# Edexcel GCSE

Design and Technology 1DT0

1

# Industry and enterprise

Unit 1
New and emerging technologies

PG ONLINE

# Objectives

- Apply a breadth of technical knowledge and understanding of the characteristics, advantages and disadvantages of:
  - Industry, including unemployment, workforce skill set, demographic movement, and science and technology parks
  - Enterprise, including privately-owned business, crowd funding, government funding for new business start-ups, and not-for-profit organisations

# Old technology

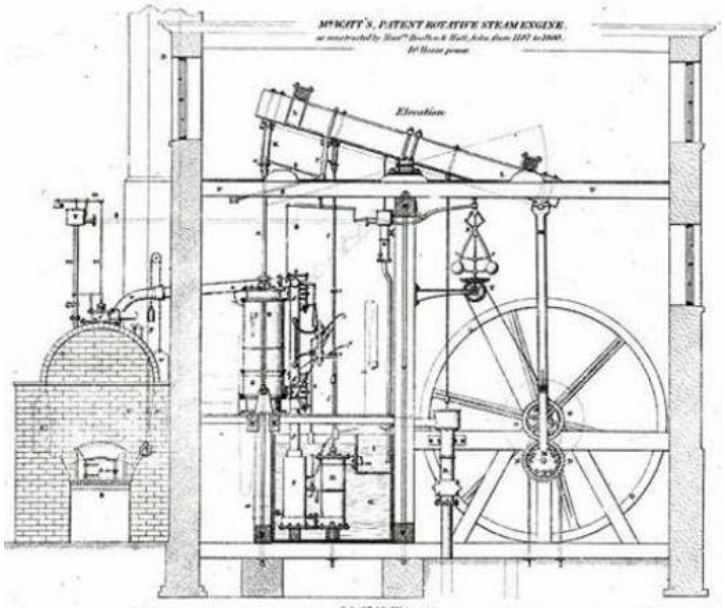
- Early man began to invent tools to aid everyday life
- Even in the Stone Age, 'modern' technology changed the way people lived
  - How would new tools such as simple stone axes and knives have affected the lives of prehistoric people?

# Embracing change

- Technologists over the millennia have embraced change, refined ideas and developed new ideas

# The industrial revolution c.1780

- The late 1700s saw the invention of steam powered machines and early automation
  - This was the start of a social and economic change that began to improve living standards for the masses
  - This came through employment, movement of people and goods, mills, mines and agriculture



# The digital revolution c.1940

- The computer has enabled huge change in industry
- How have computerisation and the Internet affected:
  - Globalisation?
  - Communications?
  - Productivity?
  - Accuracy?
  - Processing speed?

# Modern tools and equipment

- How have developments in technology impacted the tools and equipment used in industry and enterprise?
  - How have these new tools contributed to manufacturing?

# Automation

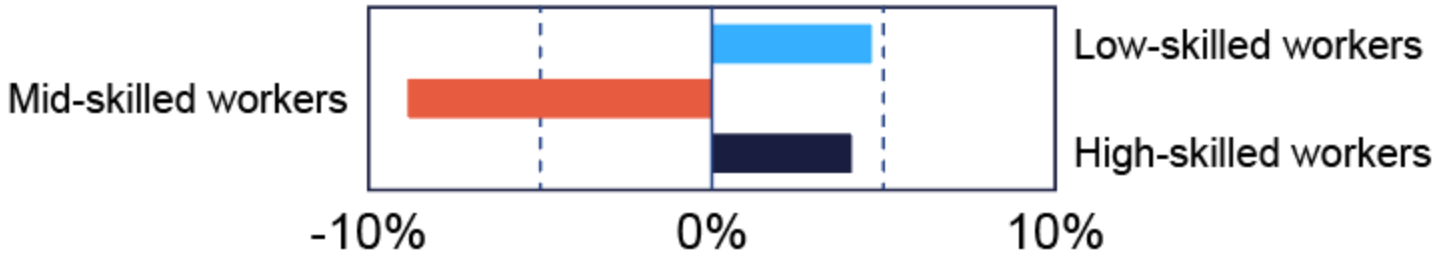
- Robotic automation of manufacturing processes offers significantly greater consistency, accuracy, reliability and productivity than human workers
  - What kinds of job are robots good at doing?
  - What are the benefits of using robots in the manufacture of goods?
  - How have human jobs been replaced by robots?
  - How have job roles changed?
  - How have jobs been created?

# Organisation of the workplace

- New and emerging technologies have influenced change in:
  - Personnel, job roles and hierarchical structure
  - Physical space and layout of the workplace
  - Systems, processes and workflow

# Effect on employment

- New technologies, particularly in automation, have increased unemployment of middle-skilled workers such as machine operators and secretaries
  - Where have these mid-skilled workers gone?
  - How are companies helping staff adapt to change caused by technology?




**Employment shift by sector in the UK 1996 - 2008**

# Workforce skill sets

- London's Docklands Light Railway was opened in 1987 using driverless trains
- A similar proposal has been put forward for the Tube
  - How will this affect the London Underground workforce?
  - What new skills may employees require?
  - What skills will no longer be required?

# Demographic movement

- Demographics study the growth, structure and movement of human populations
- Areas renowned for specialising in one particular industry, such as Sheffield steel, or Tyneside shipbuilding attract workers with specific skills sets
    - How might this have changed over time as these industries became more automated?

# International migration

- Every year hundreds of thousands of people enter or leave the UK with the intention to start a new life
- What are the advantages and disadvantages to the UK of people entering and leaving its borders?
  - How is the UK workforce affected?
  - How is society affected?

# Science and technology parks

- Science Parks create a hotbed of local talent, often utilising bright young graduates from top universities
  - Cambridge Science Park was set up by Cambridge University in 1970 and has hosted Toshiba, ARM, Philips and other leading technology firms
  - How does this affect local unemployment?
  - How does this affect demographic movement?

# Silicon Valley

- Silicon Valley, near San Francisco, USA is the world's most influential and attractive Science Park
  - Google, Tesla, Apple and Microsoft are all based here

# Worksheet 1

- Complete **Task 1** to examine the effects of new and emerging technology on industry

# Enterprise

- A new invention or idea requires a considerable investment to make it a commercial success
- No matter how good an idea is, it can still fail if its development and execution is not right
  - A huge industry exists to support fledgling ideas and research using new and emerging technology

# New materials and technology

- Graphene is a honeycomb lattice carbon structure only one atom thick
- It is 200 times stronger than steel, very flexible, conducts heat and electricity, and is almost transparent
  - Electronics and energy storage could be revolutionised
  - How might a new material affect new technologies?

# Developing ideas

- Innovation such as 3D printing has the potential to change product development everywhere
- This fuels a cycle of new ideas, new businesses, new jobs and newer ideas
  - 3D printers can produce solid objects, intricate hollow artefacts and moving parts that actually work
  - What if 3D printing technology became 100 times faster?

# Privately-owned business

- Small businesses can use new technology to compete with their larger competitors
  - Computer technology has enabled individual designers to access the leading industry design tools
  - Production technology has meant that widgets can be made on demand, avoiding the costs of holding stock
  - Communications technology has enabled remote working so small teams can be formed across the globe
  - Crowd funding provides opportunity for significant start-up investment capital

# Crowd funding at POD POINT

- Crowd funding enables organisations to raise investment from individuals who believe in their idea
  - POD Point supply electric vehicle charging solutions to individuals and organisations across the UK
  - In 2015, they launched an online crowd funding campaign
  - This raised over £1.8m in investment from 618 individuals
  - What are the alternatives to crowd funded investment?

# Government funding

- New business start-ups can apply for government grants or loans at preferential rates
  - Grants do not need to be repaid
- There are hundreds of options but they are very competitive
  - Why is the UK government keen to support businesses that focus on innovation?

# Not-for-profit organisations

- Not-for-profit organisations include charities, voluntary groups or social enterprises
- They do not make private profit for directors, members or shareholders
  - Charitable groups are often run by a committee of volunteers
  - A social enterprise reinvests profits back into the local community, often buying raw materials from the same community

# Impact on enterprise

- Complete **Task 2** on the worksheet

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Design and Technology 1DT0

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## Sustainability and the environment

Unit 1
New and emerging technologies

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# Objectives

- Understand that new and emerging technologies need to be developed in a sustainable way
- Consider the following with regards to sustainability:
  - Transportation costs, pollution, the demand on natural resources and the waste generated
- Understand the positive and negative impacts that new products can have on the environment including:
  - Pollution, waste disposal, materials separation, the transportation of goods around the world and the packaging of goods

# Fragile Earth

- Our planet is a well-balanced eco-system
- Our consumption of the Earth's resources is damaging our environment
  - World population is predicted to hit 9.7 billion by 2050
  - How can new technologies help the environment and address the sustainability of resources?

# Sustainability of raw materials

- Finite (non-renewable) resources and fossil fuels:
  - Are being used faster than they are naturally replaced
  - Cannot be synthetically reproduced
  - Include coal, gas and oil
- 84% of our energy comes from non-renewable sources
  - Governments are working hard to reduce this through harnessing more non-finite energy sources

# Atmospheric pollution

- The quality of our air can be affected by industrial pollution
  - How does air pollution affect us?
  - What are the effects of atmospheric pollution on the planet?
  - What can be done to reverse and prevent pollution?

# Oceanic pollution

- The pollution of waterways and oceans is caused by the mismanagement of toxic by-products
  - Oceanic pollutants might be toxins such as fertilisers, dyes and chemicals being released or washed into the water system
  - Why are polymer based products particularly damaging to our oceans compared to wood or metal?

# Demand on natural resources

- The development and use of new technologies is affecting the demand for natural resources
  - Demand for fossil fuels is falling owing to renewable alternatives, government initiatives and incentives
  - Why is the demand for fresh water expected to increase?

# Farming

- It is estimated that 15% of greenhouse gas emissions are generated from farming
  - What kinds of chemicals are used to increase yield?
  - As populations grow and the demand for meat increases, so too do the negative effects of farming
  - Farming is used to grow crops for biofuels such as oilseed rape

