistant (does not get worn out easily)

Coolmax fabric

Properties:
- Draws sweat from the skin
- The fabric dries quickly
- Breathable (Lets sweat out)
- Soft
- Comfortable
- Holds its shape

Rhovyl

- is an antibacterial material that has antibacterial agents integrated into the fibre itself. thermal insulation and natural
- fire retardancy
- wicks away moisture
- resistant to mildew, fungi and chemicals

Thermochromic dyes

Properties:
- Can dye a fabric any colour
- The colour changes when heat or UV light reacts with the fabric
- The colour can change on a scale, depending on temperature or light(For example the colour may go more vibrant as the material is heated up more)

Microfibre fabric

Properties:
- Breathable (let sweat out)
- Durable (does not get worn out easily)
- Crease resistant
- Some variations can hold chemicals such as deodorants, insecticides and perfumes that are released when worn

X-Static fabric

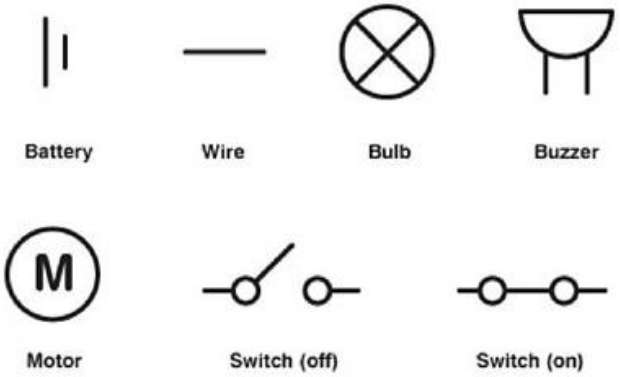
Properties:
- Anti odour (Does not hold smell)
- Made with pure silver
- Very flexible
- Soft
- Long lasting
- Stretchy
- The silver reacts with bacteria
- Has been proven to eliminate 99% bacteria within one hour

KEY QUESTIONS

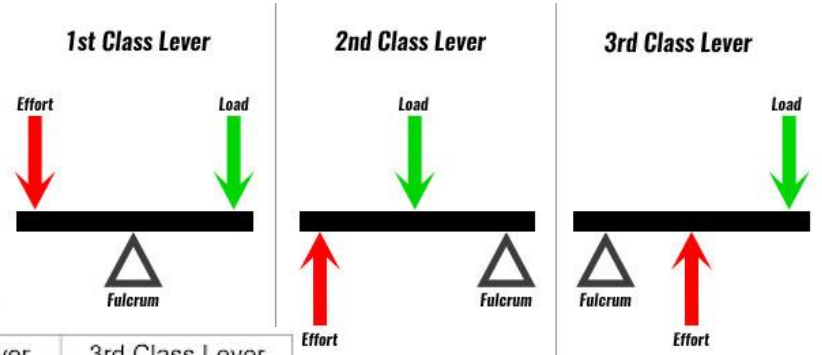
1. WHAT ARE THE MOST COMMON BASIC ELECTRONIC COMPONENTS?
2. WHAT ARE LEVERS?
3. HOW ARE THEY USED TO GIVE A MECHANICAL ADVANTAGE?

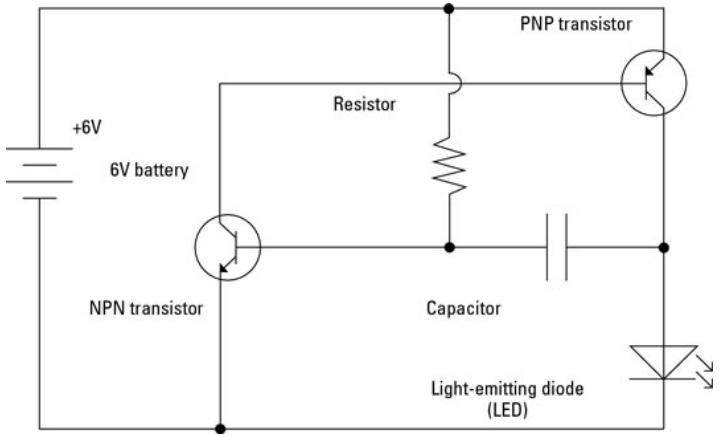
YEAR 10 – SUMMER

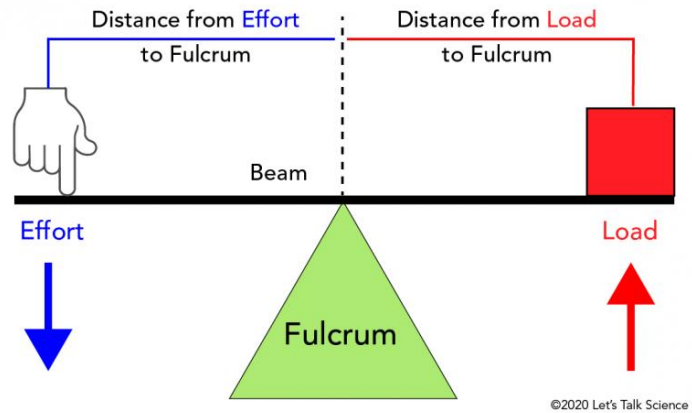
ELECTRONICS AND MECHANICAL DEVICES



FLE 123







$$\text{Mechanical Advantage} = \frac{\text{Effort (input force)}}{\text{Load (output force)}} = \frac{\text{Distance from Effort to Fulcrum}}{\text{Distance from Load to Fulcrum}}$$

YEAR 10 – SUMMER	PAPERS AND BOARDS

KEY QUESTIONS

1. HOW ARE PAPER BASED MATERIALS DEFINED?
2. WHAT ARE SOME COMMON TYPES OF PAPER BASED MATERIALS?
3. HOW CAN PAPER BASED MATERIALS BE FINISHED AND PROTECTED?

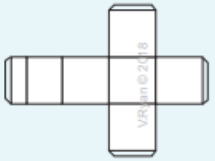
YEAR 10 – SUMMER

PAPERS AND BOARDS

COMMON PAPER AND BOARDS

CARTRIDGE PAPER - Used for general drawing. It is often good quality. This paper is used for design and technology projects and will take colour from pencils and felt pens, without too much bleeding to the opposite side of the paper. **120 to 160gsm.**

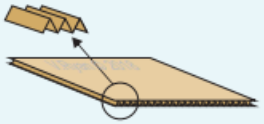
CARDBOARD - Thicker than paper as it is made up of a number of layers, glue or laminated together. The diagram opposite shows a net / development of a package.



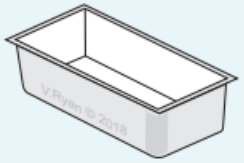
DUPLEX BOARD - Used for containers and can contain liquids, as it may have a water-proof liner on the inside. It can have a wax feel. This type of card is used by the food industry and consequently recycled card is not used in its manufacture. **200 to 500 gsm**

SOLID WHITE BOARD - This is normally top quality cardboard, made from quality bleached wood pulp. It is suitable for printing on to and consequently, it is used for hard backed books and general, expensive items. **200 to 500gsm**

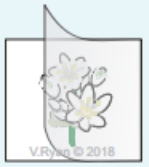
CORRUGATED BOARD - Often used for packaging large items. These boxes (brown in colour), protect the contents from damage. Corrugated board is strong because it is composed of a top and bottom layer and in between there is a triangulated section. A triangular section is very strong, compared to its weight. **1000 to 5500gsm**



FOIL LINED BOARD - Good quality cardboard with an aluminium foil lining. This type of container is ideal for ready made meals or take away meals. The foil retains the heat helping to keep the food warm. **220 to 420gsm**

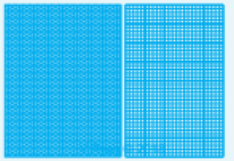


TRACING PAPER - Is used by pupils, students and designers. Allows the designer to copy an existing drawing / shape. Tracing paper can be useful, when there is a need to produce several drawings, that are based on the same outline. **40 to 130gsm**



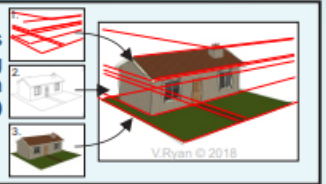
BLEED PROOF PAPER - Does not allow felt pens/ink pens (water or spirit based), to spread or bleed through and across the surface. When a felt pen is used on the surface of cartridge paper, accuracy can be lost, as the ink is absorbed and spreads out, leaving an inaccurate line. Bleed proof paper, has a coating that prevents this happening. **70gsm**

GRID PAPER - Is manufactured in a range of patterns, the most common being isometric and square grids. This type of layout helps when drawing in three dimensions (isometric) or drawing graphs and pictograms (graph paper). **Standard 80gsm**



INK JET CARD - A high quality paper, often used when a photograph is printed. The surface is normally gloss or matt, in texture. It is relatively expensive compared to cartridge or photocopying paper. **120 to 400gsm**

LAYOUT PAPER - Used by architects, designers and artists, to lay over the top of an existing drawing, in order to copy parts / aspects. When put together, the various layers appear as one. **40 to 60gsm**



FOR DETAIL, INFORMATION AND EXERCISES ON GRAPHICS AND VISUAL COMMUNICATION GO TO:

http://www.technologystudent.com/despro_flsh/graphics_main1.html

http://www.technologystudent.com/designpro/drawdex.htm

YEAR 10 – SUMMER

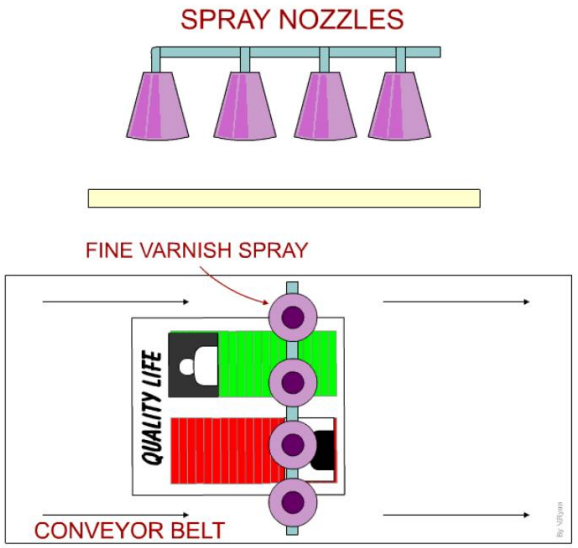
PAPERS AND BOARDS

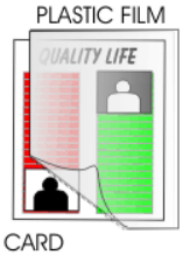
Paper and boards are measured in 2 ways:

