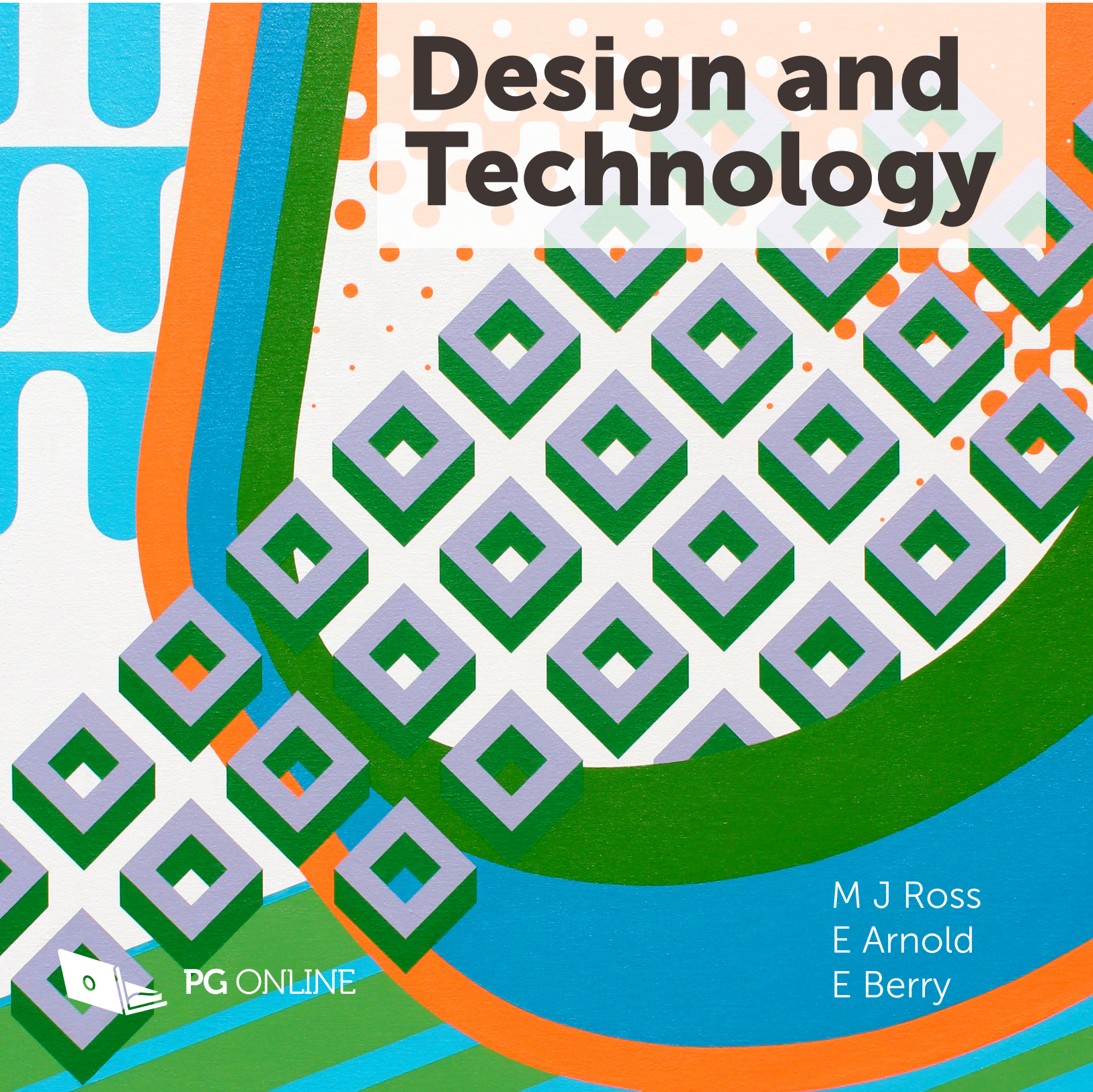
Endorsed for
Pearson Edexcel Qualifications

Edexcel GCSE (9-1)

Design and Technology



M J Ross
E Arnold
E Berry

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Contents

Core sections 1–5

Specialist sections

Section 1

New and emerging technologies

In this section:

Q1 Which inventions do you feel have significantly changed the way we live our lives? Justify your response and compare with other students.

