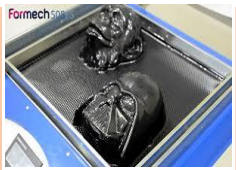
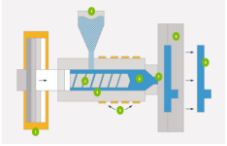
Plastic Forming

Vacuum forming



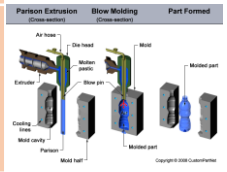
where a sheet of plastic is heated to a forming temperature, stretched onto a single-surface mold, and forced against the mold by a vacuum. This process can be used to form plastic into permanent objects

Injection moulding



Plastic injection moulding is the process of melting plastic pellets (thermosetting/ thermoplastic polymers) that once malleable enough, are injected at pressure into a mould cavity, which fills and solidifies to produce the final product.

Blow moulding

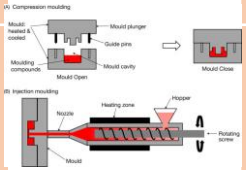


Blow molding is the process of forming a molten tube of thermoplastic material and placed within a mold cavity and inflating the tube with compressed air, to take the shape of the cavity and cool the part before removing from the mold.

Rotational moulding

Rotational Moulding involves a heated hollow mold which is filled with a charge or shot weight of material. It is then slowly rotated, causing the softened material to disperse and stick to the walls of the mould.

Compression



Compression moulding is the process of molding in which a preheated polymer is placed into an open, heated mold cavity. The mold is then closed with a top plug and compressed in order to have the material contact all areas of the mold.

Metal Forming

Forging

Forging is a manufacturing process involving the shaping of a metal through hammering, pressing, or rolling. These compressive forces are delivered with a hammer or die.

Casting

liquid metal is poured into a mold that contains a hollow shape. The metal and mold are then cooled, and the metal part (the casting) is extracted. Pewter is an example of Casting we have done in school

Bending

Bending is a metal forming process in which a force is applied to a piece of sheet metal, causing it to bend at an angle and form the desired shape.

Material Removal

Turning Centre lathe

The **Centre Lathe** is used to manufacture cylindrical shapes from a range of materials including; steels and plastics.

Milling Machine

The **vertical milling machine** is a precision tool used for shaping and fabrication by the removal of stock typically from metallic work pieces

Threading

Tap and Die

Threading is the process of creating a screw thread

Knowledge organiser

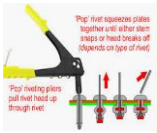
Engineering processes and production

Joining Methods

Welding

Welding is a joining process whereby two or more parts are united by means of heat or pressure or both.

Riveting



When installed the rivet is either drilled, placed or punched into a hole, afterwards the tail is then deformed, holding the rivet in place.

The rivet is deformed by of the tail, which makes the material flatter and usually causes the tail to be expanded by about one and a half times the size of the stem's original diameter.

Soldering

Soldering is a process in which two or more items are joined together by melting and putting a filler metal into the joint,

Brazing

Brazing is a metal-joining process in which two or more metal items are joined together by melting and flowing a filler metal into the joint,

Threaded Fasteners

A threaded fastener is a discrete piece of hardware that has internal or external screw threads. hey are usually used for the assembly of multiple parts and facilitate disassembly. The most common types are the screw, nut and bolt.

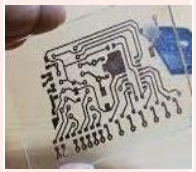
Self Tapping Screws

A self-tapping screw is a screw that can tap its own hole as it is driven into the material

PCB Manufacture

PCB Mask

The PCB mask is generated using CAD. This is printed onto a transparency ready to put in the UV light Box



UV Lightbox

The PCB mask is placed under the Photo Resist Board in the Light box. This is exposed for 2 minutes.