- **Microns**
- **GSM (Grams per Square Metre)**

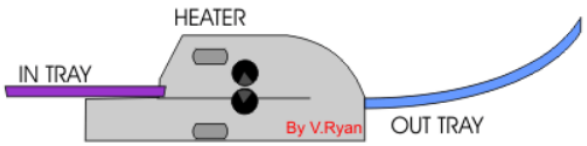
Vinyl Application

Printing and Varnishing





Lamination or Encapsulation



TETRAPAK

YEAR 10 – SUMMER	POLYMERS

KEY QUESTIONS

1. WHAT IS THE PRIMARY DIFFERENCE BETWEEN THERMOFORMING POLYMERS AND THERMOSET POLYMERS?
2. WHAT ARE SOME COMMON EXAMPLES OF EACH CATEGORY?
3. WHAT COMMON APPLICATIONS ARE THESE USED FOR?

YEAR 10 – SUMMER

POLYMERS

Thermoforming polymer	Properties	Uses
Acrylic (PMMA)	Hard with good plasticity when heated so can be folded well, resists weather well but is brittle and scratches easily, available in lots of colours	Car headlights, visors and baths
High density polythene (HDPE)	Stiff, strong but lightweight, good plasticity when heated with excellent chemical resistance	Washing-up bowls, pipes, chairs, buckets and bottles
Polypropylene (PP)	Lightweight but strong and tough, has good heat and chemical resistance	Computer game cases, chairs, children's toys and food packaging film
Polyvinyl chloride (PVC)	Can be matt or high gloss with both chemical and weather resistance, low in cost with good strength, can be made to be flexible or rigid	Window frames, building cladding, guttering

Thermoforming polymers can be **heated and formed repeatedly.** They are **pliable** and **recyclable**.

YEAR 10 – SUMMER

POLYMERS

Thermosetting polymer	Properties	Uses
Epoxy resin (ER)	Supplied as two parts, one resin and one hardener (see image) - the resin and hardener combine to create an extra-strong adhesive, good chemical and heat resistance and an excellent thermal insulator, can be brittle	Bonds materials and can be used for waterproof coatings and lamination
Melamine formaldehyde (MF)	Excellent heat resistance as well as being resistant to scratching and staining, hard and strong	Laminates for worktops, food safe so used for picnic tableware
Urea formaldehyde (UF)	A hard and stiff polymer with excellent thermal insulation	Electrical fittings, toilet seats, holding the wood chips together in the making of medium-density fibreboard (MDF)

Thermosetting polymers are **brittle** and can only be **formed once**. They **are hard to recycle**. They are **good insulators** and are **resistant to heat and chemicals.**

YEAR 10 – SUMMER	METAL BASED MATERIALS

KEY QUESTIONS

1. WHAT IS THE PRIMARY DIFFERENCE BETWEEN FERROUS AND NON FERROUS METALS?
2. WHAT ARE SOME COMMON EXAMPLES OF EACH CATEGORY, AND ALLOYS?
3. WHAT COMMON APPLICATIONS ARE THESE USED FOR?

YEAR 10 – SUMMER

METAL BASED MATERIALS

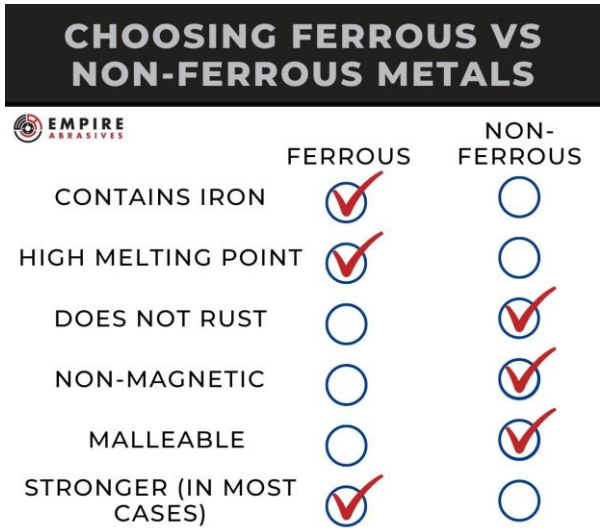
Ferrous metal	Properties	Uses
Cast iron	Brittle if thin, can be cast in a mould, strong compression strength, good electrical and thermal conductivity but poor resistance to corrosion	Manhole covers, pans and gates, vices
High-carbon steel (tool steel)	Hard but brittle, less malleable than mild steel, good electrical and thermal conductivity	Taps and tools, eg screwdrivers and chisels
Low-carbon steel (mild steel)	Ductile and tough, easy to form, braze and weld, good electrical and thermal conductivity but poor resistance to corrosion	Nuts, bolts, screws, bike frames and car bodies

Non-ferrous metal	Properties	Uses
Aluminium	Light in weight and malleable but strong, a good conductor of heat and corrosion resistant	Drink cans, saucepans, bike frames
Copper	An excellent electrical conductor of heat and electricity, extremely malleable and can be polished, oxidises to a green colour	Plumbing fittings and electrical wires, professional chef's saucepans
Silver	A precious metal that is soft and malleable when heated, highly resistant to corrosion and an excellent electrical conductor of heat	Jewellery

YEAR 10 – SUMMER

METAL BASED MATERIALS

Alloy	Properties	Uses
Brass (alloy of copper and zinc)	Non-ferrous metal that is strong and ductile, casts well and is gold coloured but darkens when oxidised with age, a good conductor of heat	Taps, screws, castings, locks and doorknobs
Bronze (alloy of copper, aluminium and/or nickel)	Non-ferrous alloy, harder than brass and corrosion resistant, reddish/yellow in colour	Castings, bearings
Stainless steel (alloy of steel also with chromium, nickel and magnesium)	Ferrous metal that is silver when polished, hard and tough with excellent resistance to corrosion	Cutlery, sinks, saucepans, surgical equipment



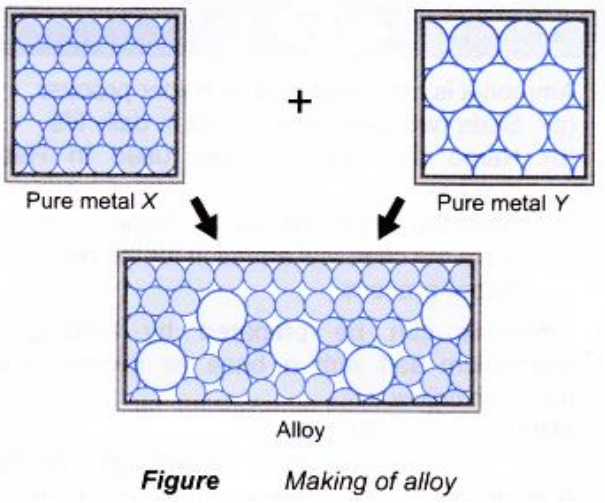


Figure *Making of alloy*

YEAR 10 – SUMMER	TIMBER BASED MATERIALS

KEY QUESTIONS

1. WHAT IS THE PRIMARY DIFFERENCE BETWEEN SOFT AND HARD WOOD?
2. WHAT ARE SOME COMMON EXAMPLES OF EACH CATEGORY, AND MAN MADE BOARDS?
3. WHAT COMMON APPLICATIONS ARE THESE USED FOR?
4. HOW SHOULD TIMBER BASED MATERIALS BE FINISHED?

YEAR 10 – SUMMER

TIMBER BASED MATERIALS

Hardwood	Properties	Uses
Balsa	Soft and easy to form, lightweight, pale in colour, not durable but cheap	To make models
Beech	Close-grained, hard, strong and tough, can be challenging to work with and is prone to warping and splitting	Furniture, toys and tool handles, a veneer for worktops
Jelutong	A pale, close-grained timber, with medium toughness, easy to work with	Sculpture and pattern making
Mahogany	Deep reddish colour that is strong and durable, fairly strong and of medium weight, relatively easy to work with but prone to warping	Indoor furniture, panelling and veneers
Oak	Moderate-brown colour with unique and attractive grain markings, tough and durable, polishes well	High-quality furniture, kitchens units, flooring and for veneers as an expensive material

Softwood	Properties	Uses
Paraná pine	Hard, straight-grained, strong and durable with a smooth finish, almost knot free, expensive and tends to warp	Quality, indoor joinery, eg staircases and built-in furniture
Scots pine	Straight-grained but knotty, fairly strong and easy to work with and paint, cheap	Indoor joinery, eg staircases and furniture - if used outdoors it needs regular protection
Western red cedar	Lightweight and knot free, has natural oils that protect it, easy to work but weak and expensive	Outdoors including building cladding

YEAR 10 – SUMMER

TIMBER BASED MATERIALS

Manufactured board	Properties	Uses
Chipboard (particle board)	Large chips or flakes of wood glued together under pressure, brittle, difficult to shape and finishes poorly, absorbent to water and low in cost	Used for veneered worktops and flooring
Medium-density fibreboard (MDF)	A compressed board made from wood fibres glued together, smooth, light brown, can be veneered and painted, hard, keeps edges well on cutting, goes soggy when exposed to water if not protected	Used for kitchens and flat pack furniture
Plywood	Odd number of layers of veneer glued at 90 degree angles for strength, aesthetically pleasing outer layer, it is stiff and hard to bend unless glued into set shapes	Used for shelving work surfaces, floors and furniture

Clear Finished

No Finish

When finishing wood, abrasives are commonly used first to remove excess material, to remove blemishes, and to smooth surfaces.