Industry

Before the industrial revolution, most people lived in the countryside outside cities and towns, working on the land. As automation led to larger workshops, mills and factories, more people moved away from the countryside to find work. Towns and cities grew up around areas of manufacturing, and flourished. Output increased, prices fell and generally quality improved. Gradually, a society based on consumerism and enterprise developed. People now had money to buy goods and services and manufacturing boomed. This same society exists today, although there have been a number of changes along the way.

Q2 Which technological developments in agriculture have led to fewer people being needed to work the land to produce food?

Unemployment and workforce skill set

Historially, greater technical advances have signalled that the type of employment available and the skills required are likely to change. As villagers and country folk came into towns and cities, they had to learn new skills to find work. It is similar today and failure to move with the times, develop and updatie one's personal **workforce skill set**, could leave you redundant or unemployed.

There has always been fear within the workforce that new technologies result in **unemployment**. The truth is actually much more complicated. Greater demand for products originally created jobs as machines needed manual labourers, machine operators and engineers to keep them running. More recently, with the introduction of intelligent machines and robotic production lines, many of these jobs have been lost. The latest fully automated production lines only require a few highly skilled engineers to ensure that smooth running is maintained. Additionally, automation leads to high levels of safety and quality products.

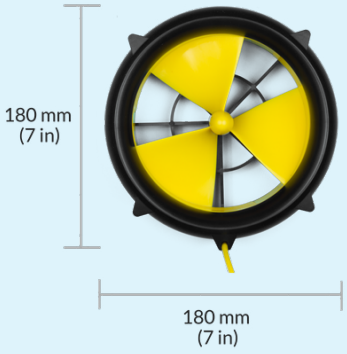
Q3 How might automation have affected unemployment in industrialised areas?

Portability of a power source

Using power on the move or in remote places is becoming more widely possible and more in demand. People like to be constantly connected to their business, family and friends while on the move, therefore portability plays a major role in facilitating this connectivity. Battery technology is one part of the chain but recharging them is the tricky bit. There has been a surge in the number of products that support remote charging including compact, flexible solar cells and micro-wind turbine generators that can take advantage of flowing rivers as well as air streams. Home generators, including biomass versions, are becoming smaller and more efficient, meaning that power can be taken to more remote locations that are not connected to the National Grid.

Case study: WaterLily turbine

This advanced charging device works in both moving air and water. It can recharge devices using a USB or 12V charging cable delivering up to 15W of power to charge smartphones, battery packs, lights or speakers in areas without any standard power source.



https://waterlilyturbine.com/products/waterlily-turbine

Environmental impact of power generation and storage

The environmental impact of some power generation is obvious, such as the smoke and CO_2 produced from burning fossil fuels, others are more subtle, such as the noise from wind farms and the potential harm to migrating birds colliding with turbine blades. The energy and natural resources needed to create these generators also needs to be considered, however, on balance, renewable energy sources have a much-reduced impact compared to fossil fuel powered systems.

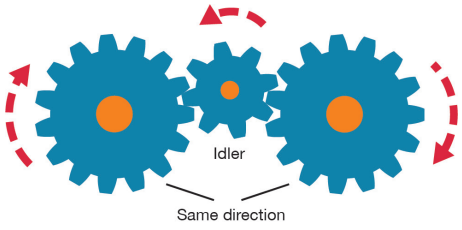
Q3 Other than the CO_2 emissions from burning fuel to create electricity, what other environmental factors might affect people living near a fossil fuelled power station?

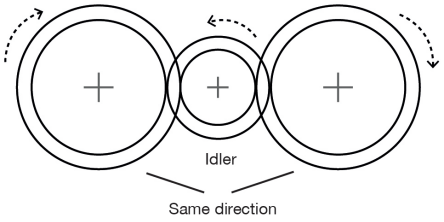
Disposal of batteries

Batteries need to be disposed of properly since they contain toxic electrochemicals and some metals that can be harmful to the environment. If a battery is disposed of in a landfill site, it will degrade over time and the chemicals and metals from which it is made can leach into the soil and eventually end up entering the water table and river systems. The result is that the increased levels of toxins and metals can cause serious harm to wildlife and potentially humans too.