# Mining

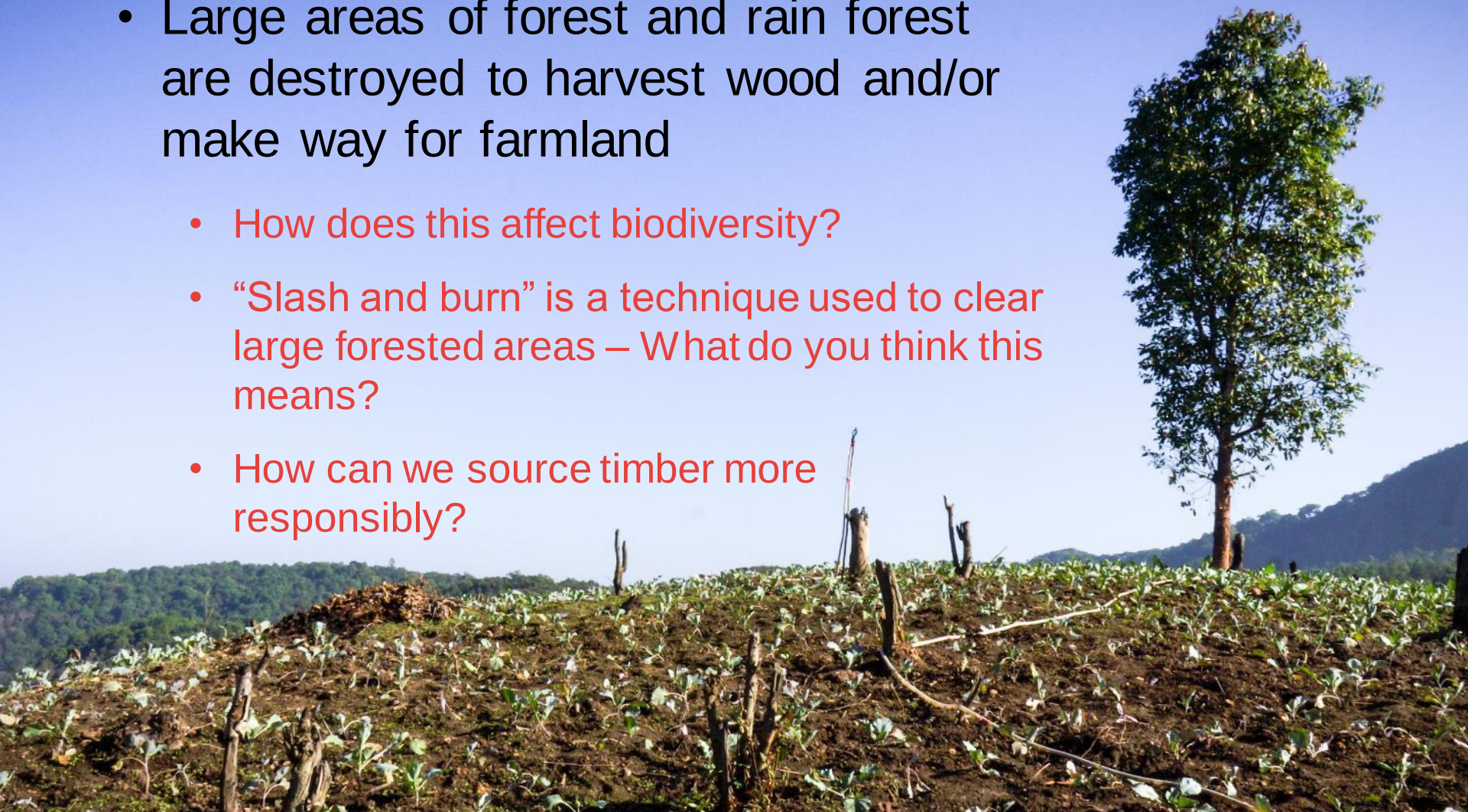
- What kinds of rock and minerals come from mines?
  - What is the difference between surface mining and underground mining?
  - What are the negative impacts of mining?

# Drilling

- Which fossil fuels are harvested through drilling?
  - Rigs are often set up off-shore
  - Why do some rigs need to be built in the sea?

# Deforestation

- Large areas of forest and rain forest are destroyed to harvest wood and/or make way for farmland
  - How does this affect biodiversity?
  - “Slash and burn” is a technique used to clear large forested areas – What do you think this means?
  - How can we source timber more responsibly?



# Renewable energy

- Wind, solar, hydroelectric, tidal and biomass
  - Energy is used in residential, commercial and industrial situations, and for transportation

# Non-finite materials

- Non-finite resources include those that are unlikely to be exhausted, or those that are replaced faster than we can use them
- These include:
  - Oxygen
  - Water
  - Timber
  - Leather
- Is paper a renewable resource?

# Responsible design

- What factors should be considered by responsible designers and manufacturers?

# Responsible design

- Considerations include:
  - Production techniques that may use non-renewable energy
  - Toxic by-products created in manufacture
  - Environmental impact of mining or harvesting
  - The product itself or production processes may emit $CO_2$
  - Powering a product may require non-renewable energy
  - Transportation and distribution distance
  - Maintenance and repair costs
  - Welfare of workers in the material supply chain
  - Recyclability at the end of a product's lifetime

# Generation of waste

- The production and consumption of resources creates waste
  - How we treat and dispose of this waste can dramatically improve its impact on the planet
- What impact might the following methods have?
  - Incineration / burning
  - Landfill / burial
  - Dumping at sea
  - Recycling

# Packaging of goods

- Packaging materials need to be as carefully considered as the products themselves
- Materials that are environmentally friendly to manufacture and to dispose of should be used
  - What packaging products cannot be recycled and why?
  - Give **two** examples of environmentally unfriendly packaging

# Materials separation

- New products should be manufactured in a way that makes them easy to disassemble
  - Integrated packaging uses mixed materials, often combined in a way that they cannot easily be separated
  - What are the implications of this for household recycling?

# Impact of consumption

- What happens when waste is liquid, toxic or radioactive?
  - Chemicals can leach into the soil and water courses
  - Some industrial waste may be radioactive, particularly that from nuclear reactors
  - What is meant by a radioactive half-life?
  - How is radioactive waste dealt with?

# Impact on the enviroment

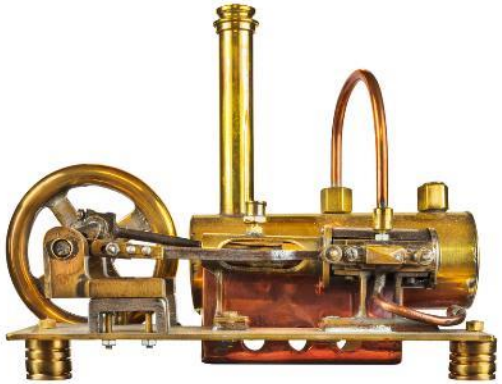
- Plastic microbeads in exfoliating scrubs, body washes and toothpaste
  - These are not a new idea, but only recently have we found them inside deep sea animals and they are polluting oceans
  - Plastics absorb toxins
  - Fish eat plastics
  - We eat fish. Mmmm

# Helping the environment

- Hydrogen fuel cells produce only water as waste
- Electronic paper could replace printed paper
  - What might be the environmental impacts of producing these technologies?
  - How might each of these technologies actually help the environment?

# Eco-friendly technology

- Old technology combined with new ideas can create excellent new products
  - The engine has become more and more efficient with refinements and technological developments
  - Where / how could current technology be developed in the future to do more?

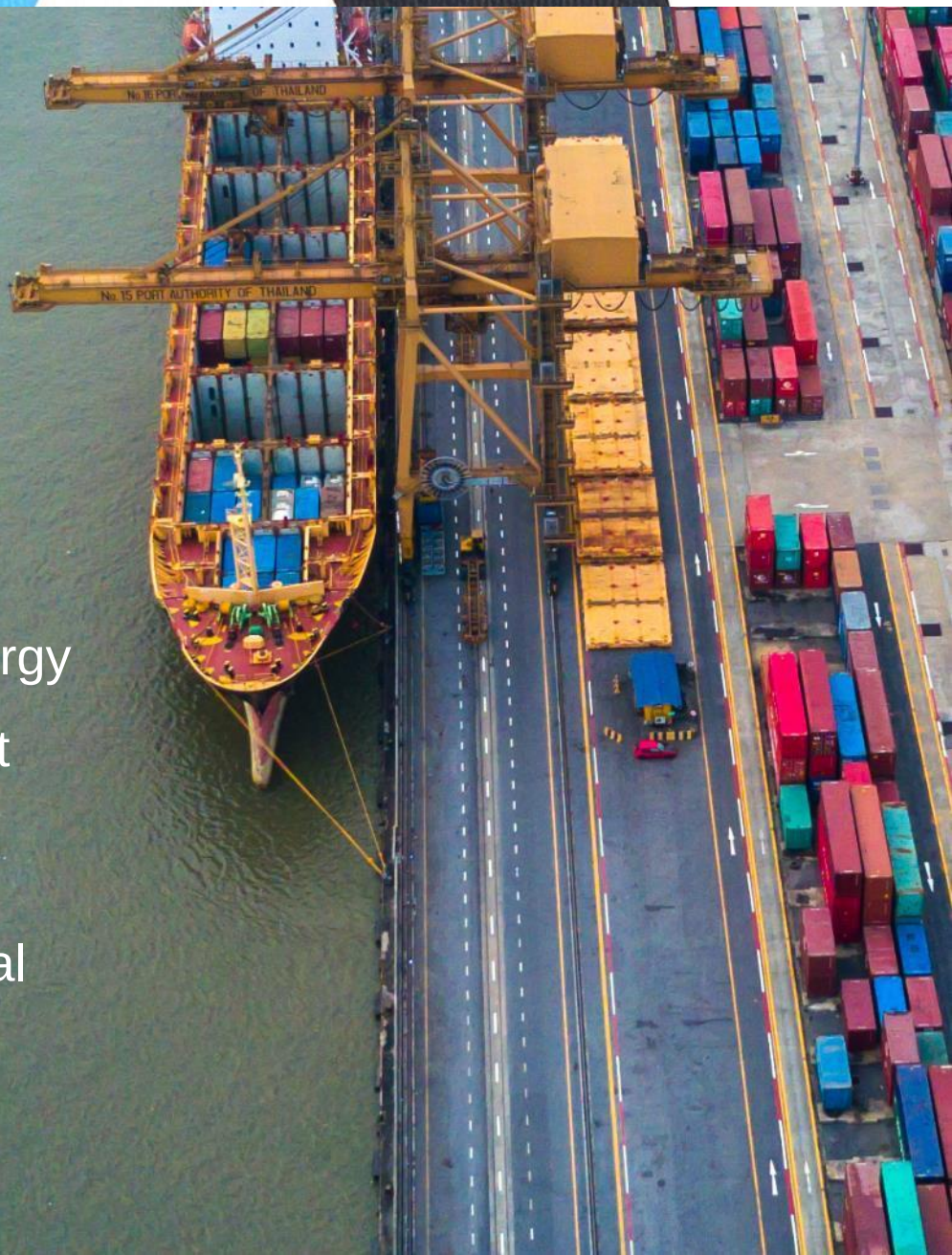


# Reducing consumption

- Digitisation and consolidation of many devices in one
  - Reading a book, playing a CD and taking a photo can all be done with one device, without requiring any more raw material
  - Devices also combine Sat Nav systems, calculators, torches, watches, alarm clocks and more

# Transportation

- The transportation of goods around the world has significant economic and environmental cost
  - Moving goods requires enormous amounts of energy
  - What methods of transport have the most detrimental environmental impact?
  - How can the environmental costs of transportation be reduced?



# Worksheet 2

- Complete the tasks on the worksheet

# Edexcel GCSE

Design and Technology 1DT0

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## People, culture and society

Unit 1
New and emerging technologies

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# Objectives

- Understand how new and emerging technologies impact the workforce, with regard to:
  - Highly-skilled staff, wage levels and apprenticeships
  - Consumers, children and people with disabilities
- Understand how population movement within the EU and social segregation is influenced by technologies
- Be aware of changes in society and how they affect designers and manufacturers, including:
  - Changes in working hours and shift patterns, the Internet of Things (IoT), remote working and the use of video conferencing

# People

- Understanding the consumer market is one of the most challenging aspects for designers and manufacturers
- What works for one person, will not necessarily work for another
  - How do mobile phone companies tailor their products to best suit as many people as possible?
  - What makes you decide to purchase a product? How and why do different consumer's decisions vary?

