AQA GCSE **Design and Technology** 8552

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Each specification topic has been referenced and distilled into the key points to make in an examination for top marks. Questions on all topics assessing knowledge, application and analysis are all specifically and carefully devised throughout this book.

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PREFACE

Absolute clarity! That's the aim.

This is everything you need to ace your exam and beam with pride. Each topic is laid out in a beautifully illustrated format that is clear, approachable and as concise and simple as possible.

Each section of the specification is clearly indicated to help you cross-reference your revision. The checklist on the contents pages will help you keep track of what you have already worked through and what's left before the big day.

We have included worked exam-style questions with answers for almost every topic. This helps you understand where marks are awarded and to see the theory at work for yourself in an examination situation. There is also a set of exam-style questions at the end of each section for you to practise writing answers for. You can check your answers against those given at the end of the book.

LEVELS OF LEARNING

Based on the degree to which you are able to truly understand a new topic, we recommend that you work in stages. Start by reading a short explanation of something, then try and recall what you've just read. This has limited effect if you stop there but it aids the next stage. Question everything. Write down your own summary and then complete and mark a related exam-style question. Cover up the answers if necessary, but learn from them once you've seen them. Lastly, teach someone else. Explain the topic in a way that they can understand. Have a go at the different practice questions – they offer an insight into how and where marks are awarded.

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THE SCIENCE OF REVISION

Illustrations and words

Research has shown that revising with words and pictures doubles the quality of responses by students.[1] This is known as 'dual-coding' because it provides two ways of fetching the information from our brain. The improvement in responses is particularly apparent in students when asked to apply their knowledge to different problems. Recall, application and judgement are all specifically and carefully assessed in public examination questions.

Retrieval of information

Retrieval practice encourages students to come up with answers to questions.[2] The closer the question is to one you might see in a real examination, the better. Also, the closer the environment in which a student revises is to the 'examination environment', the better. Students who had a test 2–7 days away did 30% better using retrieval practice than students who simply read, or repeatedly reread material. Students who were expected to teach the content to someone else after their revision period did better still.[3] What was found to be most interesting in other studies is that students using retrieval methods and testing for revision were also more resilient to the introduction of stress.[4]

Ebbinghaus' forgetting curve and spaced learning

Ebbinghaus' 140-year-old study examined the rate in which we forget things over time. The findings still hold power. However, the act of forgetting things and relearning them is what cements things into the brain.[5] Spacing out revision is more effective than cramming – we know that, but students should also know that the space between revisiting material should vary depending on how far away the examination is. A cyclical approach is required. An examination 12 months away necessitates revisiting covered material about once a month. A test in 30 days should have topics revisited every 3 days – intervals of roughly a tenth of the time available.[6]

Summary

Students: the more tests and past questions you do, in an environment as close to examination conditions as possible, the better you are likely to perform on the day. If you prefer to listen to music while you revise, tunes without lyrics will be far less detrimental to your memory and retention. Silence is most effective.[5] If you choose to study with friends, choose carefully – effort is contagious.[7]

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2. Roediger III, H. L., & Karpicke, J.D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, 17(3), 249-255.
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Designing principles

Designing principles

MARK ALLOCATIONS

Green mark allocations[1] on answers to in-text questions through this guide help to indicate where marks are gained within the answers. A bracketed '1' e.g. [1] = one valid point worthy of a mark. There are often alternative responses with many more points to make than there are marks available so you have more opportunity to max out your answers than you may think.

ACKNOWLEDGMENTS

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SECTION A
3.1 Core technical principles

Information

At least 15% of the exam will assess maths and at least 10% will assess science.

All dimensions are in millimetres.

The marks for questions are shown in brackets.

The maximum mark for this paper is 100.

The qualification is subject to the assessment of one NEA project and one examination.

There are 20 marks for Section A, 30 marks for Section B and 50 marks for Section C.

NEW AND EMERGING TECHNOLOGIES

Technology impacts our lives in many ways and is being developed to improve how we live and work.

Design technologists have always looked to the world of science in order to utilise new discoveries in the design and manufacture of materials or products. In harnessing these new discoveries, technology continues to develop and meet ongoing human needs.

Technology utilises many skills including communication, design, innovation, modelling and manufacturing. It also combines knowledge, problem solving and organised, structured methods to produce finished items. Designers and manufacturers use a combination of skilled people, tools, robots and machines for efficient and effective output of their product or service.

Consumers are continually looking for new and improved products, which means manufacturers are developing more and more items to satisfy demand. It is critical to understand the impact design and technology has on the world.

The collection of raw materials and converting them into usable products can use vast amounts of energy, which is having a negative impact on the planet. Designers are continually exploring new methods of working with technology to manufacture products more sustainably. These continuous improvements lead to greater efficiencies, improved functionality, which in turn reduces energy output and negative effects on the environment.

INDUSTRY

Designers utilise technology to continually improve the efficiency and quality in manufacturing products and materials.

Automation and the use of robotics

Automation enables repetitive tasks to be performed by mechanised assembly lines rather than by a human. It has been a significant development in the manufacturing process and helps meet increased demand for products. Software automation performs computer-based tasks, industrial automation performs physical tasks.

Robots can be controlled to automatically perform a series of complex movements. They can be used to substitute humans in environments that are hazardous, exposed to high temperatures or where there are harmful vapours. They are commonly used on assembly lines in the manufacture of vehicles, in packing plants, laboratories and in aerospace.

Advantages

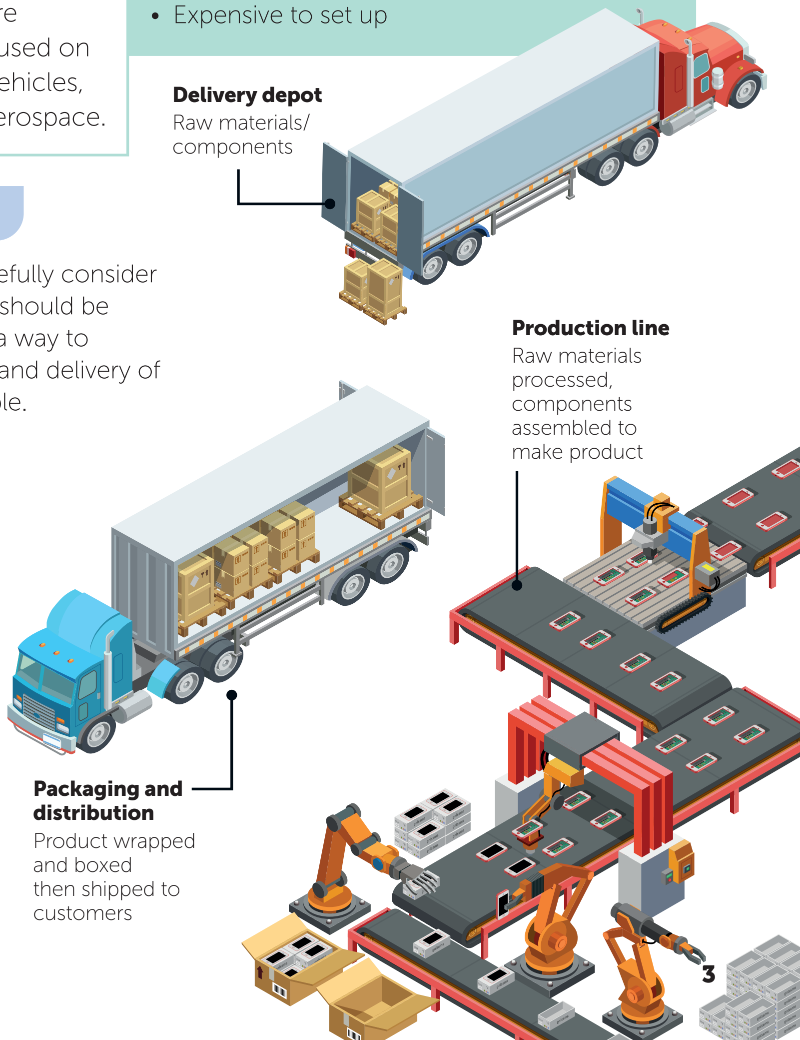
- Increased efficiency and speed of production
- Accurate and consistent output
- Reduced labour costs and can work 24/7
- Ability to work in a variety of environments

Disadvantages

- Replaces workforce leading to some job losses
- No human input/decision making
- Up-skilled workforce to maintain robots
- Expensive to set up

Buildings and the place of work

At the point of conception, companies carefully consider the layout of their buildings. The workflow should be logically thought through and designed in a way to ensure each stage of design, manufacture and delivery of a product to market is as efficient as possible.



