DOWNHAM MARKET ACADEMY Technology

# Product Design Summer Preparation Task.

Learning intention:

To start your engineering journey by analysing a product you currently use, but that you believe could be improved.

Success criteria:

Has identified a product and analysed it.
Has considered the materials and their properties used.
Has made suggestions for improvements.

Keywords:

Product, properties, analysis, materials, judgements, manufacture.

Designing is largely problem solving. The field of design may change but ultimately there is a thing that needs to be invented/ adapted/ manufactured to make something better and it is the job of a designer to do that.

"Engineers make things that work, and they make things that work better." Professor Bill Lucas.

But designers have to be smart. There is no point in exactly recreating a thing that already exists, so a good designer will analyse existing products before starting to create their solution.

In order to excel in product design this is a skill you will need to develop – so we're starting you off now…

Over the summer we would like you to **produce a detailed product study** about a product of your choice.

You need to choose a product which you think could be improved. Your job is to analyse the original product that you have at home.
(Before you start taking things apart please check with an adult that it is safe and you are allowed!)

The next slides show some examples and a checklist of the things your product study should include.

DOWNHAM MARKET
ACADEMY
Technology

Learning intention:

To start your engineering journey by analysing a product you currently use, but that you believe could be improved.

Success criteria:

Has identified a product and analysed it.
Has considered the materials and their properties used.
Has made suggestions for improvements.

Keywords:

Product, properties, analysis, materials, judgements, manufacture.

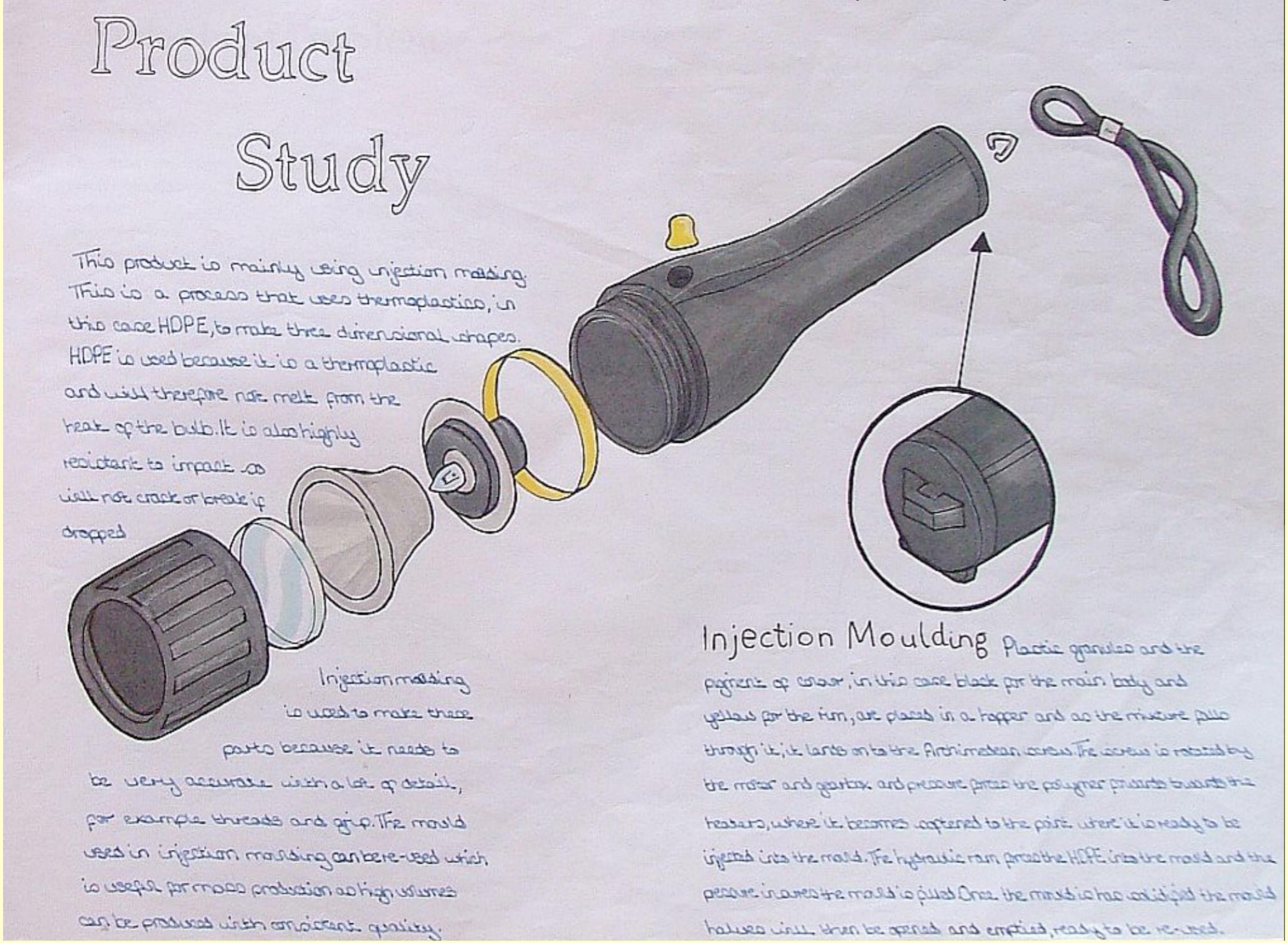
Produce a detailed product study that includes…