# New ways of working

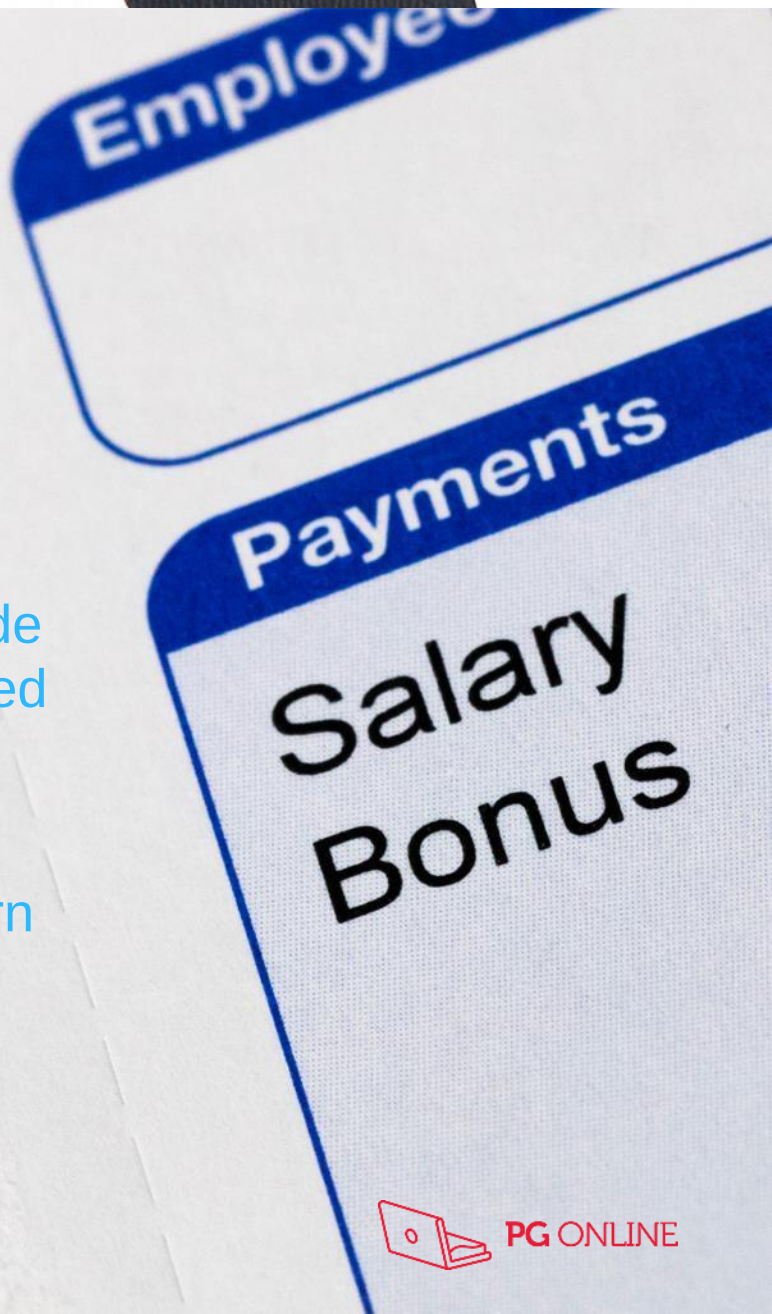
- Automation has had a significant impact on job roles and in shaping the workforce
  - How have factory robots changed production line jobs?
  - How have computers changed administrative roles?
  - Which jobs have remained largely unaffected by technological change?

# Highly-skilled workforce

- Advances in technology have resulted in an increase in highly-skilled workers such as engineers, bankers and programmers
  - There has been a shift from 'brawn' to 'brain' with many mid-skilled workers' jobs disappearing or changing
- Highly-skilled workers are commonly at the forefront of research and development

# Wage levels

- Technological advancements over the past 200 years have largely been responsible for an increase in wages
  - Today, technology has driven a divide between highly-skilled and low-skilled workers, reducing the need for mid-skilled workers
  - Technology can challenge us to learn new skills and acquire new knowledge, and this is key to increasing wages



# Apprenticeships

- An apprentice learns a new trade from a skilled employer in return for low wages
  - Often, apprenticeships require regular study and can be accompanied by a formal qualification
  - How might new technology increase the availability and need for apprenticeships?

# Consumers

- The Internet has hugely affected our buying habits
  - Have we become a consumer society?
  - Do you *need* the latest technology first?
  - How can the latest technology change our buying habits?

# Consumer choice

- How does the global market affect choice?
- How does the global market affect manufacturers?
- You don't need inside knowledge to find the best deal, just a price comparison website
  - What ethical questions might buyers have about production or import methods?

# Children

- British and European regulations require a higher level of safety standards in children's toys, clothing and bedding
  - What safety considerations might a child's soft toy require?
  - What do the following labels and warning marks mean?

# Youth and technology

- Technology has provided greater convenience and entertainment to children than any generation before – the down-sides are also well published:
  - Reduced social and conversational skills
  - Depression, disassociation and relationship issues
  - Higher risk of obesity and sleeping problems
- At what age is it appropriate for a child to own a mobile phone?

# Design specifically for the disabled

- New materials have enabled new designs of prostheses to be developed
  - Body scanners and 3D printing technology can make more comfortable, customised sockets
  - Lightweight and flexible materials can improve shock absorbency and freedom of movement

# Inclusive design

- Designs may be developed to be easily used by the elderly or disabled
  - Pedestrian crossings have been designed using audible beeps and bright colours for the partially sighted
  - They are positioned within easy reach of wheelchairs
  - How are buses designed to avoid a negative impact on elderly or disabled users?

# People

- Complete **Tasks 1** and **2** of **Worksheet 3**

# Cultural design

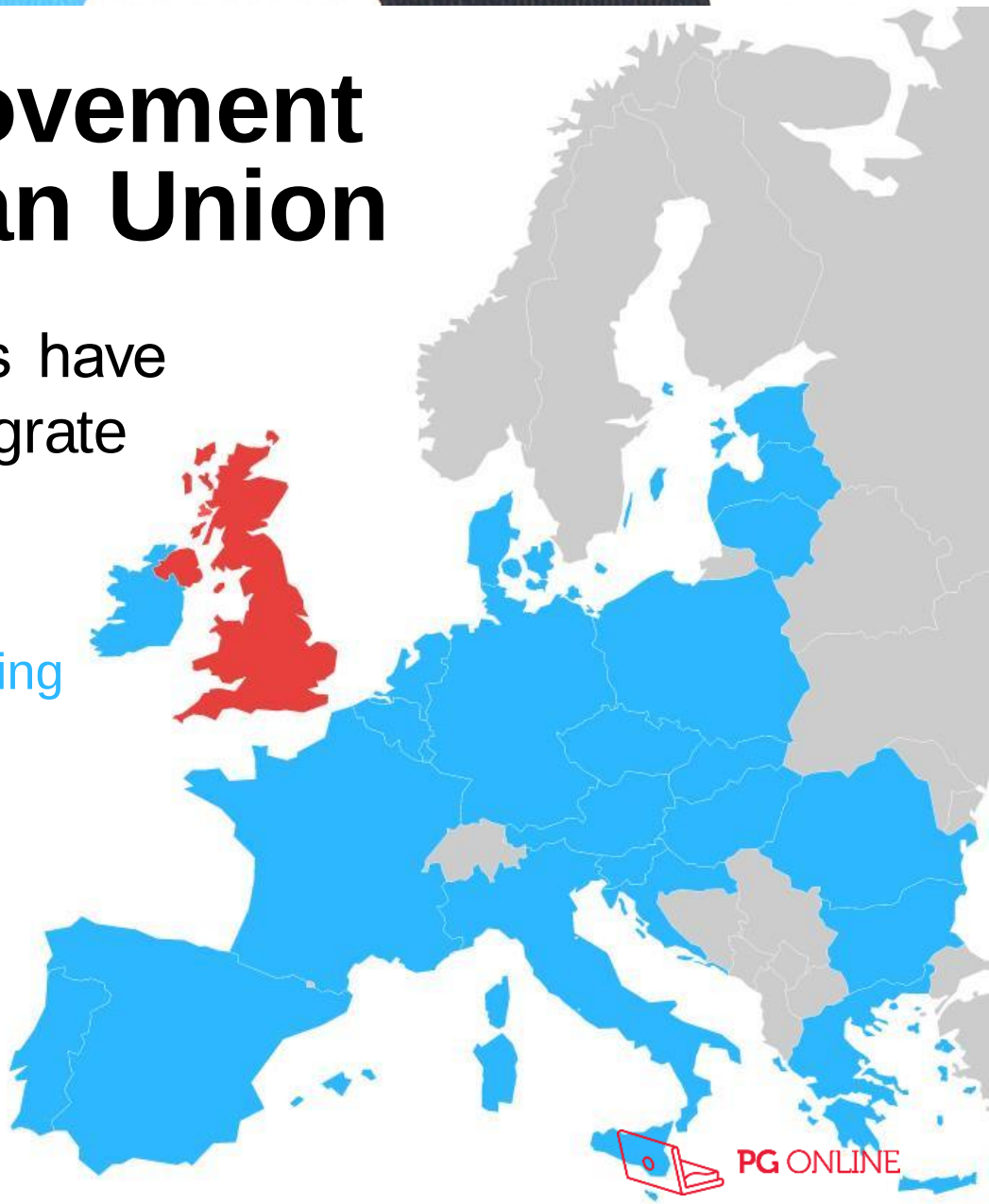
- Japanese culture is to sit on the floor at mealtimes
  - Design of tables and chairs in Japan is therefore very different from those in the rest of the world

# Design, colour and layout

- How do cultural issues affect the way information is presented and understood?
  - How is colour interpreted in different countries?
  - Are there different cultural assumption behind certain icons?
  - Are text and graphs displayed in the same way globally?

# Population movement in the European Union

- The EU's open borders have enabled workers to migrate to where the work is
  - How has this affected employment in the building and fruit picking trades?
  - In what ways has this affected society?
  - What impact might Brexit have?



# Social segregation

- With migration on the increase, many ethnic or national minority groups have clustered together in foreign cities
  - What effect has the Internet on these ethnic communities?
  - London has a greater population of some national minority groups than some cities in their native countries

# Case study Polymer currency

- Polymer currency contains a small amount of tallow in the polymer pellets used to make notes in the UK
- Tallow is a substance derived from animal fat
  - This has upset a large community of Hindus, Sikhs, Jains, vegetarians and vegans living in the UK
  - What are the potential consequences for the Bank of England?

# Design for different religious groups

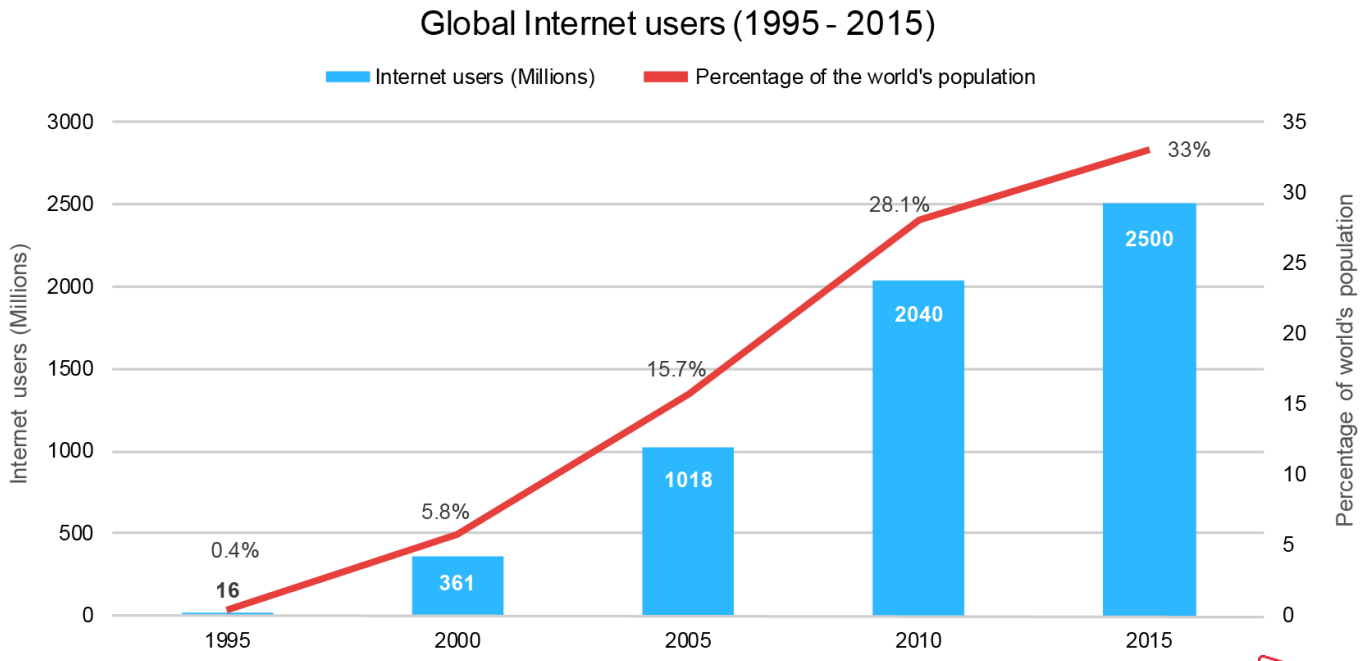
- Textile and fashion design may be judged very differently by those of different religions
  - Some religions require fuller coverage of skin and hair than others
  - Some have particular grooming requirements
  - Some require that certain materials must not be blended
- How might a doll be perceived by different groups?