Development/Etching Tank

The Photo Resist Board is then placed into the developer for 20 seconds the etching tank for 20 minutes

Types of materials		
Ferrous Metals	Ferrous metals which contain **iron**. They may have small amounts of other metals or other elements added, to give the required properties. They will corrode if unprotected	Iron, carbon steels, high speed steels
Non Ferrous metals	Non Ferrous metals which do not contain iron. Pure metals (have no other metal or element)	Copper, brass, bronze, aluminium, zinc, tin, lead, titanium
Alloys	Alloying metals involves mixing two or more metals and other elements to improve their properties.	
Polymers		
Thermo plastics	**Thermo Plastics** -usually a plastic polymer, which becomes more soft when heated and hard when cooled. **Thermoplastic** materials can be cooled and heated several times without any change in their chemistry or mechanical properties	ABS, Polyethylene, HIPS, PVS, polycarbonate, polypropylene
Thermoset plastics	polymer that irreversibly becomes rigid when heated.	Polyester resin, urea – formaldehyde, epoxy resin, phenol-formaldehyde.
Composites	A composite material is a material made from two or more materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the original components	Glass reinforced plastic, Carbon fibre, concrete
Smart Materials	Smart materials, are designed materials that have one or more properties that can be significantly changed in a controlled fashion by external stress, moisture, electric or magnetic fields, light, temperature, pH, or chemical compounds	Shape memory alloys, thermochromic materials, Shape memory plastics, Quantum Tunnelling Composite.

High Carbon Steel

The hardest of the carbon steels. Less ductile, tough and malleable.
Uses - Chisels, hammers, drills, files, lathe tools, taps and dies

Medium Carbon Steels

Stronger and harder than mild steels. Less ductile, tough and malleable.
Uses - Metal ropes, wire, garden tools, springs.

Cast Iron

Hard, brittle, strong, cheap, self-lubricating.Whitecast iron, grey cast iron, malleable cast iron.
Uses - Heavy crushing machinery. Car cylinder blocks, vices, machine tool parts, brake drums, machine handle and gear wheels, plumbing fitments.

Knowledge organiser

Engineering materials and properties

Aluminium

Greyish-White, soft, malleable, conductive to heat and electricity, It is corrosion resistant. It can be welded but this is difficult.
Uses - Aircraft, boats, window frames, saucepans, packaging and insulation, pistons and cranks.

Copper

Red, tough, ductile, High electrical conductor, corrosion resistant, Can work hard or cold. Needs frequent annealing.
Uses - Electrical wire, cables and conductors, water and central heating pipes and cylinders. Printed circuit boards, roofs.

Aluminium alloys

Ductile, Malleable, Work Hardens.
Uses - Aircraft and vehicle parts.

Brass

Very corrosive, yellow in colour, tarnishes very easily. Harder than copper. Good electrical conductor.
Uses - Castings, ornaments, valves,forgings.

Mild Steel

Tough, high tensile strength, ductile. *Because of low carbon content it can not be hardened and tempered. It must be case hardened.*
Uses - Girders, Plates, nuts and bolts, general purpose.

High Speed Steel

Can be hardened and tempered. Can be brittle. Retains hardness at high temperatures.
Uses - Cutting tools for lathes.

High Tensile Steel

Very strong and very tough.
Uses - Gears, shafts, engine parts.

Stainless Steel

Corrosion resistant
Uses - Kitchen draining boards. Pipes, cutlery, aircraft.

Properties of materials	
malleability	The ability of a material to permanently deform in all directions without cracking.
ductility	The ability of a material to deform, usually by stretching along its length.
conductivity/resistivity	The ability of a material to conduct heat or electrical energy. Opposite for resistivity
hardness	**Resistance of a material to deformation, indentation, or penetration by means such as abrasion, drilling, impact, scratching**
machinability	**Machinability is a characteristic of a material, such as a metal, that makes it easy to drill, shape, cut, grind**
corrosion resistance	**How well a substance (especially a metal) can withstand damage caused by oxidization or other chemical reactions**
elasticity/plasticity	The ability of a material to permanently change in shape.