- ❑ A photograph of the product you have chosen.
- ❑ A list of parts, including the materials that have been used.
- ❑ For each part/ material state at least 2 properties of the material and explain why these properties make it suitable.
- ❑ Use ACCESSFM to analyse the current product and make judgements about the good and bad points.
- ❑ Make suggestions about how the product could be improved, include annotated drawings to show these improvements.
- ❑ An investigation in to how a main part or parts of the product have been manufactured. Provide written details of this, including diagrams where possible.
- ❑ An exploded diagram of the product.
- ❑ An orthographic drawing of the product, including dimensions.

DOWNHAM MARKET ACADEMY

Technology

## Example: An exploded diagram.




### Learning intention:

To start your engineering journey by analysing a product you currently use, but that you believe could be improved.

### Success criteria:

Has identified a product and analysed it.
Has considered the materials and their properties used.
Has made suggestions for improvements.

### Keywords:

Product, properties, analysis, materials, judgements, manufacture.

DOWNHAM MARKET
ACADEMY
Technology

# Example: An exploded diagram.

## Learning intention:

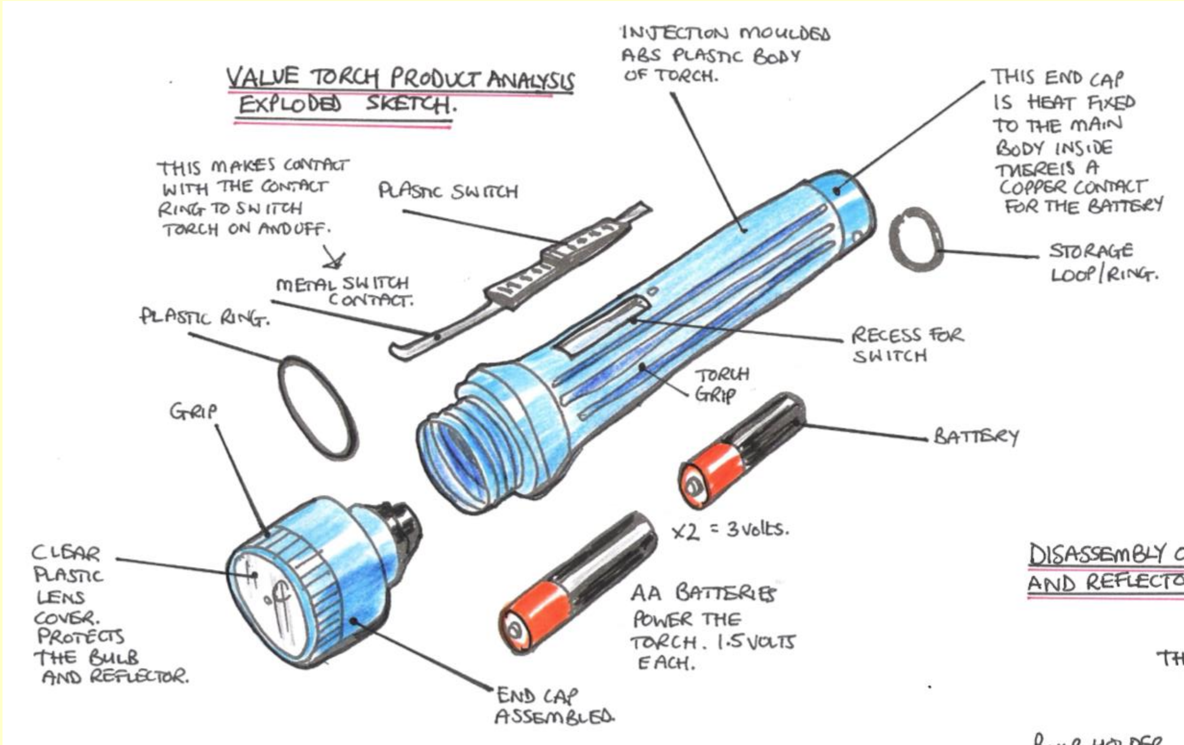
To start your engineering journey by analysing a product you currently use, but that you believe could be improved.