# Working hours and shift patterns

- Technology, consumer demand and the 'global village' has impacted the traditional 9am-5pm job
  - How does shift work affect family life?
  - What are 'anti-social' hours?

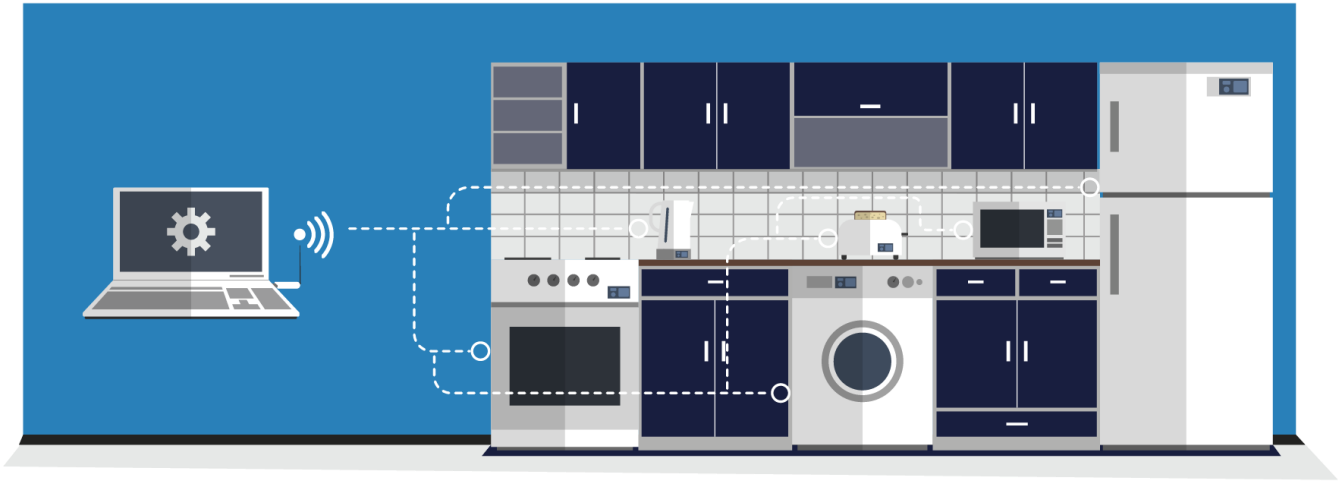
# Internet growth

- In 1969, there were 4 Internet connected networks
  - By 1989, there were 100,000 connected networks
  - By 2012, 2.1 billion people were Internet users



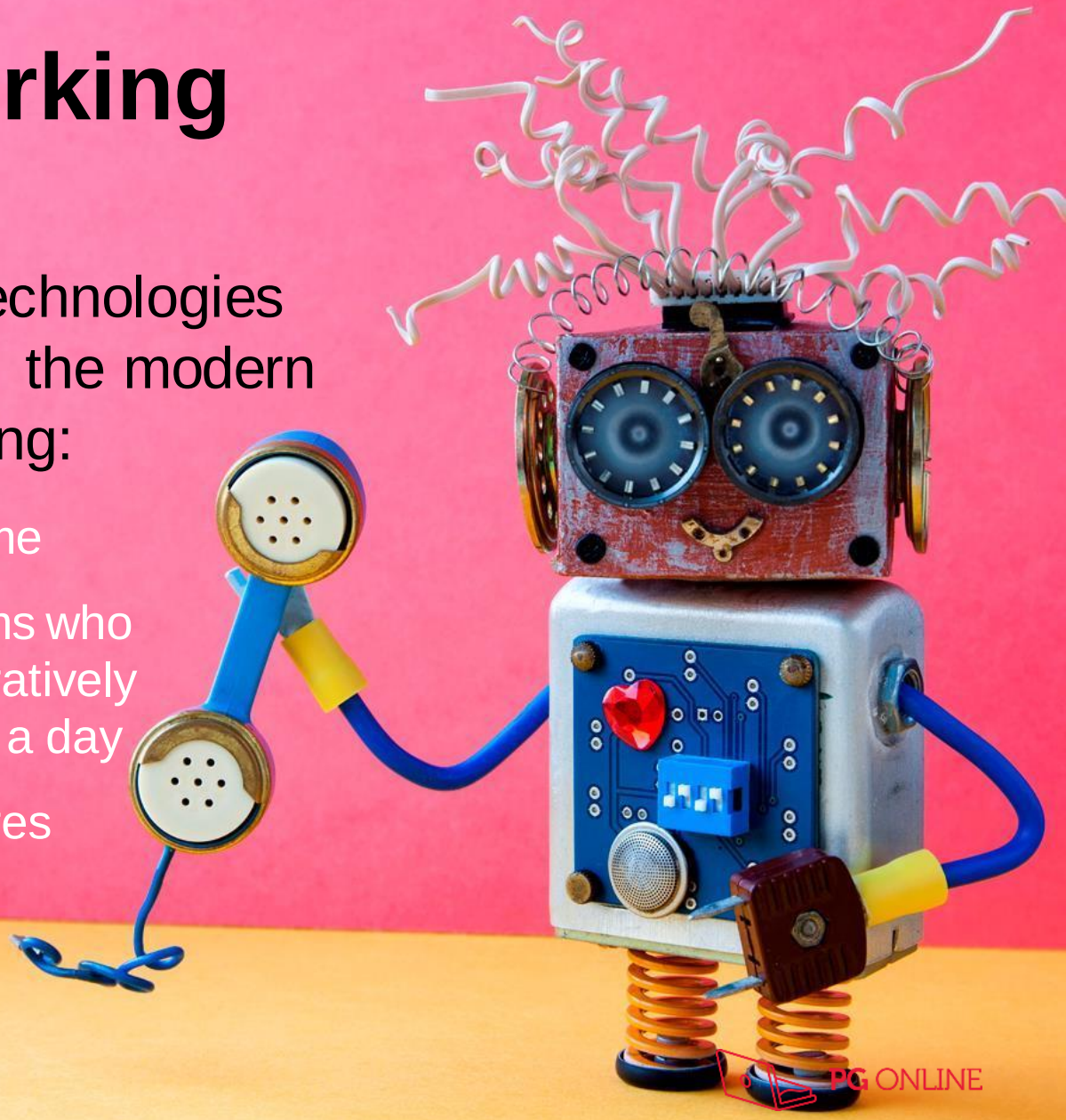
# The Internet of Things (IoT)

- By 2020, it is predicted that more than 50 billion devices will be connected to the Internet including:
  - Lightbulbs, parking meters, thermostats, roads, cars, supermarket shelves, kitchen appliances, dogs, cats…



# Remote working

- The Internet and communication technologies have transformed the modern workplace including:
  - Working from home
  - International teams who can work collaboratively on projects 24hrs a day
  - Remote call centres



# Video conferencing

- Video calling has become an accepted alternative to phone calls in business and socially
  - What are the advantages to businesses in using it for meetings?
  - How has video conferencing helped healthcare?
- What are the advantages and disadvantages of this technology?

# Culture and society

- Complete **Task 3** of **Worksheet 3**

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Design and Technology 1DT0

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## Production techniques and systems

Unit 1
New and emerging technologies

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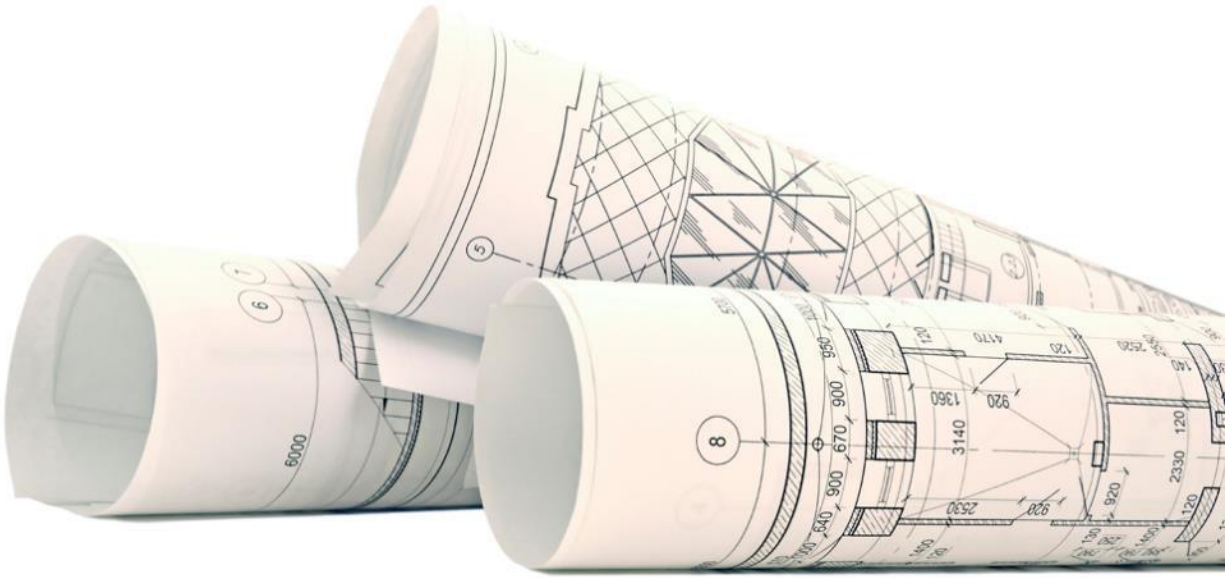
# Entry Task

- Why do many schools and portable classrooms share the same or similar designs?
  - What advantages are there in standardising the design and building of new schools and portable classrooms?



# Objectives

- Understand the advantages and disadvantages of standardised design and components
- Understand how Just In Time (JIT) and lean manufacturing contribute to manufacturing efficiencies
- Understand how products are produced in different volumes
- Explain when and why different manufacturing methods are used for different production volumes

# Standardised components

- Standard components of a part or product can be outsourced
  - This can speed up manufacture
  - Reduce costs
  - Negate the need for maintenance
- Which of these cable connections are standard components?
  - What is the advantage to the company?
  - What is the advantage to the user?

# Lean manufacturing

- ‘Lean’ is based on a philosophy created by Toyota
- It aims to manufacture products just before they are required to eliminate areas of waste including:
  - Overproduction
  - Waiting
  - Transportation
  - Inappropriate processing
  - Excessive inventory
  - Unnecessary motion
  - Defects

# Just In Time (JIT) production

- Items are created as they are demanded
- No surplus stock of raw material, component or finished parts are kept
  - What are the benefits of holding no stock?
  - What are the drawbacks of ordering parts as you need them?
  - What are the potential problems of relying on ‘just in time’ deliveries of materials?
  - How do JIT systems subscribe to the ethos of ‘lean’ manufacturing?