Materials and uses	
Ferrous and non ferrous metals and alloys	**Used for cast iron machine bases, bronze for boat propellers, Copper used in wiring and circuit boards.**
Thermoplastics	**ABS for appliance casing.**
Thermoset Plastics	**Phenol-formaldehyde for heat resistant saucepan handles.**
Composites	**Carbon fibre for bicycle frames**
Smart materials	**Shape memory alloy in alarm systems**

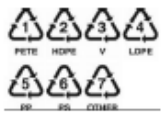
Materials Testing Processes		
Destructive testing	is undertaken in order to understand a specimen's performance or material behaviour, these procedures are carried out to the test specimen's failure.	Tensile Testing, Hardness testing
Non Destructive Testing	is a testing and analysis technique used by industry to evaluate the properties of a material, component, structure or system for characteristic differences or welding defects and discontinuities without causing damage to the original part	Conductivity testing, Crack testing, Ultra Sonic Testing

Environment

Use , Disposal, Recycling , Materials development , Engineering processes, Costs, Transportation, Sustainability

Recycling

Recycling means **reprocessing a material** so that it can be used again. This helps to reduce damage to the **environment** by reducing the need for **new materials**. For example, this might mean melting plastic parts so that they can be shaped into new products. **Symbols** are used on plastic products to show the type of plastic used, so that it can be sorted into different types and recycled.



Biodegradability

If it is essential to dispose of a product in landfill, ideally the material should be **biodegradable**. This means that it will **decompose** (naturally break down) relatively quickly into naturally-occurring substances - as opposed to non-biodegradable ones that **take many years to decompose.**

For example, most **plastics** made from **oil** are not biodegradable and may **take hundreds of years to break** down

The 6 R's

Recycle - Take an existing product that has become waste and re-process the material for use in a new product.

Reuse - Take an existing product that's become waste and use the material or parts for another purpose, without processing it.

Reduce - Minimise the amount of material and energy used during the whole of a products life cycle.

Refuse - Don't accept a product at all if you don't need it or if its environmentally or socially unsustainable.

Rethink - Our current lifestyles and the way we design and make.

Repair - When a product breaks down or doesn't function properly, fix it.

Renewable Energy Sources

Tidal
Wind
Solar
Geothermal

Sustainability

Maintaining resources to ensure they will last for a long time.

LANDFILL

A dumping ground for waste products.

Biodegradable

Naturally breakdown in the atmosphere.

Environment

Use , Disposal, Recycling , Materials development , Engineering processes, Costs, Transportation, Sustainability

Materials and the environment

One way to reduce impact on the environment is to **use less material** in the product.

Metals

Most metals are relatively easy to **recycle** and **reuse**, and there are advantages for manufacturers. It is **20 times** more efficient to recycle **aluminium cans** than to make new ones.

Plastics

Although most plastics are not **biodegradable**, they can be **recycled** and **reused. Polystyrene** vending cups can be **recycled** to make items such as pencils and rulers, and plastic carrier bags can be reused.

Disposal

At the end of their **useful life**, most products are **disposed** of in some way.
How this is carried out can have a significant **effect** on their impact on the **environment.**
A large proportion of products that we use currently end up in **landfill** – this means that they are buried in underground rubbish dumps. This is one of the **least** environmentally friendly methods of disposal.

Lifecycle analysis...what is it?

Lifecycle analysis **(LCA)** is used to work out the **environmental impact** of a product throughout its whole life (from extraction of materials through to final disposal).

- Look at the two products above - what might be the first stage in the product's lifecycle?

Life Cycle Analysis: In more detail.

- Companies are increasingly being asked to account for the impact their products and businesses have on the environment.
- They have to calculate environmental impact at each stage of the product lifecycle. This includes:
  - extracting materials
  - processing
  - transporting
  - using
  - and finally disposing of the product.

