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.

Generating a range of engineering solutions

Engineers create new products through a process of research and iterative development.

Research can include the analysis of products that may have similar solutions or even parts of them could be incorporated into a new idea.

The **brief** should be followed in all areas to ensure that solution and proposals meet the specific requirements of the task. If a **specification** is issued alongside the brief, then those points should also appear in annotation within the design process.

Sketches should be used to explore a range of ideas but should be fully supported by clear and detailed **annotation**. Where appropriate, links or references to a brief and specification should be present.

Development should be clearly annotated and form a part of an iterative process that clearly shows how the idea has progressed through to a final conclusion. Again, annotation and links to the specification and brief should clearly be evident.

Generating a range of engineering solutions

CAD can be used to show clear development and is an excellent tool to make the iterative process clearer. Designs can be modified and saved in stages prior to presenting. It is also a good way of generating engineering drawings for the final solution. CAD also allows the production of high quality and realistic visuals.

Testing is used to support development of ideas and can focus on a number of areas:

- **Aesthetics:** seeing how the overall product looks from a visual sense.
- **Materials:** testing on materials to see if they are fit for purpose.
- **Ergonomics:** can be tested to see if the interface between product and user meets expectations.
- **Mechanical:** simple tests to check if mechanisms work in the way expected.
- **Electronic:** tests on circuits using breadboards or prototypes.

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Communicating design ideas

The information in design proposals needs to be relevant and use a suitable media to display the information. Sketches and CAD are the most common form of displaying ideas and development stages.

It's important that sketches have a logical structure so that the iterative nature of the development of ideas can be seen. Annotation should include appropriate terminology associated with design and engineering.

Ideas are often easier to explain when supported by models and detail sketches showing more complex sections in possibly enlarged details, exploded views or isometric.

Models can use a variety of materials including paper and card, foam, clay or other materials.

They are not required to be fully detailed or functional but to be a visual aid to assist in the design process.

Developing ideas through to a conclusion

Ensuring that all aspects linked to the brief and design specification are addressed is a vital part of the designing stages. As a part of this process, evaluative methods such as a **SWOT** analysis should be undertaken against a small number of design ideas.

SWOT analysis looks at four key areas of selected design proposals:

1. **(S) Strengths:** these focus on the strengths of the design, what works well, what makes it better than the competitions' products, etc.
2. **(W) Weaknesses:** explore areas that need improving to ensure the design is successful.
3. **(O) Opportunities:** unexpected benefits from the design.
4. **(T) Threats:** looks at what could be problematic for the design, such as a better product being launched by a competitor.

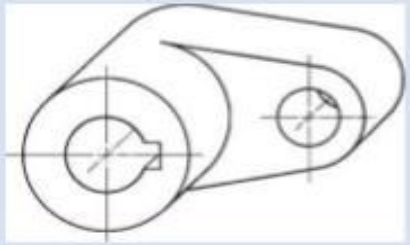
This is not the only technique you can use.

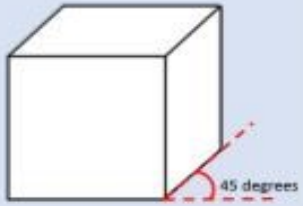
Communicating design ideas

Sketches / designs should be 3D

Oblique

Flat front and 45 degree angle.

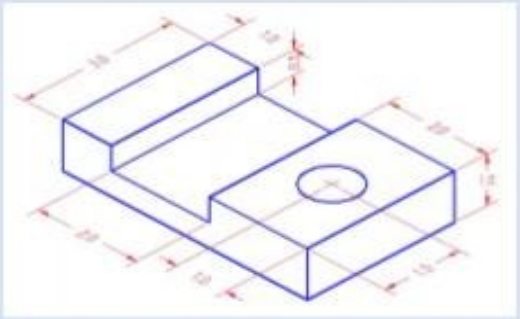


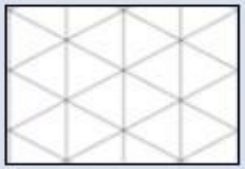


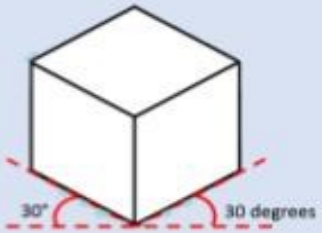
Isometric

Both sides angled 30 degrees.

You can use a grid.





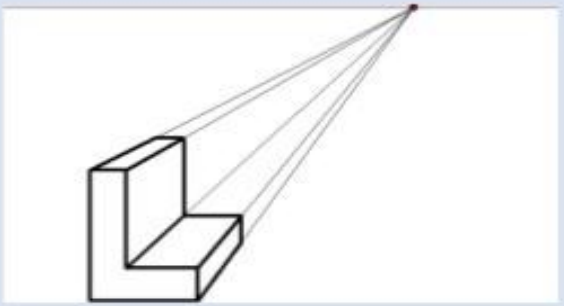


Communicating design ideas

1 point perspective

One vanishing point.