Idler gear

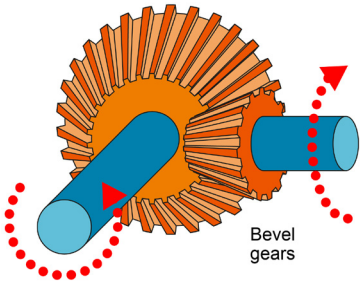
An idler gear is used to change the direction of rotation so that the driven gear goes in the same direction as the drive gear. The size of the idler gear does not matter as it just transfers the movement from the drive gear to the driven gear.

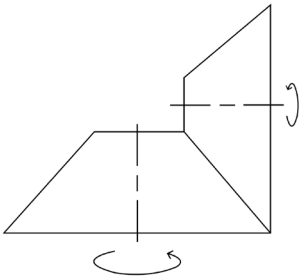




Bevel gears

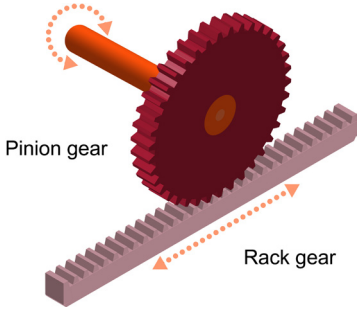
These special gears change the direction of drive through 90 degrees. They are used on hand drills, some kitchen whisks and numerous power tools.

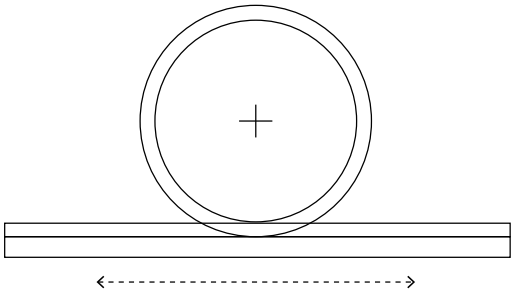




Rack and pinion

Rack and pinion gears convert rotational motion to linear motion and vice versa. They are commonly found on steering systems but can also be seen on pillar drills to raise and lower the table.





To calculate the distance a rack gear moves per revolution of a pinion gear we use the following calculation:

$$\frac{\text{Number of teeth on pinion gear}}{\text{Number of teeth on rack gear per metre}} \times 1 \text{ metre}$$

Therefore, if a pinion gear has 20 teeth and a rack gear has 160 teeth per metre then 20 ÷ 160 = 1/8 metre = 125mm

Q10 If a pinion gear has 30 teeth and rack gear has 120 teeth per metre, how far will the rack gear move in half a revolution?

Raymond Loewy 1893–1986: Example case study

Hailed as the Father of Industrial Design, Raymond Loewy's influence has touched everyone in the modern world and gave the American way of life a distinct identity which has travelled across the globe. He said of himself "… I have made the mundane side of the 20th century more beautiful".

Loewy was born in Paris to Austrian-French parents and distinguished himself at the age of 17 by designing the winning model aeroplane in the Gordon Bennett Cup, which then went on to commercial success in the following year.

After World War I, he moved to New York and worked as window designer for various large department stores as well as working as a fashion illustrator for Vogue and Harper's Bazaar. His first industrial design commission was in in 1929 to redesign the appearance of the Gestetner duplicating machine, a design that persisted for the next 40 years. This was the first instance of the streamlined look that characterised Loewy's work which went on to include the Greyhound bus, the Coca-Cola bottle, and the GG1 and S1 locomotives.

In the 1930's, his successful styling of the Hupp Aerodynamic motor car paved the way for automotive design to become a legitimate profession. Motor manufacturers began to use external stylists like Loewy, who then designed the classic 1953 Studebaker Starliner.

He was quick to realise that a product's appearance was a saleable commodity and his streamlined look became the emblem of western society. He also understood that appearance had a knock-on effect on production cost and performance, and enhanced the product's standing in the marketplace: stating that of two similarly specified products, the most aesthetically pleasing would be the most successful.

