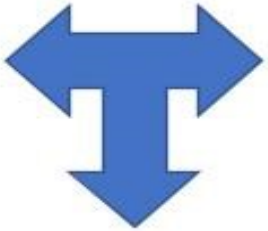
WJEC Level 1-2 Vocational award in Engineering (Technical Award)

Year 10 Knowledge Organiser Learning Cycle 2

Course outline
The course contains 3 elements

Engineering knowledge, understanding and skills (including practical skills) can and will be assessed throughout all 3 units. Many of the topics are covered in all 3 units, therefore, in each Learning Cycle you will be learning elements from all 3 units.

Unit 1: Manufacturing Engineering Products
Controlled assessment: 20 hours
40% of qualification



Unit 2: Designing Engineering Products
Controlled assessment: 10 hours
20% of qualification

Unit 3: Solving Engineering Problems
Written examination: time of exam - 1 hour 30 minutes
40% of qualification

An assignment brief will be provided by WJEC for both Units 1 and 2 (basically they tell you what to make and design). Unit 1 must be completed before Unit 2, as they are linked.

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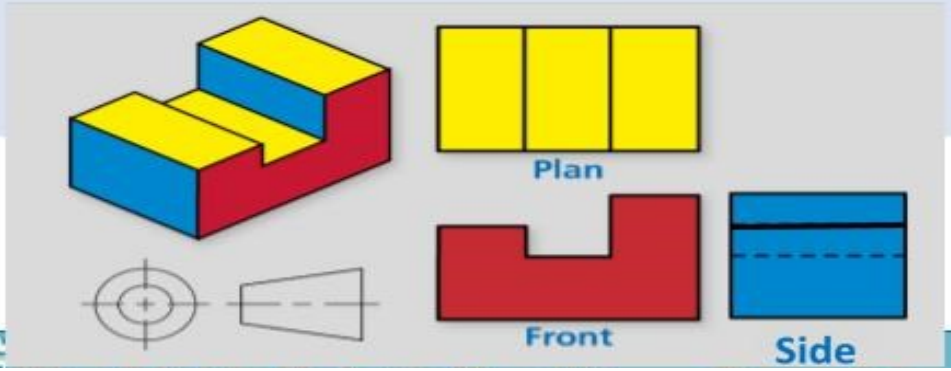
Technical details in engineering drawings

Engineering drawings may be made up of several different parts to the drawing. All elements of an engineering drawing must conform to a standard convention.

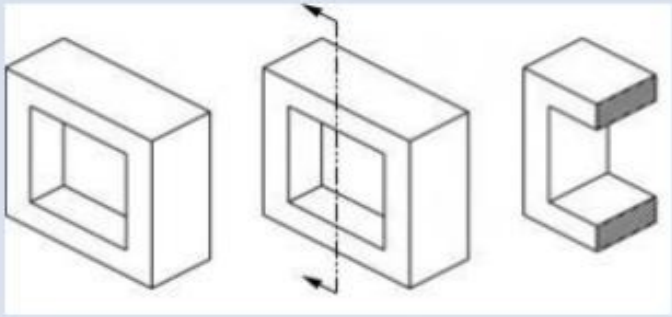
Orthographic views
Orthographic views are the standard views used to lay out a set of engineering drawings. They must conform to British standards (BS8888) to allow a common format of presenting information to various people such as manufacturers.
These are the views of a product or part, which appear on engineering drawings. Typical views are Plan View, End View and Front View. See below.

Hidden detail
Hidden detail lines are used to show surfaces that are not directly visible. All surfaces must be shown in all views. If an edge or surface is blocked from view by another feature, it is drawn using a hidden detail line. See below.



Technical details in engineering drawings

Section view
A sectional view or a section looks inside an object. Sections are used to clarify the interior construction of a part that cannot be clearly described by hidden lines in exterior views.
Section views show a drawing of a part that may have been cut through to allow the reader to see further details.
Hatched .lines are used to show the material. See below.



Isometric views
Isometric projection is a method for visually representing three-dimensional objects in two dimensions in technical and engineering drawings.
You can draw with or without the grid.