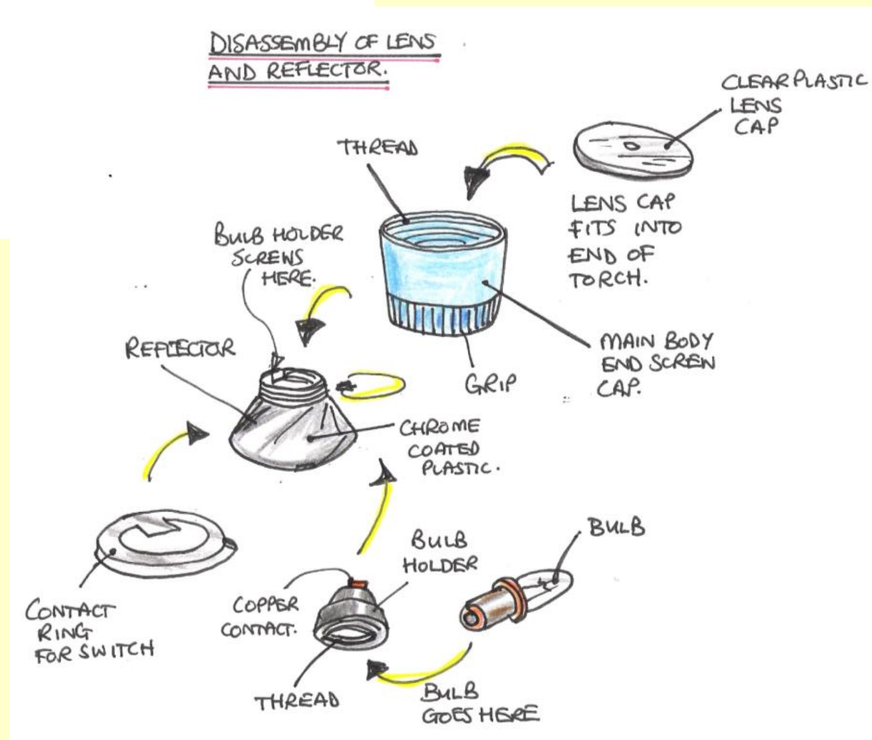
## Success criteria:

Has identified a product and product and analysed it.
Has considered the materials and their properties used.
Has made suggestions for improvements.

## Keywords:

Product,
properties,
analysis,
materials,
judgements,
manufacture.