Common abrasives are **glasspaper**, **sandpaper**, and **steel wool**. Glass and sandpaper come in different grades depending on the amount of grit on the paper. The more grit, the more abrasion, and the smoother the surface finish.

Once the surfaces have been prepared, a finishing product is often added to add a layer of protection and to give a more pleasing appearance to the item.

Wax is used to apply a protective coating to wood. It can also change the colour of wood and make it smooth.

Varnish and **stains** can bring out the grain of the wood and also change the wood's colour and appearance. Typically several layers are applied to build up a good finish.

Paint can massively transform the look of a wood by drastically changing its colour. Built up in layers, it also provides protection from the elements to the wood. Polish can also be applied to provide a protective coating.

YEAR 10 – SUMMER

TIMBER MANUFACTURING METHODS

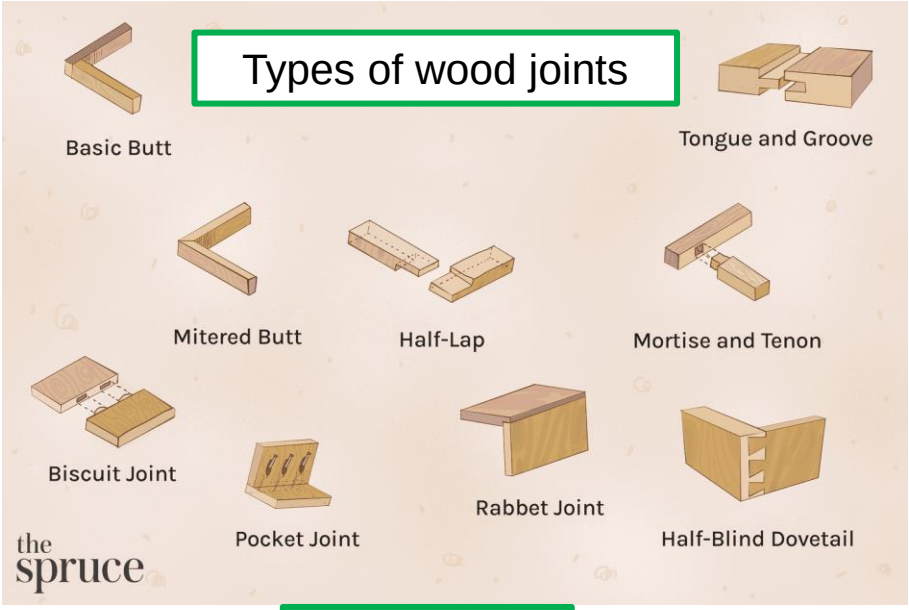
KEY QUESTIONS

1. WHAT MANUFACTURING METHODS ARE SPECIFIC TO TIMBER BASED MATERIALS

YEAR 10 – SUMMER

TIMBER MANUFACTURING METHODS

Types of wood joints



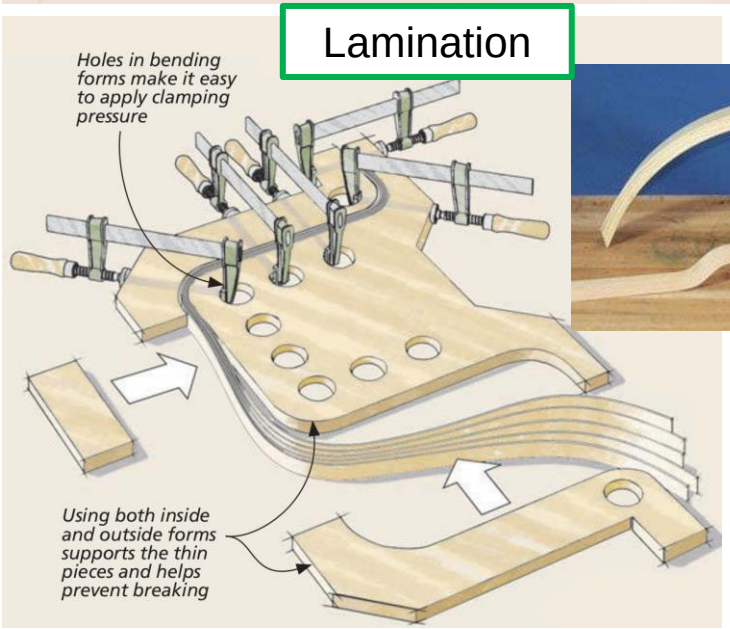
Types of Wood Glue

There are different types of wood glue, and you need to know about wood glue advantages and disadvantages for your project(s). The basic wood glues are:

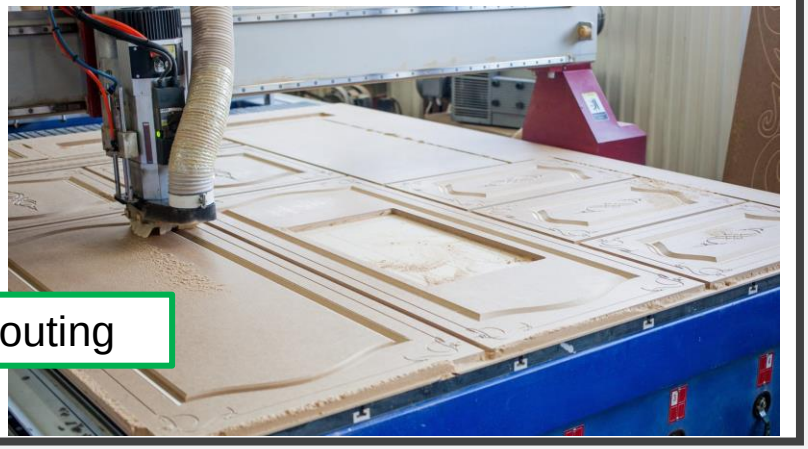
- Polyvinyl acetate (PVA)
- Polyurethane
- Cyanoacrylate
- Animal or hide
- Epoxy

Wood turning – using a lathe

Lamination



CNC Routing



YEAR 10 – SUMMER	TEXTILE BASED MATERIALS

KEY QUESTIONS

1. WHAT IS THE PRIMARY DIFFERENCE BETWEEN SYNTHETIC (MANUFACTURED) AND NATURAL FIBRES?
2. WHAT ARE SOME COMMON EXAMPLES OF EACH CATEGORY?
3. WHAT COMMON APPLICATIONS ARE THESE USED FOR?

YEAR 10 – SUMMER

TEXTILE BASED MATERIALS

Natural fibre	Properties	Uses
Cotton (plant)	Highly absorbent so is comfortable to wear, strong and durable, easy to care for but can shrink and has poor elasticity so creases	Most clothing, bed linen, upholstery fabric and in the medical industry (because it can be boiled)
Linen (plant)	Highly absorbent and cool to wear, very strong and durable, poor elasticity so creases easily	Summer clothing, upholstery fabric, table clothes and napkins
Hemp (plant)	Absorbent, strong and naturally antibacterial	Carpets, rugs and ropes
Jute (plant)	Absorbent and very strong but coarse	Bags, sacks for vegetables, carpets and twine
Wool (animal)	Absorbent with good insulating properties due to the fibre's natural crimp (curl), has good elasticity so doesn't crease much, relatively strong but can shrink on washing	Jumpers, suits, carpets and blankets
Silk (insect)	Drapes well and has good lustre (sheen), absorbent but difficult to wash and creases	Luxury clothing, eg dresses, underwear and bedding

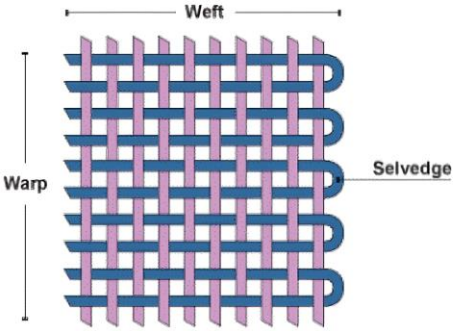


Figure 3. Woven fabric (general).

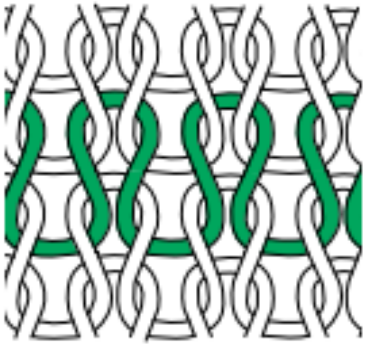


Figure 7. Weft knit.

YEAR 10 – SUMMER

TEXTILE BASED MATERIALS

Manufactured fibre	Properties	Uses
Acrylic	Like all synthetic fibres, has good strength with good elastic properties so doesn't crease, has poor absorbency but can be a good insulator if crimp is added to replicate wool fibres	Jumpers and other knitted clothing that looks like wool, fake fur jackets
Polyester	Hardwearing with good tensile strength, good elasticity but poor absorbency, a highly versatile fibre	Clothing and sportswear
Nylon (polyamide)	A hardwearing fibre with good tensile strength, has good elasticity so doesn't crease and is resistant to chemicals, not absorbent and melts easily	Parachutes, tents, rucksacks, sports clothing, rope and carpets
Elastane	Highly elastic and stretchy, strong and hardwearing	Clothing such as leotards, swimming costumes and gym clothing, mixed with cotton in T-shirts for a better fit

Felt is made by matting together wool, other hair fibers, or certain man-made fibers. Felting is done by applying heat, moisture, and pressure to a layered web of tangled fibers. Felt does not ravel and does not have a yarn direction or grain. Felt is not durable as a garment fabric, but it is often used in decorative projects for home furnishings.

Fusing, laminating, and bonding use adhesives to interlock short fibers or glue fabrics together. Interfacing is an example of fused fibers. A laminated fabric may be a bond of fabric to fabric, fabric to foam, or a combination fabric and foam. Fabrics are laminated or bonded to increase warmth, reduce cost, improve handling, reduce shrinkage, and increase the uses of the fabric.