In addition to his automotive designs Loewy was also a prolific commercial artist and illustrator with simple but effective graphic designs. Of the many logos he created, he said, "We want anyone who has seen the logotype even fleetingly to never forget it."

Loewy's ideal of creating beauty through function and simplicity is still in tune with the requirements of industrial production today and his work still influences designer and consumer decisions.

Zaha Hadid RA DBE 1950-2016

Known as the 'Queen of the curve', Dame Zaha Hadid was an Iraqi-British architect who often pushed the boundaries between sculpture and architecture. In 2004 she became the first woman to receive the Pritzker Architecture Prize and went on to scoop the prestigious Stirling Prize in 2010 and 2011. In 2016 she was awarded the Royal Gold Medal from the Royal Institute of British Architects - the first and only woman to have received this accolade so far. Her architectural achievements are many and include the London Aquatics Centre built for the 2012 Olympics, the Guangzhou Opera House in China and Port House, Antwerp, Belgium.

Heatherwick Studio est. 1994

Set up by the British inventor and designer, Thomas Heatherwick CBE, in 1994, Heatherwick Studios have been responsible for a growing number of modern icons such as the spun chair and the new Routemaster bus. They also took centre stage at the 2012 London Olympics by creating the magnificent Olympic Cauldron composed of 204 copper petals, one for every nation taking part. Their influence is undeniably unconventional, as can be witnessed in many of their architectural projects, such as the Nanyang Technological University Learning Hub, Singapore, and the UK Pavilion built for the Shanghai World Expo in 2010 in which the acrylic rod structure held 250,000 seeds.

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Pixar est. 1979

Having started life as Lucasfilms' Computer Division, Ed Catmull was tasked with developing a number of digital film editing systems. In 1982 they completed the first fully computer animated sequence in a feature film. In 1986 Steve Jobs bought the company from George Lucas and rebranded it Pixar. The famous Anglepoise lamp 'Luxo Jr' won them critical acclaim and an Oscar nomination for best animated short film. In 1991 Pixar started work on Toy Story for Disney which was released in 1995. Since then they have gone on to create some of the most watched animated films including Monsters INC, Up, Finding Dory, Inside out and Coco.

Tesla est. 2003

Tesla is an American company based in California, known for its world-leading all electric cars and solar charging systems. Built around an ethos of harnessing renewable energy to power not only transportation, but eventually the home as well, the company have invested heavily into research and development. They have created solar rooftiles and the Tesla Powerwall, which is a battery pack designed to power the home.

In early 2019, Elon Musk CEO stated that Tesla was releasing all of the electric car patents in order to 'accelerate the advent of sustainable travel' to help fight climate change. Both Tesla's flagship vehicle, the Model S and the more affordable Model 3 are in very high demand and can travel over 300 miles on one charge.

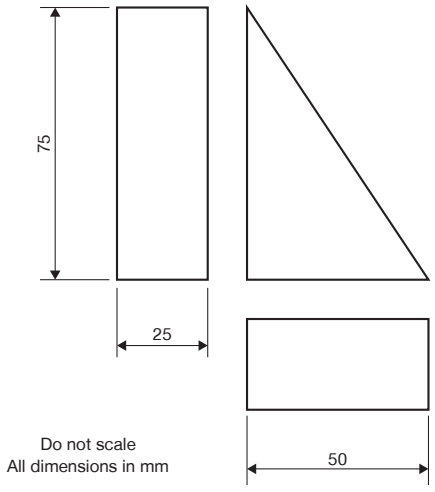
Exercises

1. Describe **two** different design strategies used by designers. [4]

2. Explain the term ‘design fixation’. [2]

3. Describe what is meant by each of the following terms.
   (a) Ergonomics [2]
   (b) Anthropometrics [2]

4. The drawing below shows an orthographic drawing of a wooden toy building block.



   Use an annotated sketch to show an accurate isometric view of the toy wooden building block. [4]

5. Explain the difference between primary and secondary data sources giving **one** example for each in your answer. [4]

6. Give the most applicable presentation technique or drawing style to use for the following tasks:
   (a) Planning out an electrical circuit. [1]
   (b) Designs for a bride to choose a wedding dress. [1]
   (c) Flat pack furniture instructions [1]
   (d) 3D view of a product with dimensions [1]
   (e) Accurate drawing of a product with dimensions ready for manufacture. [1]