DOWNHAM MARKET ACADEMY Technology

## Learning intention:

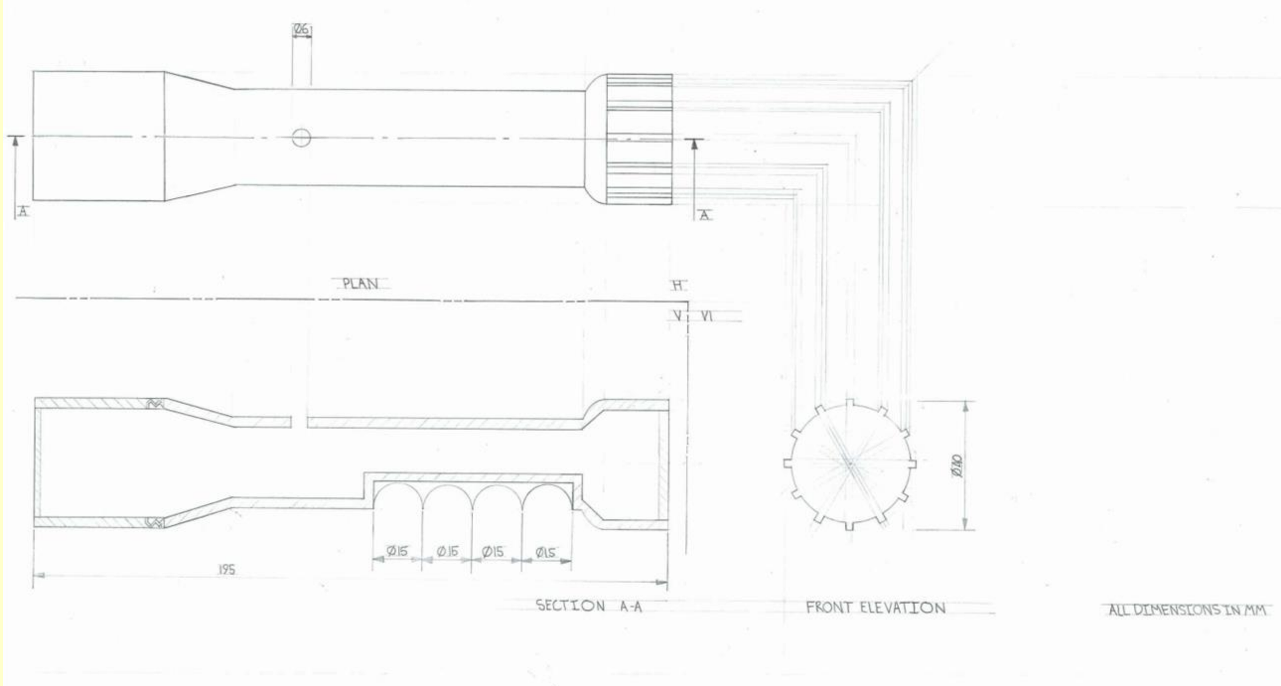
To start your engineering journey by analysing a product you currently use, but that you believe could be improved.

## Success criteria:

Has identified a product and analysed it.
Has considered the materials and their properties used.
Has made suggestions for improvements.

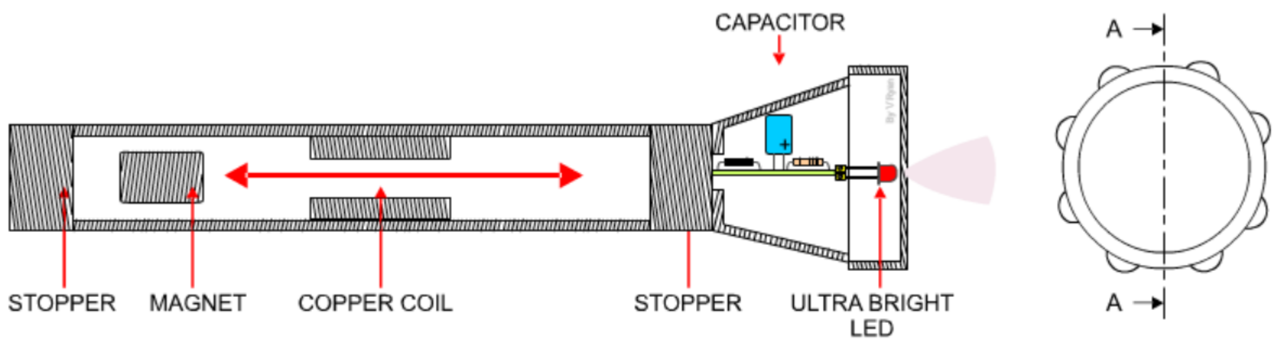
## Keywords:

Product, properties, analysis, materials, judgements, manufacture.