SCALES OF MANUFACTURING

KEY QUESTIONS

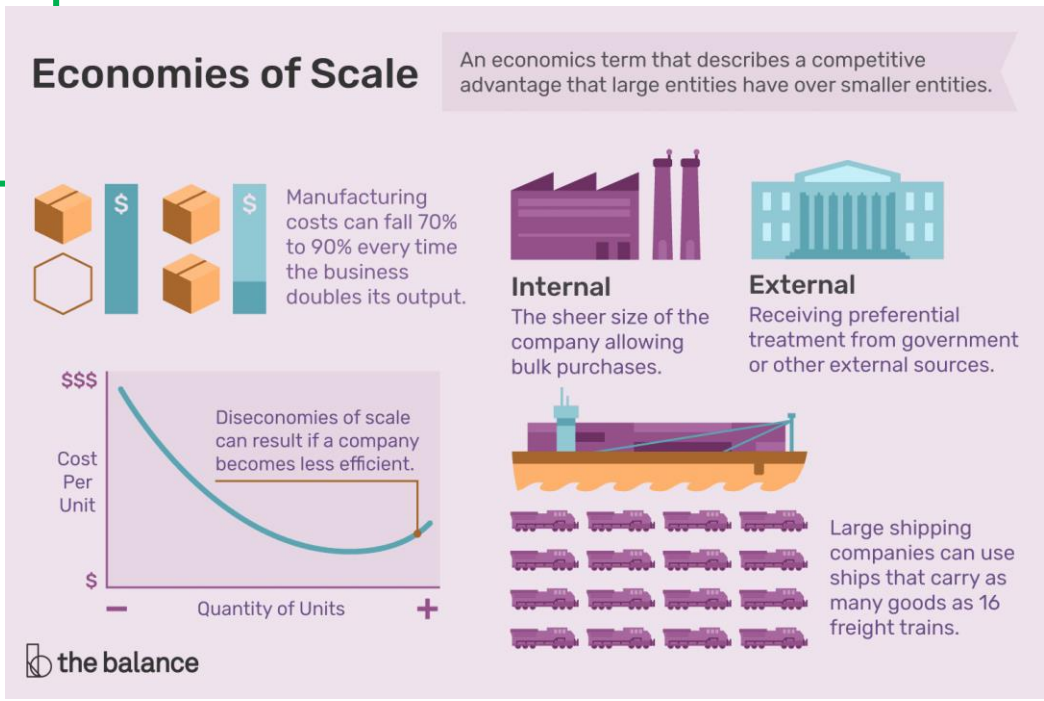
1. WHAT ARE THE MAIN “SCALES OF MANUFACTURING”?
2. WHAT SORTS OF PRODUCTS ARE MANUFACTURED WITH EACH PRODUCTION APPROACH?
3. HOW DO THEY COMPARE, IN TERMS OF COST PER PART VS INITIAL SETUP COSTS?

YEAR 10 – SUMMER

SCALES OF MANUFACTURING

Mass production is a way of making many identical products quickly and efficiently. It involves using machines and assembly lines to produce large quantities of goods, such as cars, electronics, and toys.
In mass production, each worker is responsible for a specific task or job. They repeat the same task over and over again, which allows them to become very skilled and efficient at it. The machines and equipment are also designed to perform specific functions quickly and accurately.

Scale of manufacturing	Initial setup costs	Cost per part
Mass/ Continuous	High	Low
Batch	Mid	Mid
One-off/ bespoke	Low	High



YEAR 10 – SUMMER

SCALES OF MANUFACTURING

Batch production is a manufacturing process where a specific quantity of a product is produced in a single batch, rather than being produced continuously. This means that all the materials and equipment needed for the production of a specific batch are gathered and prepared at once, and then the production process is carried out for that entire batch.
For example, let's say a company wants to produce 1000 jars of peanut butter. Instead of making each jar one at a time, they would gather all the necessary materials and equipment, like peanuts, jars, labels, and packaging, and prepare them for a batch production run. They would then produce all 1000 jars in a single batch, ensuring that each jar is consistent in quality and meets the same standards.

One-off production is a type of manufacturing process where a single unique product is made. This means that the product is not mass-produced or made in large quantities, but rather each item is custom-made to meet specific requirements or needs.

YEAR 10 – SUMMER

DESIGN APPROACHES

KEY QUESTIONS

1. WHAT IS USER-CENTRED DESIGN?
2. WHAT FACTORS AFFECT THE DESIGN AND MANUFACTURE OF PRODUCTS?

YEAR 10 – SUMMER

DESIGN APPROACHES

We use **ACCESS FM** to help us write a **specification** - a list of requirements for a design - and to help us **analyse and describe** an already existing product.

ACCESS FM - Helpsheet

A is for **Aesthetics**

Aesthetics means **what does the product look like?**
What is the: Colour? Shape? Texture? Pattern? Appearance? Feel? Weight? Style?

C is for **Cost**

Cost means **how much does the product cost to buy?**
How much does it: Cost to buy? Cost to make?
How much do the different materials cost? Is it good value?

C is for **Customer**

Customer means **who will buy or use your product?**
Who will buy your product? Who will use your product?
What is their: Age? Gender?
What are their: Likes? Dislikes? Needs? Preferences?

E is for **Environment**

Environment means **will the product affect the environment?**
Is the product: Recyclable? Reuseable? Repairable? Sustainable?
Environmentally friendly? Bad for the environment?
6R's of Design: Recycle / Reuse / Repair / Rethink / Reduce / Refuse

S is for **Size**

Size means **how big or small is the product?**
What is the size of the product in millimeters (mm)? Is this the same size as similar products? Is it comfortable to use? Does it fit?
Would it be improved if it was bigger or smaller?

S is for **Safety**

Safety means **how safe is the product when it is used?**
Will it be safe for the customer to use? Could they hurt themselves?
What's the correct and safest way to use the product? What are the risks?

F is for **Function**

Function means **how does the product work?**
What is the products job and role? What is it needed for? How well does it work? How could it be improved? Why is it used this way?

M is for **Material**

Material means **what is the product made out of?**
What materials is the product made from? Why were these materials used? Would a different material be better? How was the product made? What manufacturing techniques were used?

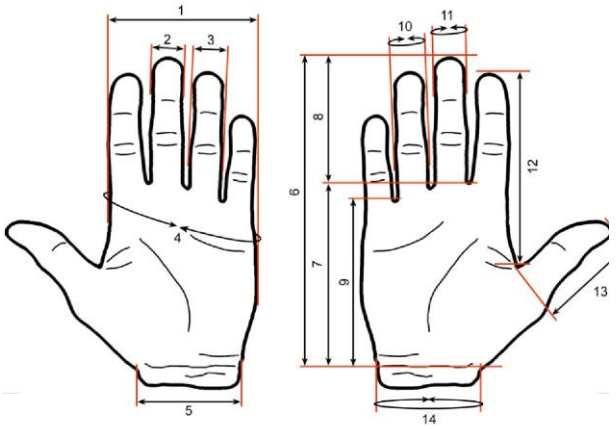
User-centered design (UCD) is a way of designing products or services with the user in mind. It is an approach that focuses on understanding the needs, goals, and preferences of the people who will be using the product, and designing it in a way that meets those needs.

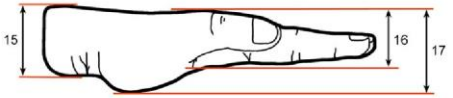
UCD involves several steps, including user research, prototyping, and testing. During the user research phase, designers gather information about the users and their needs through methods like surveys, interviews, and observation. This information is then used to create prototypes of the product or service, which are tested with users to see how well they meet their needs.

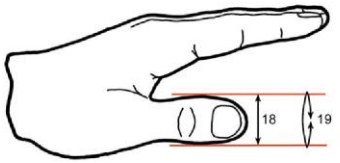
YEAR 10 – SUMMER

DESIGN APPROACHES

Ergonomics is all about designing things so that people can use them comfortably and safely. It's a way of making sure that everything fits well with the human body and makes tasks easier to do.







Anthropometrics is the study of the measurement of the human body. This includes things like height, weight, body mass index (BMI), and other physical features like the length of limbs, the size of hands and feet, and the circumference of the head.