Describe **two** factors that make the production of circuit boards suitable for automated assembly line manufacture. [4]

Identical circuit boards and products are passed through the production line[1] *making it easy to program robots to perform repetitive operations*[1]. *Precision is required and must be maintained*[1] *robots are able to work consistently and indefinitely*[1].

3.1.1

CULTURE

Culture is an amalgamation of the ideas, beliefs, customs and social behaviours of a society or group of people. It often manifests itself through ritual, art and fashion. It is important for designers to be aware of the society around them and to try to understand the different cultures that exist within it.

Fashion and trends

Fashion and trends come and go. The design market is influenced by the 'latest thing'. It is quite natural for consumers to want to buy into a certain lifestyle. Blog sites, social media and the Internet enable new fashion and products to be showcased or endorsed. They can receive a very rapid customer response.

Faiths and beliefs

A designer must be responsible for considering the wider implications of a new product within different faiths and communities and in meeting the needs of different groups of society.

Discuss how clothing designs, fabric colour and materials may sell well in one country but not in another. [3]

Faiths and beliefs restrict the styles of clothing that some people wear.[1] A popular style of top or shorts exposing the shoulders or knees is considered too revealing in some areas of the world.[1] Green is considered a positive, environmentally friendly colour in the West, and is the traditional colour of Islam. In Indonesia, green has traditionally been forbidden.[1] White symbolises purity and cleanliness in Western cultures. However, in China and Korea, white represents death and bad luck.[1] Silks may sell very well in Asian cultures, as part of national dress styles, but less so in the West.[1]

3.1.1

SOCIETY

Design for differently abled and elderly

Products are often designed for the average user. **Inclusive design** is important for any new product to ensure the environment or design can be used by as many people as possible, regardless of gender, disability or age. All users should be able to use the design safely, easily and with dignity.

Designers will consider these factors when working on a new product, improving access to buildings, or looking at how people access different types of transport. Modern materials have enabled products to be lighter, tougher and more adaptable to help with weaker grip, and reduced mobility.

A charitable organisation inspects and awards new car parks with a rating for their accessibility and facilities.

Describe how car park design can incorporate features to improve accessibility for all users including the disabled and the elderly. [3]

Clear and visible signage to identify entrances, exits, walkways.[1] The height of payment machines, lift buttons, exit panels[1] are considered so that wheelchair users can reach easily[1]. Lifts as well as stairs to assist those who find stairs difficult.[1] Handrails and balustrades on stairwells.[1] Automatic opening doors with sensors.[1] Wide parking bays for disabled vehicular access and those with push chairs[1]. Well lit walkways.[1] Induction loop systems and assistive listening in payment, information and lift spaces.[1]

3.1.2

NUCLEAR POWER

A nuclear power plant produces energy through a process called fission - the splitting of uranium atoms in a nuclear reactor.

The process harnesses a nuclear reaction which takes place inside a reactor. This releases a large amount of energy as heat. The heat is used to generate steam which drives turbines to produce electricity.

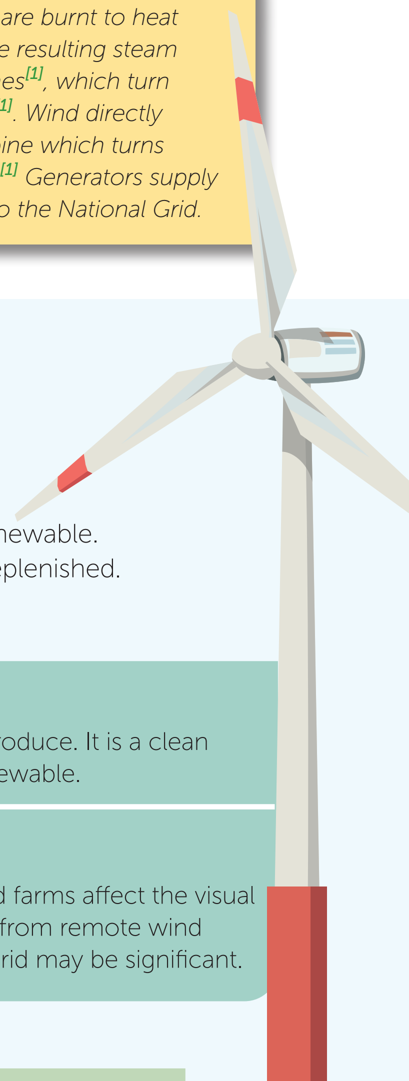
Nuclear power is clean and efficient. Nuclear energy runs continuously generating large scale power and supplies about 12% of the world's electricity. However, the waste material is radioactive and dangerous to life. The waste fuel requires specialist handling, decommissioning and lots of storage space.

Wind energy and fossil fuel energy are both used to create power. Explain the similarities and differences between their methods of power generation. [3]

Fossil fuels are burnt to heat water.[1] The resulting steam turns turbines[1], which turn generators[1]. Wind directly turns a turbine which turns generators.[1] Generators supply electricity to the National Grid.

3.1.2

RENEWABLE ENERGY



Wind, wave, tidal, hydroelectric, geothermal, biomass and solar energy are renewable. These are natural sources of energy that are **non-finite** and can be quickly replenished.

Wind power

Wind turbines convert kinetic energy from the wind into electricity. The energy of the wind turns the propeller-like blades on the rotor. This is connected to a generator which creates the electricity.

Advantages

Wind energy is now very cost effective to produce. It is a clean source of energy and is sustainable and renewable.

Disadvantages

Wind energy can be unpredictable and wind farms affect the visual appearance of the landscape. The distance from remote wind sites and connection costs to the national grid may be significant.

Tidal power

Tidal power converts energy from tides into power. The movement of water turns underwater turbines, which drive the generators that convert the energy into electricity. Tidal barrage systems utilise the difference between low and high tides. Tidal stream power utilises fast flowing currents around coasts and islands.

Advantages

A constant, predictable, renewable energy source which is clean.

Disadvantages

Expensive to set up and maintain.

3.1.5

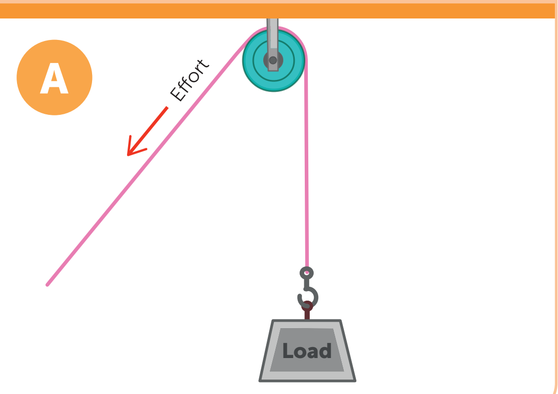
PULLEYS AND BELTS

Pulleys

Pulleys can help to lift a load providing a mechanical advantage. In machines, pulleys transmit rotary motion and force from the input or drive shaft to the output or driven shaft. For the movement to be transferred it's important the belt does not slip or stretch. Pulleys are not ideal for transmitting high torque due to their tendency to slip. Belts are often made of reinforced rubber or high strength materials such as Kevlar®.

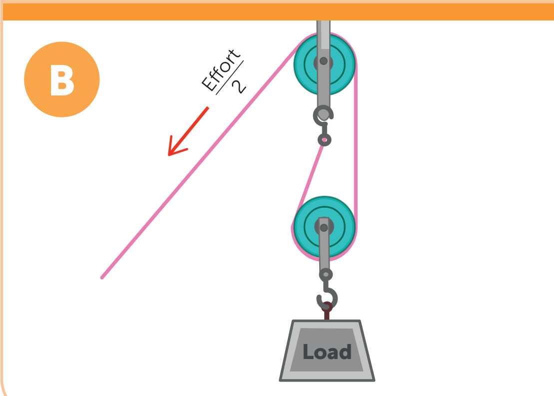
Fixed pulley

A fixed pulley uses a wheel with a groove in it and a rope that sits in the groove. It allows you to change the direction of the force needed, which makes lifting easier, but the weight will feel the same.



