AQA Design & Technology 8552
Unit 1 - New and emerging technologies
1.1 Production Techniques and Systems

1. CAD – Computer Aided Design

Advantages of CAD	Disadvantages of CAD
Designs can be created, saved and edited easily, saving time	CAD software is complex to learn
Designs or parts of designs can be easily copied or repeated	Software can be very expensive
Designs can be worked on by remote teams simultaneously	Compatibility issues with software
Designs can be rendered to look photo-realistic to gather public opinion in a range of finishes	Security issues - Risk of data being corrupted or hacked
CAD is very accurate	SolidWorks 2D DESIGN CAD Software
CAD software can process complex stress testing	

2. CAM – Computer Aided Manufacturing

Advantages of CAM	Disadvantages of CAM
Quick – Speed of production can be increased.	Training is required to operate CAM.
Consistency – All parts manufactures are all the same.	High initial outlay for machines.
Accuracy – Accuracy can be greatly improved using CAM.	Production stoppage – If the machines break down, the production would stop.
Less Mistakes – There is no human error unless pre programmed.	Social issues . Areas can decline as human jobs are taken.
Cost Savings – Workforce can be reduced.	


Laser Cutter


Robots


Barcode Scanner


AGV – Automated Guided Vehicle

3: Production Techniques

3.1 Flexible Manufacturing Systems (FMS) : involves an assembly of automated machines commonly used on short-run batch production lines where the products frequently change.

3.2 Lean Manufacturing: It aims to manufacture products just before they are required to eliminate areas of waste including:

- Overproduction
- Waiting
- Transportation
- Inappropriate processing
- Excessive inventory
- Unnecessary motion
- Defects

3.3 Just In Time (JIT) : Items are created as they are demanded. No surplus stock of raw material, component or finished parts are kept.

Advantages of JIT	Disadvantages of JIT
No warehousing costs	Reliant on a high quality supply chain
Ordered secured before outlay on parts is required	Stock is not available immediately off-the-shelf
Stock does not become obsolete, damaged or deteriorated	Fewer benefits from bulk purchasing

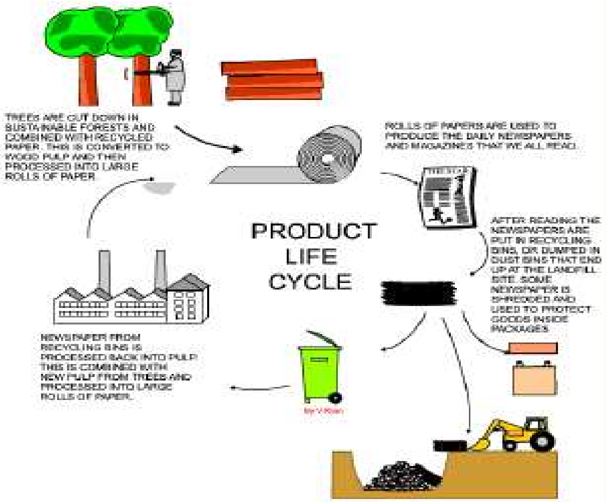
4. Scales of Production

<u>One off</u>: when you make a unique item
<u>Batch</u>: when you make a few/set amount
<u>Mass</u>: when you make thousands
<u>Continuous</u>: open ended production

5: Informing Design Decisions

5.1 Planned obsolescence - Planned obsolescence is when a product is deliberately designed to have a specific life span. This is usually a shortened life span.
5.2 Design for maintenance - Products are often designed to be thrown away when they fail... This can be achieved by designing products that can be repaired and maintained.
5.3 Disposability – Some products are designed to be disposable.

5.4 Product Lifecycle -



7: KEY WORD FOCUS

You should be able to explain the meaning of each of these words by the end of this rotation.

CNC	Computer Numerical Control
EPOS	Electronic Point Of Sale (Barcodes)

AQA Design & Technology 8552
Unit 1 New and Emerging Technologies
1.1 Industry and Enterprise

New and emerging technologies

New technologies are those that are currently being developed or will be developed in the next 5 to 10 years, and which will alter the business and social environment.
Examples:

Fuel-cell vehicles
Zero-emission cars that run on hydrogen

Additive manufacturing
The future of making things, from printable organs to intelligent clothes

Industry - Automation and the use of robotics

As industry has grown new and emerging technologies have changed the way designers, architects and engineers work.
Intelligent machines and robotics have replace machine operators and engineers.
The development of work now almost always involves the use of **Computer Aided Design (CAD)**.
This software can carry out complex tasks such as virtual stress testing this is called **Computer Aided Testing (CAT)**.
Designs can be produced to look 3D so customers ca give opinions before **prototyping** begins.

Enterprise

An idea that is developed into a business proposal for a product that has commercial viability.
Products developed in this way require a patent to protect the idea so that other companies cannot use it without permission this is called a registered trademark.

Buildings and the place of work

The development of the internet has changed how data is transferred. This has lead to people being able to work together remotely (from different buildings or countries).
Projects can be sent to machines using **computer aided manufacturing (CAD)** techniques including **computer numerical control (CNC)** machines such as laser cutters and rapid prototyping (RPT) machines such as 3D printers.
Physical layout of buildings for production should be logical to increase efficiency. This will reduce unproductive time, movement and waste materials.

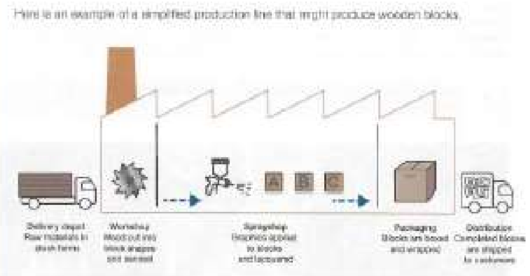


Image from AQA

Crowdfunding

Funding a project or venture by raising money from a large number of people who each contribute a relatively small amount, typically via the Internet.

Virtual marketing and retail

Virtual marketing the use of search engines positioning and ranking, banner advertising, e-mail marketing and social media in order to reach a wider audience to promote a product.

Co-operatives

A farm, business, or other organization which is owned and run jointly by its members, who share the profits or benefits.

Fairtrade

Trade between companies in developed countries and producers in developing countries in which fair prices are paid to the producers.

AQA Design & Technology 8552
Unit 1 New and Emerging Technologies
1.3 People, Culture and Society

People

Consumer Choice

Growth of global manufacturing has lead to a wider variety of products being available, prices of products are kept low because of the wider competition.

Technology Push

Advances in technology and science lead to the development of new products. Research and Development (R&D) Departments are used within large companies to ensure they can create new and exciting products.

1993 APPLE NEWTON PDA 1996 PALM SERIES 2012 SAMSUNG GALAXY

Advances in touchscreen technology

Market Pull

The demand for new products from the consumer market. Market Pull is the pressure put on a company to improve their products by consumers.

Changing Job Roles

The development of new technologies and automation has meant there is less reliance on manual labour. Workers need to be 'skilled up' and be more flexible.

Society

Companies putting the environment and people before profit.
Examples:

- Carbon Neutral Products
- Use of renewable materials
- Reduction of carbon emissions/greenhouse gasses
- Use of recycled materials
- Products designed to be 100% recyclable
- Promotion of Fairtrade
- Reduction of transportation
- Non profit organisations that reinvest money to support good causes
- Consideration to designing products for the elderly or disabled
- Consideration to different religious groups

4 main ways to consider the population when designing

Type of Production	Example
One size fits all	Door Frames Baths
A range of sizes to cover all	Shoes Clothes
Adjustability to allow use by all	Car Seats Shower head height
Adaptability to support location or user	Children's booster seats Car roof bars

Culture

A combination of ideas, beliefs, customs and social behaviours of a society or group of people.

Fashion and Trends

Designers developing products that are influenced by 'the latest thing'.

Faiths and Beliefs

Designers being responsible for the impact their design choices may have on a community.

AQA Design & Technology 8552
Unit 1 New and Emerging Technologies
2.1 Sustainability and the environment

1. Sustainability

Avoidance of the depletion of natural resources.

Finite Resources e.g. Ore and Oil
Materials which are in limited supply. Use of these should be avoided where possible or only used in small amounts.

Non Finite Resources e.g. Trees and Plants
Materials in abundant supply and are unlikely to ever run out or ones that can be grown again.

The impact of the use of resources can be measured by the following:

- CO_2 emissions
- Transportation method and distance travelled
- Impact on the environment through mining or harvesting
- Availability or scarcity
- Maintenance or repair costs
- Ethical and moral issues

2. Life Cycle

Life cycle assessment (LCA) to assess the impact of a product during the different stages of its life. The 5 main stages are:

Image from AQA

3. Waste Disposal

Consideration to waste disposal has an impact on the environment and a product life cycle.
Businesses are charged for waste disposal, reducing waste disposal will save money.
The effects of careful consideration of waste disposal within a business are:

- Less raw materials required
- Reusing waste materials/components within a company
- Sale of recyclable waste
- Energy to heat and power a business could be generated

4. Environment

Technologies that have a **positive impact**:

- Renewable materials from managed resources
- Use of renewable energy
- Using recyclable materials
- Consideration to the 6r's
- Designing products with low power consumption
- Designing products with fewer components and reduced weight
- Designing products that are upgradable extending their life

Technologies that have a **negative impact**:

- Use of finite/non-recycled materials
- Use of components that are hard to repair
- Use of fossil fuels for power
- Products with high power consumption
- Products that have built in **planned obsolescence**
- Components that are shipped globally

5. Key Terms

Continuous Improvement
Kaizen, also known as continuous improvement, is a long-term approach to work that seeks to achieve small, incremental changes in processes in order to improve efficiency and quality. It is best known for being used in **lean manufacturing**.

Efficient Working
Just in time (JIT) and **lean manufacturing** are examples of how businesses reduce costs. Other examples are members of staff doing 'energy walks' to turn off lights etc. to reduce costs and CO_2 emissions.

Pollution
Business's should aim to reduce pollution by conducting an LCA.

Global Warming
The release of CO2, methane (CH4) and nitrous oxide (N2O) into the environment resulting in the rise of average temperatures of the earth's atmosphere and oceans.

Carbon Offsetting

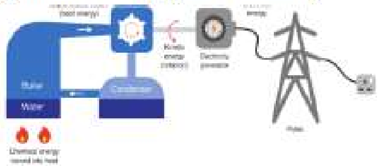
Image from AQA

AQA Design & Technology 8552
Unit 2: Energy, Materials, Systems and Devices
2.1 Energy Generation and Storage

1. Energy Generation

Power can be generated from renewable and non-renewable sources. Non-renewable power is generated from fossil fuels.

Most electricity is created by rotating a turbine which turns a generator. Fossil fuels are burnt to create heat which superheats the water. The steam rotates the turbine which is linked to the generator to supply the electricity.



1.1 Fossil Fuels – Most electricity in the UK comes from burning Fossil Fuels such as **Coal, Gas and Oil.** Fossil fuels are **finite** resources and **cannot be replaced** as they run out. Burning fossil fuels creates carbon dioxide and is not environmentally friendly and contributes to **global warming.**

1.2 Fracking – Shale gas is trapped within the earths crust. Fracking is the process which removes it so it can then be burnt to create electricity. It involves drilling the earths crust and sending high pressure water, sand and chemical mixtures into the rock to release the gas.

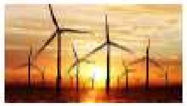
3. Nuclear Power

Nuclear power is highly controversial. The process harnesses a nuclear reaction to create to create heat to power the turbines.

• Clean • Efficient	• High start up costs • Radioactive waste which is very dangerous to all living things. • Nuclear waste stays radioactive for millions of years and is stored underground.

2. Renewable Energy

Energy that comes from the planets non-finite resources is renewable. It includes



2.1 Wind Power	
• Low cost • Produce More power in winter when demand is higher.	• Do not create power when not enough wind or it is too windy. • Harmful to wildlife • Ugly

2.2 Solar Energy	
• Low maintenance costs. • Improvements in technology mean the efficiency is always improving.	• Only produce energy during daytime. • Production is less in winter.

2.3 Tidal Energy	
• Predictable and consistent.	• Machinery has to be located some distance from land making repair and maintenance difficult.

2.4 Hydro Electric Power	
• Very reliable	• High set up costs both financially and environmentally.

2.5 Bio Fuel	
• Carbon Neutral – They absorb the CO2 whilst growing and produce similar amounts when burnt for energy.	• Vast amounts of land and water needed to produce the crops which contribute to food shortages in developing countries.

4. Energy Storage

Most mechanical power is stored by using tension or compression. Coiled springs used in clocks, watches and wind up toys store physical energy from the winding process which is then released slowly through cogs, gears and other mechanisms.

4.1 Pneumatics – A form of compression is used to store gas or air under pressure. They are commonly used to controlling production lines. They are accurate, efficient and low maintenance.

4.2 Hydraulics – Very similar to Pneumatics but uses a liquid, most commonly Oil. Extremely powerful and using in manufacturing industrial applications.

Both systems will use a compressor which pump the air or liquid into a storage tank to hold it until it is needed.

4.3 Kinetic Energy – any object in motion has kinetic energy. Objects not in motion store potential energy which is converted to kinetic energy when a force is applied to the object such as gravity.

4.4 Batteries – Electrical power can be stored in batteries. Battery technology has vastly improved alongside the power consumption of modern electronic devices helping save valuable finite resources.

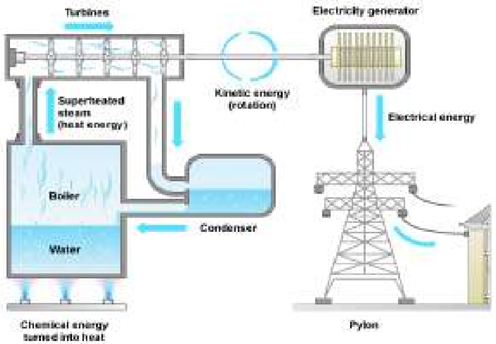
Alkaline batteries are more efficient than traditional acid based batteries and hold their charge well.