# Advantages and disadvantages

- The advantages of Just in Time manufacturing include:

| Advantages of JIT | Disadvantages of JIT |
|---|---|
| No warehousing costs | Reliant on a high quality supply chain |
| Orders are secured before outlay on parts and materials is required | Stock is not available immediately off-the-shelf for purchase |
| Stock does not become obsolete, damaged or deteriorated | Fewer benefits from bulk purchasing |

# Manufacturing techniques

- Complete **Task 1** of **Worksheet 4**

# Production volumes

- Put the following items in order by the volume manufactured:





Many → One

# Production volumes Answers

- How did you decide where to place the objects?
  - Why do we produce products in different volumes?
  - How were these products made?
  - How do production volumes affect production techniques?

Many → One

# Scales of production

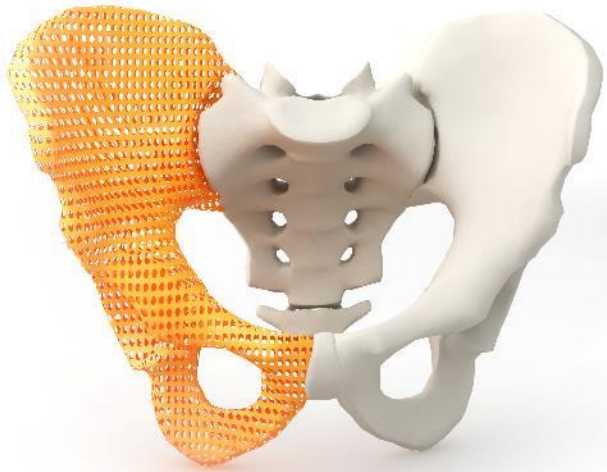
- Some products are manufactured in huge volumes, whereas for other products, only one unit is made
- There are four different **scales of production**:
  - One-off production
  - Batch production
  - Mass production
  - Continuous production

# One-off production

- A single product or **unit** is made
- One-off production is suitable for prototypes and when a product is designed for a client with specific needs
  - Why might one-off production be linked with design for disability?
  - Suggest **two** other examples of one-off products?
  - Why do one-off products have a high unit cost?

# Prototypes and 3D printing

- Prototypes are classified as one-off products and 3D printing is often used to manufacture them
  - What makes 3D printing a suitable process for one-off production?



# Personalisation and one-off products

- What is the difference between one-off and personalisation?
  - Complete Worksheet **Task 2**

# Batch production

- More than one unit is produced at a time in a set or batch e.g. confectionary, newspapers or furniture items
- Patterns, templates or **jigs** are used to increase efficiency
- Production lines are **flexible** and generally enable shorter **lead times**
    - Why are seasonal products suitable for batch production?

# Jigs, patterns and templates

- Jigs and patterns can be made or bought in to expedite a certain process
  - They can help to perform repetitive or awkward tasks accurately
- Jigs can be used in one-off, and batch production
  - How do jigs make production faster and more accurate?
  - How could jigs help reduce waste?

# Worksheet 4

- Complete **Task 2**
- Study the jigs, patterns, templates and stencils in **Task 3** and explain what each one is designed to do

# Mass production

- Mass produced products are made in large volumes, in factories with a high level of automation and very few, if any, processes completed by hand
- **High set-up costs** and **low unit costs** characterise mass production
  - Give **three** examples of mass produced products
  - Why are mass production lines less flexible than those for one-off or batch production?

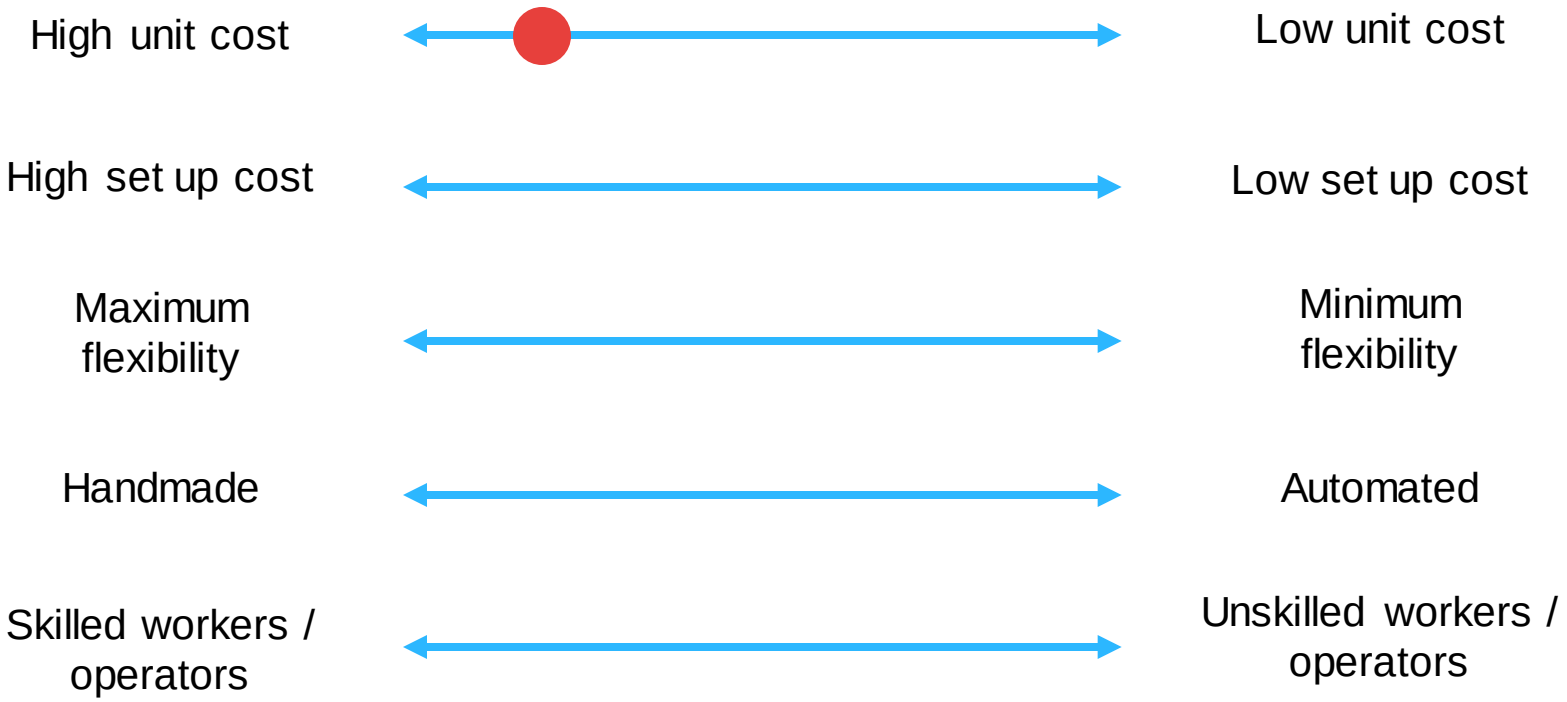
# Set-up costs

- The more automation in a production line, the higher the set-up costs will be
- Products made using complex industrial machinery will be mass produced
  - Which industrial processes or industrially manufactured products have high set-up costs?
  - How can a manufacturer justify the high set-up costs of mass produced products?

# Continuous production

- A continuous production line is run non-stop, 24 hours a day, 7 days a week, manufacturing products to meet a constant demand
  - What types of products would be suitable for continuous production?
  - How labour intensive are continuous production lines?
  - How does this affect unit and set-up costs?

# Consider the scales below:



# Answers

High unit cost — Low unit cost

High set up cost — Low set up cost

Maximum flexibility — Minimum flexibility

Handmade — Automated

Skilled workers / operators — Unskilled workers / operators

**One-off**

**Batch**

**Mass**

**Continuous**

# Plenary

- A variety of different manufacturing techniques have been covered:
  - Manufacturing by hand
  - 3D printing
  - Injection moulding
  - Robotics
- Complete **Worksheet Tasks 4** and **5**

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Design and Technology 1DT0

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# Critical evaluation of new & emerging technologies

Unit 2 Informing design decisions

PG ONLINE

CQ

# Challenge Question

- Can you critically evaluate new and emerging technologies that inform design decisions with reference to:
  - Budget constraints
  - Timescale
  - Who the product is for
  - The materials used
  - Manufacturing capabilities

Entry Task

# Evaluating an existing product

- Critically evaluate this sauce bottle using the following considerations:

1. The form and function of the product
2. The user and their specific requirements
3. Its performance requirements
4. The materials used
5. The scale of production and manufacturing techniques used
6. The likely cost of manufacture

# Informing design decisions

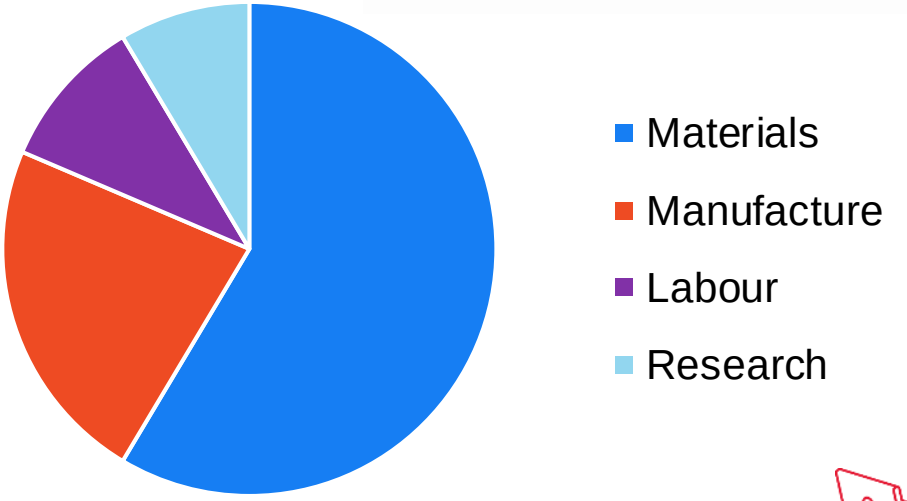
- How can you use the evaluation of a product to make design decisions for a future product?
  - What worked well?
  - What didn't work?
  - What can new technology offer to improve or change things for the better?
  - How has camera technology developed to enable reliable face recognition security features?

# Budget constraints

- Material costs and profit margins will affect product costs and influence the sale price
- A product using cutting edge materials and technology is likely to be expensive to source or produce
  - Should materials dictate price, or should price dictate material type and quality?
  - Would you pay more for a product with the latest technology?
  - Is this premium price likely to be more than the additional cost of manufacturing the new materials?