7. Discuss the use of cheap materials such as corrugated card and masking tape, toile, breadboards and components for early prototypes of 3 dimensional products. [6]

8. Name **two** types of designers that may benefit from using cut and paste techniques for their early presentations to clients. [2]

9. Explain how digital media recordings can assist when gathering primary data. [2]

Cutting and sawing

Saws are used to cut materials and joints to size. The tenon saw, rip saw and cross-cut saw are common hand saws that are used for cutting straight lines in wood. The tenon saw is used for cutting wood joints and for small section material. Rip and cross-cut saws are used for cutting large panels. The coping saw enables curved lines to be followed. The bandsaw is powered and can be used for straight cuts and gentle curves through thick and thin material.

The bandsaw is a powered tool used to cut curved lines through thin material.

Q2 Do some research on saw blades and explain the following:
a) Tooth pitch b) Kerf

Tenon saw

Coping saw

Rip saw / Cross-cut saw

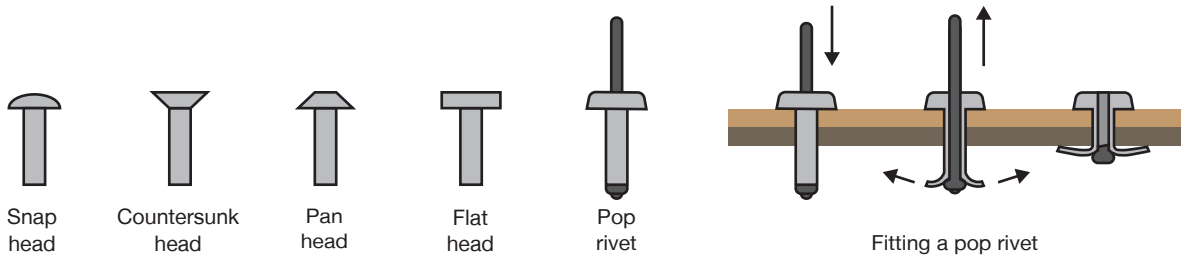
6-1

Wasting and abrading by hand

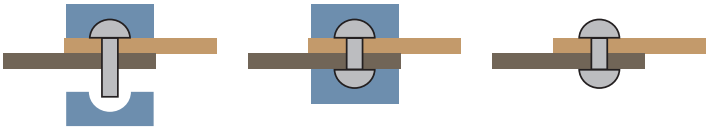
Using hand tools to accurately shape wood is a skill that is learned over many years. Accuracy is vital and mistakes are easy to make which can be costly. Practice is needed in order to achieve the quality that you need at GCSE level, therefore it is recommended that you use some scrap wood to become acquainted with the following tools first; especially chisels. Planes can take some delicate setting up before they work correctly but it is worth taking time to ensure an even cut is made.

Wasting tools			Abrading tools		
Name	**Characteristics**	**Image**	**Name**	**Characteristics**	**Image**
Smoothing plane	Smoothing plane removes very thin layers of wood, smooths and flattens along the grain		Rasp	Like a file with very rough teeth for fast removal of material, different profiles available	
Chisel	Different versions used with a mallet to remove wood to form rebates and recesses		Surform	For fast removal of material, a cheese grater-like blade is sharp but brittle, different profiles available	

The **pop rivet** is the simplest type to use and requires a tool called a pop rivet gun. As pressure is applied to the handles of the tool, the pop rivet domes over and the shaft 'pops' off leaving the deformed rivet holding the materials together. Pop riveting only needs access from one side making it easier to use where access is limited or awkward.