Rechargeable batteries are capable of being charge d and discharged thousands of times reducing the resources needed. The time it takes for rechargeable batteries to reach full charge has also improved in recent years making their use much more convenient.

4.5 Disposal of Batteries – Batteries must be disposed of correctly as they contain toxic electro chemicals. If placed in the normal bin and they end up in land fill sites, it will degrade over time and release harmful chemicals and metals into the soil and water.

AQA Design & Technology 8552
Unit 2: Energy, Materials, Systems and Devices
2.1 Energy Generation and Storage

Energy Types
1. Fossil Fuels – Non-renewable energy



In a thermal power station fuel such as coal, oil or gas is burned in a furnace to produce heat - chemical to heat energy.

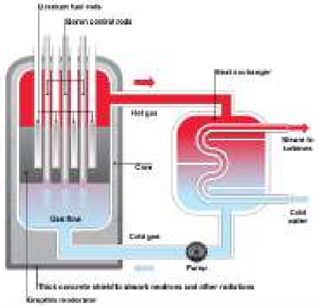
- this heat is used to change water into steam in the boiler.
- the steam drives the turbine - heat to kinetic energy
- this drives the generator to produce electricity - kinetic to electrical energy.

Some experts believe that fossil fuels will run out in our lifetime.

Energy Types 2. Biomass Energy –Renewable Energy

Biomass is an industry term for getting energy by burning wood, and other organic matter. Burning biomass releases carbon emissions, but has been classed as a renewable energy source in the EU and UN legal frameworks, because plant stocks can be replaced with new growth.

Energy Types
3. Nuclear Energy – Renewable energy



The main nuclear fuels are **uranium and plutonium**. In a nuclear power station nuclear fuel undergoes a controlled chain reaction in the reactor to produce heat - nuclear to heat energy.

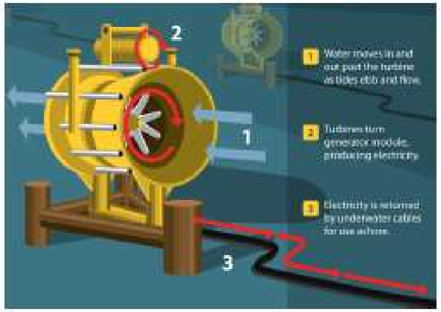
- heat is used to change water into steam in the boiler.
- the steam drives the turbine (heat to kinetic energy)
- this drives the generator to produce electricity - kinetic to electrical energy.

Energy Types
8.Batteries

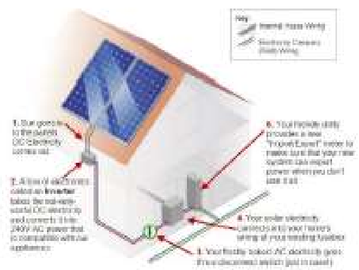
Alkaline batteries are the most common type of domestic batteries, they are disposable but contain chemicals that are bad for the environment. Fortunately more and more battery recycling banks are appearing now where most of the battery can be reused. **Rechargeable batteries** are better for the environment and more economical in the long run (High initial purchase price). Their lifespan decreases with every charge.

Energy Types
4. Wind Energy – Renewable Energy

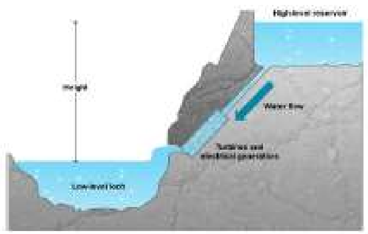
6. Tidal Energy – Renewable Energy



5. Solar Energy – Renewable Energy



7. Hydroelectricity – Renewable Energy



- In a hydroelectric power station water is stored behind a dam in a reservoir. This water has gravitational potential energy.
- The water runs down pipes (potential to kinetic energy) to turn the turbine
- The turbine is connected to a generator to produce electricity (kinetic to electrical energy).

AQA Design & Technology 8552
Unit 2: Energy, Materials, Systems and Devices
2.2 Smart & Modern Materials

1. Modern materials

1.1 Corn Starch Polymers – plastics that are **biodegradable** and not toxic to the environment. They are easy to recycle.

Name	Uses	Characteristics
Polylactic acid (PLA)	• Disposable food and drink containers • 3D Printed Items	• Smooth or textured finish • Easy to Colour • Easy to mould • Fully biodegradable 
Polyhydroxybutyrate (PHB) Biopol™	• Bottles • Pots • Disposable food containers	• Smooth or textured finish. • Easy to Colour • Easy to mould • Fully (but slowly) biodegradable. 

1.2 Flexible MDF – Is made from wood pulp fibres in the same way as standard MDF, with the addition of grooves cut along the length of the board leaving about 2mm of the MDF intact which allows the MDF to become flexible.

1.3 Titanium – Pure titanium does not react with the human body and is used by the medical profession for artificial joints and dental implants. It has a high strength to weight ratio and has excellent corrosion resistance.

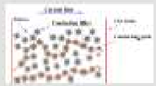
1.4 Graphene – thinnest material ever discovered, a million times thinner than a human hair, 200 times stronger than steel. It is transparent, impermeable and highly conductive.

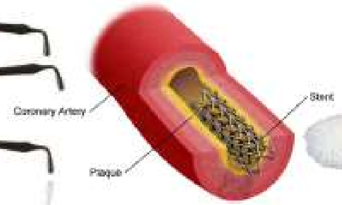
1.5 Nanomaterials - Their use in electronics has helped miniaturisation whilst improving conductivity. IN the textiles industry, they have been used as protective coatings to improve water resistance and give UV protection.

1.6 Metal Foams - Porous metal structures, often made from Titanium and Aluminium use as little as 25% of the mass. This makes them extremely lightweight but retaining most of the properties of the base material.

2. Smart Materials

***A material that reacts to an external stimulus or input to alter its functional or aesthetic properties.*.** They can react to heat, light, pressure, moisture and electricity.

Name	Stimulus	What is does?	Uses
2.1 Thermochromic pigments	Heat	Changes colour when heat is applied.	• Flexible thermometers • Temperature indicators • Novelty goods 
2.2 Photochromic pigments & particles	UV Light (Natural Light)	Changes colour in sunlight/UV Light	• Transition Lens Sunglas • Nail varnish • Clothing • Novelty goods 
2.3 Shape memory alloy Nitinol	Heat or Electricity	Returns to original/pre set shape when heated to 70°C or electricity is applied.	• Glasses Frames • Fire Sprinklers • Dental Braces • Surgical Stents   
2.4 Polymorph	Heat	Becomes mouldable by hand when heated to 62°C	• Personalisation of products • Repairs • Prototyping & Modelling 
2.5 Quantum Tunnelling Composite	Pressure	Varies the amount of electrical current depending on pressure applied.	• Touch sensitive pads • Wearable technology • Variable speed controls 
2.6 Piezoelectric Material	Movement, stress or electricity	Stress or movement produces electrical signal or *vice versa.*	• Mobile phone speakers and microphones • Gas Lighters ignition spark 
2.7 Litmus Paper	Levels of PH in substances.	Changes colour spending on chemical balance.	• Scientific experiments • Soil testing for gardener/farmers • Testing swimming pools and fish tanks 

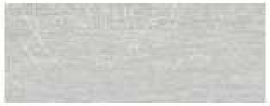


AQA Design & Technology 8552
Unit 2: Energy Materials Systems and Devices
2.10: Composite Materials and Technical Textiles

From AQA

1. Composite Materials

2 or more materials combined to create a new material with improved properties.

Name	Appearance	Image	Characteristics	Uses
Glass Reinforced Plastic (GRP)	Glass fibre matting covered in a smooth resin with a glossy finish. Can be coloured, complex shapes can be formed.		Lightweight, strong, resistant to heat, chemicals and corrosion. Waterproof. Labour intensive to produce.	Car body parts, pipes, helmets, boat hulls.
Carbon Fibre Reinforced Plastic (CRP)	Carbon in the form of graphite is soft. But very thin strands of carbon are very stiff. These carbon fibres are useful for reinforcing other materials to make them tougher. They are embedded in strong plastics to make composite materials.		Lightweight, strong, good tensile strength, rigid, very expensive resistant to heat, chemicals and corrosion. Waterproof. Labour intensive to produce.	Skateboards, boat hulls and high performance sports equipment.

2. Technical Textiles

A technical textile is a textile developed with enhanced properties to withstand specific uses.

Name	Appearance	Image	Characteristics	Uses
Gore-Tex®	Thin membrane between an liner and outer material.		Has the desirable properties of nylon, but is also 'breathable'. Lets water vapour from sweat pass to the outside, but it stops rain drops from passing to the inside.	Outdoor clothing and footwear
Kevlar ® by DuPont™ (Polyparaphenylene terephthalamide)	Naturally a yellowish gold material which can be dyed.		Very strong artificial fibre. It is woven to make a material that is used for light and flexible body armour. High thermal protection, non flammable, good chemical resistance.	Body Armour, safety clothing
Conductive Fabrics and Thread	A silvery fabric or thread.		Electrical current passes through the thread linking electrical components. It allows flexible and wearable control of electronic products.	Wearable inputs and processes such as switches, lights, clothing, toys etc.
Fire Resistant Fabrics	Appearance varies. Most can be dyed to change colour.		Protects the wearer from ignition from naked flame. Heat resistant.	Fire blankets, safety clothing. Race car driver protection.
Microfibers and Microencapsulation	A thin synthetic fibre woven into products. Can be dyed to change colour.		Polyester or nylon microfibres are 60 to 100 times finer than a human hair. They can be blended with synthetic or natural fibres. Thermoplastic polyester or nylon microfibres can be heat-treated to give them coils, crimps and loops, which makes these textured yarns stretchy and warm.	Clothing for outdoor pursuits, active sports, underwear, knitwear and carpets.

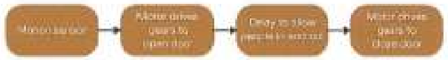
2.11 Systems approach to designing

1. Systems

A system is parts or components working together to control tasks or activities.

Systems Diagram

A simple flowchart that lays out input, process, output – an automatic door

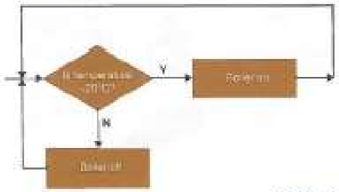


Open loop and closed loop

Has no feedback and is unable to make a decision – a room heater- has to be manually switched off

Closed loop

Able to make a decision using feedback – central heating system – automatically switch off when the desired temperature is reached



Images from AQA

2. Input Components

Name and symbol	Appearance	Image	Characteristics	Uses
Toggle switch (latching)	Available in a variety of shapes, sizes and switching positions depending on the task		Off and on positions, once switched they stay on (latched) until switched again	Lighting, power switch, control panels
Push to make (PTM) switch normally open	A wide variety of shapes, colours and sizes		The legs of the switch are only connected when the switch is pressed (momentary); it is normally open, no polarity	Door bell, intercoms, keyboards
Push to break (PTB) switch normally closed	They are identical to PTM switches so you may need to check the connectivity		The legs are only disconnected when the switch is pressed (momentary); it is normally closed, no polarity	Alarm systems, control systems
Light dependent resistor (LDR)	Small light sensitive panel often in plastic shroud, two wires for mounting to circuit		Resistance increases in the dark and decreases in the light, no polarity	Street lights, solar garden lights, security and child night lights, low-light meter for sporting events
Thermistor	Small coloured disc, two wires for mounting to circuit		Resistance changes with a change in temperature, no polarity	Thermostats on central heating systems, fridges and freezers, digital thermometers
Pressure switch	Come in all different shapes, sizes and colours.		Detects pressure from being pressed, can perform on/off tasks or detect gradual pressure being applied	Burglar alarm systems, video game floor mats, sensing fluid pressure in pipes

Image from AQA

3. Output Components

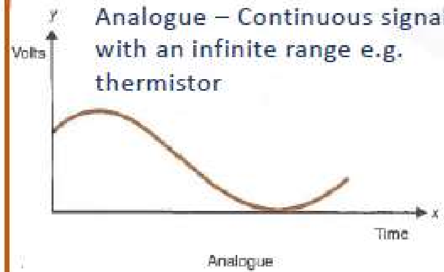
Name and symbol	Appearance	Image	Characteristics	Uses
Light emitting diode (LED)	Available in a variety of sizes, shapes and colours, most commonly 5mm round		Produces light, connected by an anode (+ve) and cathode (-ve), has polarity. Low voltage, low power consumption, long-lasting, can be hard to change if broken	Low power lighting, torches, TV screens, power indicators
Lamp	Available in a variety of sizes, shapes, colours and levels of power (wattage) or brightness (lux)		Produces light, can be brighter than LEDs, less economical due to the heat produced. Not long-lasting but easy to change	Household lamps, car headlamps, street lights, floodlights and security lights
Buzzer	Small compact units in plastic casing, available in a variety of sizes and sounds		Mid- to high-pitched buzz created by fast oscillating electromagnetic parts, has polarity	Alarm systems, door entry systems, children's toys, electronics games
Speaker	Speaker cone shaped into magnetic coil at base, available in a wide variety of sizes		Full range of sound available, variety of power ratings (wattage), variety of frequency responses (treble to base)	Headphones, music systems, intercoms, radios

AQA Design & Technology 8552
Unit 2: Energy Materials Systems and Devices
2.12 Electronic systems processing

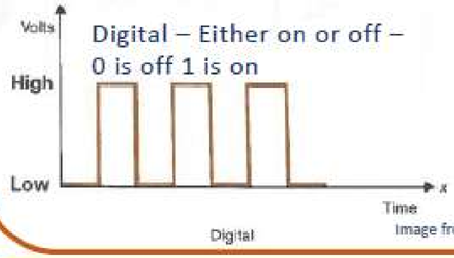
1. Processes

Components that process electronic signals and enable output devices to perform tasks. This is controlled by an integrated circuit (IC) e.g. A microcontroller

2. Digital and Analogue Signals



Analogue – Continuous signal with an infinite range e.g. thermistor

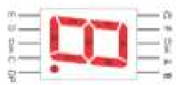


Digital – Either on or off – 0 is off 1 is on

Image from AQA

3. Counters

Counters – Keep count of how many times something occurs, output information to a **seven segment display.**



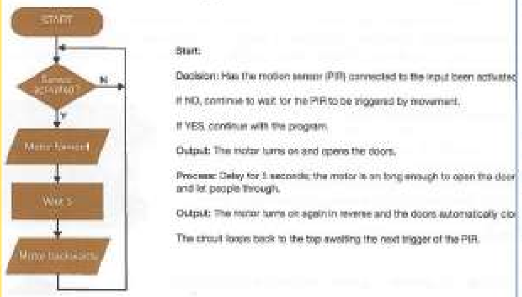
4. Programming

Micro controllers also called Peripheral interface controllers (PICs) can be programmed to perform differently by a computer.