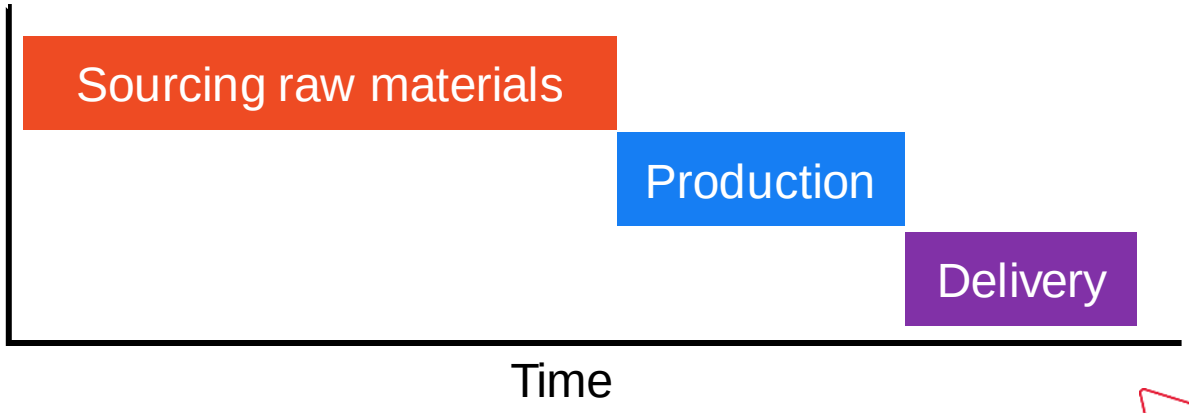
# Budgeting for manufacture

- Suppose that research has concluded that the current market would not tolerate more than £100 for a battery-powered Bluetooth speaker
  - How might a decision to use new technologies affect costs?
  - Complete **Task 1** of **Worksheet 1**



# Effect of timescale on decisions

- What impact could sourcing new materials have on lead times?
  - Will customers tolerate waiting or will they go elsewhere?
- New technologies may be used in the procurement, manufacture or delivery of a new product
  - How might this affect quality, lead times or production costs?



# Manufacturing capabilities

- Print-on-demand technology has enabled start-up publishers and the general public to self-publish books whilst maintaining zero stock
  - Each order is paid for and printed individually before delivery
  - How might this affect unit costs and lead times?

# Manufacturing technology

- How can changes in new technology affect manufacturing techniques, rather than the end products?
  - Modern 3D printing technologies, robotics and CNC machinery have enabled cost-effective one-off production, more complex designs, and improved manufacturing efficiency

# Choice of materials used

- Are new materials and technologies going to give rise to issues that are often only ironed out with the passage of time?
- What levels of testing should be carried out on a new material before it is released?
    - A new medicine technology will undergo years, sometimes decades of testing before it is released for general practice

# Getting it wrong

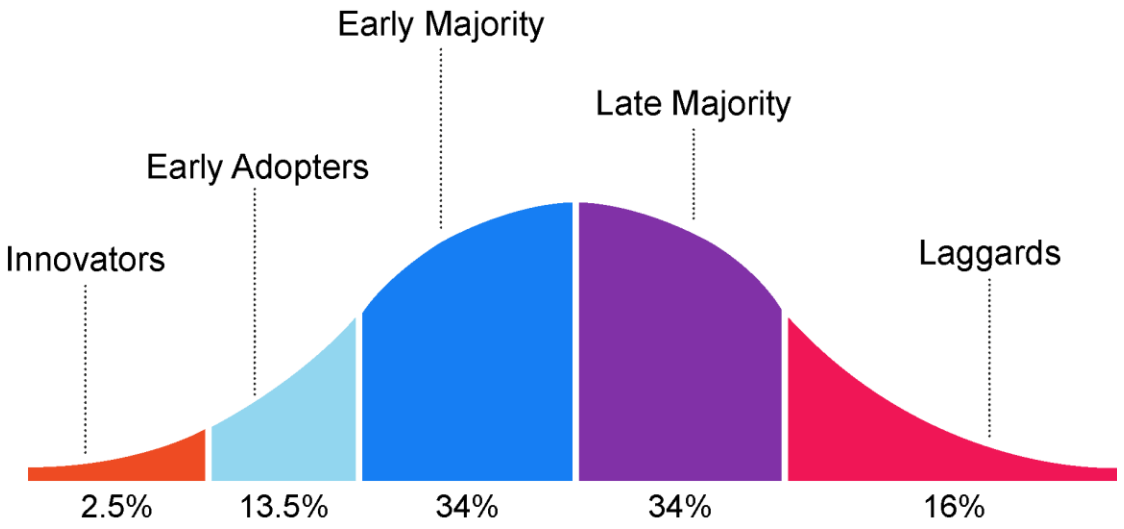
- BPA was a new plasticiser technology developed in the late 1950s which has been widely used in bottles
  - BPA can be released from the polymer with repeated scrubbing, dishwashing and boiling
  - Tests have proven since that the BPA chemical can affect reproduction and growth development

# Lead paint

- Until the 1960s, lead was commonly added to paint to improve drying times, durability and protection
  - Lead is a poison and can be inhaled or consumed as dust particles or flakes
  - Children and those working with paints were most at risk
- Paints have since used safe alternative metals such as Zinc or Titanium

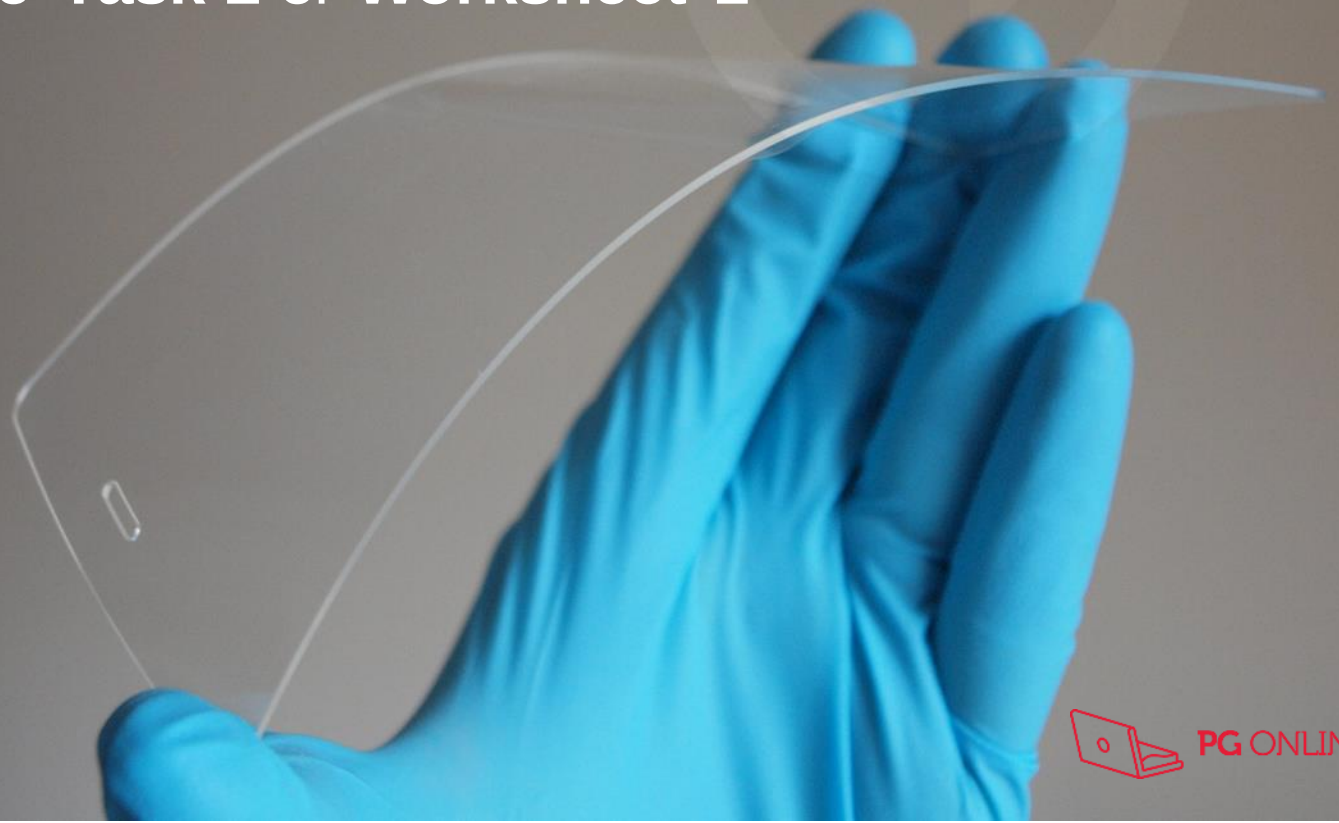
# Making decisions

- If a new technology or material is released, would you be amongst the first to use it or continue using existing technology?
  - How does this decision affect consumers and product manufacturers differently?



# Case study

- Flexible graphene mobile device screens were created in 2017 by the University of Sussex
- Complete **Task 2** of **Worksheet 1**



# Edexcel GCSE

Design and Technology 1DT0

2

## Contemporary and future scenarios

Unit 2
Informing design decisions

PG ONLINE

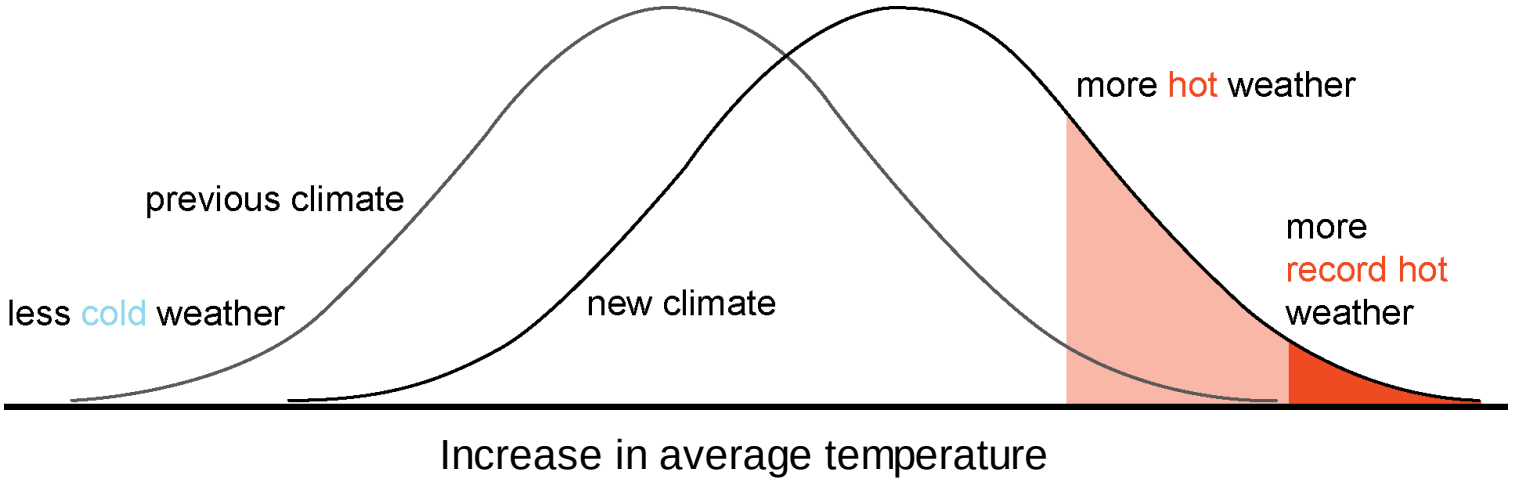
# CQ Challenge Question

- Consider contemporary and future scenarios in making design decisions, including:
  - Natural disaster alerts, defence and recovery
  - Medical advances
  - Travel
  - Global warming
  - Communication