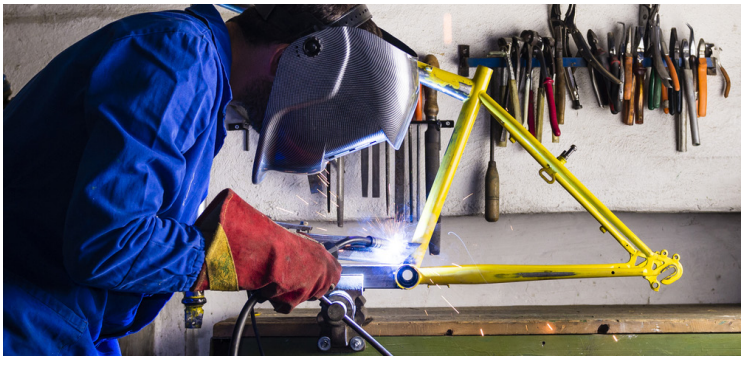
Cold-formed rivets use a tool called a snap which helps to set the rivet in place while the other end is domed over to form the joint. This can also be formed as a countersunk finish to create a smooth surface.



Cold-formed rivets

Welding

There are a few different types of welding but they all involve fusing together two metals of the same type using a filler. This means that both adjoining surfaces partially melt together becoming one piece. The joint is as strong as the parent material.



Common welding methods are **oxyacetylene** which is a very hot gas flame, MIG (metal inert gas) and TIG (tungsten inert gas). **MIG** and **TIG** are both electric arc welding methods, where a very powerful electric current is used to create the heat.

Brazing

Brazing is a process of permanently joining two pieces of metal together through heating by adding a filler material called **spelter**. The joint is first cleaned with emery cloth to degrease and remove any rust or oxide. Then **flux** is added all around the joint to stop oxidation during the heating process and to improve the flow of the spelter around the joint. The joint is evenly heated with a gas torch to melt the spelter as it is applied to the joint. If the joint has an even and close fit, then **capillary action** will assist the spelter to flow along the joint. The joint can then be quenched and cleaned.

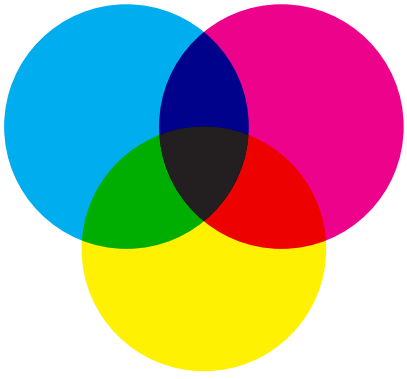
as a mask. This is often done using a printed transparency. Light is shone onto the screen; this fixes the photo emulsion that is left exposed and after this, the mask is removed, and the un-exposed photo emulsion is washed away.

A different screen has to be made for each different colour and **jigs** are often used to help align the screens for printing. To make a print, the screen is laid on top of the substrate, ink is applied at the top of the screen and pulled across the screen using a squeegee. Screens can be washed and reused.

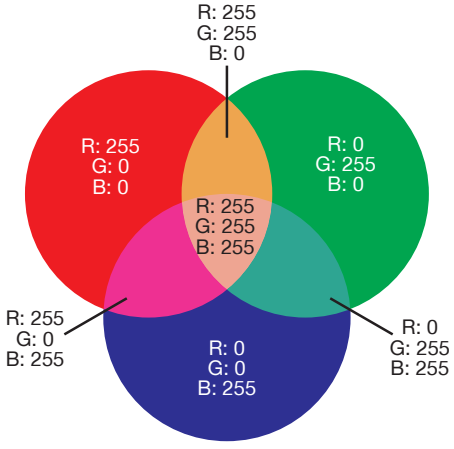
Drawing the ink across whilst making a screen print

Colour printing

Commercial colours are based on blending specific amounts of base colours to form the required shade or tone. The full-colour printing process uses **CMYK** (cyan, magenta, yellow and key [meaning black]) to form colours.



CMYK



RGB

Home printers often have a combined colour ink cartridge containing three colour wells and a black ink cartridge. Larger printers and commercial printers have separate inks (usually CMYK).

Companies such as Pantone® produce a huge range of colours that are given a specific combination of values for either RGB or CMYK. Digital colours on computers tend to use **RGB** with values for each colour between 0 and 255. Therefore 255, 0, 0 will be process red.

Q2 How many different combinations of colour are there in the digital RGB system?