Timers

Devices used to perform specific tasks. 2 types monostable and astable.

Monostable – output turned on for a set period of time e.g. Automatic doors



Astable – fluctuates between on and off – oscillating output e.g. Seatbelt alarm in a car

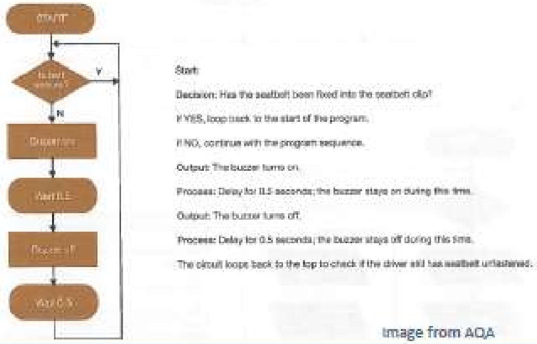
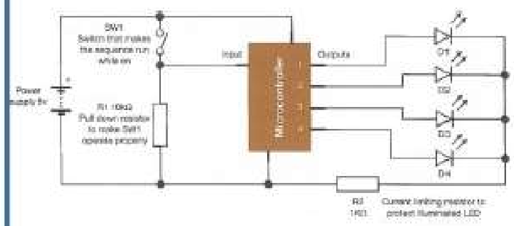


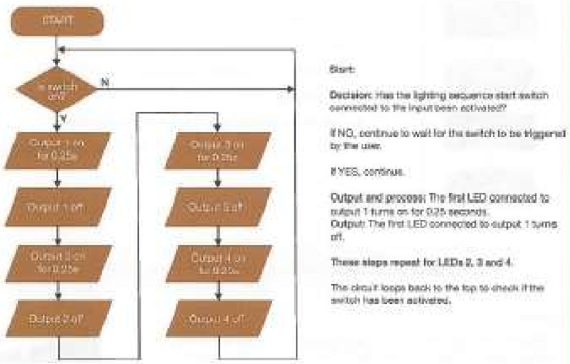
Image from AQA

5. Programming 2

Microcontrollers – How a microcontroller would control a bike light.



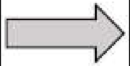
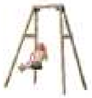
Program for the microcontroller to make LED's flash in sequence



AQA Design & Technology 8552
Unit 2: Energy, Materials, Systems and Devices
2.5 Mechanical Devices

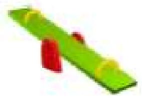
1: Mechanical Devices - Motion

There are four types of motion:

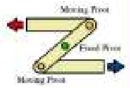
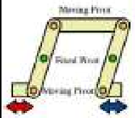
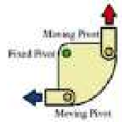
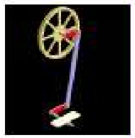
Linear Motion is movement in one direction along a straight line.		
Oscillating Motion This motion is similar to reciprocating motion, but the constant movement is from side to side along a curved path.		
Rotary Motion Examples of circular motion include a ball tied to a rope and being swung round in a circle		
Reciprocating Motion, this is repetitive up-and-down or back-and-forth linear motion		

2: Mechanical Devices – Levers

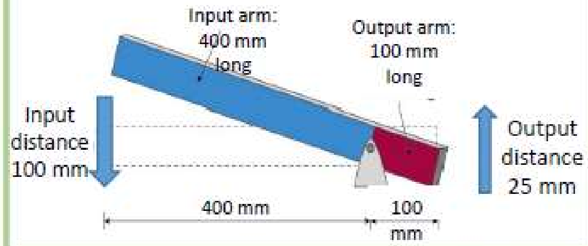
There are three classes of levers.

Class One A class one lever has its input on one side of the fulcrum and its output on the other.		
Class Two A class two lever has its input at one end of the lever, its output in the middle and fulcrum at the other end.		
Class Three A class three lever has its output at one end of the lever, its fulcrum at the other with its input in the middle.		

3: Mechanical Devices – Linkages

Reverse motion linkage	The reverse motion linkage changes the direction of the input motion so that the output travels in the opposite direction. If the input is pulled the output pushes and vice versa. It uses a central bar held in position with a fixed pivot (fulcrum) that forces the change in direction and two moving pivots which are connected to the input and output bars.	
Parallel motion or push/ pull linkage	The push/pull linkage maintains the direction of the input motion so that the output travels in the same direction. If the input is pulled the output is pulled and so on. It uses three linking bars, four moving pivots and two fixed pivots.	
Bell crank linkage	The bell crank linkage changes the direction of the input motion through 90 degrees. It can be used to change horizontal motion into vertical motion or vice versa. It uses a fixed pivot and two moving pivots.	
Crank and slider	The crank and slider linkage changes rotary motion into reciprocating motion or vice versa. It uses a crank which is held with a fixed pivot. A connecting rod uses two moving pivots to push and pull a slider along a set path.	
Treadle linkage	The treadle linkage changes rotary motion into oscillating motion or vice versa. It uses a crank which is held with a fixed pivot. A connecting rod uses two moving pivots and a further fixed pivot to create a windscreen wiper motion.	

4: How to work out a levers distance of travel



Output ÷ Input x Input distance = Output distance

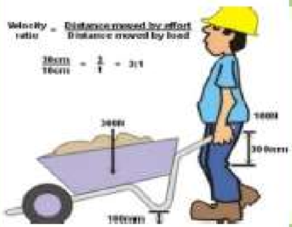
100 ÷ 400 x 100 = 25 mm

5: How to work out the Mechanical Advantage

Or use the following formula:

MA = $\frac{\text{Load}}{\text{Effort}} = \frac{300N}{100N} = \frac{3}{1}$

This is written as 3:1 or just MA of 3



AQA Design & Technology 8552
Unit 3: Materials and Working Properties
3.1 Paper and Board

1. Paper

Type	Description and uses
Layout paper	• lightweight, thin white paper • used for initial ideas • takes colour media well • low cost
Tracing paper	• thin, translucent paper • making copies of drawings • high cost
Cartridge paper	• good quality white paper • available in different weights • general purpose work • can be used to make simple models • medium cost
Bleedproof paper	• smooth, hard paper • used with water-based and spirit-based felt-tip pens • medium cost
Grid paper	• printed square and isometric grids in different sizes • a guide for quick sketches and working drawings • low cost

2. Selection of materials or components

When selecting materials and components considering the factors listed below:

- Functionality: application of use, ease of working
- Aesthetics: surface finish, texture and colour.
- Environmental factors: recyclable or reused materials, product mileage.
- Availability: ease of sourcing and purchase.
- Cost: bulk buying.
- Social factors: social responsibility.
- Cultural factors: sensitive to cultural influences.
- Ethical factors: purchased from ethical sources such as FSC.

What is the FSC? http://www.fsc-uk.org/en-uk/about-fsc/what-is-fsc/fsc-principles

3. Boards

Type	Description and uses
Corrugated card	• strong and lightweight • used for packaging protection and point of sale stands • available in different thicknesses
Duplex board	• large foam-based board • different finishes available including metallic and hologrammatic • used for food packaging, e.g. take-away pizza boxes
Foil lined board	• quality cardboard with a aluminium foil lining • ideal for ready made meals or take away meal cartons • The foil retains the heat and helps keep the food warm
Foam core board	• very light, very stiff and very flat. • It has a white, rigid polystyrene foam centre, with smooth white paper laminated onto both faces. • It is easy to cut with a knife, a mount cutter or on a wall cutter • great for modelling
Ink jet card	• Has been treated so that it will give a high quality finish with inkjet ink • available in matt and gloss
Solid white board	• top quality cardboard made from quality bleached wood pulp. • used for hard backed books and more expensive items • excellent print finish

4. Paper and Boards- Stock sizes and weights

Paper and board is available in sizes from A0 (biggest) to A7 (smallest). The most common size is A4.
Each size is half the one before, eg A4 is half the size of A3.
They are also sold by weight: GSM – grams per square metre.

Card thickness or calliper is traditionally measured in **Microns**. 1000 Microns = 1mm, so the higher the value, the thicker the card or paper.

5. Properties of paper and boards.

Type	Weight or thickness	Uses	Relative cost (10= high)
Newsprint	50gsm	Newspapers	1
Layout Paper	60gsm	Sketches and tracing	3
Tracing Paper	70 gsm	Tracing	4
Sugar Paper	90gsm	Cheap mounting work	2
Inkjet/Photo paper	150-230gsm	Photos/Presentations	9
Board (Card)	230-750 microns	Model-making	5
Mount Board	230-1000 microns	Model-making, High picture quality mounting	9
Corrugated Card	3000-5000 microns	Packaging protection	5

7: KEY WORD FOCUS

You should be able to explain the meaning of each of these words by the end of this rotation.

GSM	Grams per Square Metre
Microns	Thickness of paper or card. 1000microns =1mm thickness

AQA Design & Technology 8552
Unit 3: Materials and Working Properties
3.2 Natural and Manufactured Boards

1. Woods

Man-Made Woods


Medium density fibreboard (MDF)

Description
- Has a smooth, even surface
- Easily machined and painted
- Available in water and fire-resistant form
- Often veneered or painted to improve its appearance

Uses
- Furniture and interior panelling


Chipboard

Description
- Made from chips of wood glued together with urea formaldehyde (glue)
- Usually veneered with an attractive hardwood or covered in plastic laminate

Uses
- Kitchen and bedroom furniture
- Shelving and general DIY Work


Plywood

Description
- A very strong board, constructed of layers of veneer or plies, which are glued together with the grains at 90° to each other
- Interior and exterior grades available.

Uses
- Furniture making
- Boat building and exterior work


Hardboard

Description
- A very cheap particle board
- Can have a laminated plastic surface

Uses
- Kitchen unit and furniture back panels

Hard Woods

Oak

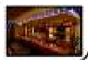
Description
- A very strong, light-brown wood
- Open grained
- Very hard, but quite easy to work with

Uses
- High quality furniture
- Beams used in building
- Veneers

Mahogany

Description
- Reddish-brown in colour
- Easy to work with

Uses
- Indoor furniture
- Shop fittings
- Bars
- Veneers



Beech

Description
- A straight- grained hardwood with a fine texture
- Light in colour
- Very hard but easy to work with
- Can be steam bent

Uses
- Furniture
- Toys
- Tool handles

Ash

Description
- Open grained
- Easy to work with
- Pale cream colour, often stained black
- Can be laminated (i.e. sliced into veneers which are glued together)

Uses
- Tool handles
- Sports equipment
- Furniture
- Ladders
- Veneers

Soft Wood

Pine

Description
- Pale-yellow coloured with dark lines and a fine, even texture.
- Medium in weight
- Stiff and stable
- Inexpensive

Uses
- Readily available for DIY work
- Mainly used for constructional work and simple joinery
- Furniture

2. Plastics

Acrylic

Properties:
- Hard wearing
- Will not shatter
- Can be coloured
- Bathtubs, School Projects, Display signs

Polypropylene

Properties:
- High Impact strength
- Softens at 150°C
- Can be Flexed many times without breaking
- School chairs, Crates

High Impact Polystyrene (HIPS)

Properties:
- Light but strong
- Widely available in sheets
- Used for casings of electronic products

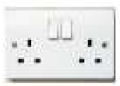
Polythene (LDPE)

Properties:
- Weaker and softer than HPDE.
- Lightweight
- Carrier Bags + Squeezy Bottles

Polythene (HDPE)

Properties:
- Stiff strong plastic
- Used for pipes and bowls
- Buckets

Urea formaldehyde



Properties:
- Colourless plastic
- Can be coloured
- Door and cupboard handles, Electrical fittings

3. Material Properties

Strength
The ability of a material to stand up to forces being applied **without it bending, breaking, shattering or deforming in any way.**

Elasticity
The ability of a material to **absorb force and flex in different directions, returning to its original position.**

Ductility
The ability of a material to **change shape (deform) usually by stretching along its length.**

Malleability
The ability of a material to be **reshaped in all directions without cracking.**

Hardness
The ability of a material to **resist scratching, wear and tear and indentation.**

Toughness
A characteristic of a material that **does not break or shatter when receiving a blow or under a sudden shock.**

3. Metals

Aluminium

Properties:
- Light Weight
- Light grey in colour
- Can be polished to a mirror like appearance
- Rust resistant

Mild Steel

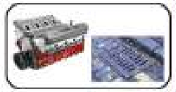
Properties:
- Heavy
- Dark grey in colour
- Rusts very quickly if exposed

Stainless Steel

Properties:
- Heavy
- Shiny appearance
- Very resistant to wear / rust.