Mathematical Techniques

Use of formulae
Ohms Law
Area and Volume

Ohms law

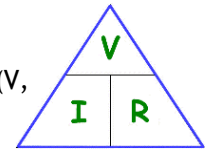
One of the most important and basic laws of electrical circuits is Ohm's law which states that the current passing through a conductor is proportional to the voltage over the resistance.

$$I = \frac{V}{R}$$

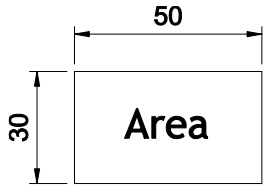
where I = current in amps, V = voltage in volts, and R = resistance in ohms This same formula can be also be written in order to calculate for the voltage or the resistance:

$$I = \frac{V}{R} \quad \text{or} \quad V = I \times R \quad \text{or} \quad R = \frac{V}{I}$$

Ohms Law Triangle
If you ever need help in remembering the different equations for Ohm's law and solving for each variable (V, I, R) you can use the triangle

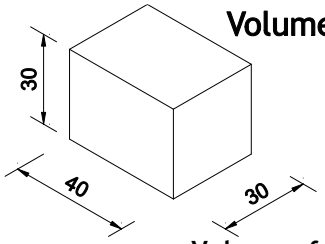


Area and Volume



Area = Length x height

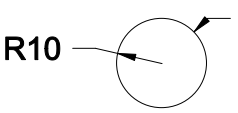
30 x 50 = 1500mm²



Volume = Length x width x height

40 x 30 x 30 = 360000mm³

Area of a Circle πr^2



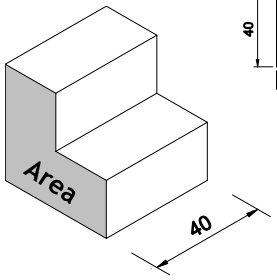
π x 10²

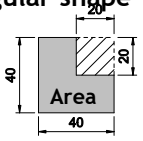
3.142 x 100

= 314.2mm²

Ø Diameter Symbol

Volume of an irregular shape
Area x width





40 x 40 = 1600
20 x 20 = 400
1600 - 400 = 1200
Area = 1200mm²

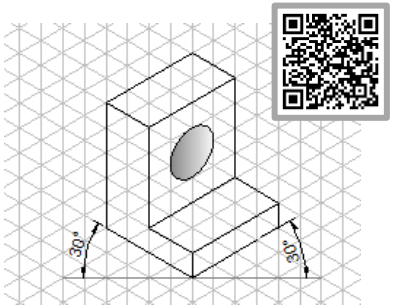
1200 x 40 = 48000

Volume = 48000mm³

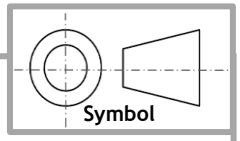
Working Drawings

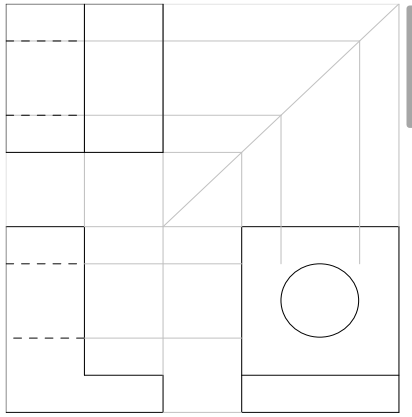
Isometric Drawings, Orthographic Drawings, Sectional views, Construction lines, Centre lines, Hidden Detail