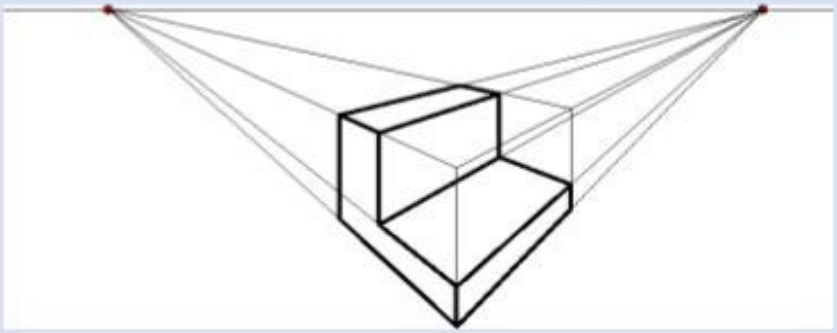
Similar to the oblique technique – the flat front.



2 point perspective

Two vanishing points.

Similar to the isometric technique – angled both sides.



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

Polymers/Plastics:

Commercial production of plastics really started after WWII. The raw materials used were either coal or oil. A **finite** resource – it will eventually run out!

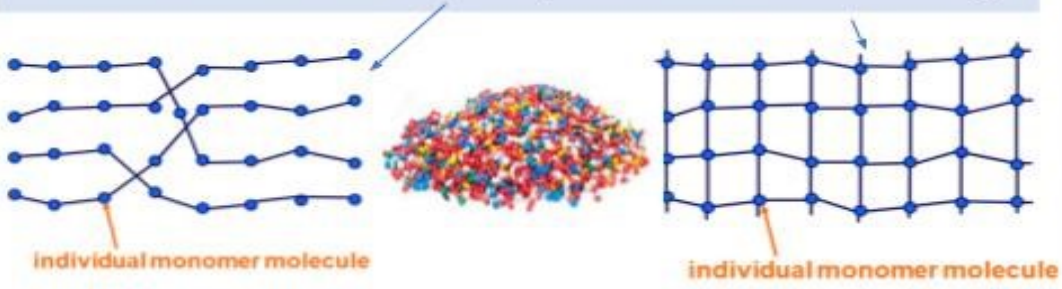
They contain several different chemicals which can be separated into parts by a process called Fractional Distillation.

Some of the fractions contain chemicals that are small molecules (Monomers).

The monomers are chemically joined together to make longer molecular 'chains' called Polymers.

Naphtha is processed into 'plastic' granules, in a processing plant.

The difference between **Thermoplastics** and **Thermosetting**



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

Properties and classifications of materials

Thermoforming polymers/Thermoplastics

Thermoforming polymers can be heated and shaped repeatedly and are readily recyclable. Thermoplastic can be reheated, remoulded without causing a chemical change.

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 impact polystyrene (HIPs) is a lightweight polymer that has good plasticity when heated; it is perfect for food packaging. It can be vacuum formed.

Polyvinyl chloride (PVC) is available in a range of colours as well as transparent. It can be used for pipe fittings and sleeving for electrical wires.

Nylon is a hard wearing, tough plastic. Easily machined into shapes, it is often used as wheels and gears due to low friction properties. Nylon can also be formed into threads for clothing, luggage and ropes.

There are many others.

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

Properties and classifications of materials

Thermosetting polymers

Thermosetting polymers will strengthen when heated and cannot be re-moulded or heated after the initial forming. They cannot be recycled so will need to be disposed of after they are no longer needed.

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.

Epoxy resin is mouldable, hard and an excellent electrical insulator. It has a range of uses from adhesives, printed circuit boards (PCBs) to being mixed with other materials such as glass fibre to create GRP and carbon to create carbon fibre.

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 – not all plastics can be recycled. What affect does this have?

Sustainability in terms of Engineering means:

- Creating products that are made from sustainable resources.
- Creating products that use minimal resources during manufacture and transport.
- Creating products that use renewable resources during manufacture and transport.
- Creating products that can be fully recycled.

6Rs

Refuse	Reuse
Repair	Recycle
Reduce	Rethink

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

Understanding the physical properties of materials

Common properties shared by most plastics

- **Plasticity** – easily moulded or shaped
- **Good strength to weight ratio** – lightweight but strong
- **Self-finishing** – no extra processes needed
- **Corrosion resistant**
- **Ductile**
- **Good electric insulator**
- **Low-cost**
- **Chemically inert** – will not react to other substances
- **Durable**
- **Good impact resistance**
- **Waterproof**
- **Available in a range of colours**

These can be used along with the original list

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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:

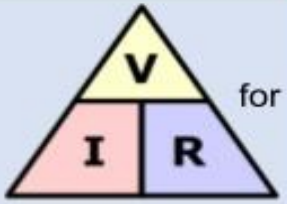
Electrical components

- 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.

Mathematical techniques

Ohms law

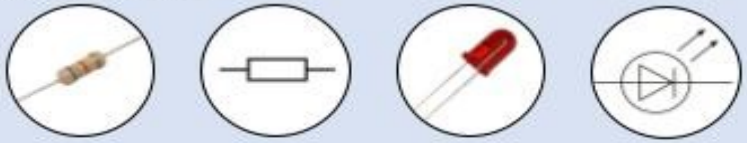
Ohm's Law is commonly used in electronics for calculating the correct resistor to use with an LED or the amount of amps of a circuit.