Drawing an engineering design to standards

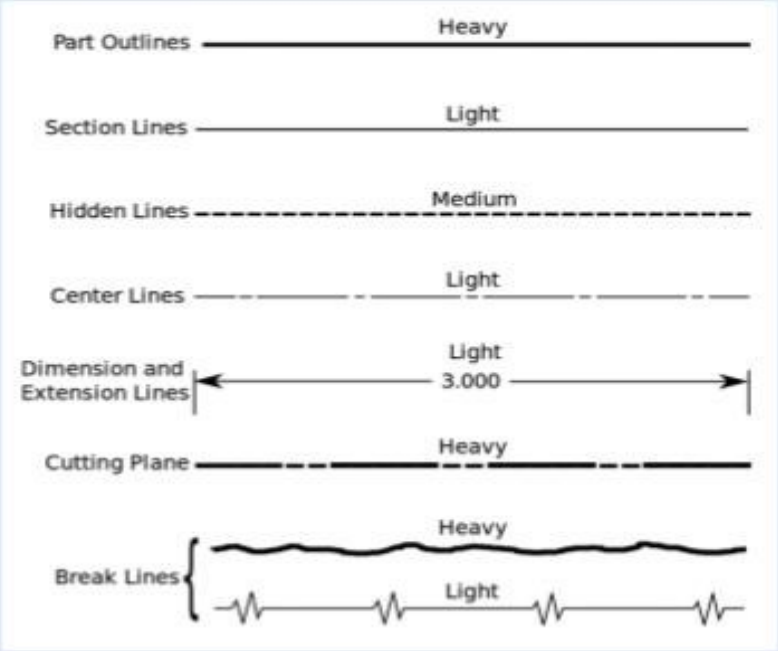
Engineering drawings are used to provide all of the details for items to be manufactured in all areas of design and engineering.
Engineering drawings must follow a **set of conventions** laid out by **British standards** and these dictate the way that the drawings should be laid out, dimensioned, what scales should be used as well as the types of lines to be used to depict certain views and actions.
In the United Kingdom, designers and engineers use the third angle projection method to layout their information on plans and drawings.
Drawings undertaking using traditional drawing boards must follow the same conventions as those drawn on CAD (computer aided design) using PC's.

Conventions, such as:

Title block: gives additional information on a drawing such as scale, name and title
Dimension lines: the actual sizes on an engineering drawing
Extension lines: continue or extend from the surface of the object and establish the size of the dimension
Centre lines: show the exact centre of a circle or arc
Metric: units of measurements to be used.

Drawing an engineering design to standards

Line weights in engineering drawings also follow British standards and should again be used in traditional and CAD work. See below.



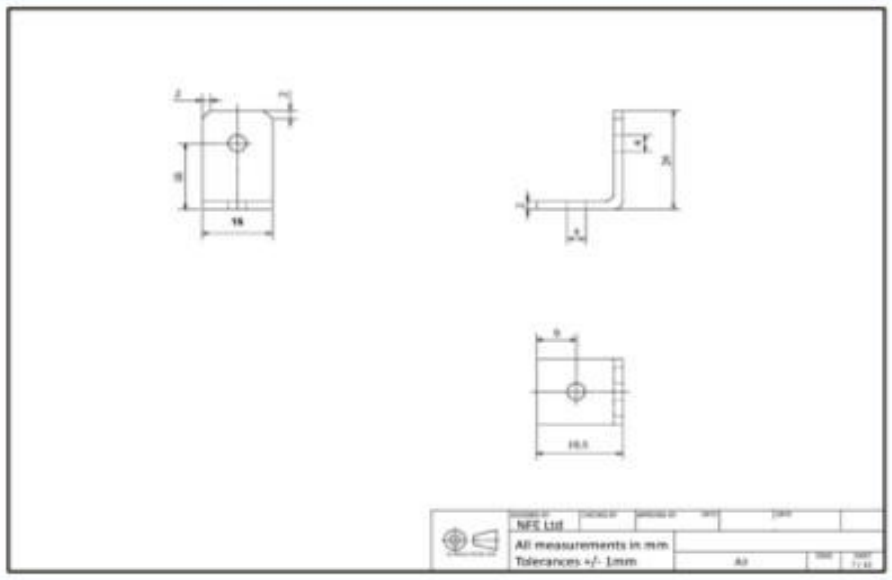
Dimensions and associated symbols:
Diameter: the size of a line that runs from one side of a circle, through the centre to the opposite side
Circumference: the perimeter of a circle or ellipse
Radius: half of the diameter
Height, Depth and Width.