Name				Date				Su 2	Au 1	Au 2	Sp 1	Sp 2	Deadlines
		0	1-2	3-5	6-8	9-10	Mark						
Identifying and investigating design possibilities (AO1)	Identifying opportunities	produced no work that is worthy of a mark.	identified one opportunity for the possible develoment of designs within the prescribed context.	identified some opportunities for the development of designs within the prescribed context.	undertaken a generally effective identification of opportunities for development of designs within the prescribed context.	undertaken a comprehensive and effective identification of opportunities for the development of designs within the prescribed context.							
	Relevant research		undertaken little research and investigation, which is only partially linked to the context.	undertaken research and investigation, generally linked to the context and, where appropriate, the work of past/present professionals and companies.	undertaken relevant research and investigation, linked to the context and, where appropriate, the work of past/present professionals and companies.	undertaken comprehensive, relevant research and investigation, clearly linked to the context and, where appropriate, the work of past/present professionals and companies.							
	User wants/needs and analysis		undertaken a superficial analysis of information, with little or no consideration of the needs, wants and values of potential users.	undertaken a partially effective analysis of information, though the needs, wants and values of potential users may not have not been fully considered.	undertaken a mostly effective analysis of information, reflecting the needs, wants and values of potential users.	undertaken an effective analysis of information, reflecting the needs, wants and values of clients or potential users.							
	Explored possibilities to develop briefs		identified few problems/opportunities which are of little use in the development of possible design briefs.	identified some problems/opportunities which partially inform the development of possible design briefs.	identified a range of problems/opportunities to inform the development of possible design briefs.	identified a range of problems/opportunities to clearly inform the development of possible design briefs.							
						Mark/10							
		0	1-2	3-5	6-8	9-10							
Developing a design brief and specification(AO1)	Considered range of design problems	produced no work that is worthy of a mark.	focussed on a single opportunity to produce a basic design brief.	considered some problems/opportunities before deciding on a final design brief.	considered a range of problems/opportunities before deciding upon a final design brief.	thoroughly considered a range of problems/opportunities in detail before deciding upon a final design brief.							Hand in 21st July 2023
	Understanding of the design task		demonstrated a limited understanding of the task ahead, with little or no consideration of the needs, wants and interests of potential users.	demonstrated a general understanding of the task ahead and one or two requirements have been identified to satisfy some of the needs, wants and interests of potential users.	demonstrated a good understanding of the task ahead and most of the requirements which have to be met, to satisfy most of the needs, wants and interests of potential users.	demonstrated a very good understanding of the task ahead and the requirements which have to be met, to satisfy fully the needs, wants and interests of potential users.							
	Design brief		written a design brief with little or no reference to their research and investigation.	written a satisfactory design brief, based upon some aspects of the analysis of their research and investigation.	written a good design brief, linked to the context, based upon a general analysis of their research and investigation.	written a comprehensive design brief, directly relevant to the context, based upon a thorough analysis of their research and investigation.							
	Design specification		produced a small range of partially appropriate specification points.	written a satisfactory specification, including some key points, to partially inform the design and manufacture of a prototype.	written a relevant specification, including a range of objective and measurable criteria, to inform the design and manufacture of a prototype.	written a comprehensive, relevant specification, including a range of objective and measurable criteria, to direct and inform the design and manufacture of a prototype.							
						Mark/10							
		0	1-7	8-15	16-23	24-30							
Generating and developing design ideas (AO2)	Use of design strategies and iterative design	produced no work that is worthy of a mark.	generated and communicated a limited range of undeveloped initial ideas.	considered some design strategies and techniques and applied an iterative design process to generate and communicate a range of basic initial ideas.	considered a range of design strategies, techniques and approaches and applied an iterative design process to generate and communicate a range of initial ideas which generally reflect requirements.	considered a range of design strategies, techniques and approaches and applied an iterative design process to generate and communicate a range of initial ideas which fully reflect all requirements.							Hand in 3rd November 2023
	Social, Moral, Economic Factors		identified aspects of social, moral or economic factors, though these are not closely related to the context and or potential user(s).	identified social, moral and/or economic factors with some attempt to relate these to the context and potential user(s).	identified and considered social, moral and economic factors which are generally relevant to the context and potential user(s).	identified and considered social, moral and economic factors which are fully relevant to the context and potential user(s).							
	Testing to develop designs		made little or no use of testing to evolve ideas.	made some use of testing to evolve ideas and to refine their design decisions.	clear and generally effective use of testing to evolve ideas and to refine their design decisions.	clear, effective and detailed use of testing to evolve ideas and to refine their design decisions.							
	Fully developed design proposal		developed a proposal, with superficial details of materials, dimensions, finishes and/or production techniques which addresses few requirements of the design brief and/or specification.	developed a proposal, including satisfactory details of materials, dimensions, finishes and/or production techniques, which address the main requirements of the design brief and specification.	developed a proposal, including relevant details of materials, dimensions, finishes and production techniques, which address most requirements of the design brief and specification.	developed a proposal, including comprehensive and relevant details of materials, dimensions, finishes and production techniques, which clearly address all requirements of the design brief and specification.							
	Communication techniques		demonstrated limited ability to communicate their idea(s) to a third party.	demonstrated satisfactory use of skills/techniques to communicate ideas and proposals to a third party.	demonstrated good use of skills/techniques to communicate ideas and proposals to a third party.	demonstrated sophisticated use of skills/techniques to clearly communicate ideas and proposals to a third party.							
						Mark/30							
		0	1-7	8-15	16-23	24-30							
Manufacturing a prototype (AO2)	Planning for manufacture	produced no work that is worthy of a mark.	communicated superficial or no details of a sequence for manufacture and/or testing of their final prototype.	communicated details of a sequence for manufacture and testing of their final prototype.	communicated relevant details of a logical sequence and achievable timeline for the stages of production and testing of their final prototype.	clearly communicated comprehensive and relevant details of a logical sequence and achievable timeline for the stages of production and testing of their final prototype.							Hand in 20th January 2024
	Worked with materials and components		worked with materials and components to partly complete the manufacture of their prototype, generally to a defined schedule.	worked with materials and components to partly complete the manufacture of their prototype, generally to a defined schedule.	worked with appropriate materials and components to complete most aspects of the manufacture their prototype, generally to a defined schedule.	worked with appropriate materials and components to complete all aspects of the manufacture of their prototype to a defined schedule.							
	Produce a high quality prototype		implemented making skills and processes to produce a partially functioning prototype, some aspects of which meet elements of the design specification.	used making skills and processes to produce a satisfactory, functioning prototype that partially meets the requirements of the design specification and is generally fit for purpose.	used appropriate making skills and processes to produce a good quality functioning prototype that generally meets most of the requirements of the design specification and is fit for purpose.	used appropriate making skills and processes to produce a high quality functioning prototype that fully meets all requirements of the design specification and is fit for purpose.							
	Understanding of materials (properties and finishes)		a limited understanding of the working properties and/or performance characteristics of the specified materials.	a satisfactory understanding of the main working properties and performance characteristics of the specified materials and, where appropriate, demonstrated basic consideration of surface treatments/finishes.	a good understanding of the working properties and performance characteristics of the specified materials and, where appropriate, demonstrated consideration of surface treatments/finishes.	an excellent understanding of the working properties and performance characteristics of the specified materials and, where appropriate, demonstrated consideration of surface treatments/finishes.							
	Using tools/ techniques/ processes/ equipment		selected and safely used specialist tools, techniques, processes, equipment and machinery with a limited degree of accuracy, the prototype only just performs or is unable to perform as intended, and meets few aspects of the needs, wants and values of the user.	selected and safely used specialist tools, techniques, processes, equipment and machinery with a fair degree of accuracy and precision, the prototype partially performs as intended and meets some aspects of the user's requirements.	selected and safely used specialist tools, appropriate techniques, processes, equipment and machinery with good accuracy and precision to enable the prototype to perform as intended and generally meet the user's requirements.	selected and safely used specialist tools, appropriate techniques, processes, equipment and machinery with excellent accuracy and precision to enable the prototype to perform as intended and fully meet the user's requirements.							
						Mark/30							
		0	1-5	6-10	11-15	16-20							
Analysing and evaluating design decisions and prototypes (AO3)	Evaluation and testing of ideas	produced no work that is worthy of a mark.	produced a superficial evaluation of their ideas and decisions.	undertaken a satisfactory analysis, evaluation and/or testing of their ideas and decisions whilst applying iterative design processes.	undertaken an objective analysis, evaluation and testing of their ideas and decisions whilst applying iterative design processes.	undertaken a critical, objective analysis, evaluation and testing of their ideas and decisions whilst applying iterative design processes.							Hand in 9th February 2024
	Evaluation and testing of prototype		produced a superficial evaluation of their final prototype.	undertaken a satisfactory analysis, evaluation and/or testing of their final prototype, with partial consideration of the views of potential users.	undertaken an objective analysis, evaluation and testing of the final prototype, with some consideration of the views of potential users.	undertaken a critical and objective evaluation and testing of their final prototype, taking into account the views of potential users.							
	Further development		partially identified how their prototype could be modified.	identified the potential for some further development of their prototype, including suggestions of how modifications could be made.	responded to feedback and identified the potential for further development of their prototype, suggesting how modifications could be made.	responded to feedback and clearly identified the potential for further development of their prototype, with detailed suggestions for how modifications could be made.							
						Mark/20							
						TOTAL MARK/100							

Eduqas GCSE D&T Technical Principles Core Knowledge and Understanding 2.1.2/3

Design and Technology and our World 3

Changing society's views

There are many ways in which society is encouraged to reduce waste and recycle more, because:

- 90% of waste is dumped or burned, mostly in low income countries
- lots of poorly managed waste contaminates the world's oceans
- waste causes clogging of drains, flooding, the spread of disease and harm to wildlife.

Recycling – with economic development and population growth, the generation of waste will also increase. High income countries provide nearly universal waste collection, and more than one third of waste in high income countries is recovered through recycling and composting.

Low income countries collect about 48% of waste in cities, but only 26% in rural areas, and only 4% is recycled.

Overall, only 13.5% of global waste is recycled, and 5.5% is composted.

The circular economy refers to society putting waste back into a good use and continuing this cycle. This means that once a material, component or product comes to the end of its useful life with the owner, it is disposed of and becomes re-usable in some way. This prevents new materials being required, saving resources and reducing waste.

Designers need to build this kind of thinking into products!

Living in a greener world

Being kinder to the planet should be on everyone's minds, but especially designers who are producing products for users in today's world.

- Waste food is a problem in most households, so portion control and re-using leftovers will help.
- Cutting down on packaging is a great way of reducing unnecessary waste that is not really an essential part of the product we purchase.
- Reducing plastics where possible will be a massive gain. Plastics can be difficult to recycle and biodegrade, so finding an alternative would be very helpful.
- Recycling waste correctly is another area for improvement.
- Repairing products or choosing not to upgrade when a newer version becomes available can be beneficial.
- Green energy should be used where possible.
- Greener travel options, car sharing, or cycling should be chosen instead of driving, where possible.
- Economise your home – optimise your 'white goods' to operate correctly. Set your fridge and freezer to eco settings if possible, turn off lights when not needed, and try to lower the central heating thermostat – wear another layer instead.

Before purchasing a product, think about its Life Cycle Analysis (LCA). Consider where the material comes from, how the product has been made, running costs and eventual disposal.

Opt for sustainable design

Whether you are a designer or consumer, making the right choice is critical. Sustainable, eco or greener alternatives are much better for the environment. They have been designed and manufactured with minimising damage and promoting sustainability at the core.