Cast Iron

Properties:
- Re melted pig iron with some quantities of other metals
- Strong in compression
- Brittle

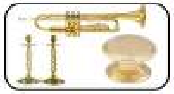


Copper

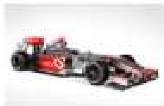
Properties:
- Reddish brown metal.
- Soft
- Excellent conductor of heat and electricity

Brass

Properties:
- Yellow metal
- Hard
- Alloy



4. Composites

Carbon Fibre	GRP Fibreglass
Expensive in comparison to other materials. Very good strength to weight ratio. Used in the manufacture of high end sports cars and sports equipment.	GRP is composed of strands of glass which are woven to form a flexible fabric. The fabric is normally placed in a mould and polyester resin is added. Glass reinforced plastic is lightweight and has good thermal insulation properties. It has a high strength to weight ratio
	

AQA Design & Technology 8552
Unit 3: Materials and Working Properties
3.3 Textiles

1. Fabrics

Natural Fabrics

Cotton	Soft, good absorbency, prints well, machine washable, strong breathable	Origins from the Cotton Plant.	Uses: Jeans, towels, Shirts, dresses, underwear
Wool	High UV protection, flameproof, breathable, durable insulating	Origins from Sheep.	Uses: Jumpers, Coat, blankets
Silk	Smooth, Soft, Strong	Origins from the silk worm.	Uses: Wedding dresses, lingerie.
Linen	Strong, cool in hot weather	Origins from the flax plant	Uses: Trousers, tops.
Leather/Suede	Strong, hardwearing, durable.	Origins from the skin of animals, mainly cows.	Uses: Jackets, Trousers, Shoes.

Synthetic fabrics

Polyester	Durable, wrinkle resistant, stain resistant	Uses: Shirts, jackets. Also used in safety belts, conveyor belts and tyre reinforcement.
Polyamide (Nylon)	Durable, high abrasion resistance	Uses: Sportswear, carpets.
Elastane (Lycra)	Stretchy, durable, high stain resistance	Uses: Sportswear, Swimwear, tights.
Viscose	Soft, comfortable, absorbent, easily dyed.	Uses: Dresses, linings, shorts, shirts, coats, jackets and outerwear.
Acrylic	Absorbent, retains shape after washing, easily dyed, resistance	Uses: Jumpers, tracksuits, linings in

1. Fabrics

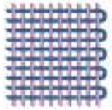
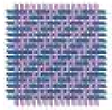
Blended and mixed Fabrics

These fabrics take on the positive characteristics of their combinations

Cotton/Polyester	Easy care and crease resistant	Uses: School shirts.

2. Fabric Construction

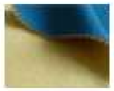
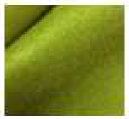
Woven

Plain Weave	Extremely strong and hard wearing	
Twill Weave	Extremely high strength and abrasion resistant.	

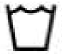
Knitted

Knitted fabrics	Stretchy, soft and comfortable.	

Non-Woven

Bonded Fabrics	These are webs of fibres held together by glue or stitches.	
Felted Fabrics	Felt is made by combining pressure, moisture and hear to interlock a mat of wool fibres.	

3. Care Labels

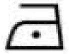


Washing Label- will usually have a max. temp number included

Hand Wash only

Do not wring out

Tumble Dry



Iron on low heat. The more dots the higher the heat setting

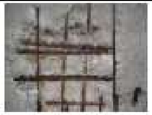
Do not bleach

AQA Design & Technology 8552

Unit 4: Specialist technical principles

4.1 Forces and Stresses

1: Forces and Stresses

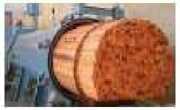
Force	Description	A fair test for each force/stress.	How a material / object can be adapted to resist	Examples
Tension	Forces pulling in opposite directions.	Apply the same weight to each material and suspended in the same manner.	Concrete can have steel bars inserted to reinforce.	
Compression	Forces that are trying to crush or shorten.	Insert materials into a vice/clamp and apply the same amount of twists to the handle.	Composite panels can have a honeycomb structure sandwiched in the middle to resist.	
Bending	Flexing force	Apply the same weight to the material.	Steel beams have an I profile to resist bending.	
Torsion	Twisting force.	Use clamps & stands to hold the materials and turn in opposite directions at the same angle.	The diagonals on a tower crane help the structure against torsion.	
Shear	A strain produced when an object is subjected to opposing forces.	Place the material between a tool that works in opposite directions. e.g. Shears	Bolts are hardened and have unthreaded shanks to help stop shearing.	

2. Improving functionality of materials

Process	Description	Result	Example	Visual Example
Lamination	Layering of thin materials	Depending on the direction of lamination it can make boards stiffer or actually more flexible	Plywood: Laminations at 90 degrees to each other - Rigid Flexi-ply: laminations all the same direction - Bendy	
Bending / Folding	Folding a 90 degree edge on sheet metal / plastic	Makes the panel more rigid	Body panels on cars	
Webbing	Modern polymer fabrics woven together	Extremely strong and durable fabric	Seat belts	
Fabric interfacing	A strengthening material added to the unseen face of a fabric	Adds strength / shape	Shirt collars	

1: The Modification of properties for specific purposes

Process	Material	Purpose
Seasoning	Timber	Removes the moisture content so that the timber will not shrink, warp and twist
Annealing (heating)	Copper	Softens the copper to make it more malleable
Addition of Stabilisers	PVC	Stops plastic become brittle with exposure to the sun



Timber being seasoned in a kiln

Copper bowl being annealed

Metal compounds (stabilisers) are added to PVC for UV protection

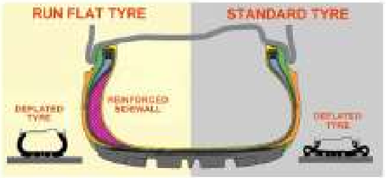
AQA Design & Technology 8552
Unit 4: Common specialist technical principals
4.20 Improving functionality

1. Key Terms

Reinforcing

Strengthening a material so it withstands force and stress

Car tyre



Concrete

Denim - rivets

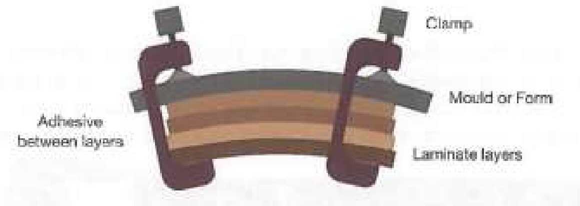
Webbing

2. Key Terms

Laminating

Stiffening a material to improve strength, stability and flexibility.

Plywood



Material bent over a former and held in place with clamps

Paper

3. Key Terms

Fabric Interfacing

An additional layer of fabric to support certain areas of fabric.

Shirt Collar

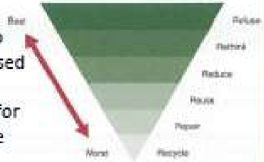
Baseball cap - peak

AQA Design & Technology 8552

Unit 4: Specialist technical principles

4.4 6Rs

The 6 R's



The 6 Rs are an important checklist. They are used by designers to reduce the environmental impact of products. They can also be used to evaluate the environmental impact of other products.
The hierarchy of sustainability places the strategies that are best for the planet about those that have a greater negative impact on the environment.

1. Refuse

The first stage in the process is to ask whether the proposed product, part, purchase or even journey is required at all. Asking the question 'Is it really necessary?' can play a major role in reducing the demand on materials. Simply not using something saves 100% of what you have chosen not to use. Example include:

- Using your own carrier bag rather than purchasing a new one.
- Walking or cycling to school instead of being driven.
- Not using products such as some pesticides that are known to be harmful to the environment.
- Not eating (or using) products that are over-farmed, over-fished or on the endangered list.

2. Rethink

Consumers have a growing number of choices to make about where and on what they spend their income. Greener and more sustainable options are not always the cheapest or the best, but making informed decision and rethinking ones spending power can play a huge part in conserving resources.
Deciding on the design of a product, e.g. the materials being used in its production, will directly affect its sustainability. The types of questions designers need to ask are:

- Are the materials locally sourced?
- Are they sustainably produced?
- Is it essential to use this material, of which there is a finite supply?

By rethinking how the product is likely to be made, the product can often be redesigned in a more responsible way.

3. Reduce

Reduction is often the result of having re-thought a design or action. Materials and energy are saved due to efficient manufacturing practices and the use of clever design, incorporating sustainable materials.

- Modern materials that are lighter and stronger than traditional ones have contributed to the miniaturisation of products, saving material and energy in manufacture and use.
- Reducing the complexity or number of parts a product uses and reducing the number of different materials in a product makes recycling easier.
- In factories, schools and hotels, fitting motion sensitive lighting and smart heating systems can significantly reduce energy usage.
- Many large companies employ staff to conduct 'energy walks' to turn off unused appliances and lights and to ensure windows and doors are shut to conserve heat.

4. Reuse

Reusing products multiple times for the same purpose is also known as **primary recycling**. Reusing a product in a different way from the one it was designed for is known as **secondary recycling**.
The classic glass milk bottle is reused many times before it reaches the end of its useful life, as which point it is recycled. A plastic milk bottle, however, is intended to be used only one, although it can have many different subsequent uses.
Donating to and buying from charity shops extends the life of products and in recent years there has been a resurgence of in products having second lives, thanks to websites such as eBay, Freecycle or Gum tree.

ebay freecycle Gumtree

It is also becoming popular for furniture and other household items to be **upcycled** with a coat of paint and some minor repairs or adaptations, extending their useful life by many years.

5. Repair

Being able to repair a product when it is broken or worn is a way of extending its life and delaying the purchase of a new one. Repairing is a positive option over replacement as it means that only some parts of the product are replaced. This creates jobs for skilled people who conduct repairs and stimulates a spare parts market.
Unfortunately, repairing products has become harder over years. Growing number of products are not design to be repaired. There are a number of reasons why items may be designed this way, but it is usually because they are cheaper to replace than repair. Some products, especially modern electronic products, are designed to last only a few years as technology dates quickly and older products will be superseded by newer, faster, more efficient models. This is called **planned obsolescence.**

6. Recycle

Tertiary recycling, although a very important stage, is lower down the hierarchy of preferred options because most materials that are recycled this way tend to be of lower quality than the original material. It takes a lot of energy to recycle materials.
This form of recycling requires the reprocessing of the material and in many cases involves chemicals and/or heat to recover the recycled materials. In an ideal world, tertiary recycling would remove all recyclable materials from our household waste so that only biodegradable materials would be left. Only very few parts of the world are set up to cope with this level of processing.

7. Sustainability

Our planet has to provide all of our basic human needs, such as food, shelter and warmth.
Designers now have a much better understanding of which materials are sustainable and which are not.
The general principle is that resources fall into two categories:
Finite resources – are ones which are in limited supply or cannot be reproduced.
Non-finite resources – are ones which are in abundant supply and are unlikely to be exhausted.

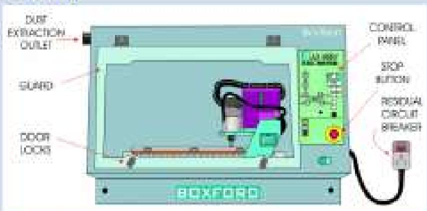
8. Recyclable materials

Once all useful and recyclable materials are removed, the majority of the remaining waste is organic matter and can be processed in one of two ways; 'Recover' or 'Rot'. Food waste and garden waste can be processed at a high temperature and turned into compost. The waste can also be buried in **landfill** sites where the resulting methane gas from the rotting matter is collected and burned and used to generate heat or electricity in the same way.

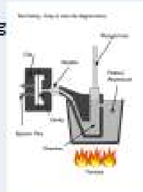
AQA Design & Technology 8552
Unit 5: Materials
Original source, commercial manufacturing and surface finish

From AQA

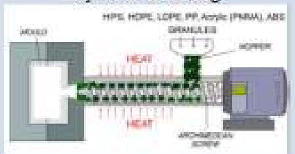
1. Wood

Material	Original Source	Commercial Manufacturing	Surface Finish
Hardwood - Oak	Deciduous Tree	CNC Routing and turning 	Oil – Soaks into the timber, must be reapplied frequently.
Softwood - Pine	Coniferous Tree		Wood preservative – Protects from fungal or insect attack and prevents rot. Reapplication may be required.
Manufactured Board - MDF	Trees		Paint – painted on with a roller or brush, can also be sprayed. Needs a primer and undercoat.

2. Metal

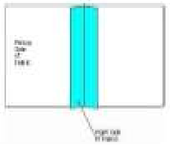
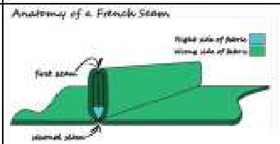
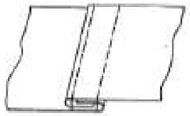
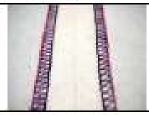
Material	Original Source	Commercial Manufacturing	Surface Finish
Ferrous metal – Steel	Iron ore (rocks and minerals)	Hydraulic Press 	Galvanising: involves dipping metal into a bath of molten zinc. The zinc provides a good corrosion resistant finish.
Non-ferrous metal - aluminium	Bauxite ore (rocks and minerals)	Die Casting 	Anodising: provides a hard-wearing corrosion-resistant finish. Anodising involves electrolysis and uses acids and electric currents.
Alloy - Duralumin	Metal ore (rocks and minerals) Alu 94% Copper 4% Magnesium 1% Manganese 1%	CNC Milling 	Powder coating: process used in industry. The powder is sprayed onto products which run through an oven.