Block and tackle pulley

A block and tackle pulley uses two or more pulleys, one fixed and one moveable, to help reduce the amount of effort needed to lift a load. It provides a mechanical advantage making a load easier to lift.



Look at the block and tackle pulley in diagram B above.

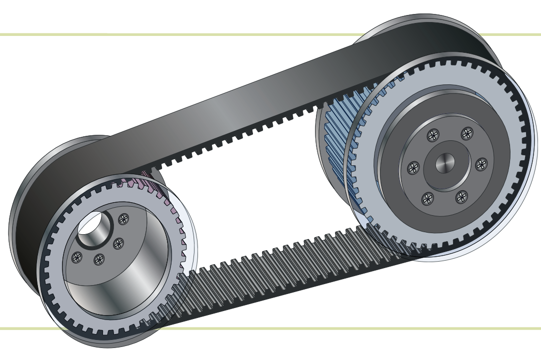
(a) Calculate the distance the rope will need to be pulled in order to raise the load by 1m. [1]

(b) Calculate the effort is required to raise a 120kg load. [1]

(a) 1m height x 2 pulleys = 2m rope distance.[1] *(b) 120kg / 2 pulleys = 60kg effort.*[1]

Belts

A drive belt (loop of flexible rubber) connects two or more pulleys together. The belt transfers power from the pulley to the receiving system. In the instance of a car, a belt transfers engine power to the alternator to recharge the battery.



EXAMINATION PRACTICE

1. Explain the difference between renewable and non-renewable energy sources. [2]

2. Energy production fell in the UK from 2,619 TWh in 2004 to 1,465 TWh in 2016.
   (a) Calculate the percentage reduction in the amount of energy produced in the UK between 2004 and 2016. [2]
   (b) 21% of the UK's energy is supplied from nuclear sources.
      (i) Explain how energy is generated from nucelar power. [2]
      (ii) Give **one** similarity and **one** difference in the process of energy generation between using fossil fuels and nuclear fuels to generate power. [2]
      (iii) Explain why some people are against using nuclear energy. [2]

3. Explain **two** disadvantages of using biomass as an energy source. [4]

4. The photograph below shows a tidal barrage used to generate electricity.

   Explain **two** disadvantages of using a tidal barrage to generate electricity. [4]

5. Give **three** benefits of using rechargeable batteries rather than traditional alkaline batteries. [3]

6. A metals foam uses 25% of the mass of the base metal for its comparative size.
   (a) Calculate the mass of metal foam that is required to replace a solid 5.6 kg block of metal. [2]
   (b) Explain **one** reason why metal foams might be used to make aircraft parts. [2]

7. Give **two** ways in which nanomaterials have been used in the textiles industry. [2]

8. Explain what is meant by the term 'smart materials'. [2]

9. Which **one** of the following is a composite material? [1]
   (a) Titanium
   (b) Glassfibre Reinforced Plastic (GRP)
   (c) Polyester
   (d) Graphene

NATURAL TIMBERS

Hardwoods

Hardwood is from a **deciduous** tree, usually a broad-leafed variety that drops its leaves in the winter.

Ash

Properties: Flexible, tough and shock resistant, laminates well. Pale brown.

Uses: Sports equipment and tool handles.

Beech

Properties: Fine finish, tough and durable. Beige with pink hue.

Uses: Children's toys and models, furniture, veneers.

Mahogany

Properties: Easily worked, durable and finishes well. Reddish brown.

Uses: High end furniture and joinery, veneers.

Balsa

Properties: Very soft and spongy, good strength to weight ratio. Pale cream/white.

Uses: Prototyping and modelling.

Oak

Properties: Tough, hard and durable, high quality finish possible. Light brown.

Uses: Flooring, furniture, railway sleepers, veneers.

1. Give **two** differences between hardwood and softwood. [2]

Hardwood comes from deciduous trees.[1] *Softwood comes from coniferous trees.*[1] *Deciduous trees are usually slower growing which makes the wood denser.*[1]

Softwoods

Softwood is from a **coniferous** tree, one that usually bears needles and has cones.

Pine

Properties: Lightweight, easy to work, can split and be resinous near knots. Pale yellowish brown.

Uses: Interior construction, furniture.

Spruce

Properties: Easy to work, high stiffness to weight ratio. Creamy white.

Uses: Construction, furniture and musical instruments.

Larch

Properties: Durable, tough, good water resistance, good surface finish. Pale reddish brown.

Uses: Exterior cladding, decking, flooring, machined mouldings, furniture and joinery. railway sleepers and veneers.

ALLOYS

Alloys are a mixture of at least one pure metal and another element.

The alloying process combines the metals and other elements to improve working properties or aesthetics. Alloys are harder than pure metals as they contain atoms of different sizes. These distort the arrangement of the atoms making it hard for the layers of atoms to slide over each other, creating a harder, stronger metal.

High speed steel

Composition may include:

- Chromium Molybdenum
- Tungsten Vanadium
- Cobalt Carbon

Properties
Can withstand high temperatures when machining at high speed.

Uses
Cutting tools such as drill bits, mill cutters, taps and dies.

Stainless steel

Composition:

- Low carbon 0.03–0.08%
- Chromium 10.5–26%

Properties
Hard, ductile. Rust resistant. Chromium layer protects steel from corrosion.

Uses
Cutlery, kitchen and medical equipment.

Brass

Composition:

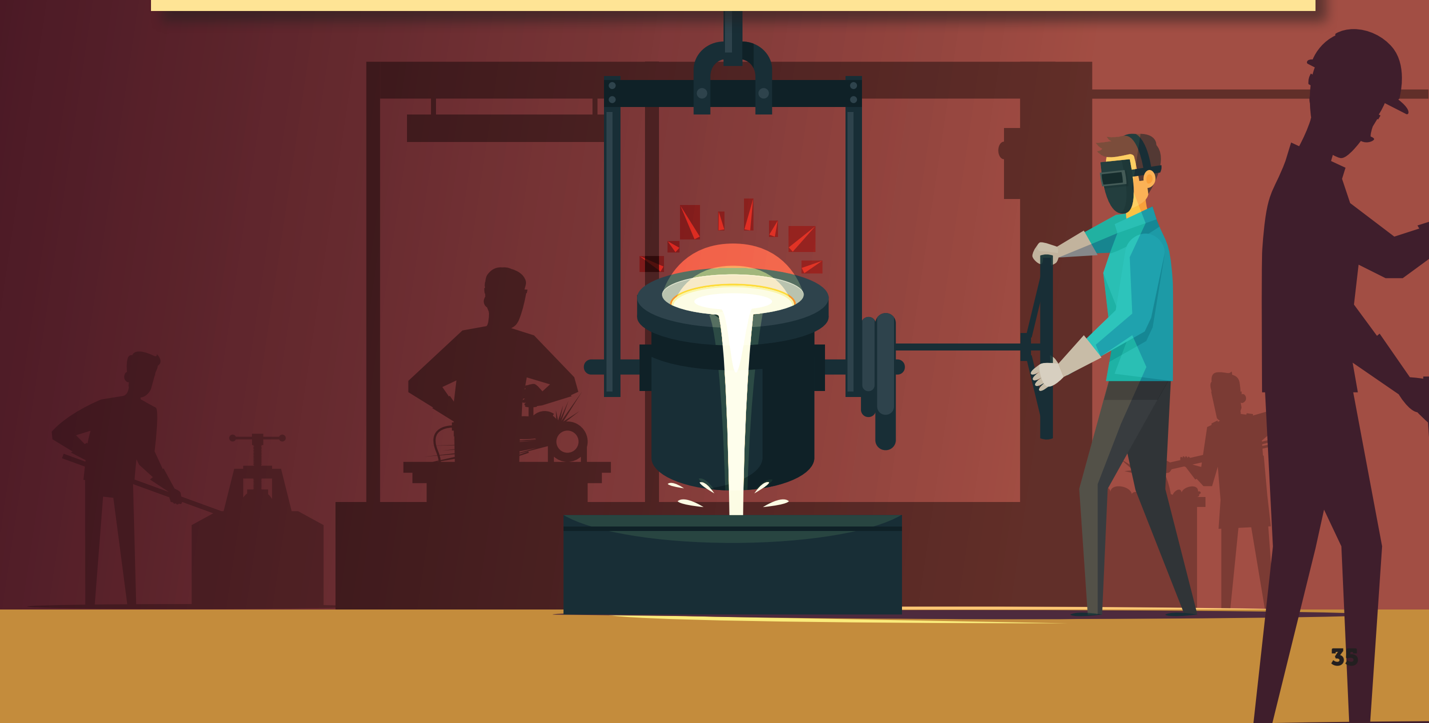
- Copper: 65%
- Zinc: 35%

Properties
Malleable and easily cast. Good corrosion resistance.