Average life of a mobile phone

Research reveals that the average life of a mobile phone is two and a half years, and 15 to 18 months for a smart phone. Often, this short life is because the user has damaged the device, dropping or breaking the screen for example, which requires replacement. Using a protective cover is one option to improve the life of the phone. Mobile phone manufacturers often release new models frequently to replace previous versions. This is known as 'incremental' development and can help ensure consistent sales.

Products using 'greener' power supplies

Solar power can often improve energy consumption for users and also makes the product more flexible and less reliant on 'plugging in'. Photovoltaic (PV) cells can be used as power supplies and 'trickle chargers', converting free sunlight into electricity.

Wind-up technology offers far more opportunities for designers. A wind-up torch uses the mechanical movement provided by turning the handle of the device. This can then operate without the need for batteries.

Eduqas GCSE D&T Technical Principles Core Knowledge and Understanding 2.1.2

Design and Technology and our World 1

Life Cycle Analysis (LCA), sometimes referred to as Cradle to Grave includes:

- the source of materials for the product or component
- the energy used and pollution caused when manufacturing
- the energy used and pollution caused during a product's useful life
- the disposal of the product at the end of its useful life.

Designers and consumers consider these before purchasing a product. These factors can often influence purchasing decisions.

New or emerging materials, manufacturing methods or energy sources can often provide opportunities for greener products. This could be a more eco-friendly material or a self-repairing material. For example, the inner tube in the tyre below, which contains a sticky liquid that hardens when it contacts air – a perfect cure for punctures.

The Six Rs of Sustainability

Designers can often improve products by using the Six Rs. **REDUCE, REUSE, RECYCLE, REPAIR, RETHINK, REFUSE** can often provoke innovation in products.

Better build quality can improve a product's performance during its expected life – designers can ensure that products are easy to service, maintain and repair.

Ecological footprint

Ecological design can be defined as solving problems alongside minimising environmental damage. Designers must solve problems without creating other problems. Eco is about nature, living things, cycles and patterns.

Eco-efficiency refers to moving towards sustainable development – creating goods, products and services to satisfy user needs and wants while reducing ecological impacts and resource depletion. After all, any natural resources that we use will eventually run out!

The footprint of a product is a measurement of the environmental impact from cradle to grave.

Fair trade

This is an arrangement to help producers in developing countries to achieve trade relationships with other countries. It promotes sustainable development by improving trading conditions, including the rights for the workers.

Worker exploitation

Different countries have different laws about employment for workers. Sometimes workers can be exposed to unfair working conditions including poor or unfair levels of payment. This includes child labour.

Social, cultural, economic and environmental responsibilities

Designers and manufacturers have a duty to ensure that their decisions do not infringe certain codes and laws.

Social – products must not have an unforeseen side effect on a group of people.

Cultural – ensuring that a product is acceptable and not offensive for a specific group.

Economic – ensuring that financial decision making is good for the product. This could relate to material selection, profit margins, running costs or energy efficiency.

Environmental – recently, a lot of legislation and laws have been passed to enforce certain conditions. Many manufacturers now have to comply with targets on lowering CO_2 (carbon dioxide) emissions.

Eduqas GCSE D&T Technical Principles Core Knowledge and Understanding 2.1.3

Design and Technology and our World 2

Renewable and non-renewable energy sources

There are two types of energy sources – **renewable** and **non-renewable.**

- Renewable energy sources include wind, solar, tidal/wave, geothermal, biomass and hydro-electric.
- Non-renewable energy sources include coal, oil, gas and nuclear.

Renewable energy sources are often referred to as 'clean' or 'green' energy sources, because they come from a natural supply that is continuously replaced.

Non-renewable energy sources are often called 'dirty' and 'fossil fuels'. Coal, oil and gas are available in different parts of the world, but in limited amounts. Non-renewable energy sources often need to be extracted from the earth and sometimes processed, which can give off pollution and be very damaging. We currently depend highly on non-renewable energy sources, so a shift to 'greener' sources is underway and developing more and more.

Wind farms use turbines.

Coal fired power stations create lots of pollution.

Advantages and disadvantages of renewable energy

Wind power has relatively little impact on the environment, although some people consider turbines to be unsightly, or 'visual pollution'. They are expensive to install, and reliable when there is wind. Turbines can affect wildlife, particularly birds.

Solar energy is expensive to set up, and is very dependent on sunny weather conditions to be at its most productive, although some electricity will be generated on cloudy days. Home owners fitting solar panels to their roofs can find them space-consuming too. Storing solar energy can also be difficult and expensive.

Wave or Tidal systems are expensive to set up and can damage ecological coastlines and harm marine life. The tidal/wave power generates power for around 10 hours per day. It is around 80% efficient, better than solar or wind-based systems.

Geothermal energy uses 'hot spots' where molten rock close to the earth's crust generates hot water. In some locations, geothermal systems involve drilling into the earth's surface to reach deeper geothermal resources, allowing broader access to geothermal energy. This is a very high-cost resource and also risks triggering earthquakes.

Manufacturing using renewable energy

Industrial and commercial manufacturing plants and factories around the world are implementing alternative methods of power generation from renewable energy sources, in order to increase production and reduce their energy usage.

Currently, about 66% of the energy used by the industry and manufacturing sector is fossil fuels, with a small percentage of renewable energy and biofuels.

Government targets

The UK government has made a commitment for the UK to be net zero emissions by 2050.

This includes increasing clean wind energy, slashing carbon emissions and increasing offshore wind capacity.

Fossil fuel powered road vehicles

By 2030, the UK will ban the production of petrol- and diesel-powered cars. Some hybrid vehicles that use both electricity and petrol or diesel will still be allowed to be produced until 2035.

In addition to some cities having congestion charges to help reduce congestion and pollution, electric vehicles and hybrids are becoming a more popular choice for motorists. There is often reduced or no road tax, as these vehicles are very clean and some produce zero emissions. Lots of car manufacturers are now producing fully electric cars, however battery technology and charging facilities remain problematic.

Eduqas GCSE D&T Technical Principles Core Knowledge and Understanding 2.1.4

Smart Materials

Modern materials

Carbon fibre is a material that has several advantages including high stiffness, high tensile strength, low weight, high temperature tolerance, high chemical resistance, low thermal expansion and resistance to corrosion. Carbon fibre is created when carbon atoms are bonded together in crystals and can be woven into fabric. Carbon fibres are usually combined with other materials to form a composite. Commonly, fabrics or matting made from woven carbon is bonded in layers to create complex shapes for performance products like racing bicycles, Formula One cars, aerospace vehicles and many sporting products where strength, lightweight properties and speed are essential.

Kevlar is another newer material with special performance characteristics. Kevlar is a heat resistant and strong synthetic fibre with the ability to stop bullets and knives form penetrating it. Kevlar is often described as being five times stronger than steel for its weight. It can be woven into different shapes and remains lightweight and flexible, which is ideal for protective vests.

GRP or Glass Reinforced Polymer is also called fibreglass. Fibre strands are embedded into a polymer resin matrix, resulting in high compressive and tensile strengths in the finished products. Many products are made from fibreglass including fun water slides, jacuzzis, car body panels, boats and roofing products.

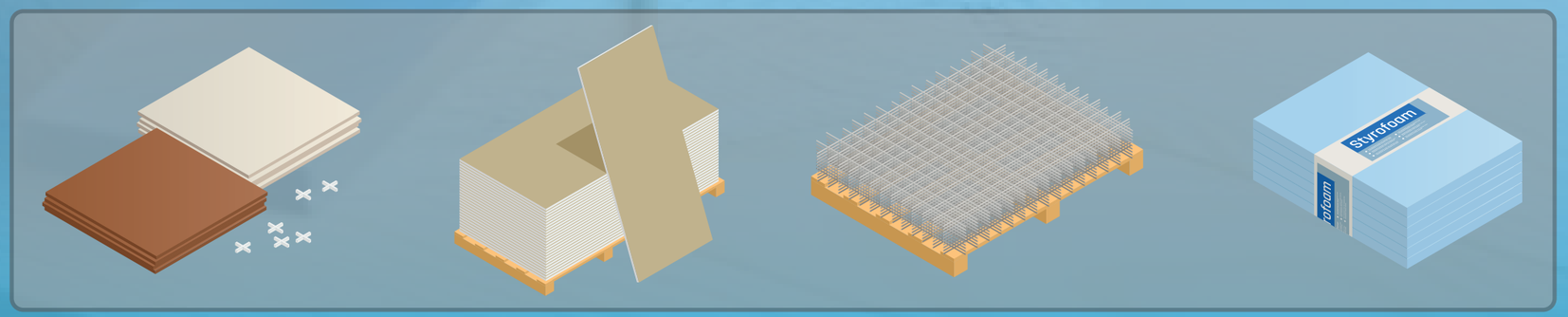
Smart materials

A smart material is a category of materials that react when something triggers them. It can be a change in temperature or light for example.

QTC or **Quantum Tunnelling Composite** is a black rubbery material which is an electrical insulator, but when placed under compression, it becomes a conductor. It is used in clothing, smart phones and outdoor equipment, normally as a material to make an electrical switch.

Differences between modern and smart materials

Modern materials are designed to have specific properties and characteristics, so that they can be used to improve existing materials used in products. Smart materials have unique changes that occur in response to external stimuli, making the smart material react in a clever way.



Eduqas GCSE D&T Technical Principles Core Knowledge and Understanding 2.1.8

Materials: Paper and Boards

Categories of papers and boards

Papers and boards are made from wood pulp which originates from trees. Wood pulp is rolled out into thin sheets at an industrial setting called a papermill.

- Paper density is measured by weight in grams per square metre (gsm).
- Paper comes in standard sizes, A0 is the largest, down to A10 (postal stamp size). In schools, A4 and A3 are very common paper sizes.

Types of paper

- Tracing paper (40 – 90 gsm) – translucent, smooth and strong, non-absorbent. Used for copying sketches and drawings, used as an overlay.
- Layout paper (50 gsm) – smooth, translucent and cheap to purchase. Great for designing, sketching and developing ideas.
- Copier paper (80gsm) – smooth, opaque, clean white finish. Uncoated and finishes well when printed on. Also used for photocopying.
- Cartridge paper (80 – 140 gsm) – thick, textured surface finish, a creamy off-white colour. Works well with paints, watercolours, pastels and inks.