The Trans-Alaskan oil pipeline in northern Alaska, USA

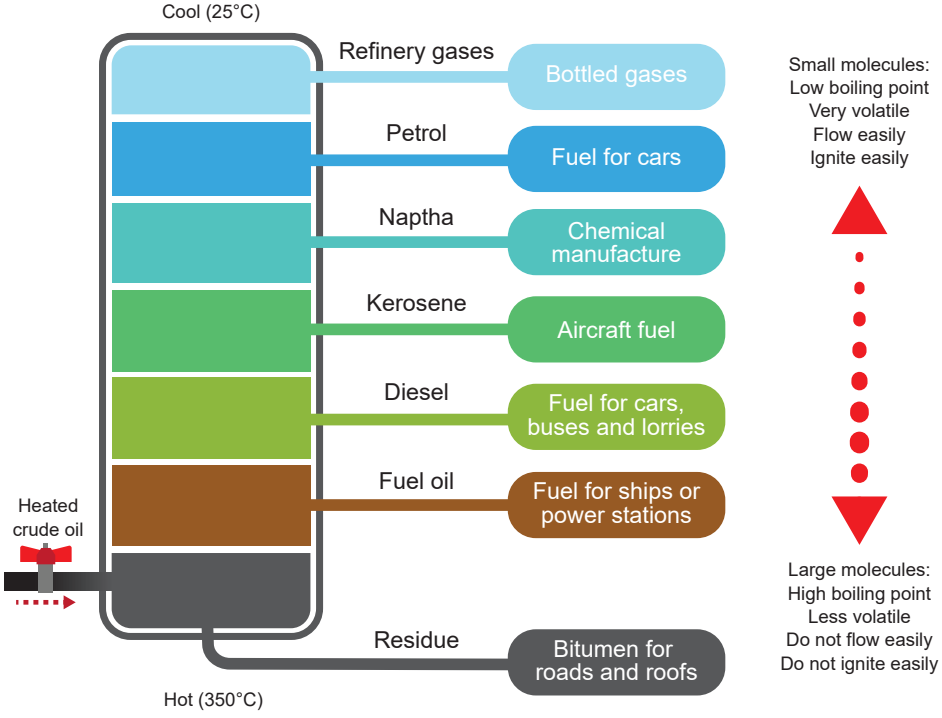
Q1 Describe how polymerisation is used to make plastics.

Q2 Which plant-based materials can be used to make sustainable plastics?

Refining crude oil with fractional distillation

Refining is the process of converting black sticky crude oil into other more usable products such as transportation fuel, including petrol and diesel, or oils for machinery. The waste product, bitumen, is used as a binder in road surfacing.

6-4



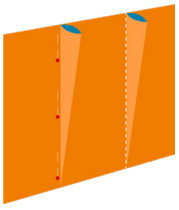
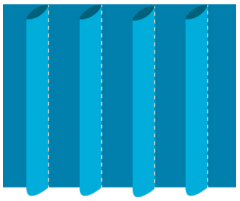
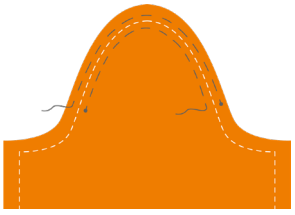
Fractional distillation occurs when crude oil is heated in the crude oil distillation unit (CDU). This process separates the heated crude oil into many different compounds or fluids using condensers. Each product has a different boiling point and condenses at a different temperature, thus allowing the multiple condensers to draw the product off separately at different stages.

The thickness of the material and the size of the individual gathers required will govern the spacing and length of the running stitch. Larger stitch length and spacing will create bigger gathers. Shirring elastic can be used to gather fabric which creates both fullness and stretch. Once the gathered material is spaced as required, it can be sewn onto another piece of material, such as a waist band, so that it stays in position.

Q4 Why is gathering such a popular technique used in curtain making?

Under stitching adds a line of stitching to linings or facings to stop them from sliding out from the inside of a garment – often used at the neckline.