Uses
Musical instruments, plumbing fitments and ornate artefacts.

Explain **one** advantage of alloys over pure metals. [2]

An alloy can take on the properties of each of its component metals[1] making it more suitable for specific tasks.[1] Alloys are generally harder than pure metals[1] since they are made of different sized molecules which makes the layers more difficult to slide over each other[1]. An alloy often has better corrosion resistance than a pure metal[1] and can be more easily manipulated into different forms[1].



SECTION B
3.2 SPECIALIST TECHNICAL PRINCIPLES

Information

At least 15% of the exam will assess maths and at least 10% will assess science.

All dimensions are in millimetres.

The marks for questions are shown in brackets.

The maximum mark for this paper is 100.

There are 20 marks for Section A, 30 marks for Section B and 50 marks for Section C.

Specification areas 3.2.1 to 3.2.9 are covered in this Section. Some content has been covered in other sections where it relates more closely to the materials or techniques covered elsewhere.

3.2.2

FORCES AND STRESSES

Materials and objects

All materials, structures and products must withstand stress as certain forces are applied to them when in use. The ability to withstand stress is what allows them to perform their functions successfully.

Compression

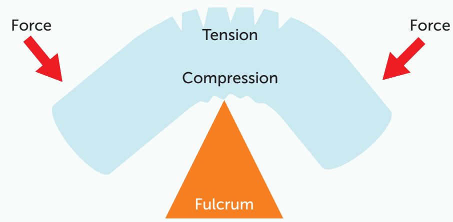
Compression occurs when a pushing force is applied to either end of a material

Explain **one** force acting on a pair of pliers when gripping a nail head. [2]

The handles will be subject to a bending force.[1] *The outer edge of the handles will be under tension*[1]*, whilst the insides will be under slight compression*[1]*. There will be a shear force acting on the pivot or fulcrum as the pliers are squeezed around the nail head.*[1]

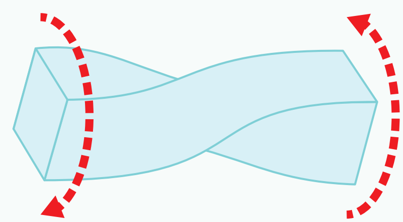
Bending

Bending is both tension and compression forces; tension on one side with compression on the other.



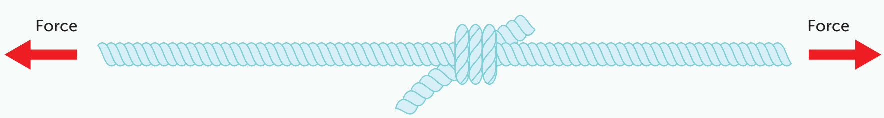
Torsion

Torsion forces occur when a material is twisted.



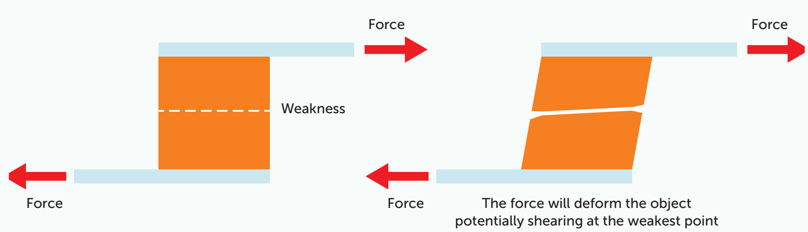
Tension

Tension occurs when a pulling force is applied to either end of a material.



Shear

Shear force acts on an object in a direction perpendicular to its length



ECOLOGICAL AND SOCIAL FOOTPRINT

Product miles

This is the number of miles a product travels from all stages of manufacture through to its final retail destination. For example, a bicycle may be made up of frame components from China, gearing and mechanisms from the USA, tyres from Germany, and an English handmade saddle.

The finished product is then distributed to a wholesaler or shop anywhere in the world. Once sold, it travels once again to the consumer. At the end of its useful life the bicycle should be recycled. The recycled components may travel again to an appropriate recycling plant.

By adding up the mileage for each section of the product's journey, the total product mileage can be calculated. Using a carbon footprint calculator, the total CO_2 emissions can be calculated. This calculation is part of the **life cycle assessment**. Further detail on the LCA is covered in section 3.1.1.

Carbon emissions

In manufacturing goods, we consume energy which emits greenhouse gases. In order to reduce carbon emissions our production and consumption of energy needs to be reduced. Becoming more energy efficient, using low or no-carbon fuels and using new technologies such as carbon capture and storage all help.

Mining

Mining extracts minerals, metals and coal from the earth. The environment is adversely affected by soil erosion, air and water pollution and a loss of biodiversity. Mining creates open pits in the landscape, piles of waste and a potential risk of sinkholes. Mining companies are expected to return the land back to its original state after extraction.

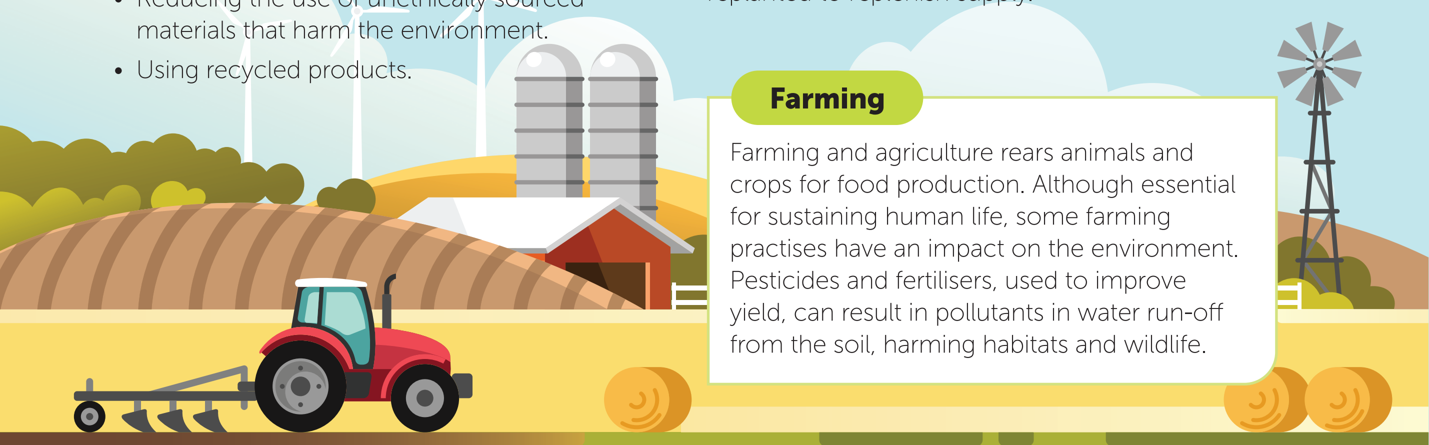
Social factors

Designers have a social responsibility to consider what impact their products may have on the environment. Factors for consideration include:

- Using materials from sustainable sources.
- Sourcing materials that have a positive impact on farmers and workers.
- Reducing the use of unethically sourced materials that harm the environment.
- Using recycled products.

Deforestation

Deforestation is the permanent removal of trees to use the land for alternative means, such as agriculture. This results in a loss of wild habitat. Trees remove CO_2 from the atmosphere so when large areas are cut down, this contributes to an increase in CO_2 levels. Timber sourced from a sustainably managed forest means new trees are replanted to replenish supply.



Farming

Farming and agriculture rears animals and crops for food production. Although essential for sustaining human life, some farming practises have an impact on the environment. Pesticides and fertilisers, used to improve yield, can result in pollutants in water run-off from the soil, harming habitats and wildlife.

COMMERCIAL PROCESSES, SURFACE TREATMENTS AND FINISHES

Different finishes can be applied to papers and boards to enhance appearance and improve function.

Printing

Printing is used on both papers and boards to improve visual appearance.