Boards

Board is categorised by weight as well as thickness. The thickness of board is measured in microns, with one micron equal to 1/1000th of a mm.

Corrugated cardboard (3000 microns) – strong and lightweight, with two or more layers of wavy 'fluted' sheets to provide additional rigidity. Corrugated card is available in different thicknesses, making it perfect for packaging various items. It is fully recyclable, but not water-resistant.

Mounting board (1400 microns) – has a rigid and smooth surface, normally black and white in colour but available in other colours. It is popular for framing mounts, scale architectural modelling and concept designs.

Folding boxboard (300 – 1699 microns) – This is a stiff board normally made from recycled paper. It scores and folds well, bending without splitting, perfect for packaging supermarket foods.

Laminating papers, cards and boards

Some materials can be coated to add thickness, weight and strength for specific purposes. This additional layer is known as laminating. Many food containers and drinks cartons are laminated to ensure food and drinks are retained effectively and hygienically, and to keep produce fresh. Laminated cardboard is also good for book binding.

Adding surface finishes to papers, cards and boards

Surface finishes can be aesthetic and functional. Varnish can be added to card to give a glossy finish. Sometimes, part of a logo or brand name is varnished so that it stands out to the customer from the rest of the detail. Edge staining is another finishing process where dye is applied to the edge of a book to improve visual quality. UV (ultraviolet) varnishing produces a high-gloss finish on card, which is great for marketing materials like business cards. Embossing is a process that can create raised patterns or shapes in card and paper, usually by stamping. This is popular in greetings cards, perfume boxes and invitations.

Folding ability and absorbency

Some uses require materials to remain rigid, and to resist folding or creasing, such as corrugated cardboard coffee cups. These need to insulate heat, retain hot liquid, and must not leak. Other products, like sandwich containers, are die cut, flat packed items that erect easily to provide display, packaging and keep food stuffs fresh. These have crease lines, fold easily, and are again waxed inside to resist absorbency.

Greener solutions

A lot of paper-, card- and board-based packaging is designed to be easily fully recycled. This provides a 'cradle to cradle' approach and reduces waste and the need for new materials. Reusability is also high, where containers can be washed and used again for the same or similar purposes.

Eduqas GCSE D&T Technical Principles Core Knowledge and Understanding 2.1.9

Materials: Natural and Manufactured Timber

Hardwoods

- This wood comes from trees that lose their leaves during autumn and are known as deciduous trees.
- Hardwood trees are slow-growing and therefore less amounts are available, which makes it more expensive.

Oak is a moderate brown colour with close, straight grain. Oak is a tough and durable hardwood, it polishes well and is used for high quality furniture, doors, skirting and staircases.

Beech is a pink-tinted, closely grained hardwood. Beech is a very tough and durable material and is smooth to finish. It is popular with products that require a hard-wearing and robust material.

Mahogany is a dark red/brown hardwood with very close grain. It cuts and polishes easily, and gives a deep finish, popular for furniture and cabinet making.

Natural timber availability

Hardwoods and softwoods are available in a variety of forms including plank, board, strip, square and dowel. Natural timbers need to be cut at the sawmill and seasoned before use. Many are planed and cut to standard sizes ready for sale.

Softwoods

- This wood comes from trees that are evergreen, possibly bearing pinecones and needles, not leaves and are known as coniferous trees.
- Softwood trees grow quicker and in more locations. They are readily available and less expensive.

Pine is a pale-yellow coloured wood with darker brown grain. It is lightweight, easy to work, used for construction and furniture products.

Cedar is lightweight, pale with even texture. It is more expensive than pine but not as strong. Good for outdoor use, fencing, decking and shed construction.

Larch is a darker shade with brown grain, used for exterior cladding and boats, as it is water resistant and durable. It is more expensive than other softwoods.

Manufactured board

Man-made boards like MDF (medium density fibreboard), plywood and chipboard are all manufactured boards. They are made from wood fibres, normally collected from recycled wooden materials, bonded together with resins to form sheets.

MDF is made from small fibres which are mixed with a wax and resin, then heated and compressed into the desired thickness. MDF has no grain, and is easy to work. It is popular for interior DIY furniture.

Chipboard is made from small ‘chips’ of timber bonded together to produce a dense sheet. Kitchen worktops can be made using chipboard with an additional veneer applied for aesthetic and functional purposes.

Plywood is made from layers of wood, bonded together at an angle of 90 degrees to increase strength and rigidity. Sometimes, the facing layers can be high quality, e.g. birch, to provide a better aesthetic finish.

Finishes for hardwoods and softwoods

Surface finishes can be aesthetic and functional. High-traffic areas like floors might require a hard-wearing and sealing finish like polyurethane, which can be oil or water based, and matt, semigloss or high gloss finish.

Waxes and oils are popular to provide enhancement of the natural grain in the wood.

Stains and varnishes help to add colour to natural wood, and even change colours to match colour schemes. Preservatives are sometimes used to provide protection and ensure the wood is long-lasting.

Finishes for manufactured boards

Man-made boards like plywood are often finished depending on the visibility of the veneers. Plywood can have natural grain on the face veneers, so a spray-on lacquer or a paint-on varnish might be best.

MDF can be stained to match other natural woods, or it can be painted. However, as MDF is very porous, it is best to seal any exposed edges first to avoid paint being absorbed.

Chipboard can look unattractive and is normally finished with a veneer. On kitchen worktops, this is a melamine layer that provides heat, scratch and water resistance, and a variety of colours and patterns that can enhance the look of the user’s kitchen.

Eduqas GCSE D&T Technical Principles Core Knowledge and Understanding 2.1.10

Materials: Ferrous and Non-Ferrous Metals

Ferrous metals

- Metals that contain iron and are magnetic are ferrous metals.
- They are prone to rust and require a protective finish to prevent corrosion.

Cast iron is brittle if thin, can be cast in a mould, has strong compressive strength, good electrical and thermal conductivity, but poor resistance to corrosion. It is used for gates, manhole covers, drains and vices.

High carbon steel, also known as tool steel, is hard and brittle, less malleable than mild steel and is a good electrical and thermal conductor. Uses include tools, screwdrivers, and chisels.

Low carbon steel or mild steel is ductile and tough, easy to shape, braze and weld, a good conductor of heat and electricity, but again corrodes easily. Popular for nuts and bolts, screws, bicycle frames and car parts.

Alloys

An alloy is a mixture of metals with an element to improve its working properties or aesthetics.

- Brass is an alloy of copper and zinc.
- Bronze is an alloy of copper, aluminium and/or nickel.
- Stainless steel is an alloy of iron and chromium, nickel and magnesium.

Non-ferrous metals

- Metals that do not contain iron and are not magnetic are non-ferrous metals.
- They are metals that do not rust.

Aluminium is lightweight, malleable and strong. A good conductor of heat and electricity. Used in drinks cans, cycle frames and saucepans.

Copper is very malleable and an excellent conductor of electricity and heat – perfect for plumbing and central heating applications. It is orange/brown when polished, but will oxidise green.

Silver is a precious metal used in jewellery, it is soft and malleable when hot, highly corrosion-resistant and a good conductor.

Alloys: properties and uses

Brass is a non-ferrous alloy that is strong, ductile and a good conductor of heat. It works well when cast, is golden in colour but darkens with age. Used for taps, door fittings, hinges, locks and door handles. Due to its workability and durability, brass is commonly used for musical instruments.

Bronze is another non-ferrous alloy. It is hard and corrosion resistant, making it useful for bearings (due to its low friction) and outdoor mechanical components and monuments. Darker than copper, it is more reddish-brown. Bronze is also used in nautical applications due to its corrosion resistance.

Stainless steel is a ferrous alloy that is shiny silver when polished. It is hard and tough with good resistance to stains and corrosion. Used extensively in kitchen sinks, cutlery and hospital equipment. Stainless steel is also used in architecture, aerospace and general transport.

Properties of metals

- **Hardness –** a metal's ability to withstand friction and abrasion.
- **Toughness –** how well a metal can resist fracturing when force is applied.
- **Elasticity –** the rate at which a metal distorts in size and shape under stress.
- **Conductivity** – how well a metal allows electricity or heat to flow through it.
- **Ductility –** the ability of the metal to be drawn or deformed without fracture.
- **Tensile strength** – the amount of load a metal can withstand before failure.
- **Malleability** – the metal's ability to be bent or shaped easily.

Finishing metals

Metal finishing is the process of placing a coating onto a metal for cleaning, polishing or improving the surface in a functional or visual context. Finishing is the last step in the manufacturing process to provide environmental protection and improve aesthetic qualities. Popular finishing processes for metals include electroplating, anodising, powder coating, hot blackening, brushing, sand blasting and buff polishing.

Metals availability

Metals are sold in a variety of forms including sheet, bar, rod, tube and angle.

Eduqas GCSE D&T Technical Principles Core Knowledge and Understanding 2.1.11

Materials: Thermoforming and Thermosetting Polymers

Thermoforming Polymers

- These are materials that can be heated and shaped repeatedly, and are able to be recycled.

Acrylic is hard with good plasticity when heated, so it can be bent and folded easily. Acrylic resists weather well, but it is easy to scratch and can be brittle. It is popular for car headlights, protective visors and baths. It is a polymer frequently used for D&T school projects.

Polypropylene (PP) is a lightweight polymer that is strong and tough, with good heat and chemical resistance. It is used to make computer game cases, patio chairs, children's toys and food wrapping film.

Polyvinyl chloride (PVC) is a low-cost polymer. It can be flexible or rigid, glossy or matt, and has good strength, chemical and weather resistance. It is used to make window and door frames, guttering and building cladding.

High density polythene (HDPE) is a stiff and lightweight polymer that provides excellent chemical resistance. It has good plasticity when heated, perfect for buckets, bottles, pipes and washing up bowls.