Example: Orthographic drawings. Remember to use a pencil, ruler and include dimensions.

An orthographic drawing of the torch is drawn below. It is comprised of a front view and a sectional side view. The centre line labelled 'AA' on the front view, shows where the 'cut' through the torch has been made. Any surfaces that have been cut have 'hatched' lines. This sectional view reveals the interior of the torch, making possible for the manufacturer to understand how the torch and its parts go together.




SECTIONAL SIDE ELEVATION ON 'AA'

FRONT VIEW

DOWNHAM MARKET ACADEMY Technology

# Help sheet:

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

**ACCESS FM - Helpsheet**
DESIGN & TECHNOLOGY

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

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

**C** is for **Customer**
**Customer** means **who will buy or use your product?** Who will buy your product? Who will use your product? Are they the products target market group? How will it improve their life? What is their Age? Gender? What are their Likes? Dislikes? Needs? Preferences?

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

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

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

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

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

## Learning intention:

To start your engineering journey by analysing a product you currently use, but that you believe could be improved.

## Success criteria:

Has identified a product and analysed it.
Has considered the materials and their properties used.
Has made suggestions for improvements.

## Keywords:

Product, properties, analysis, materials, judgements, manufacture.

Downham Market Academy Technology

Help sheet:

# Properties and testing materials

eduqas wjec cbac

## Understanding the physical properties of materials

Understanding that materials can be defined by a range of properties, for example:

- **tensile strength** – the ability of a material to resist stretching or breaking when pulled
- **compressive strength** – a materials ability to withstand loads without changing its shape
- **hardness** – this is a materials ability to resist changing shape when impacted by another object
- **toughness** – the ability of a material to absorb energy (impacts) before it starts to deform (change shape)
- **malleability** – the materials ability to be repeatedly hammered, pressed, bent or rolled into thin sheets
- **ductility** – the ability of a material to be drawn or plastically deformed without breaking
- **conductivity** – a measure of how well the material conducts heat or electricity
- **corrosive resistance** – how well the material can withstand damage caused by chemicals or oxidisation
- **elasticity** – the ability of a material to limit distorting and return to its original shape and size
- **environmental degradation** - how the physical environment is degraded, damaged or compromised through a range of situations such as air pollution, water contamination etc.

## Physical properties required for specific products (examples)

### Mobile phones

- **compressive strength** to resist weight put on the phone casing
- **corrosive resistance** to limit damage to the phone casing from chemicals such as hairspray, sun cream or other daily exposures.

### Security alarm

- **compressive strength** in its casing to avoid deformation from high winds
- **hardness** to avoid possible vandalism or attempts to gain access to the circuit.

### Bicycles

- **ductility** to allow the tubular forms of the frame to be created (drawn)
- **toughness** to absorb impact, for example when children drop bikes on the floor or during a crash in a race
- **compressive and tensile strength** to absorb the shifting weight of the cyclist on the bike.

### Children's play area

- **toughness** to absorb impact when children climb frames and obstacles
- **elasticity** when children climb ladders and ropes or walk across suspended bridges
- **compressive strength** to withstand loads of several children standing in a small area or climbing on frames
- **tensile strength** when children hang or swing on sections of the play area.

## How materials are tested to determine their physical properties

Testing is undertaken in engineering to determine the physical properties of materials.

Destructive testing will test the material, part or product until it breaks or is destroyed. Non-destructive testing is used to evaluate the property of the material without causing it damage.