Screen printing

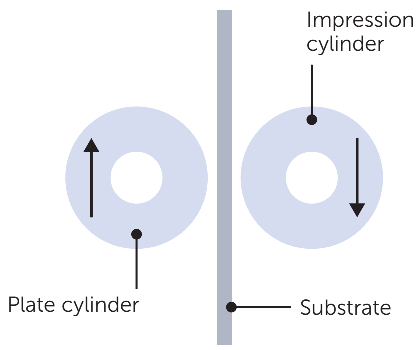
This is an effective technique for creating bold and striking prints for posters and artwork, and for printing on fabrics, particularly t-shirt design.

- A frame is covered with a tight, fine mesh – this is the screen.
- The chosen design or text is set into the mesh with a layer of light-reactive emulsion which hardens under bright light, producing the desired stencil.
- Printing ink is poured over the screen and pressed through the fine mesh to create a printed design on the paper or fabric below.
- The stencil can be used multiple times so is efficient for producing batches of identical designs.

Flexography

'Flexo' printing accommodates a wide variety of materials that don't have to be flat. Examples include plastics, cellophane, metallic film and plastics. These can be used in flexible packaging, gift wrap, textiles, carrier bags and wallpaper.

It is a high-speed process made for large print orders. It uses rolls of substrate to print high quantities without interruption. Flexography uses the 4-colour process **CMYK**.



Gravure

Gravure printing produces excellent print quality, particularly fine detail and is used for very high print volumes such as postage stamps, catalogues, greetings cards and high-volume print advertising.

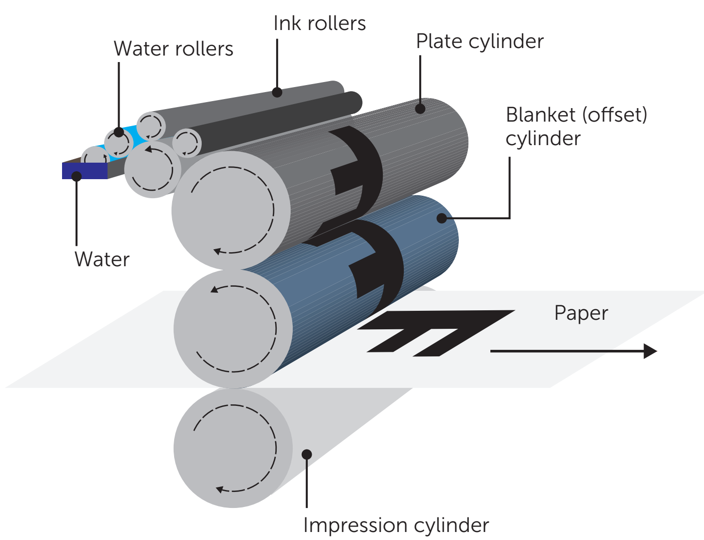
Gravure acid-etches an image on the surface of the metal printing surface. The etched areas are known as cells. The cells hold the ink that is transferred to the printable surface.

Embossing

Paper embossing creates a raised design on the paper surface, whereas debossing creates a recessed pattern.

Paper or card is placed between two dies, one raised and one recessed. The dies fit each other so when the paper is pressed between them, a permanent impression is made.

Embossing is used to add a high-quality finish to luxury card and paper products. It is also used for Braille labelling on medicines for the visually impaired.



Offset lithography

Also called **offset printing**, this is an indirect printing process. The inked image is transferred from the printing surface to a rubber blanket and then onto a flat printing surface, such as paper or board. Ink rollers transfer the ink on to the image areas and water rollers apply a water based-based film to the non-image areas.

The **CMYK** colour model is used in colour printing. This refers to the four ink plates used: **cyan**, **magenta**, **yellow** and **key**, which is black. The print process is repeated for each colour.

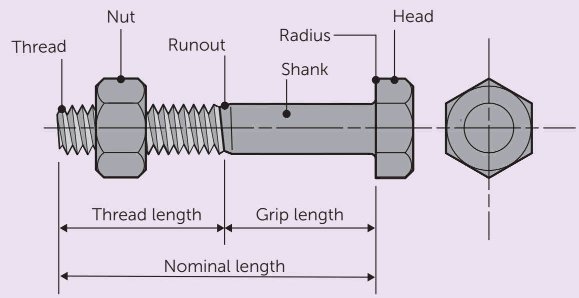
This colour process is used for high volume print runs such as books, magazines and newspapers.

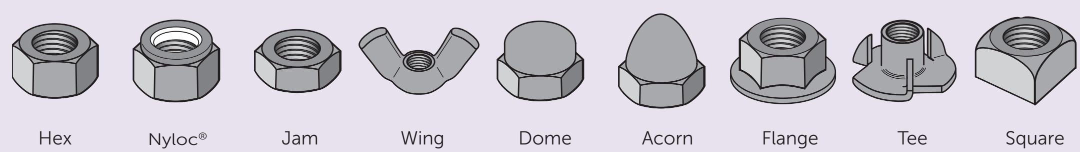
STOCK FORMS, TYPES AND SIZES

Stock form is the form in which a product can be bought and stored ready for use. Designers need to aware of stock sizes in order to manufacture economically and reduce waste.

Standard components

Nuts and bolts are used to join two or more parts together. A bolted joint can be disassembled and reassembled so are important in manufacture. Bolt heads are usually hexagonal for tightening with a spanner or socket set.

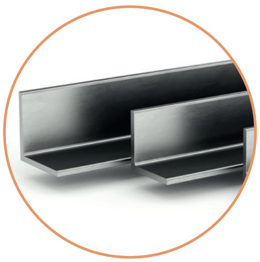




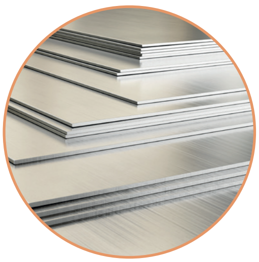
Nuts:	Usually a hexagonal profile. Used on bolts and machine screws to fasten parts together.
Bolt:	Combined with a nut to assemble components together.
Washer:	Thin disc of metal to distribute the load on a nut and bolt fastening. Prevents damage to the surface being fixed.

Standard dimensions

Dimensions are given in mm.
Standard dimensions for **sheet** and **flat bar** are given as length × width × thickness.
Box sections and shaped profiles – profile shape plus the length.
Rod – diameter × length. **Tube** – diameter × length plus the thickness of the wall or the gauge.



Angle



Sheet

Bar

Strip

SOURCES AND ORIGINS

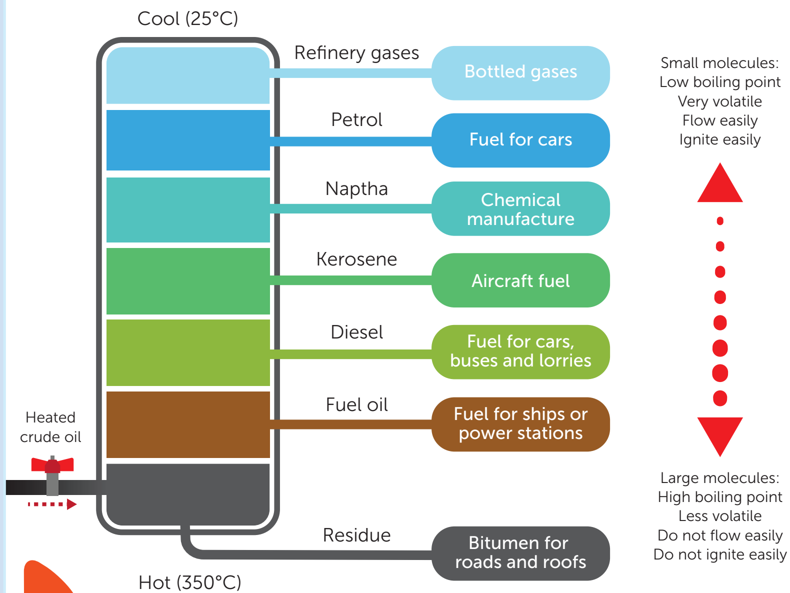
Man-made polymers are referred to as plastics. Plastics are derived from coal, gas, cellulose and commonly crude oil. Crude oil needs to be processed before use.

Refining crude oil

The process of **fractional distillation** separates crude oil into useful hydrocarbon products. The different components that are separated out are known as fractions. The fractions include petrol, kerosene, diesel and bitumen.