Interpret engineering drawings

Orthographic views / Hidden detail

You will need to interpret Orthographic views. So basically, this means read the drawing:

- Look at all the sizes?
- See where the holes are?
- What size are the holes?
- Where is the bend?

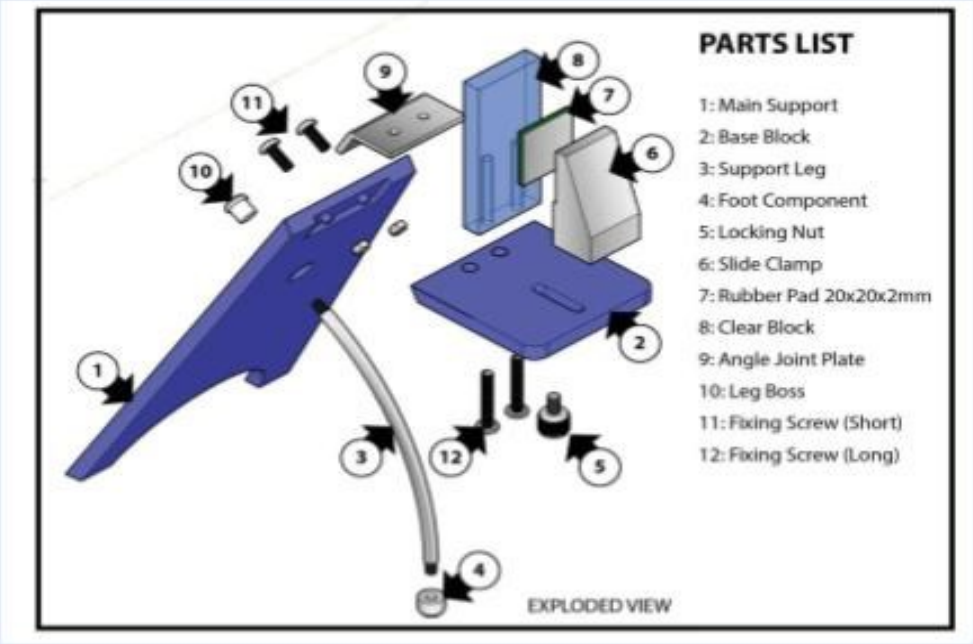


You will need to interpret drawings in Unit 1 and draw your own orthographic views in Unit 2.
It could also be in Unit 3, the exam.

Interpret engineering drawings

Exploded views

An exploded view shows the product taken a part.
In this example, all the parts have a title and are numbered, this makes it easier to identify all the separate pieces.



You will need to interpret exploded views in Unit 1 and draw your own exploded views in Unit 2.
It could also be in Unit 3, the exam.

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

Properties and classifications of materials

Natural woods – Hardwoods

- Hardwoods come from **deciduous** or broad-leafed trees.
- As they are deciduous, this means they **lose their leaves** in Autumn.
- You can distinguish hardwoods by the structure of the wood grain.
- Hardwoods **grow slower** than softwoods, so they are usually more **expensive**.
- Hardwoods include **Ash, Beech, Birch, Oak, Balsa, Teak** and **Mahogany**.

There are many others.

How environmental issues affect engineering

How engineering applications and products have an environmental impact

Raw materials – how the landscape is affected? Transport and pollution? Cost of materials and production?

Recycling – all woods can and should be recycled. What affect does this have?

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

Properties and classifications of materials

Natural woods – Softwoods

- Softwoods come from **coniferous** trees, sometimes called **evergreens**.
- Softwood trees do not have leaves, they have **needles.**
- The needles stay on the tree all year.
- Softwoods **grow faster** than Hardwoods, so they are usually **cheaper**.
- Softwoods include **Cedar, Larch, Pine** and **Spruce.**

There are many others.

Implementing engineering processes

Common wood finishes:

- Paint
- Wax
- Stain
- Varnish

There are many others.

The finish needs to be carefully selected to match the environment the wooden product will be used in.

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.

Know the names and the definitions

Mathematical techniques

Units

Using metric and imperial units for measurements and calculating costs such as:

- millimetres and metres – used in giving sizes on engineering drawings and during manufacture of products.
- pounds and pence – used for estimating and working out costs of materials.
- time in hours, minutes and seconds – used in planning stages for manufacture.