Additional shaping techniques are described in the grid below:

Darts	Tucks	Easing
		
Used to create 3D forms which fit the contours of the body and /or create shape. Commonly used at the waist, bust, hips and shoulders.	Used to reduce fullness, add structure and create an aesthetic feature.	Line(s) of loose straight stitches added temporarily during assembly so fabric can be gathered without visible tucks. Used for assembling curved features e.g. armholes

Woven and non-woven fabrics can be **moulded** into 3D forms using steam, heat or adhesive. Polymer-based textiles can be formed by heating the fabric to just below the melting point of the thermoplastic fibre, forming, then allowing the fabric to cool. This method can be used to create textures and elastic fabrics. Milliners use water, steam and heat to form and drape felt.

Adding structure

Interfacing is used to create stiffer, more rigid elements to a garment (see Chapter 56). Different weights of interfacing are more rigid than others. Collars and cuffs, for example, need more structure than most other parts of a garment.

Highly structured garments such as bodices, corsets, bras and crinolines (in times gone by) use **boning** to add rigidity and shape to garments. Boning is usually incorporated into seams. Strips of boning are used to create an internal structure, like a skeleton, which fabric can hang from.

Crinoline used to give shape to the skirt of a period costume

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Edexcel GCSE 1DT0 (9-1) Specification map

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Informing design decisions												
1.2	Informing design decisions		✓									
Energy, materials, devices and systems												
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1.4	Modern and smart materials			✓								
1.5	The functions of mechanical devices			✓								
1.6	Electronic systems			✓								
1.7	The use of programmable components			✓								
Material types, properties and structures												
1.8	Ferrous and non-ferrous metals				✓							
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1.10	Polymers				✓							
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1.13	Contextual practice				✓							
Designing principles												
1.14	Investigate social and economic challenges					✓						
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1.16	Avoiding design fixation					✓						
1.17	Developing design ideas					✓						

The content in each section of the textbook covers the same specification points as the corresponding downloadable teaching unit, e.g. Section 1 complements Unit 1.

Specialist material categories

		Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6-1	Unit 6-2	Unit 6-3	Unit 6-4	Unit 6-5	Unit 6-6
2.1	Design contexts											
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2.5	Stock forms, types and sizes											
2.6	Manufacturing processes											
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Materials covered in Units 6-1 – 6-6:

6-1 Timbers

6-2 Metals

6-3 Papers and boards

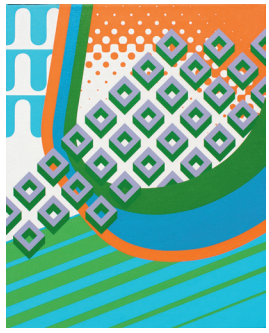
6-4 Polymers

6-5 Systems

6-6 Textiles

Edexcel GCSE (9-1)

Design and Technology



This book provides detailed and concise coverage of all the topics covered in the new Edexcel 1DT0 Design and Technology (9-1) specification, written and presented in a way that is accessible to teenagers and easy to teach from. It can be used both as a course text and as a revision guide for students nearing the end of their course.

It is divided into 11 sections covering every element of the specification. Sections 6-1 to 6-6 of the textbook cover each of the specialist material categories. These sections would complement practical classroom experience. Each chapter contains relevant questions and exercises from past papers, which can be set as homework. Answers to all these are available to teachers only, in a Teachers Supplement which can be ordered from our website **www.pgonline.co.uk**

About the authors

Mike Ross has 16 years' experience as Head of Design and Technology in secondary schools in the state and private sectors. He has overseen all disciplines at GCSE as well as A level Product Design for both Resistant Materials and Graphics specialisms. He has also taught Electronics at GCSE and A level. He has a BEd degree in Secondary Design and Technology Teaching.

Emma Arnold initially studied furniture design and manufacture at Parnham College. She has 15 years of experience teaching years 7-13 in the state and private sectors and was Head of Design and Technology for seven years. For eight years, she has been a freelance tutor and visiting lecturer for the Department of Education at Buckingham University, training and assessing trainee teachers.

Emma Berry brings eight years' teaching experience, from inner city schools to some of the highest achieving schools in the country, spanning state, grammar and private sectors. A Subject Leader for Design and Technology, her industry experience includes sustainable design and curation. Emma brings rich cultural insights enhanced by international experience and dressmaking.

Cover picture:
'Stop Static (Before It Stops You)'
Acrylic on canvas,
30" x 24" © Grant Wiggins 2014
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This book has been endorsed by Edexcel.

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