Before the fractions can be used, they need to be broken down by the process of **cracking**.

Cracking breaks large hydrocarbons into individual hydrocarbons called **monomers**.



Polymerisation

The individual monomers are joined to form a longer polymer chain. '*Poly*' means '*many*'. For example, a long chain of ethylene forms **polyethylene** which is used to make carrier bags, toys and bottles.

Explain why crude oil is a finite resource. [2]

Crude oil is naturally occurring and unrefined[1]*, formed from the deposits of plants and animals that lived millions of years ago.*[1] *It cannot be naturally replaced at the rate at which man consumes it*[1]*, making it a limited resource.*

TOOLS, PROCESSES, SHAPING AND FORMING OF TIMBERS, METALS AND POLYMERS

Sawing and cutting

1. Before cutting or shaping, mark out the cutting lines. Measure from a datum point.
2. Material being cut should be securely clamped or held in a vice to prevent movement.
3. Drag the saw backwards to create a nick which marks the starting point clearly. Use the full length of the cutting blade. Avoid pressing too hard.
4. At the end of the cut, support the end piece to ensure a clean cut. Rough edges can be removed.

Wasting is a process of removing unrequired material by cutting sections off or out of a larger piece.

Saws have a blade with a hard, toothed edge. They are used for cutting materials such as timber, plastics and metals to size.

Rip / cross-cut saw

Uses: For cutting wood along or across the grain.

For: Timber.

Tenon saw

Uses: Cutting shallow lines into small pieces of wood. Wood joints.

For: Timber.

Coping saw

Uses: For cutting curved lines through a thin material.

For: Timber, plastic and thin metal.

Hacksaw / junior hacksaw

Uses: Fine toothed for cutting hard materials such as metal and plastic pipes.

For: Metal and plastic.

MODIFICATION OF TEXTILE PROPERTIES

Flame retardants

Fabrics can be chemically treated to make them more resistant to fire. Fabrics used for upholstery are tested to strict guidelines to ensure they are safe for use in the home or in public spaces. Items sold with a 'fire resistant' label indicate they meet British Standards.

Items protected include:

Children's nightwear	Clothing is treated for their safety, to protect young skin.
Theatre drapes / curtains	Treated to meet strict safety guidelines in public spaces.
Racing drivers' clothing	Treated to protect the driver in the event of an accident.
Protective workwear	Protection from burns for those who work with hot metal e.g. welders.
Furnishings	Sofas, curtains and chairs are all treated to reduce the spread of fire.

Laminated fabrics

Lamination fuses two or more layers of fabric together with heat, adhesives and pressure.

Common uses include: Outdoor clothing and rainwear, outdoor cushions and seating, restaurant seating, car covers, wall coverings and baby bibs.

Protects	Provides a barrier against dirt, grease, liquids and bacteria.
Preserves	Prevents staining, fading and tearing.
Easy to maintain	Provides an easy wipe surface.
Durability	Increases durability and weather resistance. Reduces wear and tear.
Aesthetics	Can improve the surface of textiles, such as blinds and curtains.

Give **two** ways in which lamination can change or improve the properties of fabrics. [2]

Lamination can provide additional surface protection[1], waterproofing[1] insulation[1].

COMMERCIAL PROCESSES

Soldering robots are used in industry. The process is fully automated and programmed to produce precise and repeatable results.

Pick and place assembly

Commercially manufactured PCBs use surface-mount technology. Components are mounted directly onto the surface of the PCB. **Pick and place machines** are robotic machines which are used to place the components, many of which are extremely small and difficult to place manually. This system of component placement is very quick and completed with a high level of precision.

Manufacturers will set up quality control systems to check at regular stages throughout production that the boards have been correctly assembled and meet quality guidelines.

Flow soldering

A solder paste, made from powdered solder and flux, is used to temporarily attach electrical components to their contact pads. The board is then heated making the paste melt which then flows, creating a solder joint. This method of flow soldering is used to attach surface mount components to a circuit board. Heating is done carefully with either an infra-red lamp, placing the board in a reflow oven or by warming individual components with a hot air pencil.

Give **two** benefits of pick and place technology over hand assembled boards [2]

Pick and place machines are precise[1], quick[1] and able to work with tiny components[1].

SECTION C
3.3 DESIGNING AND MAKING PRINCIPLES

Information

At least 15% of the exam will assess maths and at least 10% will assess science.

All dimensions are in millimetres.

The marks for questions are shown in brackets.

The maximum mark for this paper is 100.

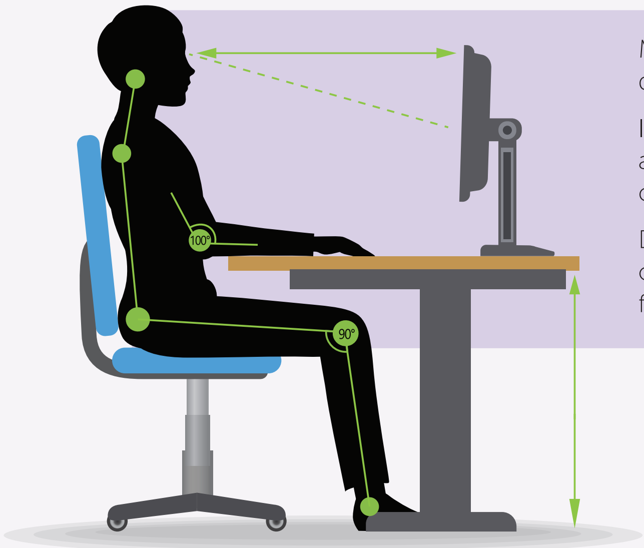
There are 20 marks for Section A, 30 marks for Section B and 50 marks for Section C.

Specification areas 3.3.1 to 3.3.11 are covered in this Section. Some content has been covered in other sections where it relates more closely to the materials or techniques covered.

3.3.1

ERGONOMICS

Ergonomics is the process of designing products and workplaces to fit the people who use them. It improves the human interaction with a product, environment or workspace, and minimises the risk of injury.



Many people sit for long periods of time at a desk.

If the height of the computer, chair and desk are not correctly aligned to the user, it can cause pain and **repetitive strain injury**.

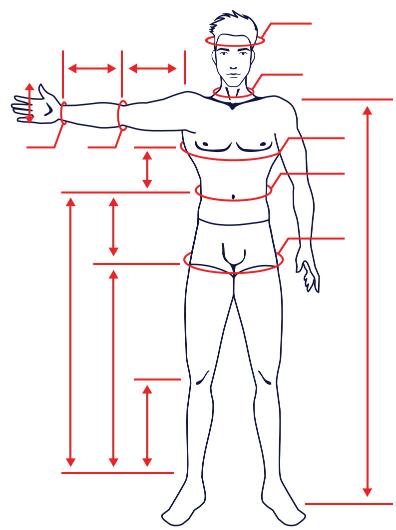
Designers will consider the measurements of humans and products to ensure they function well together.

Anthropometric data

Anthropometric data is the study of the human body, its measurement and proportions.

Data will be collected from a large sample of people of a variety of sizes to gather detailed body measurements.

Weight measurements are also taken to understand the stress or load a component may need to withstand.



Explain **one** way in which ergonomics can aid carrying a product. [2]

The design of ergonomic handles will make carrying a product more comfortable.[1] *A form-fitting design will help evenly distribute the load through the fingers.*[1] *The inclusion of hand holds in boxes or in large bulky items will make lifting easier and safer.*[1]
Holdalls, rucksacks and baby carriers can be designed to fit the body with adjustable straps and belts[1] *to spread the load more evenly and reduce strain*[1].

ENVIRONMENTAL, SOCIAL AND ECONOMIC CHALLENGES

Environmental, social and economic challenges influence design. Responsible designers and manufacturers are continually looking at how to reduce their use of limited resources and use new technologies to meet with consumer demand.

Fair trade

Fair trade aims to offer improved terms of trade to local producers and workers. By buying fair trade goods, it helps to support local communities, who can afford to develop and improve their methods of production. See page 4 for more detail.

Many farmers cannot compete with highly subsidised producers and will be offered poor rates for their products. Fair trade organisations give farmers an alternative route to market and ensure a higher and stable income.

Textile designers can source fair trade cotton which is often grown in an ethical and environmentally friendly way. This helps countless workers who work in the cotton farms in developing countries.