3. Polymer

Material	Original Source	Commercial Manufacturing	Uses
Thermoplastic - ABS	Crude Oil	Injection Moulding 	Toys (Lego), hard hats, electronic castings
Thermosetting plastic		Press Moulding 	Electrical fittings, handles
Biodegradable Plastic – Polylactic acid (PLA)	Vegetable starch	3D printing 	Rapid prototyping, disposable items

AQA Design & Technology 8552
Unit 5E: Textile based Materials
5E.1 Working with textile based Materials and Fixings

1. Construction Techniques

Open seam	This is used as the main method for constructing textile products. It is normally finished with overlocking to neaten the edges and prevent fraying.	
French Seam	This seam is used on delicate fabrics that can not be overlocked. It is generally used within lingerie.	
Machine and Fell Seam	Very strong double stitched seam for heavy fabrics. Commonly used on jeans.	
Overlocking	Used to neaten seams to prevent fraying. Generally hidden on the inside of a product.	
Binding	Used to finish a curved edge on a product, where over-locking is not suitable.	

2. Decorative Techniques


Applique


Heat Transfer


Hand Embroidery


Beads & Sequins


Tie Dye


Buttons


Gathers


Batik

Tucks


Pin Tucks

3. Equipment


Sewing Machine


Quick unpick


Pins


Fabric Shears


Ironing Board


Tape Measure


Overlocker


Sewing threads


Needle

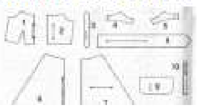

Iron


Embroidery Scissors

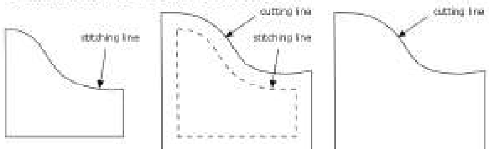

Pinking Shears

4. Key Terminology

Pattern
This is the term given to a paper template to aid in the cutting out of fabric for accurate construction.

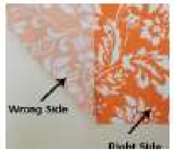


Seam Allowance
This is usually a 1cm 'boarder' around your pattern to allow for construction to be the correct size.



Right Side
This is the 'correct' side of the fabric that you wish to see.

Wrong Side
This is the side of the fabric that you do not wish to see.



Pressing
This is the term given when ironing your product; e.g. press your seams open, would refer to when an open seam is sewn and they need to pressed outwards to give a flat finish.

AQA Design & Technology 8552
Unit 5B: Specialist Technical Principles – Timber Based Materials
5.1 – Sources, origins and properties Pg. 1

1.1 Timber Conversion

After a tree is felled (chopped down) and then cut into manageable lengths, it is then converted into planks. At this point is in known as timber. Timber is supplied in two main types of finish. **Rough Sawn or planed all round (PAR).** Rough sawn timber is not planed and is rough all around to touch. It is often used for exterior tasks or where the finish is not important. PAR has a much smother finish as it has been planed down on all sides. It is used for furniture and internal features such as windows or doors. Finishes such as varnish or paint can be easily applied. Planed timber is less absorbent than rough sawn timber.

Timber is available in many different shapes and sizes, standardized to enable different varieties to be used together.

1.2 Seasoning

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

Uneven evaporation of the water content can cause some common faults such as twisting, cupping and bowing which can render the timber useless for many tasks. If the end grain dries too quickly, it can cause the plank to split.

There are two methods of seasoning; air-drying or kiln drying . Air dried timber is stacked so that air can circulate around the planks and evaporation can take place. It takes approximately one year per 25mm of plank thickness to season and in the UK the moisture content typically reduces to around 18%.

Kiln-dried timber (A kiln is basically a Giant Oven) can have a much lower moisture content and it is a much faster process, meaning the timber can be sold much sooner. It costs more then air drying, as heat and pressure is used but no additional land is required to store the timber while seasoning takes place. Kiln dried timber is less prone to faults and the heat also kills off bacteria and insects that may attack the timber.

1.3 Manufactured Board

Natural timber is combined with the adhesive to make manufactured boards. They can be made from waste, low-grade and recycled timber and are usually produced in pale brown natural finish. Each manufactured board is produced in a slightly different way, the two main process used are **lamination** and **compression.**

Plywood and block board use the lamination method where layers of wood are bonded together using an adhesive. Medium Density Fibreboard (MDF), chipboard, oriented strand board (OSB) and hardboard use the compression method where wood is shredded, chipped or pulped, then heated and compressed under high pressure, in most cases using adhesives to bond the particles together.

1.4 Veneer

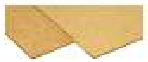
Some manufactured boards are covered in a thin slice of natural timber called a **veneer.** These natural wood slices are taken from the trunk of a tree and are bonded to the surface of cheaper sheet materials. Veneers are commonly seen on medium density fiberboard (MDF) and plywood. There are two methods of veneer production; rotary and knife cut. Rotational veneer production produces the longest sheets and involves rotating a whole trunk on an industrial machine similar to a wood turning lathe. It is a bit like a huge pencil sharpener creating one long ribbon of veneer.

AQA Design & Technology 8552
Unit 5B: Specialist Technical Principles – Timber Based Materials
5.1 – Sources, origins and properties Pg. 2

1.5 Advantages and disadvantages of manufactured board

Manufactured Board	
• Available in large sheets, very stable which saves time and energy joining arrow planks together.	• Adhesives used to bond the boards can contain hazardous particles that can cause cancer.
• No defects such as warping. Twisting, cupping and splitting which occur in natural wood, meaning less waste.	• Machining and sanding some boards especially MDF, causes very small particles of dust to be released, easily breathed in, even through a mask.
• They do not have knots or resin pockets which can be hard to work around, avoiding waste and protecting tools from damage.	• Tools can blunt easily owing to the adhesives in the boards.
• Smooth finish which requires very little preparation.	• Many traditional wood joints cannot be used effectively with manufactured board.
• Makes use of low grade, recycled and waste wood.	• Edges can be hard to finish.
• Available in many different finishes, veneers and laminates.	• Most boards are prone to absorb moisture if not treated.

1.6 Additional common manufactured boards

Name	Characteristics	Uses
Blockboard 	Stable, tough, relatively heavy, finishes well, indoor use owing to adhesives used.	Furniture, doors, shelving, indoor construction.
Hardboard 	Flexible in large sheets, even strength, easily damaged by water unless treated. Inexpensive.	Furniture and picture frame backings. Internal panelling.
Oriented Strand Board (OSB) 	Rigid and even strength in all directions, good water resistance.	Construction hoarding, interior and exterior house building.

1.7 Additional softwoods

Name	Characteristics	Uses
Redwood 	Easy to work and machines well. Some rot resistance.	Outdoor furniture, beams, posts, decking, veneers.
Cedar 	Easy to work, can blunt tools, finishes well, naturally resistant to rot.	Outdoor furniture, fences cladding for buildings, roof shingles.

1.8 Sustainable timber production

Wood is considered to be a sustainable product, as new trees can be grown to replace those used for timber and fuel. The main issue facing timber production is that in many parts of the world, it is being used at a far greater rate than it is being replanted. The result is an unsustainable supply of timber, which is frequently illegally obtained. This is causing many problems to the land in the countries where it is happening. Some countries where it is happening. Some countries are suffering from **desertification** due to **deforestation.** This activity is also thought to be a contributing factor in **global warming.**

FSC FORESTS FOR ALL FOREVER™

PEFC™
PEFC/09-31-004
Promoting Sustainable Forest Management
www.pefc.org

AQA Design & Technology 8552
Unit 5D: Specialist Technical Principles – Polymers
5D1 – Sources, origins and properties Pg. 2

2.1 Plastics additives
Many different chemicals and compounds can be added to enhance the functional and aesthetic properties of plastics. **Pigments** are added to change the colour, **plasticiers** are added to increase felicity and **fragrances** can be added, as seen in some children's toys and air-freshening products.

UV light can make plastic brittle and faded.

Stabilisers can be added to make plastic resistant to heat and light. One of the main issues with plastic degradation is the effect that ultraviolet (UV) light has on it. Over time, plastic becomes brittle and can lose its colour, starting to yellow or fade. By adding UV stabilisers, this process can be slowed down, enabling a product to last longer and perform its task more efficiently.

2.2 Availability of plastics.
Plastics are abundant in our modern society and are available in many forms. They help us to solve complex design problems because they can be manufactured to have a very high strength-to-weight ratio and have many versatile properties. This means that we can use less materials to make a stronger product. Plastics last for a very long time which means they are a value for money material.

2.3 Sustainability of plastics
End of life considerations are important for all products, but as most plastics take so long to biodegrade extra care should be taken to decide how it should be managed.

Many responsible companies producing plastic products conduct a **Life Cycle Assessment** (LCA) which informs them of the environmental impact of manufacturing their products. The information gathered helps them decide how to deal with their product when it has reached the end of its working life.

Almost all plastics are recyclable or biodegradable in some form – however, the difference in the quality of the recycled products varies dramatically.

Thermosetting plastics are generally considered non-recycled although they are frequently ground down and used as a filler material or they are used for **energy recovery** through incineration.

Thermoplastics are much more easily recycled for use as a recycled plastic product. If the plastics are carefully separated into the different types, the resulting material remains high quality and commands a higher price than mixed plastics. It is important to recycle as much as possible, and poorly discarded plastics are becoming a major environmental concern, especially in our countryside, rivers and ocean.

2.4 Biodegradable plastics
Some of the newer plastics are made from vegetable starches and are fully biodegradable id composted. The natural bacteria in the soil break down the plastic very quickly, largely owing to being exposed to moister and higher temperature.

Modern biopolymer pellets are made from vegetable and corn starches.

Bioplastics are non-toxic and are already being widely used in a range of products. Since biopolymers readily decompose they cannot be recycled. Small amounts mixed in with other recyclable thermoplastics can produce low grade recycled plastic or render a batch unusable.

AQA Design & Technology 8552
Unit 5B: Specialist Technical Principles – Polymers
5D1 – Sources, origins and properties Pg. 3

3.1 Common biodegradable plastics

Starch based biopolymers and common thermoplastics

Name	Appearance	Image	Characteristics	Uses
Polyactic acid PLA	Smooth or textured finish, easily coloured		Widely used in 3D printers, available on reels, non-toxic, fully biodegradable, easily moulded	Bottles, pots, disposable food and drink containers, pens, phone cases and 3D printing products
Polycaprolactone PCL Polymorph 62°c Coolmorph ™ 42°c	An off-white mouldable translucent pellet which can be hand-shaped. Can be coloured with pigments		Easily mouldable and re-mouldable at low temperature in hot water, non-toxic, reusable and fully biodegradable	Repairs, hand-shaped artefacts, jewellery, modifications and personalisation of products. Excellent for prototyping and modelling
Polyhydroxy-butyrate PHB Biopol ™	Smooth or textured finish, easily coloured		Quite brittle with limited chemical resistance. Non-toxic, slow but fully biodegradable, easily processed and moulded.	Bottles, pots, household items and disposable food containers

Name	Appearance	Image	Characteristics	Uses
ABS Acrylonitrile butadiene styrene	Very Smooth finish, can be textured, easily coloured		Tough, hard, good chemical resistance, good impact resistance, can be 3D printed, easily injection moulded and extruded.	Electronic castings, 3D printed products, hard hats, Lego ™
Nylon Polyamide	Smooth, easily coloured, available in various thicknesses of sheet, bar, film or thread		Self-lubricating, very low friction, hard wearing, easily machined, can be woven into fabrics	Clothing, tights, rope, cogs, gears, bushes, pipes, tents, parachutes

AQA Design & Technology 8552
Unit 5D: Specialist Technical Principles – Polymers
5D2 – Working with polymer based materials and fixings Pg 4

4.1 Selecting appropriate plastics
Looking at the different types of plastics it is possible to work out which varieties can be used for a given task. Considerations will include:

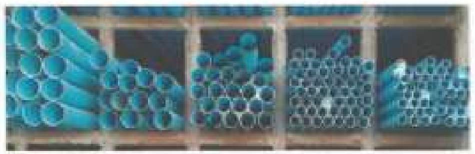
- Aesthetics
- Size of product
- Where it will be used
- Stability
- Cost
- Size of material available
- Required finish
- Availability
- Weight
- Desired properties
- Workability
- How long it is to last

4.2 Standard material stock forms, types and sizes
Most plastics comes in arrange of standard shapes and sizes. This enable materials to be more interchangeable, and the manufactures of tools and equipment to be aware of the material they need to cope with.

4.3 Sheet, rod and tube sizes
- Metric is the standard measurement system for plastic forms. Sheet material normally starts at around 1mm thick and increases to over 20mm thick; lengths and widths vary depending on the type of plastic and the thickness required. Rod is available from 2mm to well over 100mm diameter and tubing is available from 5mm to around 1 meter in diameter.

- Tubes are a little more complicated to measure, as you need to decide on the wall thickness you require. Too thin a wall section can mean the product lacks strength and too thick can add unnecessary weight and cost to your product.

- Wall thickness is usually measured in millimeters; however, traditionally it is known as the gauge and some tubular plastics may still be sold by gauge. As the gauge number increases, the wall thickness decreases.



4.4 Plastics as powder granules, foam and films
The majority of the plastics that are used in the design and technology workshop tend to be sheet, rod or tube, but they are also available in a variety of other forms.

Powders and granules are mainly used in plastic processing such as plastic dip coating, injection moulding and extrusion. The granules are heated until they become soft and can then be shaped as required. Powders tend to be bonded to the surface of hot materials such as metals. Both are available in a wide range of colours.

Rolls of plastic film are widely used for packaging, especially in the food industry. Films can easily be heat-sealed to make them airtight and tamper proof.