**Tensile testing** - the material or part is clamped in two locations, usually on opposite ends, and increasing pulling force is applied in opposing directions to measure stretching.

**Hardness testing** - this is tested by indenting the material with a known hard material such as diamond. The force used to create this is measured to determine hardness.

**Toughness testing** – this is undertaken by allowing a pendulum with a mass on the base to strike the side of the material or part. The extent to which the shape bends (deflects) dictates its level of toughness.

**Malleability testing** is done by applying a stamping action (pressing) on the material to see how much the malleable material will flatten without breaking.

**Ductility testing** is performed in a similar manner to tensile strength testing, where the material is drawn apart.

**Conductivity testing** is done by passing an electrical current through the metal material and measuring its resistance.

**Elasticity** is another stretching test but measures a material's ability to be stretched without permanent deformation.

## Learning intention:

To start your engineering journey by analysing a product you currently use, but that you believe could be improved.

## Success criteria:

Has identified a product and analysed it.
Has considered the materials and their properties used.
Has made suggestions for improvements.

## Keywords:

Product, properties, analysis, materials, judgements, manufacture.

DOWNHAM MARKET ACADEMY Technology

# Help sheet:

## Learning intention:

To start your engineering journey by analysing a product you currently use, but that you believe could be improved.

## Success criteria:

Has identified a product and analysed it.
Has considered the materials and their properties used.
Has made suggestions for improvements.

## Keywords:

Product, properties, analysis, materials, judgements, manufacture.

# Understanding properties of engineering materials

eduqas wjec cbac

## Understanding materials, their properties, and their selections for specific purposes

**Properties and classifications of materials**

**Ferrous metals** contain iron and are magnetic. They are also prone to rust and need a protective finish to prevent corrosion.

- **Cast iron** is brittle if thin, can be cast in a mould, has strong compressive strength, good electrical and thermal conductivity, but has poor resistance to corrosion. It is used for products such as gates, manhole covers and drains.
- **High carbon steel** is also known as tool steel. It is hard and brittle and is less malleable than mild steel. It is an effective electrical and thermal conductor. Uses include tools, screwdrivers, and chisels.
- **Low carbon steel** is also known as mild steel and is ductile and tough, easy to shape, braze and weld. It is a good conductor of heat and electricity, but also corrodes easily. Commonly used for nuts and bolts, screws, bicycle frames and car parts.

**Non-ferrous metals** do not contain iron and are not magnetic. They do not rust.

- **Aluminium** is lightweight, malleable and strong. It is a good conductor of heat and electricity. It is used in drinks cans, cycle frames and saucepans.
- **Copper** is very malleable and an excellent conductor of electricity and heat, which makes it perfect for plumbing and central heating applications. It is orange/brown when polished but will oxidise to a green colour.

## Differences between thermoforming and thermosetting polymers

**Thermosetting polymers** will strengthen when heated and cannot be re-moulded or heated after the initial forming. Thermoplastic can be reheated, remoulded without causing a chemical change.

**Thermoforming polymers** can be heated and shaped repeatedly and are readily recyclable.

- **Acrylic** is hard with good plasticity when heated, can be bent and folded easily but scratches and can be brittle. It is a popular material in the production of car headlights, protective visors and baths.
- **High density polythene** (HDPE) is a stiff and lightweight polymer that provides excellent chemical resistance. It has good plasticity when heated; it is perfect for buckets, bottles, pipes and washing up bowls.
- **Polyvinyl chloride** (PVC) is available in a range of colours as well as transparent. It can be used for vacuum forming.
- **Thermosetting polymers** are materials that are formed once and cannot be recycled. **Melamine formaldehyde** has excellent resistance to heat, moisture, scratching and staining, making it perfect for kitchen worktops and tableware.
- **Urea formaldehyde** is a hard, stiff polymer with excellent insulation properties, making it suitable for switches, plugs and electrical fittings.

## Smart and composite materials

**Smart materials** can display a physical change due to external stimuli.

A smart material is a category of materials that react to a change in temperature or light, for example.