Polystyrene (PS) is an inexpensive sheet or foamed polymer. It is available in a range of opaque colours as well as transparent. It is used in schools for vacuum forming.

Thermosetting Polymers

- These are materials that are formed once and cannot be recycled.

Melamine formaldehyde has excellent resistance to heat, moisture, scratching and staining, making it perfect for kitchen worktops and tableware.

Epoxy resin is supplied in two parts, the resin and the hardener. Once mixed, they create a very strong adhesive, with good chemical and heat resistance and excellent thermal insulation.

Urea formaldehyde is a hard, stiff polymer with excellent electrical insulation properties, making it suitable for switches, plugs and electrical fittings.

Polyester resin forms with a reaction of acids and alcohol. It is commonly used in sheet moulding compound, and in toner of laser printers.

Sources of polymers

Polymers can be made from natural and synthetic resources.

- Synthetic polymers are made from crude oil by scientists and engineers.
- Natural polymers are made using a variety of materials like silk, wool, cellulose and proteins.

Properties of polymers

There are many different polymers and the selection of specific polymers for particular purposes can relate to cost, resistance to corrosion, strength, strength/weight ratio, conductivity, elasticity, stiffness or malleability.

Differences between thermoforming and thermosetting polymers

The main difference is that a thermosetting polymer will strengthen when heated, and cannot be remoulded or heated after the initial forming. A thermoplastic can be reheated, remoulded and cooled as needed without causing a chemical change.

Availability of polymers

Polymers are available in a variety of forms including sheet, film, bar, rod and tube.

Eduqas GCSE Design and Technology

Timbers (Core)

Stock forms of timber

Natural timber is available in:

- different sectional forms
- various standard sizes (lengths)
- sawn or planed
- PSE (planed with squared edge)
- a range of shaped mouldings such as Torus skirting board.

Manufactured boards

Manufactured boards are available in sheet form and in standard sizes and thicknesses.

- Sheets are usually 2440mm x 1220mm, or sometimes half of this at 1220mm x 610mm.
- MDF is available in thicknesses typically 4mm, 6mm, 9mm, 12mm, 15mm, 18mm, 22mm, and 25mm.
- Hardboard sheet is available in 3.2mm thickness.
- Plywood sheets are typically 4mm, 6mm, 9mm, 12mm, 15mm, 18mm, and 24mm thick.

Aesthetics

Aesthetic properties are how a material or components looks.

This includes shape, colour, texture, form, reflection, gloss, style etc.

Function

Functional properties refer to how a material or component works for the intended use.

Function includes performance, efficiency, reliability and operation.

Oak is a mid-brown colour with prominent grain. Very strong and durable, it is perfect for furniture and doors, skirtings and cabinets.

Pine is a soft pale white or yellow timber with straight grain. It is quite lightweight and resists shrinking and swelling. Popular for country furniture, knotty pine is also common.

Plywood is a manufactured board of veneer layers glued at an angle of 90 degrees, for added strength and rigidity. Edges can look unsightly. Plywood is often improved with a veneer of high-quality wood.

MDF is a cheap, man-made board with no grain. It is very versatile but will require a finish. It is available in various thicknesses.

Wastage/addition

Cutting and removing material from stock forms, such as a sheet, is called wastage.

Additive processes, like 3D printing, build up the desired shape from an additional source without waste.

Surface treatment of timbers

Timbers are finished with both functional and aesthetic applications, depending on the location of the product/ timber and the desired outcome. Timber finishes are varied and include:

- varnishes
- wood stains
- oils
- polishes
- preservative finishes
- paints.

Applying finishes to timbers

Painting provides a colourful finish but also protects the timber. Glossy, matt or silk paints can be applied with a brush, roller or sprayer. Some include a primer too.

Wood stain is applied to enhance the appearance of the wood. Stains can also provide some protection but normally a coat of varnish is used to seal the stain.

Oil and wax soak into the timber and can enhance its appearance, whilst repelling moisture and water.

Varnish provides a shiny coat, usually applied in layers to make it more durable. Glossy and matt style varnishes are common.

Dip-treating timber protects the surface of the material, but outdoor timber fences tend to be made from pressure treated timber, which is far more long-lasting.

Eduqas GCSE Design and Technology

Timbers (Core)

Wood joining

Joining similar or different woods can be done in a temporary or permanent way. Temporary methods include screws and nuts and bolts, permanent methods include wood joints and adhesives like PVA (Polyvinyl acetate), epoxy resins and contact adhesives.

Joints

There are two categories of joints:

Box joints
Butt – a simple (but weak) join where the edges of the two pieces are glued together.

Housing – one edge slots into a groove or slot cut in the other.

Lap – a stronger joint where one piece fits into an L-shaped shoulder cut in the other.

Dovetail – very strong and looks good. A flared 'finger' fits into the same shape removed from the other piece. This is complex to achieve.

Comb – also known as a finger joint, where straight lengths on one piece slot into gaps on the other piece.

Frame joints
Dowel – a short length of round board inserted into holes in both pieces to reinforce joints.

Mortise and tenon – a very strong joint, a square 'lug' slots into a square channel and is glued.

Mitre – two 45-degree angle cuts are made to form a 90-degree angle corner.

Bridle – like a mortise and tenon joint but cut into the full width of the board.

Knockdown (KD) fittings

Standard components that are used to assemble products also come in standard forms and sizes. These include:

- screws
- nails
- nuts and bolts
- hinges
- handles
- cam lock fittings
- corner blocks
- brackets
- scan fittings
- dowels.

Screws come with different types of heads. They can be flat or round headed, with slots, crosses or square holes for different screwdriver fittings. Threads on screws vary; woodscrew threads tend to be wider than on a self-tapping screw. Machine threads are also available e.g. M3, M4, M5 etc, which are fine standard threads.

Marking out – this is a process where the required shape is marked onto the stock material. There are many tools to help mark out accurately, including a try square, tape measure, or steel rule. Materials need to be **held** or **clamped** before being cut. This could be done using a vice or clamp. **Cutting** can occur using a hand tool like a coping saw, tenon saw or hacksaw, or using machinery such as a bandsaw.

Drilling is a process used when a hole is required in a material. Drilling can be done using a **hand drill**, or **drill press/pillar drill**. **Jigs and formers** can help ensure that holes are drilled in the correct positions.

Pilot hole – a small diameter hole to guide a screw, preventing splitting.

Clearance hole – a hole large enough for a screw to fit through without the thread engaging.

Countersunk hole – the top surface of the hole is flared to receive the screwhead flush.

Counterbore hole – a flat-bottomed hole that enlarges another hole.

Calculating costs

When estimating price costs, designers and manufacturers must consider:

- the design
- the features included in the product
- the processes used to manufacture the product.

Computer aided manufacture (CAM)

CAM machines can be used to create features that allow parts to be joined to another part.

The benefit of the CAM machine is that all cuts will be accurate and exact. Laser cutters can be used to cut a variety of materials, although the correct settings are essential to avoid burning.

CAM machines can also be used to engrave materials and mark out where holes, joins and other fixings may fit.

Eduqas GCSE D&T Technical Principles In-depth knowledge and understanding

New and Emerging Technologies 2

Global manufacture

- This is when parts of products are made in different locations.
- The benefits include cheaper labour and investing in poorer countries' economies.
- However, this can result in child exploitation and unfair conditions!
- Fair Trade tries to ensure that everyone benefits.

Biodiversity and deforestation

- We must avoid damage to natural habitats and source materials sustainably.
- The Six Rs help!
- FSC and managed forests supply sustainable timbers.
- Select recycled materials over virgin materials.
- Protect wildlife and natural eco systems.

Cost of a prototype

Making a prototype involves more costs than just materials:

- energy costs to power machinery
- labour costs – prototypes can be one off, hand-made items
- CAD/CAM CNC are very expensive
- intellectual property to protect that brilliant invention.

New materials are constantly being developed to improve current materials. Take 3D printing PLA – a reel of inexpensive, bio-degradable material, sourced from nature and melts at 210˚C. It is available in lots of colours, finishes and sizes.

Eduqas D&T Technical Principles Core Knowledge and Understanding (Content 5)

Scales of Production

Scales of production

- **One off production** – single products made as prototypes or concepts, or bespoke custom-made items are manufactured.

  Advantage – the user or owner will have an original product unlike any other.

  Disadvantage – lots of manual labour will be used because no production line would be set up for one product.

- **Batch production** – products made in limited numbers at any one time, although this may be repeated.

  Advantage – small numbers of similar items are made at one time to satisfy demand.

  Disadvantage – there may be a delay until the next batch is produced.

- **Mass production** – identical products made in large volume, normally thousands, with some use of automated machinery to achieve accuracy, efficiency and identical outcomes.

  Advantage – more profit for the manufacturer as materials are bought in bulk, and automated machinery is set up so less workers required.

  Disadvantage – initial set up costs are high, and not much flexibility once production line is set up.

- **Continuous flow production** – identical products constantly being produced 24 hours per day, 7 days per week without stopping. There will be heavily automated production lines in use for speed, accuracy and quality control purposes.

  Advantage – huge numbers produced identically, efficiently and quickly, saving time, energy and need for manual workers.

  Disadvantage – one single fault can stop the whole production process and be very costly.

Jigs and repeating activities

Sometimes a process needs to be repeated several times in order to make one or more products. Manufacturers will often use devices to help complete this task and ensure accuracy and consistency.

Jigs – a jig is a device used to hold or secure material and guide cutting or drilling tools to ensure accuracy and repeatability.

Pattern – a pattern is a shape attached to the surface of the material to help to shape it.

Template – a template is a tool for marking out a shape repeatedly, so it is exactly the same each time.

Computer aided manufacture (CAM)

Machines that are controlled by a computer offer many benefits when manufacturing. They are:

- faster than working by hand
- far more accurate and precise than what manual workers could achieve.

They can:

- repeat tasks consistently and identically
- support production by making difficult components or parts while others are produced simultaneously
- produce multiple items in one go
- save material and reduce waste
- work without supervision or lunch breaks!