Expanded plastics and foams are also used by the packaging industry, and one of the most common forms in expanded polystyrene. It is incredibly lightweight and protects the contents of a packet from impact damage. Expanded plastics are also used in cars to soften areas such as dashboards and bumpers, which are prone to impact.

Plastic foams are used by the furniture industry to soften seating and beds and can even be used as floor coverings that are soft underfoot.

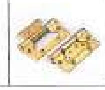
4.5 Standard Components

To temporarily attach plastic to itself or to other material a few different methods can be used. Machine screws have a finer thread than self-tapping screws and they have no point on the end. Plastic can be internally tapper with a screw thread, allowing machine screws to be inserted, but the internal thread can easily strip if too much torque is applied.

Self -tapping screws can be used without the need for a screw thread to be cut first. This special screw cuts its own thread. The correct size pilot hole must be drilled first otherwise plastics can crack or shatter as pressure is applied when it is screwed into position.

4.6 Hinges
Hinges are used to attach doors, windows and other openings to frames and carcasses. They can be made from many different materials but most commonly they are made from plastic and metal. Plastic hinges can be welded, glued, screwed or bolted to other plastics. Many varieties of hinge come in brass or steel finish; the steel versions can be galvanized to protect them from rusting when outside. Metal hinges will need to be bolted or screwed into position. Screws and bolts will need to be a countersunk variety in order for them to lay flat or flush, so the hinge can completely close. Metal hinges are often sold in pairs, plastic hinges are sold in pairs or by length. Both need to be carefully aligned to ensure accurate operation.

Common types of hinges for use with plastics.

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

AQA Design & Technology 8552
Unit 5D: Specialist Technical Principles – Polymers
5D2 – Working with polymer based materials and fixings Pg 5

5.1 Shaping, processing and machining polymers
A vast array of tools is available in the workshop in order to help us make the products we require. Tools enable us to mark out materials, cut to size, waste (remove material), add material, deform, reform, and apply a finish.

Before undertaking any activity in a workshop you need to be aware of the Health and Safety rules that apply to each of the machines, tools, pieces of equipment and materials that you use. Your teacher will guide you in tis area, but you must ensure that the correct personal protective equipment (PPE) is worn when operating machinery and using tools and equipment.

5.2 Drilling
Drilling a hole into plastic requires careful speed control. Large diameter drill bits require a slower speed than narrower ones to avoid overheating and the potential for the plastic to melt. The feed rate is another factor to consider – too much pressure can cause the plastic to crack.

A pillar drill is good for accuracy and is powerful enough to drill larger holes in thicker materials. A cordless drill is very adaptable and usually has variable speeds.

5.3 Common drill bits used with plastics

Name	Characteristics	Image	Name	Characteristics	Image
Twist drill bit	General purpose drill bit, also used on plastic, metal and wood		Hole saw	Used to cut large holes. They can easily overheat due to fast peripheral speed	
Countersink bit	Used to ensure countersunk screw heads are flush with the surface		PCB drill bits	Very small drill bits for drilling copper-clad plastic board, fitted to a shank for ease of mounting	

5.4 Cutting and sawing plastics
Saws are used to cut materials to size. The hacksaw and junior hacksaw are common plastic cutting handsaws that are used to cut straight lines. The coping saw and Abrafile enable curved lines to be followed in thin material. The hacksaw has a robust blade and be used for thicker material than the junior hacksaw, which is for light work.

The scroll saw and band saw are powered and can be used for curves and straight cuts through different thicknesses of material. With powered saws, you need to be aware that the plastic can easily overheat and melt. This can clog the blade and you may find the plastic bonds itself back together after being cut.

Extraction and appropriate PPE needs to be considered when using powered equipment.

Hacksaw Junior hacksaw Coping saw / Abrafile

5.5 Wasting by hand and abrading
Using hand tools and power tools to accurately shape plastic takes practice in order to achieve a high quality finish.

Abrading plastic can be performed by machines but is best finished and polished by hand. Hand abrading using files and wet-and-dry paper is best for hard-to-reach areas and it also allows you to apply force where it is needed most.

Wet and dry comes in different grades; the grit density determines how rough or smooth it is. Similar to glass paper, it is measured in grit per square inch – the lower the grit number, the rougher it is. Wet and dry paper starts at 150 grit and is available up to 2000 grit, which is so fine it has a polishing effect.

A disc or belt sander is best used for easy to reach sections that can be held safely. Bobbin sanders can be used for internal curves.

5.6 Wasting and abrading tools and materials

Name	Image	Characteristics	Name	Image	Characteristics
Files		Steel file with serrations on the blade that smooth the surface. Different shaped profiles and grades of cut available	Abrasive cloth		Similar to abrasive paper, removes small surface scratches ready to be polished
Wet and dry paper		Paper backed abrasive material used to clean up and apply a smooth surface, used wet or dry, medium to very fine grades	Brasso*		Although designed for metal this polish gives plastic a very smooth and high shine finish, applied with a cloth

5.7 Addition, Deforming and reforming
Laminating with plastics

Laminating Involves bonding strips or sheets of materials together in layers. It can be done with thick materials in order to create very strong structures or very thin materials to create tough and flexible products. Plastics are frequently laminated with other materials such as glass or wood to improve aesthetics or functionality.
Laminated safety glass is now used in all car windscreens. It contains a thin film of plastic, usually polyvinyl butyral (PVB) or ethylene-vinyl acetate (EVA) which holds the inner and outer glass layers together when it is cracked or shattered. Without the laminated plastic layer, the glass would fly out, potentially causing serious injury.

Plastic laminated boards are very popular for flooring products, kitchen worktops and much flat packed furniture. With these products, the plastic laminate is bonded to the surface of a manufactured board with adhesive – usually a contact adhesive that creates a strong and instant bond.

Plastic laminate comes in many colours and different effects. It can even be printed on with photographic images and is most popularly used to resemble marble or granite for kitchen worktops and wood grain effect for flooring and furniture products. The quality can be so good that it is sometimes difficult to tell if it is real or not.

The laminating process involves layering the materials with an adhesive and holding it in the chosen position using a former or jig. Pressure is applied though a press, a set of clamps or by using a vacuum. In industry melamine formaldehyde is often used for lamination, as it provides a very robust and hard-wearing surface and has a high quality finish.

AQA Design & Technology 8552
Unit 5D: Specialist Technical Principles – Polymers
5D2 – Working with polymer based materials and fixings Pg 6

6.1 Line bending
Banding most plastic involves heat unless they are very thin. Strip heaters are used for line bending which is a good way to create a permanent fold in a piece of thermoplastic such as acrylic.

Line bending process:

1. Use a marker pen or chinagraph pencil to mark out where the bend lines will be
2. Turn on the stripheater so that it comes up to a working temperature
3. Put on heat-proof gloves and have a tray of water ready to cool the workpiece
4. Place the marked line of the workpiece across the heating strip
5. Allow the plastic to heat through (the time needed will depend on the thickness of the material, thicker materials may need to be turned over to heat from both sides)
6. Test for flexibility as the workpiece approaches the right temperature (too cool can lead to it cracking, too hot can lead to scorching and blistering)

Bend the workpiece to the required angle (a **jig** or **former** may be used to ensure accuracy)

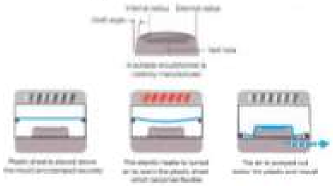
7. Once the workpiece has set it can be cooled in the water tray

6.2 Vacuum forming
Vacuum formed products include items such as plastic egg boxes and bath tubs. A sheet of thermoplastic is heated and pressed into the former (mould) by atmospheric pressure, as the vacuum reduces the pressure below the softened thermoplastic. The plastic takes on the shape of the mould, then cools and sets in position before the mould is removed.

HIPS (High impact polystyrene) is the most commonly used plastic to vacuum form within schools. In industry PETG, ABS and acrylic are also used.

To ensure a good product is made, the mould must:

- Have a positive draft angle >3°c to ensure easy removal of the material from the mould.
- Avoid under cuts that would make the removal of the mould impossible.
- Not have too deep a profile so that the plastic is drawn too thin and could easily burst.
- Have vent holes drilled to avoid vent pockets where there are dips in the profile.
- Have corners and edges rounded with a small radius to aid removal.
- Have a smooth finish so as not to adhere to the hot plastic – a release agent can be applied to the mould to assist removal.



6.3 3D printing
3D printing enables physical objects to be formed from reels of thermoplastics. 3D printers use special CAD files, usually in STL or VRML format, and converts them into a series of coordinates that the printer will follow., building up the image in layers.

There are different types of 3D printers available, including the following:

- **Stereolithography (SL)** involves using lasers to part sure the printed shape from a bath of liquid resin. This is an expensive but very accurate method.
- **Digital light processing (DLP)** is similar to stereolithography but uses a powerful light source rather than a laser.
- **Laser sintering** uses a powdered material instead of a resin bath. The solid shape is created as the heat from the laser fuses and solidifies the powder.
- An extrusion method also known as **Fused Deposition Modelling** (FDM) is the most popular in schools and involves melting plastic filament with the heated extrusion head.

The most common in schools are single-head printers that use reels of printable plastic filament. ABS and PLA are usually used in FDM style printers and come in pre-coloured cartridges. New and interesting materials are frequently being developed which allow for printing in wood, steel and brass effect. Soft rubbery materials are also becoming available, making prototype products even more realistic.
Very complex shapes can be 3D printed and some filament printers can print in more than one colour. Dry powder printers can even print in full colour.
3D printers can print other material besides plastics, including metals, paper, ceramics and even food. 3D bio-printing is also being developed, meaning that in the future we may be able to successfully print replacement body parts.

6.4 Resin casting
Thermosetting polymers can be used to produce a variety of products by casting them into a mould where they set and permanently take on the shape of the mould. The types of thermosetting polymers used in casting are made up of two parts; the resin itself and a hardener known as a **catalyst.**

To cast thermosetting resin, you begin by preparing the mould. Then the resin is thoughly mixed with the correct about of the catalyst. The mixed liquid polymer is then poured into the mould and left to set or cure. Once fully cured the casting is removed from the mould and is ready for use.

6.5 Welding plastics
There are two ways to weld plastic; with heat or with chemicals.

A chemical weld is more often used in schools and involves using a solvent based liquid that dissolves the surface of the pieces of plastic being joined. The two styles of chemical weld are liquid solvent cement and a thicker variety called dichloromethane methyl meth acrylate , known as Tensol 12. both products are methane based and need to be treated with appropriate care and PPE. Tensol must be used in a ventilated room as it has high VOC levels.

Liquid solvent cement has a water–like consistency and is applied with either a fine tipped paint brush or a syringe. The surfaces being joined need to be flush as the cement will not fill any gaps. The cement is drawn along the joint by **capillary action.** Liquid solvent cement will join styrene, ABS, Acrylic and butyrate in any combination. The join sets very quickly but is not particularly strong in thin sections. The solvent cement can damage the surface of the plastic if not applied carefully.

Tensol 12 is best used on acrylic but will work with HIPS, PETG and polycarbonate. It is a much thicker solvent and is able to fill small gaps, but a flush accurate joint will always be much stronger. Tensol 12 is applied to the surface of the joint and can take around three hours to dry.

Heat welding plastic involves using a special hot air gun which accurately heats the areas being welded together as well as a plastic filler rod that is applied to the weld joint. Filler rods are available in HDPE, rigid PVC, LDPE, PP and ABS making it a versatile way to join many plastics.

AQA Design & Technology 8552
Unit 5D: Specialist Technical Principles – Polymers
5D3 – Commercial manufacturing and quality control Pg 7

7.1 Plastics for commercial products
Plastics are widely used in commercial products. They have particular properties, such as electrical and thermal insulation, that are hard to find in other materials and most of them are waterproof and hygienic. Many plastics, such as polyethylene used for plastic bags, possess a good strength to weight ratio. Plastics offer value for money as a manufacturing material.

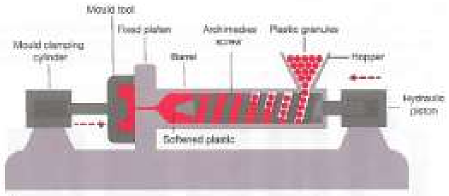
Thermoplastics are a very popular materials for seating products, as they are easy to mould and have a good level of flexibility. They are also lightweight, tough, durable, waterproof, corrosion resistant and chemical resistant making them easy to clean. Many plastics have a scratch resistant surface which helps to keep them looking good for longer. They are easily coloured and can be given a textured surface if required.

Thermosetting plastics are generally harder but more brittle than thermoplastics; they do not melt if they get hot. This is the key property that makes them so useful in electrical fittings.
Urea formaldehyde is the main thermosetting plastic used for electrical fittings and is an excellent electrical insulator with good tensile strength. It can reach a very high temperature before heat distortion occurs, making the fitting stable even if there is an electrical fault.

7.2 Commercial production techniques
There are many different plastic processing methods used in industry including **blow moulding** for bottles, **rotational moulding** for hollow shapes and **vacuum forming**. **Injection moulding** and **extrusion** are two processes that offer great repetitive accuracy and enable a high level of detail to be achieved.

7.3 Injection moulding
This process is ideal for complex shapes. Firstly a mould needs to be made; these are generally constructed from steel in two parts. They need to be very accurate as any blemishes with be transferred to every moulding produced.

1. Granules of the chosen plastic are fed into the hopper
2. The hopper feeds the Archimedes screw that drags the granules past a heater, where they are softened and become plasticised as they travel forward
3. The plastic is in a soft, pliable form as it reaches the end of the screw, where it collects until there is enough to fill the mould
4. At this point a **hydraulic piston** forces the softened plastic into the mould under pressure, filling it up
5. The plastic sets quickly, the mould is separated and **ejector pins** release the moulding
6. The process is repeated.