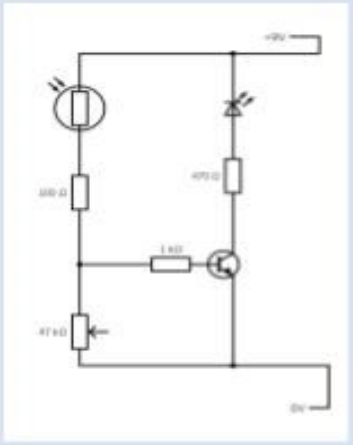
Primary features of engineering products

Electrical components

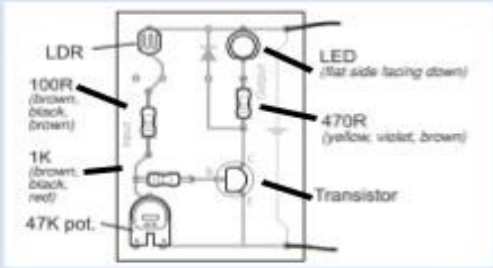
What components do? What they look like? Recognise them from the symbols?



Schematic diagrams/Circuit diagrams show the layout of the components. These use symbols.



This shows where the components go on the PCB.



Implementing engineering processes

Joining

Soldering is used to heat join softer metals such as silver in jewellery (silver solder) or to attach electronic components to printed circuit boards.

PCB tank (specialist equipment)

- Used to produce printed circuit boards for electronic circuits
- Uses a photographic and etching process and is used in combination with a UV light box to prepare the PCB artwork. Pre-made PCBs can be used.

Implementing engineering processes

Shaping

Vacuum forming:

- A process where a sheet of plastic is heated to a forming temperature, stretched onto a single-surface mould and forced against the mould by a vacuum.

Other processes used to shape plastics:

- **Injection moulding**
- **Blow moulding**
- **Rotational moulding**
- **Extrusion**
- **Press moulding**
- **Strip heater - bending**

Some of these are industrial processes but you can do some of these techniques in school on a smaller scale.

Mathematical techniques

Areas and volumes

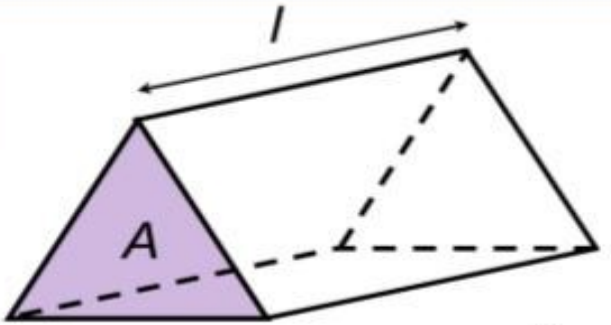
Working out the area or volume of a whole or partial shape.

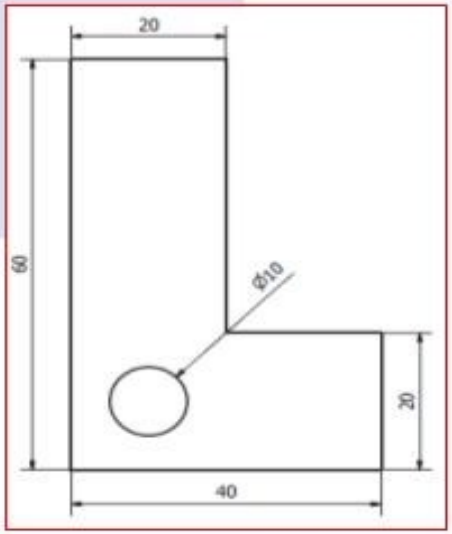
Adding or subtracting parts of materials

Using the correct formula

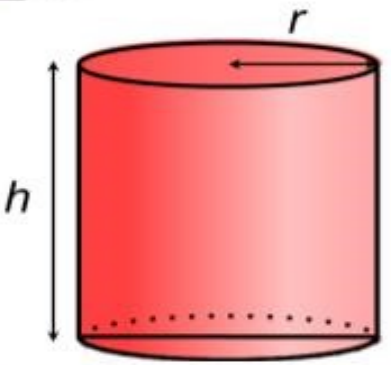
Correct use of a calculator

$V = Al$





$V = \pi r^2 h$



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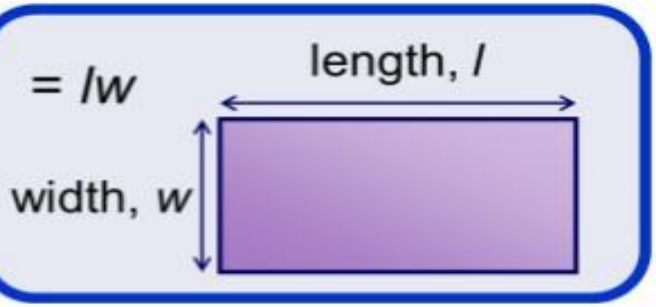

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