Explain the impact of deforestation on the greenhouse effect. [3]

Trees absorb carbon dioxide[1], offsetting the greenhouse gases produced by humans[1]. The act of deforestation produces additional greenhouse gas emissions.[1] The removal of trees takes away the vegetation crucial to absorbing carbon dioxide.[1]

Deforestation

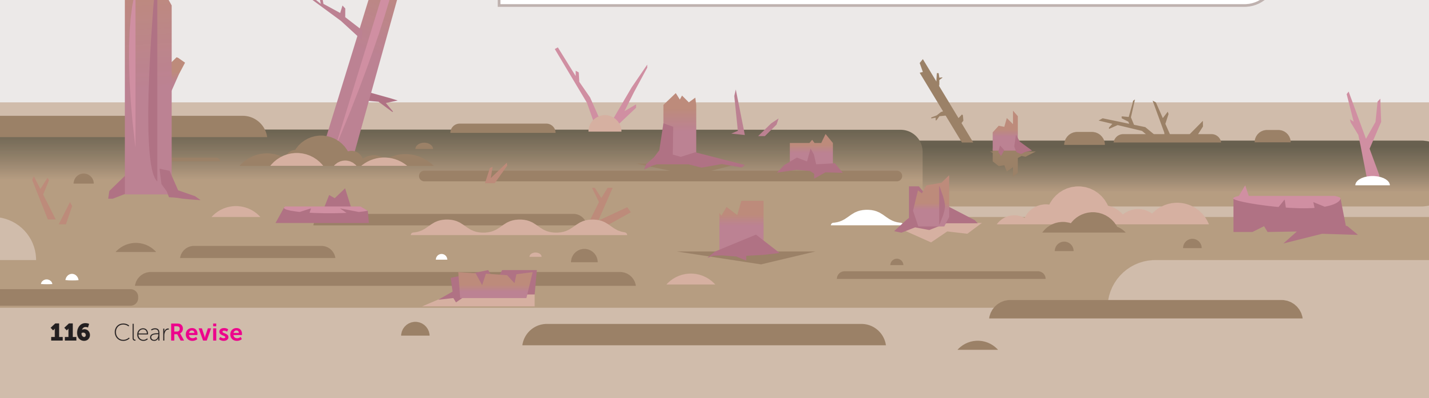
Deforestation is the permanent removal of trees and clearing the land for agricultural use and grazing. The timber may be used for fuel, construction or manufacturing. There are many effects of deforestation including contributing to global warming.

Designers can rethink the way they source and use materials.

The Forest Stewardship Council® (FSC) certifies materials which are sourced from sustainably managed forests. This means the forest will use selective logging and replanting to create a cycle of productivity that doesn't harm the forest environment.

Increased use of recycled paper and timber materials avoids more trees being felled.

Changes in energy sources and methods of manufacturing can also help manufacturers reduce their carbon footprint and impact on global warming.

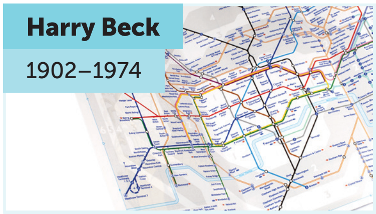


THE WORK OF OTHER DESIGNERS

Researching designers and products provides a greater understanding of the materials and processes they used. It can also help inspire new ideas.

Harry Beck

1902–1974



Harry Beck was a technical draftsman who visually simplified the layout of the London Underground by producing a clear and simple map layout of the tube system. He transformed the way people navigate around London's underground network and his design has influenced many other underground maps around the world.

Norman Foster

1935–present

Award winning British architect known for his striking architecture and high-tech vision. His practice 'Foster + Partners' are known for the Millennium Bridge, Great Court at the British Museum, City Hall, 30 St Mary Axe (the Gherkin) in London, Reichstag in Berlin and a host of other buildings around the world.

Marcel Breuer

1902–1981

Modernist designer and architect, known for two of the most iconic chairs of the 20th century, the tubular steel Wassily Chair and the cantilevered Cesca Chair, which he designed at the **Bauhaus**.

Sir Alec Issigonis

1906–1988

Designer of the Morris Minor and of the ground-breaking Mini, which used unconventional design features including a transverse engine with front wheel drive.

Coco Chanel

1883–1971

French designer, founder of the Chanel brand. Known for introducing a more casual feminine line of clothing, breaking away from corsets and long skirts.

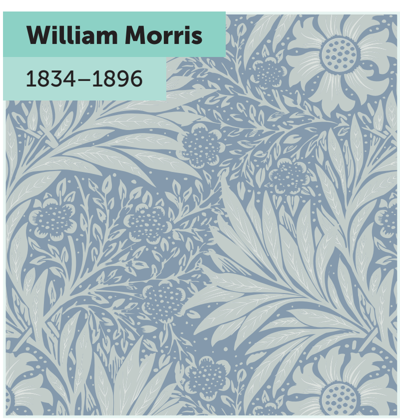
Alexander McQueen

1969–2010

British Fashion designer renowned for his unconventional designs and stunning catwalk shows combining sharp tailoring with theatrical design.

William Morris

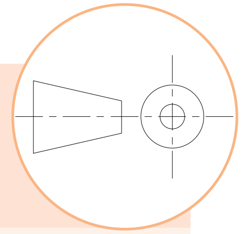
1834–1896



William Morris was a significant contributor to the British **Arts and Crafts Movement**, Morris is renowned for his block printed fabrics and wallpapers. His designs were influenced by nature with beautiful patterns of intertwined flowers, leaves and birds.

Working drawings

Working drawings contain dimensional and graphical information that can be used to work to or assemble a component. A working drawing, referred to as an orthographic drawing, has three main views: a plan view, front and side view.



Orthographic drawing conventions

The common format of a working drawing is a **third angle orthographic projection**, drawn accurately and to scale to give a manufacturer a clear overview of a design.

Dimensions will be shown in mm.

A symbol to indicate it's a third angle orthographic projection will be shown.

Outlines	
Construction lines	
Centre lines	
Dimension lines	
Hidden details	

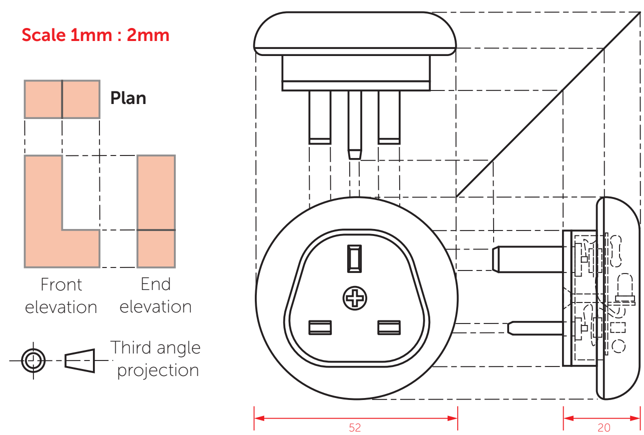
Scale and dimensions

A drawing of an object will have its real sizes enlarged or reduced by a certain amount or specified **scale**. Scale must be clearly shown on the drawing.

The scale shown on the drawing will represent the **drawn length : actual length.**

Scale is represented as a ratio for example:

1cm to 1m	=	1 cm : 1 m
	=	1 cm : 100 cm
	=	1:100



Dimensions should show the actual dimensions of an object, not the dimensions of a drawing. Measurements are shown in millimetres (mm).

CAD modelling

Computer aided design replaces manual drawing with an automated process. It is used by designers, architects and engineers to produce technical and precision drawings. It can produce two-dimensional or three-dimensional diagrams which can then be rotated so that a design can be viewed from any angle.