# Natural disasters

- Entry Task

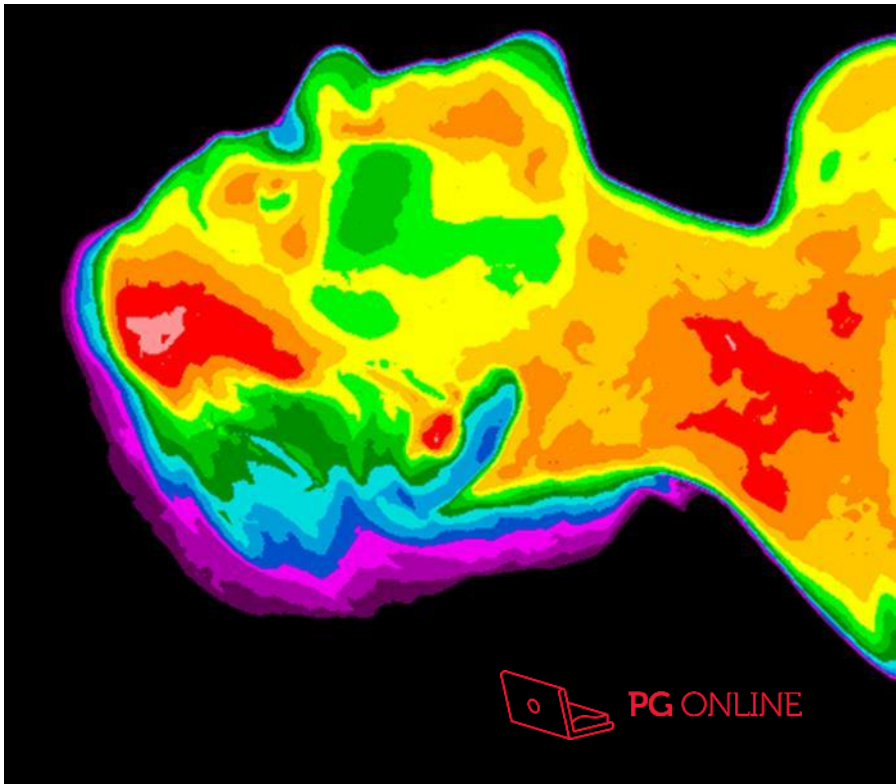
- Explain why an increase in the frequency and intensity of natural disasters is likely to be caused by an increase in average temperature
  - This can affect drought, storms, flooding and a melting of the polar ice caps, raising sea levels



# Tsunami technology

- Early warning and monitoring systems are in place to provide SMS text alerts to those in ‘at-risk’ regions

- How could the motion sensor inside mobile phones be used as an early warning system for earthquakes?



# Medical advances

- Medical robots are now able to perform operations controlled by surgeons from another room
- Surgeons use live video to manipulate robotic arms that replicate their movements in the operating theatre
  - How far away could the surgeon be?
  - How might distance or remote surgery affect patients?

# Printing body parts

- 3D bioprinting is being used to create new, living organs
- Skin tissue, livers and joint cartilage have already been 'printed' and successfully transplanted
    - A solution for more complex organs is probably only a couple of decades away

# Travel to Mars

- Space technology is making the concept of a mission to Mars a real prospect
  - SpaceX is a Californian company with the aspirational goal of a manned mission to Mars by 2024
  - They plan to build power, mining and life-support infrastructure on the red planet thereafter

# oop

all

r

- This means that London to Edinburgh would be possible in just 16 minutes

# Global warming

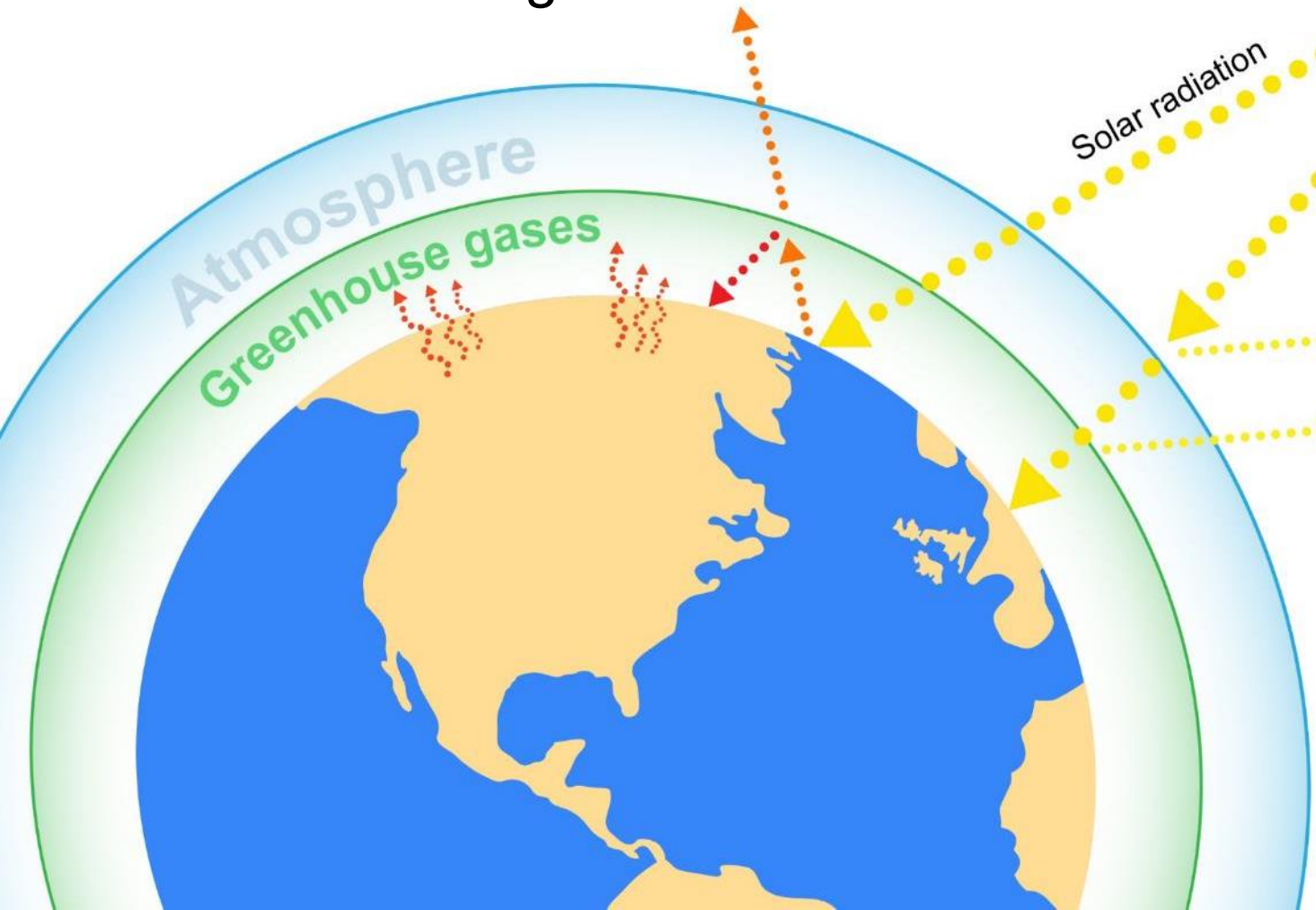
- Global warming is the change in the world's climate
  - The 'greenhouse effect' has caused an increase in the world's land and sea temperatures

# Global emissions

- There are many sources of environmental pollution that are warming the earth
  - What are the **two** key greenhouse gases?
  - What kinds of human activity generate greenhouse gases and carbon?

# The greenhouse effect

- What is the “greenhouse effect”?



# How does nature help?

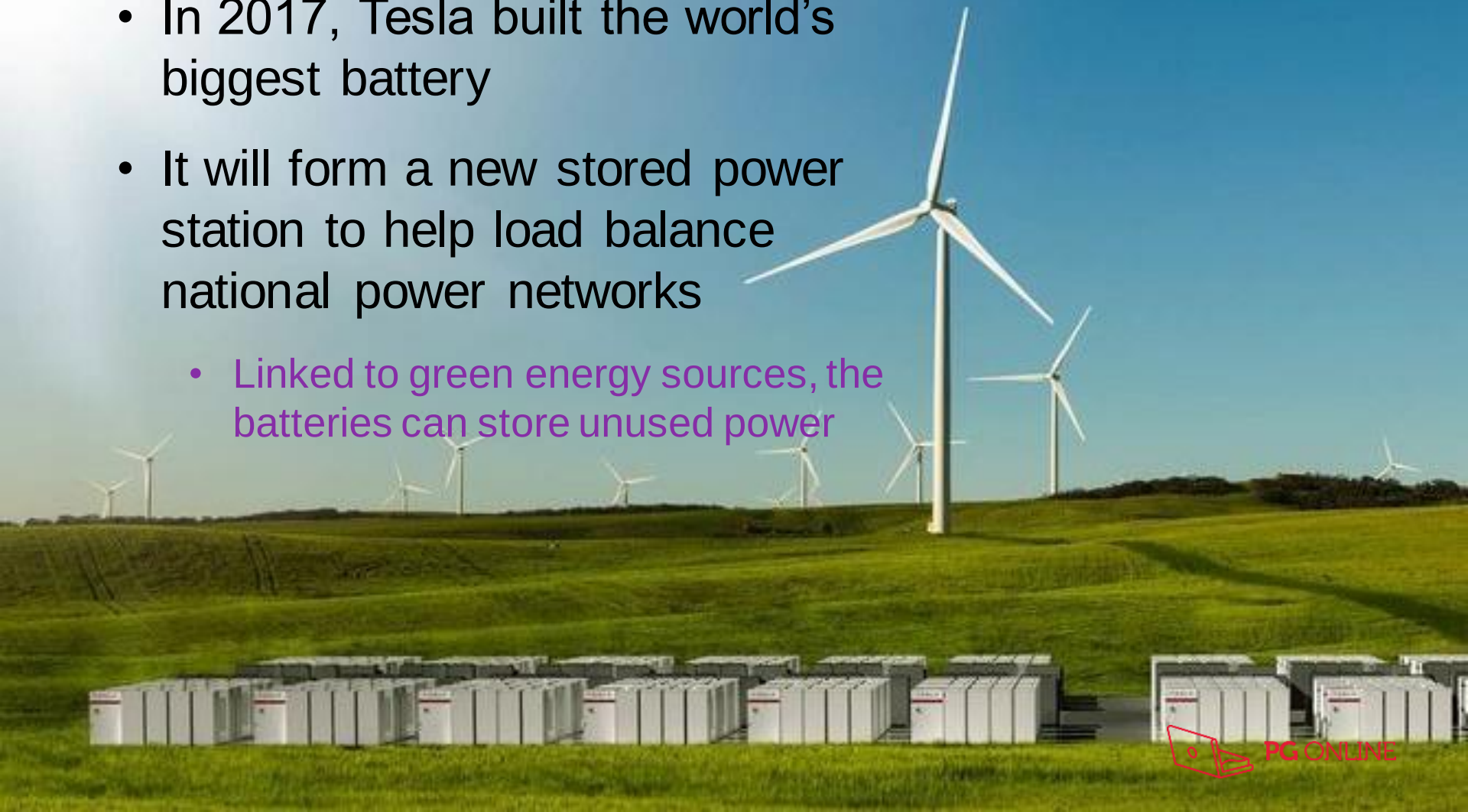
- How do plants affect the carbon content in our atmosphere?
  - How could human activity help to reduce the greenhouse effect?