- **Photochromic pigments** or film are used to change colour in ultraviolet (UV) light. This is used in spectacles that automatically darken as the sunlight gets brighter. It is useful in office blocks windows to dim sunlight.
- **Thermochromic pigments** are useful when used in baby products like spoons, bottles and bath toys. This allows the product to change colour to indicate temperature.
- **Shape memory alloys** are materials that change their shape when heated. Spectacle frames and dental braces made from Nitinol can be returned to their original shape.

**Composite materials** are relatively new and have specific working properties and performance characteristics.

- **Carbon fibre** has high stiffness and tensile strength, with low weight. Carbon fibre is created by bonding carbon atoms together in crystals. It is then woven into fabric and combined with other materials to form a composite.
- **Kevlar** is a heat resistant and strong synthetic fibre with the ability to stop bullets and knives form penetrating it. Kevlar is often described as being five times stronger than steel.

Help sheet:

DOWNHAM MARKET ACADEMY Technology

## Learning intention:

To start your engineering journey by analysing a product you currently use, but that you believe could be improved.

## Success criteria:

Has identified a product and analysed it.
Has considered the materials and their properties used.
Has made suggestions for improvements.

## Keywords:

Product, properties, analysis, materials, judgements, manufacture.

# WJEC Level 1-2 Engineering Unit 2: Understanding function and meeting requirements

wjec cbac eduqas

## Primary features of engineering products

Engineers need to be familiar with a range of components and parts that may appear in potential briefs or projects. These should include:

**Electrical components**

- **Connections:** these can include push fit electrical tabs, solder, screw down, etc.
- **LEDs:** a range of LED forms and sizes including bar graph, eight segment blocks and LED panels.
- **Resistors:** fixed and variable resistors.
- **Fuses:** their application and purpose.
- **Diodes:** identifying and understanding their use in a circuit.
- **Power supplies:** battery types, mains and low voltage systems.

**Mechanical components**

- **Fixings:** nuts, bolts, washers, etc.
- **Clamping devices:** cam locks, level locks, etc.
- **Adjusting mechanisms:** screw threads, ratchet systems and cams.

**Properties of component materials**

- **Conductivity:** looking at conductivity of both heat and electrical current, plus how these can be isolated when needed.
- **Friction:** the effects that friction can have on a product including intentional friction.
- **Durability:** how durable is the product, look at the materials and construction.
- **Quality:** does the quality of the product look high or low grade, flash on mouldings, sink marks in plastic, uneven fit of parts, etc.

**Identifying features of other engineering products** allows engineers to research and compare other similar products to determine if there are features that could be replicated or adapted to meet the criteria for the new-engineered product in the brief.

For example:

- **Aesthetics:** looking at how the aesthetic of other similar products meet the brief. Aesthetics focus on how a product looks.
- **User/customer/client needs:** how the products final outcome meet the needs of user and client.
- **Safety:** what safety factors or features are evident in the design.
- **Ergonomics:** how well do the ergonomics of the product function (comfort, use etc.).
- **Anthropometrics:** does the product conform to standard anthropometric data.
- **Mechanisms:** what mechanisms are featured, gears, levers, cranks, etc.
- **Electronics:** how have electronics been incorporated, what components have been used.
- **Sustainability:** has sustainable materials been used, is it easy to recycle the product?
- **Material properties:** what properties are required or seen in the materials used. Look at hardness, toughness, malleability, brittleness, etc.

## Function of the proposed solution

Functional requirements are identified in briefs and specifications for engineered products and are an explanation of what the expectations of the product are.

Engineers need to ensure that details of how the product functions is clearly explained. This is often undertaken using notes and sketches to further detail their solutions.

Details should be given on areas such as:

- **Mechanical function:** should include any mechanisms in the solution, gears, cams and levers, as well as mechanical fixings such as clamps and catches should be explained.
- **Electrical function:** should detail the electrical or electronic details of a solution. Details on inputs, outputs and components could feature in this area.
- **Interrelating components:** should also be details, especially if unclear from an engineering drawing. Electrical input resulting in a mechanical output, for example.