Isometric

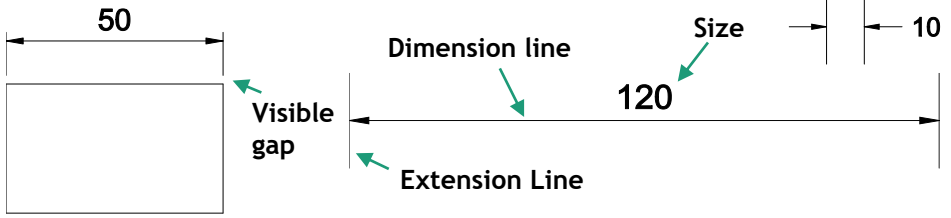


3rd Angle Orthographic

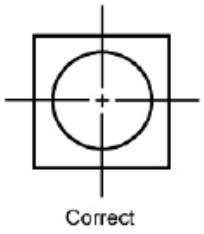


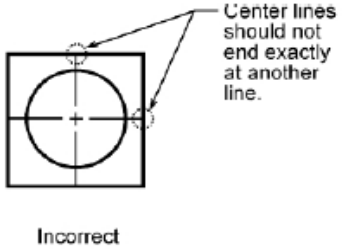


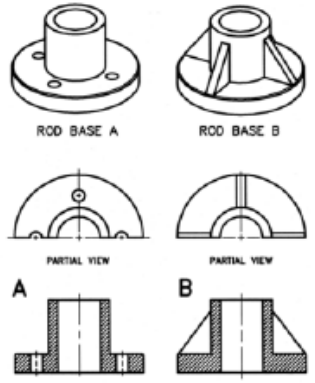
Dimensions and construction lines



Centre Lines and Sectional View







UNIT 1 Engineering Design

Identify features that contribute to the primary function of engineered products

Mild steel lamp shade. Formed using a steel press
Finished using **Electrostatic painting**

Pressure
Punch
Metal being formed
Die

The **gooseneck** is made up of a helical spring and a sectional metal wire, providing it with the mechanical properties to maintain the bending shape and position

Gooseneck inside PP flexible tube

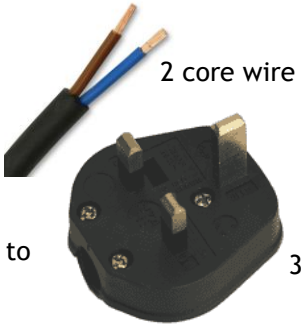
SPST Switch

Ceramic weight in base to stop it tipping over

Mild steel base
Formed using a steel press
Finished using **Electrostatic painting**

Polypropylene (**PP**) is a thermoplastic "addition polymer" made from the combination of propylene monomers.

Flexible PP tube covers 2 core electric cable which attaches the E14 lamp holder to the plug via a SPST Switch (Single Pole Single Throw)



2 core wire

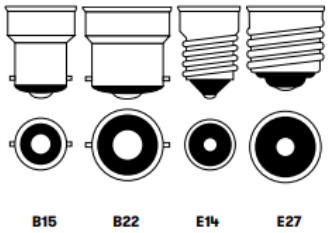
3 Pin Plug

SPST Switch

E14 Lamp Holder inside shade .

E14 Lamp

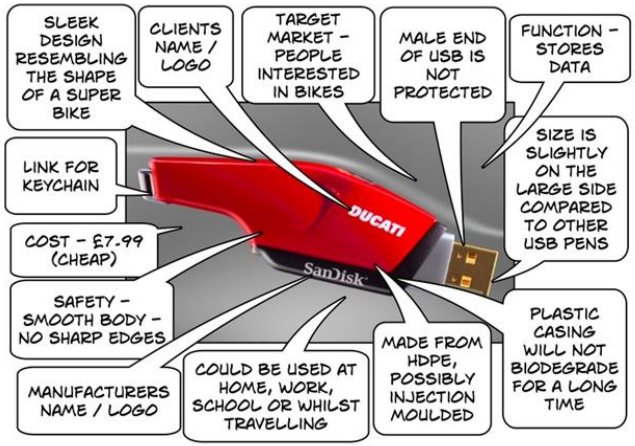
Tradition lamp fittings.



Electrostatic painting is a very efficient, cost-effective and clean method of **painting**. It can be **used on** conductive surfaces and provides a smooth finish. **Electrostatic painting** uses positively-charged **paint** particles from a specialized gun to coat grounded metal surfaces. Like a balloon clinging to a wall, it's attracted to the grounded surface and will wrap around the component, such as the mild steel lamp shade and base. This results in an even coat with little overspray and waste.

Analyse existing products

A is for **Aesthetics**
C is for **Cost**
C is for **Customer**
E is for **Environment**
S is for **Size**
S is for **Safety**
F is for **Function**
M is for **Material**



Produce design specifications

Example Design specification for a Plug

- enable the user to provide an electrical path from the socket to the appliance
- prevent an electrical path being formed between the user and the mains!
- provide a rigid set of pins for location in the socket
- be sufficiently tough to prevent failure upon dropping
- be resistant to the use environment (e.g. temperature, moisture, etc.)
- prevent or enable the user to fit the cable to the plug
- be aesthetically pleasing and easy to grip
- satisfy the requirements of the British Standards