Estimating costs and materials

Using a range of sourced costs to calculate the cost of material needed to manufacture a part or component in the engineering outcome. This may also include **percentages.**

Scale

Being able to apply and understand scale factors when reading or producing an engineering drawing is a vital skill. Scales are shown as ratios, for example 2:1 or 1:5.

2:1 = it has been drawn twice as big, 1:2 = it has been drawn half the size.

How materials are tested to determine their physical properties

Testing

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.

Types of testing:

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.

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.

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

How materials are tested to determine their physical properties

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.

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.

Testing is carried out in industry by a variety of complex machines. This makes sure that products are safe and will last.
You will be expected to carry out your own testing on materials in the school workshop.
You will need to identify simple techniques to test for hardness, toughness and other properties.

Testing is also a regular question in Unit 3. You are asked how to test for a certain property when analysing a product.

Using engineering tools

The physical making of a product (or part of) using a range of processes. PPE must be worn.

Marking out
- Engineers blue
- Scriber
- Steel rule
- Engineers square
- Dividers (straight calipers)
- Calipers – internal, external and odd leg
- Centre punch
- Ball pein hammer

Cutting/shaping/joining
- Metal vice
- Hacksaw
- Junior hacksaw
- Files
- Pillar drill
- Drill bit
- Machine vice
- Shears / Tin snips
- Rivet gun
- Tap and die sets
- Centre lathe
- Folding bars
- Sheet metal machine
- Metal cutting bandsaw

Implementing engineering processes

Adhesives

PVA – Polyvinyl acetate
PVA (polyvinyl acetate) is a commonly used wood glue. It is a thick white liquid, which becomes clear when it dries.
When wet it can be repositioned.

Contact adhesive
Contact adhesive is good for sticking a flat piece of a different material onto wood (and other materials. Apply to both surfaces.

Tensol – liquid solvent cement
Liquid solvent cement (Tensol) is used for sticking acrylic (and some other plastics) together. Looks like water. It melts the surfaces of the plastic together to provide a permanent bond.

Epoxy resin
Epoxy resin (Araldite) is used for sticking a variety of materials together. It is ideal to bond different materials together.
Two separate tubes, a resin and a hardener, mix together – use straight away.

Using engineering tools

Files are used to remove material from stock form of metals and plastics. This is known as **wastage.**

Scribers are used to mark lines for cutting on materials such as metals and plastics.

Centre punch is a tool that is used to create a small depression in material prior to drilling. This helps locate the drill accurately on the material.

Hacksaws are a framed saw used mainly to cut metal.

Rivet guns are used to place rivets in areas that are often accessible from one side.

Traditional rivets use 'sets' to form the rivet on both sides of a joint.

An engineer's square is used in marking out material. It is set at 90° and is also used for parallel marking.

Using engineering tools

Calipers are used to scribe and measure on metals and plastics. **Odd leg calipers** can be used to scribe lined parallel to an edge, whilst straight leg calipers **(dividers)** can be used to both mark equal distance sizes and produce arcs and circles.

Vernier callipers are used to measure a range of sizes such as length of material, depth of holes, internal openings, etc.

Tap and die sets are used to created threaded components. A tap used to thread a hole and a die to thread a bar such as a bolt.

Deburring tool is a tool used to remove the burr after drilling a hole.

Reamers enlarge, smooth, or contour an existing drilled hole in a work piece for a precise fit when installing fasteners or other parts in metalworking tasks.

Shears and snips are used to cut sheet metal. They may be straight or curved depending on the task.

Using engineering equipment

Commonly used items of equipment that you may find in a school workshop:

Centre lathe
A centre lathe is used to turn metals and hard plastics. The workpiece is clamped in the chuck and the tool is moved towards the spinning workpiece to complete a process. Some processes are listed below:

- **Facing off** is the process of levelling off the end of the material
- **Parallel turning** reduces the diameter of a bar.
- **Taper turning** reduces the diameter on an angle.
- Applying a **knurled finish** (pattern)
- **Boring** a hole
- **Drilling** along the centre axis line
- **Cutting a thread** onto a bar or into a hole.

Make sure you know the hazards? Risk assessment?

Using engineering equipment

Metal cutting bandsaw – can be used to cut larger/thicker pieces of metal.
It can only be used under direct supervision.
It has a continuous blade that will slowly lower to cut through the metal.

Sheet metal machine – can be used to bend metal into shapes, right angles or curves.

Folding bars can also be used for right angles.