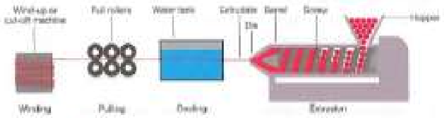


7.4 Extrusion
Extrusion is used to create a continuous flow of plastic that is pushed through a **die** to create a specific profile. Extrusion is used for cables, pipes, mouldings and even plastic film used for bags and packaging.

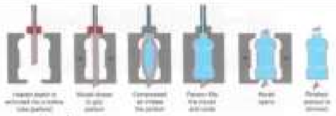
The extrusion process starts off in a similar way to injection moulding, using a die instead of a mould. The die sets the profile of the extruded plastic and must be made to a very precise tolerance.

A continuous flow of the softened plastic passes through the die at just the right temperature and flow rate to hold the shape.

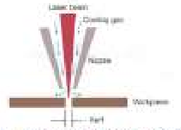
The extruded plastic then passes onto a cooling table or cooling through where it fully solidifies and is either wound onto a spool or drum if thin and flexible, or cut into lengths if rigid.



7.5 Blow moulding
Blow moulding feeds an extruded plastic tube known as a **parison** into a hollow mould such as a mould for a bottle. The parison is pinched at the bottom as the mould closes and filled with heated compressed air until the parison inflates to fill the mould.



7.6 Quality control
When products are made, checking that they are being produced correctly is an essential stage. This is known as **quality control** (QC) and is crucial to ensure dimensional accuracy is consistent and that the product is reliable and safe to use.



Laser cutters are one of the most accurate ways to cut a number of different plastics. (Note that use of some plastics, for example PVC, should be avoided as they will give off poisonous fumes when heated.) The laser itself can follow a design to a very fine tolerance, but they must be set up correctly considering the following.

- Kerf allowance –Every laser removes a little material and the thickness of the cut is know as the 'kerf' which can range from 0.1 mm to over 1 mm , depending on which material is used. Allowing for this variation is important to ensure the product fits correctly as it will affect the tolerance of the component being manufactured.
- Power and speed settings - Lasers cut using a combination of speed and power. The deepest cut would be on the slowest speed at the highest power and the lightest engraving would require the fastest speed and the least power. It is important to select the correct settings for the type of thickness of material and the type of cut or engraving required.
- Focusing the beam – The focal length of the laser will affect the quality of the cut or etch. Incorrect focus will mean the workpiece will not be cut through correctly and the keft usually becomes much wider. Many lasers have an autofocus fitted, but it still needs to be set. Manual focusing can be done with a simple measuring tool or pin.
- Clean mirrors and lenses – One of the most common issues with laser cutters is that the power seems to drop off as the cutting head moves away from the laser source. This can mean that the work furthest away may not be cut through efficiently. If this happens it often means that the laser's lenses and mirrors need to be cleaned. This is a specialist job that your teacher or workshop technician should perform.

AQA Design & Technology 8552

Unit 5D: Specialist Technical Principles – Polymers

5D3 – Commercial manufacturing and quality control Pg 8

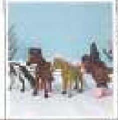
8.1 Plastic surface treatments and finishes

The reason for applying a finish to plastic's fall into two main categories; protective and aesthetics. Most plastics are self-finishing, but a number of more interesting finishes can be applied.

Adding aesthetic appeal may mean colouring plastic by painting or applying graphics, or electroplating with a desired metal like chrome, nickel or even gold. Plastics can be enhanced to give it a sheen r shine, or matt surface finish, by rubberising or lacquering. It can even be coated in a fur effect. Protection can make it less prone to UV corrosion and colour fade.

8.2 Common plastic based finishing techniques

Plastic finishes vary dramatically in method an application. A number of specialist techniques are on offer, depending on the desired finish. Many of the paint on and spray on products are solvent based and are not very environmentally friendly, as they contain high levels of volatile organic compounds (VOCs). This means that they give off fumes that are considered hazardous to health and should be used according to the manufacturer's instructions, normally in a well ventilation area with a mask being worn.

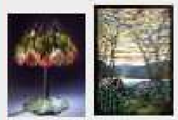
Name	Image	Characteristics	Name	Image	Characteristics
Painting – spray primer and paint		Plastics are primed and sprayed with paints for aesthetics and protection from UV degradation	Heat transfer printing		Image is printed onto special paper and transferred onto the surface with a heat press
Vinyl decals		Printed and cut self-adhesive vinyl can be attached to most surfaces	Hydro-graphic printing		Colour images are printed onto water soluble film which floats on a tank, the product is submerged and the image wraps around it
Flocking		Electrostatically charged strands of plastic stand on end and one end is bonded to the material with adhesive	Electro-plating and electroless plating		Plastics are covered in a conductive layer or etched before plating with nickel, chrome, copper, tin or gold
Engraving and frosting		Laser-engraved surface that can reflect light effectively, frosting covers larger areas to make opaque	Rubberising spray		A slightly textured coating that can be sprayed onto various materials, provides grip and has a matt aesthetic

8.3 Polishing

Plastic can become rough or scratched when it is processed. It can also become weathered and faded if left outside. Polishing techniques can be used to restore a high quality finish. Brasso®
Is often used to give a lustrous shine to certain polymers such as acrylic. Many other plastic polishes are available as are a number of products that restore faded and weathered plastics.

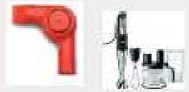
AQA Design & Technology 8552
Unit 6: Designing Principles
6.2 The work of others (Textiles)

Name	Facts	Logo	Examples
Coco Chanel	Gabrielle Bonheur "Coco" Chanel (19 August 1883 – 10 January 1971) was a French fashion designer and businesswoman. She was the founder and namesake of the Chanel brand.	CHANEL	
Alexander McQueen	Lee Alexander McQueen, CBE (17 March 1969 – 11 February 2010), known professionally as Alexander McQueen, was a British fashion designer and couturier. He is known for having worked as chief designer at Givenchy from 1996 to 2001 and for founding his own Alexander McQueen label.		
Vivienne Westwood	Dame Vivienne Isabel Westwood DBE RDI (born 8 April 1941) is a British fashion designer and businesswoman, largely responsible for bringing modern punk and new wave fashions into the mainstream.	Vivienne Westwood	
Harry Beck	Henry Charles Beck (4 June 1902 – 18 September 1974), known as Harry Beck, was an English technical draughtsman best known for creating the present London Underground Tube map in 1931.	HARRY BECK	
Norman Foster	Norman Robert Foster, Baron Foster of Thames Bank, OM, HonFREng (born 1 June 1935) is a British architect whose company, Foster + Partners, maintains an international design practice famous for high-tech architecture.	NORMAN FOSTER	

Designer Name	Facts	Logo	Examples
Marcel Breuer	Marcel Lajos Breuer (22 May 1902 – 1 July 1981) was a Hungarian-born modernist, architect, and furniture designer. Breuer extended the sculptural vocabulary he had developed in the carpentry shop at the Bauhaus into a personal architecture	Marcel Breuer	
Sir Alec Issigonis	Sir Alexander Arnold Constantine Issigonis; 18 November 1906 – 2 October 1988) was a British-Greek designer of cars, widely noted for the ground-breaking and influential development of the Mini, launched by the British Motor Corporation (BMC) in 1959.		
William Morris	William Morris (24 March 1834 – 3 October 1896) was an English textile designer, poet, novelist, translator, and socialist activist. Associated with the British Arts and Crafts Movement, he was a major contributor to the revival of traditional British textile arts and methods of production.	MORRIS & Co	
Mary Quant	Dame Barbara Mary Quant, Mrs Plunket Greene, (born 11 February 1934) is a Welsh fashion designer and British fashion icon She became an instrumental figure in the 1960s London-based Mod and youth fashion movements.	MARY QUANT	
Louis Comfort Tiffany	Louis Comfort Tiffany (February 18, 1848 – January 17, 1933) was an American artist and designer who worked in the decorative arts. He is best known for his work in stained glass.		
Philippe Starck	Philippe Starck (born January 18,. 1949) is a French designer known since the start of his career in the 1980s for his interior, product, industrial and architectural design including furniture	STARCK	

AQA Design & Technology 8552
Unit 6: Designing Principles
6.2 The work of others (Product & Industial Design)

Name	Facts	Logo	Examples
Raymond Templier	RAYMOND TEMPLIER (1891 - 1968) like many of his contemporaries in jewelry, was born to a family with a long tradition as jewelers.		
Gerrit Rietveld	Gerrit Thomas Rietveld; 24 June 1888 – 25 June 1964) was a Dutch furniture designer and architect. One of the principal members of the Dutch artistic movement called De Stijl, Rietveld is famous for his Red and Blue Chair.	Gerrit Rietveld	
Charles Rennie Macintosh	Charles Rennie Mackintosh (7 June 1868 – 10 December 1928) was a Scottish architect, designer, water colourist and artist. His artistic approach had much in common with European Symbolism. His work was influential on European design movements such as Art Nouveau and Secessionism.	CHARLES RENNIE MACKINTOSH	
Aldo Rossi	Aldo Rossi (3 May 1931 – 4 September 1997) was an Italian architect and designer who achieved international recognition in four distinct areas: theory, drawing, architecture and product design. He was the first Italian to receive the Pritzker Prize for architecture.	ALDO ROSSI	
Ettore Sottsass	Ettore Sottsass (14 September 1917 – 31 December 2007) was an Italian architect and designer during the 20th century. His work included furniture, jewellery, glass, lighting, home objects and office machine design, as well as many buildings and interiors.	SO TT SA SS	

Company Name	Facts	Logo	Examples
Alessi	Alessi is a housewares and kitchen utensil company in Italy, producing everyday items from plastic and metal, created by famous designers.	ALESSI	
Apple	Apple Inc. is an American multinational technology company headquartered in Cupertino, California that designs, develops, and sells consumer electronics, computer software, and online services.		
Braun	Braun GmbH formerly Braun AG, is a German consumer products company based in Kronberg. From 1984 until 2007, Braun was a wholly owned subsidiary of The Gillette Company, which had purchased a controlling interest in the company in 1967.	BRAUN	
Dyson	Dyson Ltd. is a British technology company established by James Dyson in 1987. It designs and manufactures household appliances such as vacuum cleaners, hand dryers, bladeless fans, heaters and hair dryers.	dyson	
GAP	The Gap, Inc. commonly known as Gap Inc. or Gap, (stylized as GAP) is an American worldwide clothing and accessories retailer.	GAP	
Primark	Primark known as Penneys in the Republic of Ireland) is an Irish clothing and accessories company which is a subsidiary of AB Foods, and is headquartered in Dublin.	PRIMARK	
Under Armour	Under Armour, Inc. is an American company that manufactures footwear, sports and casual apparel.		
Zara	Zara is a Spanish clothing and accessories retailer based in Arteixo, Galicia. It is the main brand of the Inditex group, the world's largest apparel retailer.	ZARA	

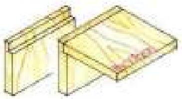
AQA Design & Technology 8552
Manufacturing Project 1 - Box

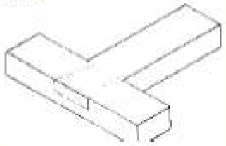
1: Joining Methods

Wood joints can be either permanent of temporary depending on the type and if glue is used.

Permanent:	Temporary:
When we do not want to take the pieces apart again	When we will, or might need to take pieces apart again
Glues, welding, rivets	Screws, bolts, nails

1.1Wood joints





Lap Joint

Mortise + Tennon Joint

Dovetail Joint

2. Scales of Production

One off: when you make a unique item

Batch: when you make a few/set amount

Mass: when you make thousands

Continuous: open ended production

3. Adhesives

P.V.A. – Poly Vinyl Acetate – best for joining 2 pieces of wood together

Epoxy – a *thermosetting* resin that can be used to bond most types of material

Contact Adhesive – a glue type that creates a tacky bond on both surfaces to be joined. It can be used with most materials.

4: Materials

4.1 Woods:	
Hardwoods:	Softwoods:
Beech Oak Ash	Scots Pine Cedar Spruce

4.2 Engineered Boards

Engineered boards are manmade materials usually made by mixing wood chips and glues to make wooden sheets.

Examples:
Medium Density Fibreboard (MDF)
Chipboard, Plywood and Hardboard

4.3 Plastics

Plastics are made of polymers, and are mostly refined from oil. There are 2 main categories:

Thermoplastics	Thermosetting plastics
Acrylic	Urea Formaldehyde
Polypropylene (PP)	Melamine Formaldehyde
High Impact Polystyrene (HIPS)	Epoxy Resin

4.4 Metals

Metals are hard and usually shiny, containing one or more elements dug and refined from the ground

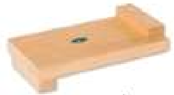
Ferrous metals are any metal that contains iron and will rust	Non-Ferrous metals do not contain iron and will not rust

Alloys are metals made from a mix of 2 metals – brass is made of copper and zinc.

Composite materials are a mix of 2 different types of material to get the best qualities from each – eg: GRP (Glass Reinforced Plastic)

5: TOOLS


Try square


Bench Hook


Vice

PVA Glue


Router Table


Mallet


Chisel


Laser Cutter


Tenon Saw

6: Surface Finishes

Finishing is usually one of the last stages of making a project. It will usually involve sanding and applying a surface coating to protect your material and improve its visual appearance.

Some examples:
Paint, Stain, Varnish, Oil, Danish Oil, Wax, Polish & Dip Coating.