Prototypes are often constructed based on prior models. Describe how modelling can be used by designers to help develop prototypes. [4]

Prototyping enables a 3D impression to be created to improve visualisation.[1] *It can reduce development time*[1] *and can avoid excessive use of materials*[1]*. Early testing using computer-based modelling such as CAD or circuit design can be used.*[1] *Physical models using card, a toile or breadboards can be created using materials that are significantly cheaper than the actual finished material.*[1] *Moving components and mechanisms can be tested.*[1] *Electronic models can be shared and worked on collaboratively by several parties who may not be in the same room or country.*[1]

PRACTICE 7

EXAMINATION PRACTICE

1. Material availability is a key factor when choosing materials for a product.
   (a) Give **two** other factors designers need to consider when selecting materials. [2]
   (b) Discuss the impact that the availability of materials may have on a project. [6]

2. A manufacturer produces bike frames that should measure 560 mm to a tolerance of +/- 1.5 mm.
   (a) State what is meant by the term 'tolerance' with respect to quality control. [1]
   (b) Calculate the maximum and minimum height of the bike frame that would be acceptable. [2]

3. Specialist marking out tools are used when marking out a material.
   (a) Name **one** specialist marking out tool you have used. [1]
   (b) Explain how you have used the tool in part (a) with precision and accuracy. [2]

4. State what is meant by the term 'template' and explain **one** reason for using a template when marking out identical items. [3]

5. Give the name of **two** pieces of PPE that can be used to ensure your personal safety in a school workshop. [2]

6. Give **two** pieces of information that you should find out before using any new piece of equipment or machine. [2]

7. Templates, jigs and patterns can be used to ensure repetitive accuracy.

   Describe how manufacturers can use these tools to ensure batches of products are reproduced accurately. [3]

8. A stationery manufacturer is creating envelopes for greetings cards.

   Explain **one** example where tolerance may be applied. [2]

9. Discuss how material allowances and pattern or grain matching affect the costs of raw materials. [4]

10. Choose **one** product from the selection below.

				
Paper cup	Wooden lampstand	Metal tongs	Plastic dog chew	Textile gauntlet

For your chosen product suggest one appropriate surface treatment or finish that could be applied to this product. [1]

EXAMINATION PRACTICE ANSWERS

Practice 1

1. Robots can work in hazardous environments / high temperatures / dangerous conditions, which means humans will not be exposed to these environments reducing the risk of harm / danger / personal injury.
   Factories / assembly lines can operate autonomously 24/7, which means that fewer staff are required / redundancies might have to be made / smaller workforce needed / change in job roles / reskilling / unease amongst staff. [2]
2. Reduces the distance / time / effort used to handle / move materials from section to section through production lines.
   Reduce the amount of time / distance that staff move from one section / area to another. [2]
3. Reponses may include, but are not limited to fruit / coffee / chocolate / cotton / wine. [2]
4. Internet / email / Twitter / Instagram / Facebook / YouTube. [2]
5. Oil. [1]
6. A resource in infinite supply (or in such significant abundance that we are unlikely ever to run out). [1]
7. Answers include: Rising sea levels, more frequent / more extreme weather, rising air and sea temperatures, melting of the polar ice caps. [2]
8. Waste materials can be reused to make smaller / alternative parts, which means that they buy fewer new materials. Waste materials can be sold as scrap, which means the company can recover some of the material cost. Waste can be burnt to produce heat, which means they spend less money on gas / oil to heat the building / water. [2]
9. Technology push is defined as the use / application of new scientific discoveries, which is applied to products despite their being no consumer awareness / demand driving forward innovation. Market pull is defined as products being created / designed to meet a demand; in response to consumer needs / market forces. [4]
10. $14 / (5 + 2) = 2$, $2 \times 5 =$ £10 million. [2]
11. 3D models can be generated from 2D CAD files. Drawings can be animated / fed into simulation / testing programmes. Drawings are more easily edited / revised / amended / sent electronically. Colours / textures are quickly / easily applied. CAD can be linked directly to CAM / 3D printers. [3]
12. Products are made to order, which reduces the number of products that are held in stock / money tied up.
    Products are not held in stock, which means they do not go out of date / fashion. Materials and components are only bought when required / needed, which reduces the need to hold lots of materials in stock / costing money to hold / warehouse space to hold materials. [2]
13. Old products / versions / fashions / trends become out of date / slow down with lack of software upgrade / support, which means there is a need to replace / buy new models / textiles / products which keeps profits / turnover going. Technology continues to advance / develop / improve capability, which means older products become relatively slow / no upgrades released / consumers need to upgrade / buy new versions. [2]
14. Use of specialist tools required; specialist knowledge required; outsourcing repairs can be labour intensive which is expensive; spare parts can be expensive and may need to be shipped from abroad; electrical components may be complex, or integrated into the product; materials are commonly bonded using permanent bonds rather than screws. [2]

BAND DESCRIPTIONS AND LEVELS OF RESPONSE GUIDANCE FOR EXTENDED RESPONSE QUESTIONS

Questions that require extended writing use mark bands. The whole answer will be marked together to determine which mark band it fits into and which mark should be awarded within the mark band.

Mark Band 3 **High Level 5–6 marks**	• Technical terms have been used precisely. • The answer is logical and shows an extensive understanding of Design and Technology concepts and principles. • The answer is almost always detailed and accurate. • All parts of the answer are consistent with each other. • Knowledge and ideas are applied to the context in the question • Where examples are used, they help to illustrate. • Arguments and points are developed throughout the answer with a range of different perspectives. Different sides of a discussion are considered against each other.
Mark Band 2 **Mid Level 3–4 marks**	• Technical terms used in the question have been understood. • The answer shows an understanding of D&T related concepts. • Arguments and points are developed in the answer, but sometimes useful examples or related knowledge to the context have not been included. • Some structure has been given to the answer with at least one line of reasoning. • Sound knowledge has been effectively shown.
Mark Band 1 **Low Level 1–2 marks**	• The answer shows that technical terms used in the question have not been understood. • Key concepts have not been understood and have not been related to the question context. • The answer is only loosely related to the question and some inaccuracies are present. • The answer only considers a narrow viewpoint or one angle • The answer is unstructured. • Examples used are mostly irrelevant to the question or have no evidence to support them.
0 marks	• No answer has been given or the answer given is not worth any marks.

The above descriptors have been written in simple language to give an indication of the expectations of each mark band. See the AQA website at **www.aqa.org.uk** for the official mark schemes used.

INDEX

EXAM TIPS

With your examination practice, use a boundary approximation using the following table. Be aware that boundaries are usually a few percentage points either side of this and change each year.

Grade	9	8	7	6	5	4	3	2	1
Boundary	90%	80%	70%	60%	50%	40%	30%	20%	10%

1. Be aware of command words at the back of the specification. If 'describe' or 'explain' questions are given you need to expand your answers. To help you justify your responses, aim to include words such as BECAUSE… or SO… in every answer because this forces you to justify your point, so you get additional marks. See how well it works!
2. Explain questions such as "explain why this is the most appropriate…" do not require just a list of benefits. Instead you should identify the benefits and then expand each one, applying them to the scenario or context.
3. Full answers should be given to questions – not just key words. Make your answers match the context of the question. Where you are asked to give examples, always do so. Access to the higher marks will be difficult without examples.
4. Avoid simple one-word answers. Adjectives such as cheap, strong or quick are unlikely to gain marks unless these are justified. For example, "robots save money on wages" is not a strong answer. It would better to explain that "once the initial investment has been made, robots do not need to be paid wages but will require maintenance by more highly skilled workers".
5. Always include notes and sketches where you are asked to do so in a question. Support your drawings by using annotations and labels. Include detail such as processes and the use of any relevant tools or equipment.
6. Questions involving mathematics should be read carefully before attempting your answer. Misreading the question is a common way to lose marks on these question types. Show your working at every stage as marks can still be awarded even if the final answer is not correct.
7. Always give answers using the correct units, e.g. mm or kg, and to the correct number of decimal places.
8. In drawing questions, look out for key features such as holes or hidden detail and incorporate them into your reponses using the appropriate line styles and techniques.
9. You are required to study at least one material area. However, not all material areas provide enough scope to answer all questions that may appear in an exam, particularly with electronic and mechanical systems. For this reason, it is recommended that you study more than one material area. This gives you more knowledge and understanding to draw from and apply to a greater range of questions.
10. 15% of the marks in the paper will test mathematics skills. You can check the full maths requirements in the most up to date version of the specifiction. This can be downloaded from www.aqa.org.uk.
11. Attempt every question, even if you are unsure of the question or the answer. Have a go. You might just get a mark or two, but you'll be guaranteed zero marks if you don't attempt a question at all.
12. Time your practice attempts in this book and in the examination based on roughly one mark per minute. A 4-mark question should therefore be given 4 minutes to complete. The real paper is 100 marks in 120 minutes. This will allow you 1 mark per minute with 20 minutes to check through things at the end.

Good luck!