7: KEY WORD FOCUS

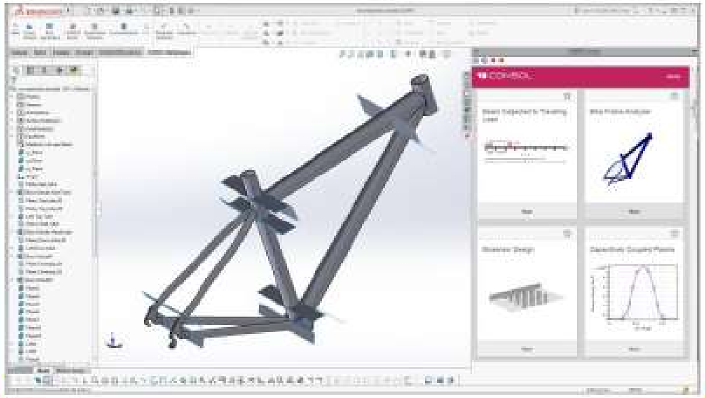
You should be able to explain the meaning of each of these words by the end of this rotation.

CAD	Computer Aided Design
CAM	Computer Aided Manufacture
CNC	Computer Numerical Control

AQA Design & Technology 8552
Unit 7: Making Principles
7.46 Selection of Materials and Components

1. Material Selection

The choice of material will depend upon the functional properties needed by the product. For example, the enclosure for an outside alarm will need to be waterproof. Advanced CAD packages will allow a designer to test the materials virtually to find out what material is most suitable, these tests include; stress loading and weight distribution etc. Further consideration must be made to aesthetic properties of the product/material. Some CAD software allow designers to render products to test the aesthetic or appearance of a product.



2. Component Selection

Component refers to a range of items used during production but is often used as a term for a pre-fabricated part of a product.

Some parts of a product may require specialist machinery, be time consuming or too expensive to produce which is why it is necessary to buy in components.

Examples of components include: Zips, buckles, handles, castors, hinges, battery compartments etc.

3. Functionality

The choice of material will depend upon the function that it needs to perform. The main areas to consider are:

Strength

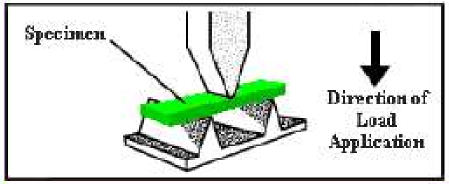
Different types of strength must be tested to ensure materials and components meet the needs of a product. This includes; resilience to wear and tear, weather proofing and chemical resistance.

Movement

Elasticity, flexibility and other forms of movement may need to be considered when working out the interactions a product may go through.

Electrical and Thermal Conductivity

This should be taken into account for products that will use electrical components.



4. Availability and Cost

Deadlines and budgets are common place in schools and workshops. Steps must be taken to ensure issues can be preempted:

Do we have the materials?
Are the materials stock forms?
Are there savings that can be made?
Are there any environmental concerns?

Compromise must be made when balancing deadlines and cost.

The 'project management triangle' states the compromise that must be made.

AQA Design & Technology 8552
Unit 7: Making Principles
7.49 Specialist tools, equipment, techniques and processes

1. Tool selection

Specialist material areas often require tools that perform only one function, others can be adaptable and perform multiple tasks. E.g. A Tenon saw is used to cut straight or angles in wood, a pillar drill can be used to drill into a variety of materials.

2. Safety for yourself and others

Once your equipment has been selected you must consider health and safety. Some machinery has age restrictions and/or training requirements see the equipment/machinery data sheets and risk assessments for information. Basic requirements for all projects are PPE (Personal Protective Equipment).

Other areas to think about are:

Extraction (to remove dust/fumes)

Cleaning up spillages immediately

Carrying tools correctly

Visual checks for damage/maintenance

Golden rule – if in doubt check it out

4. Outsourcing

Some companies may not have the skills for specialist tasks such as cutting and finishing toughened glass. Getting another company to do this them is called outsourcing.

3. Data Sheets and Instruction manuals

Data sheets are usually provided by a material manufacturer that are considered to be hazardous. This could be because they need to be handled in a particular way or because they give off harmful gasses. Some equipment and machinery is also considered hazardous and may have a safety data sheet or safety information in the instruction manual for example a laser cutter.

5. Risk Assessment

Risk assessments must be produced as they are specific to individual workshops, the hazards in one workshop are not necessarily the same as another. A risk assessment is carried out to identify whether or not it is safe to carry out a particular task in that environment. A risk assessment looks for potential risks of a process, tool, material or piece of equipment.

There are 5 stages to a risk assessment:

1. Individual risk factors
2. Identify who is at risk
3. Decide the likelihood of the severity
4. Record findings and implement control measures
5. Monitor and review the risk assessment

Risk assessment: Soldering Iron / Soldering

What are the hazards?	Who might be harmed and how?	What are you already doing?	Do you need to do anything else to manage this risk?	Risk Level H—High M—Medium L= Low	Action by whom?	Action by when?	Done
Handling soldering iron while soldering	The operator of the soldering iron. If the soldering iron is not held using the handle burns to the hands is likely. If the operator does not store the soldering iron in the stand provided burning to the contact area will result. If the operator of the soldering iron does not pay attention to who is around them and makes contact with them this will result in burning.	Soldering is undertaken in a specific area in S2 and S3. Strict guidance is given to operators and unsafe behaviour will result in immediate removal of the operator from the task.	No	M	HCL/PRO	Ongoing	
Burning through electric wire	The operator because the soldering is not being stored correctly and attention to safe storage of the soldering iron is not being observed.	Clear guidance on the safe use of the soldering is given with specific instructions on storing the iron when in use. The electric supply is rcd protected.	A safety sheet required to remind operators of the correct way to use and make aware of possible hazards.	L	HCL/PRO	Nov 2013	
Fumes	The operator could possibly inhale the fumes and also possible eye irritation could occur.	Operators are required to wear goggles. This is supported through the smaller allocation of operators soldering to minimise the generation of fumes. Observation and monitoring by the session member of staff.	No	L			

- This risk assessment and proposed actions have been discussed with staff and students (where appropriate).
- The risk assessment will reviewed annually as it might no longer be valid or if there are any significant changes to the hazards in the workplace, such as new equipment or work activities. A review date has been set.
- Operator refers to all persons carrying out an activity using a process, a series of processes using equipment within the department. An operator may be a member of staff, student or visitor.

AQA Design & Technology 8552
Unit 7: Making Principles
7.50 Surface Treatments and Finishes

1. Reasons to apply a finish

Most materials will require an exterior finish to improve the look of the material and to protect it from the environment. Surface finishes can be applied by numerous methods including brushing, spraying and dipping. The main surface finishes that are available include paints, varni shes and lacquers, oils, polishes, stains, sanding sealer, plastic dip coating, powder coating, anodising, plating, galvanising, enamelling and polishing.

Finishes are usually applied for one or more of the following reasons:

1.) To protect the material from moisture, wear, abrasion, fungus, mould or insect attack.
2.) To change the materials appearance, its colour or texture.
3.) To enhance the materials durability, surface hardness or other properties.

Sometimes products have a finish that serves more than one purpose (functional and aesthetic).

2. Common issues that affect materials

Oxidisation/corrosion

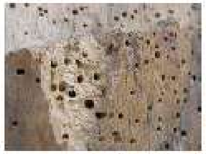
Affects: Metals (rust) and plastics (weaken, become brittle)
Occurs over a period of time, oxygen atoms form an oxide layer

Rot

Affects: Wood (wood decay fungus)
Usually caused by prolonged damp conditions affecting strength and integrity

Insect, creature, biological attack

Affects: Wood, paper, board and textiles
Wood can be attacked by woodworm, death watch beetle or termites. Paper and textiles become mouldy.



UV degradation

Affects: Textiles, papers, boards, polymers
UV light breaks down colour pigments causing fading.
Materials can also weaken.

3. Selecting treatments and finishes

Papers and boards	Printing Spot varnishing Laminating Plastic coating – Waterproofing Grease proofing – Baking products Wax coating – Waterproofing Foil blocking Foil coating	**Timbers**	Sealing Painting Varnishing Waxing and polishing Staining and colouring Oiling – Teak oil, linseed Preserving – Anti-rot, insect, fungal Tanalising – Anti-rot, insect, fungal
Metals	Painting Lacquering Electroplating – Anodising, nickel, chrome etc. Galvanizing – Zinc plating Polishing Brushing Plastic dip coating Sand or shot blasting Powder coating Hot blackening Rust stabiliser/converter	**Polymers**	Buffing and polishing Painting Lacquering Plating – Metal effects etc. Rubberising Flocking Decals – Self-adhesive Plastic additives including: - UV protection - Microbial protection - Heat stabilisers
Textiles	Dyeing Printing Decoration and embellishment Distressing Waterproofing Flameproofing Crease resistance Teflon® – Anti-stain coating Coolmax® – Anti-perspiration Purista® – Anti-bacterial Permethrin – Insect repellent	**Electronics**	Heat shrink shielding Protective insulator Conformal coating Types of PCB finishes: - Hot Air Solder Levelling (HASL) - Immersion Tin (ISn) - Organic Solderability Preservative (OSP) - Electroless Nickel Immersion Gold (ENIG)

Image from AQA

4. Surface preparation and application

Preparation must be done before a finish is applied. This includes; smooth surface, no grease, dust, fingermarks or pencil.

Occasionally a surface will need to be rougher in order for the finish to 'grip' to the surface this is known as providing a **key**.

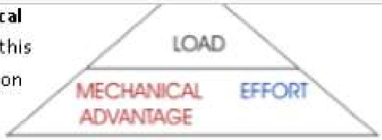
Application can happen in many different ways. Data sheets and risk assessments are used to give safety guidelines such as ventilation, extraction instructions etc.

Important information when applying a finish are it's drying time, amount of coats, further surface preparation between coats, temperature for application.

Clearing away can be important as some cleaning/finishing products may have to be kept in COSHH (**Care of substances hazardous to health**) cabinets. Some solvent based cleaners may require PPE and ventilated areas.

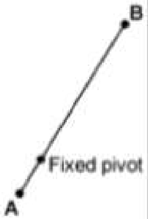
DESIGN AND TECHNOLOGY FORMULAS AND EQUATIONS

You may be asked to work out **Mechanical Advantage, Load or Effort**. Remember this triangle and you will know which equation to use.



To work out MECHANICAL ADVANTAGE $\text{MECHANICAL ADVANTAGE} = \frac{\text{LOAD}}{\text{EFFORT}}$	Example MA= $\frac{875N}{125N}$ **MA is 7 or as a ratio 7:1**
To work out LOAD $\text{LOAD} = \text{MECHANICAL ADVANTAGE} \times \text{EFFORT}$	Example Load = 7x125 **LOAD is 875N**
To work out EFFORT $\text{EFFORT} = \frac{\text{LOAD}}{\text{MECHANICAL ADVANTAGE}}$	Example Effort = $\frac{875N}{7}$ **EFFORT is 125N**

The diagram below shows the movement of a lever which is part of a toy.
The distance from point **A** to the pivot is 10mm.
The distance from point **B** to the pivot is 40mm.
If point **A** moves 10mm to the right, how far would point **B** move to the left?



To work out distance moved:

$$\frac{\textbf{DISTANCE B}}{\textbf{DISTANCE A}} \textbf{ X DISTANCE A MOVED}$$

$$\frac{\textbf{40mm}}{\textbf{10mm}} \textbf{ X 10 = } \underline{\textbf{40mm}}$$

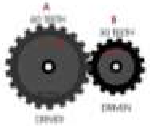
Gear Ratio

Velocity Ratio —also known as gear ratio

$$\text{VELOCITY RATIO} = \frac{\text{DISTANCE MOVED BY EFFORT}}{\text{DISTANCE MOVED BY LOAD}}$$

Low gear ratio = more speed with less force

Driver has 60 teeth the driven has 30 teeth
The gear ratio is 1:2.
Driver rotates once : Driven rotates twice

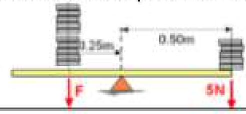
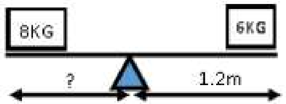
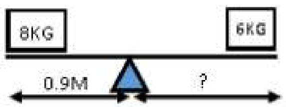


$\frac{30}{60}$ = 0.5 = 1:2

High Gear ratio= less speed with more force

Driver has 25 teeth the driven has 75 teeth
The gear ratio is 3:1.

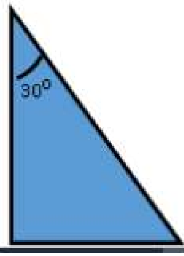
$\frac{75}{25}$ = 3 = 3:1

In order to balance the 5N force placed at 0·5 m from the FULCRUM, we require 10N on the opposite side at 0·25m to keep the seesaw balanced. 	**To work this out:** The force (or weight) needs to be doubled on the opposite side The distance from the Fulcrum needs to be halved on the opposite side
	**To work out FORCE:** **FORCE = (LOAD x D1)/D2** FORCE= (8x0.9)/1.2 FORCE= (7.2)/1.2 FORCE= 6KG
	**To work out DISTANCE 1:** **DISTANCE1= (LOAD2 x D2)/LOAD1** DISTANCE= (6x1.2)/8 DISTANCE= (7.2)/8 DISTANCE= 0.9m
	**To work out DISTANCE 2:** **DISTANCE2= (LOAD1 x D1)/LOAD2** DISTANCE= (8X0.9)/6 DISTANCE= (7.2)/6 DISTANCE= 1.2m

Tangent (Trigonometry)

$\text{TAN} = \frac{\text{Opposite}}{\text{Adjacent}}$

B



To work out the height of B

TAN 30^0= 0.58

0.58= $\frac{15}{\text{Adjacent}}$

Adjacent= $\frac{15}{0.58}$

B= 25.9cm