# Recent legislation

- The Paris Agreement, adopted by 195 countries in 2016 was the world's first comprehensive climate change agreement to:
  - Limit the increase in global average temperature to well below 2°C above pre-industrial levels
  - Reduce greenhouse gas emissions
  - Give financial support for low-emission development

# Battery farms

- In 2017, Tesla built the world's biggest battery
- It will form a new stored power station to help load balance national power networks
    - Linked to green energy sources, the batteries can store unused power

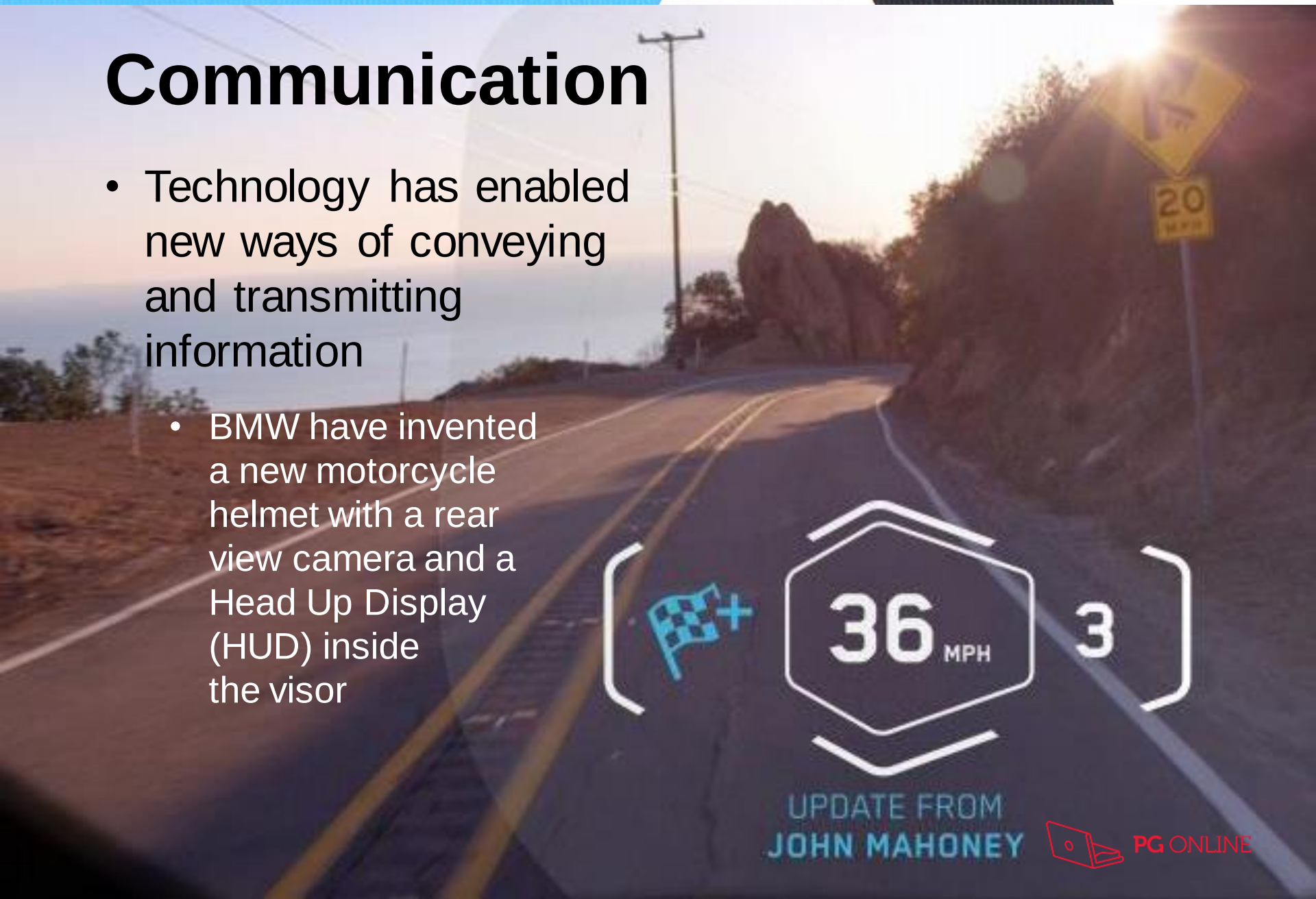


# Worksheet 2

- Complete **Task 1** of **Worksheet 2**

# Communication

- Technology has enabled new ways of conveying and transmitting information
  - BMW have invented a new motorcycle helmet with a rear view camera and a Head Up Display (HUD) inside the visor



# Access to communications

- Modern technology is enabling large parts of the world's society to become connected

# Miniaturisation

- The miniaturisation of technology is enabling advances in speed, changes of use and specialisation
  - The world's smallest mobile phones are only the size of a lipstick
  - They use almost no metal parts, making them invisible to body scanners
  - Why is this causing problems for prisons?

# Case study

- Look at **Task 2** of **Worksheet 2** to examine how autonomous vehicles may impact society

# Edexcel GCSE

Design and Technology 1DT0

3

# Ethical and environmental perspectives

Unit 2
Informing design decisions

PG ONLINE

# CQ Challenge Question

- Consider ethical perspectives when evaluating new and emerging technologies with reference to:
  - Where a product was made and who by
  - Who it will benefit
  - Fair trade products
- Consider environmental perspectives including:
  - The use of materials
  - Carbon footprint
  - Energy usage and consumption
  - Life cycle analysis (LCA)

• Entry Task

# Ethics and the environment

- Companies are increasingly aware of the need for social responsibility
  - This includes sustainably sourcing components and materials, ethical production methods, reducing waste, recycling and considerate end-of-life disposal
  - What are the benefits of social responsibility to companies?
- How might ethical factors inform design decisions?

# Product origin

- Why does it matter to people where a product was made?
  - Are you more or less likely to buy a product that has been made in your home town or country?
  - Why might a company choose to have their products manufactured overseas?

# Who makes a product?

- Do companies or people make products?
  - How should companies consider the welfare of people supplying them with parts and labour?

# Child labour

- Land and resources in developing countries are used to create products for western markets
    - Would you buy a garment made using child labour?

# Modern slavery

- There are an estimated 13,000 people in the UK working as slaves in industry
  - These include the agriculture, fishing, electronics and hospitality industries, as well as in private homes
  - Under the Modern Slavery Act (2015) companies are being held to account for the management of their supply chains and the welfare of those who work within them

# Ethical considerations

- The SnapChat ‘Ghost’ function disables or enables a new GPS location feature that displays your position to all your social media connections on a map
  - What considerations should a user make before deciding whether to continually expose their location?
  - Is it ethical for this feature to be switched on by default?

# Government responsibility

- Governments have a responsibility to protect our environment and ensure safe working conditions
  - What kinds of commitments would you make to reduce environmental impact, if you were in charge?

# Safe working conditions

- Governments set rules that outline safe working conditions for employees as well as the minimum wage
  - In the UK, the Health and Safety Executive (HSE) ensures employers have a legal obligation to provide a safe working environment
  - Some countries are more relaxed about health and safety law than others
  - How might employees' health and safety be compromised?

# Fair trade

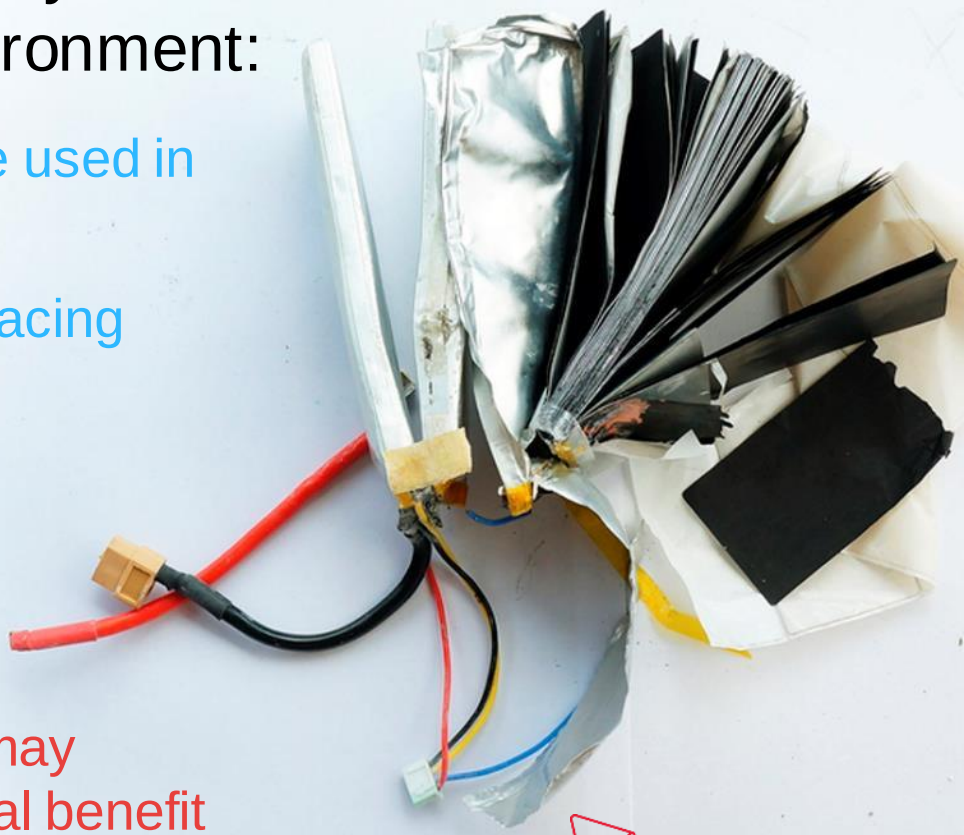
- Fair trade is about better prices, decent working conditions and fair terms of trade for farmers and workers in less economically developed countries
  - The Fairtrade Foundation also provide a premium to farmers to invest in their communities
  - What produce is frequently sold under the Fairtrade label?

# Environmental perspectives

- Environmental considerations may sway decisions in the process of designing and manufacturing products and parts
- Careful thought needs to be given to:
  - The use of materials, including the type and variety
  - The overall carbon footprint of the product or organisation
  - The energy usage and consumption during manufacture and transportation

# Use of materials

- Battery technology and electronics are developing considerably in ways that benefit the environment:
  - Fewer rare-earth metals are used in electronics manufacture
  - Battery power is slowly replacing non-renewable energy
  - However, some batteries still require an enormous amount of energy and rare elements to produce, ship and dispose of which may outweigh their environmental benefit

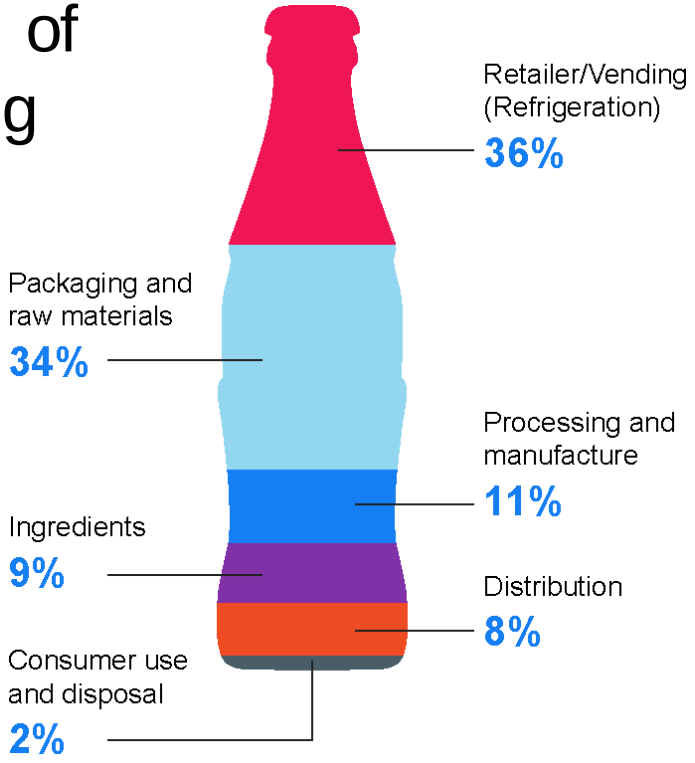


# Carbon footprint

- A carbon footprint is the amount of carbon dioxide released into the atmosphere as a result of the actions of an individual, organisation or community
  - How might your lifestyle choices affect your carbon footprint?

# Carbon footprint of products

- Looking at the carbon footprint of a product is a way of measuring its environmental impact
  - How can designers reduce the carbon footprint of the products they bring to market?
  - How can your buying choices reduce your carbon footprint?



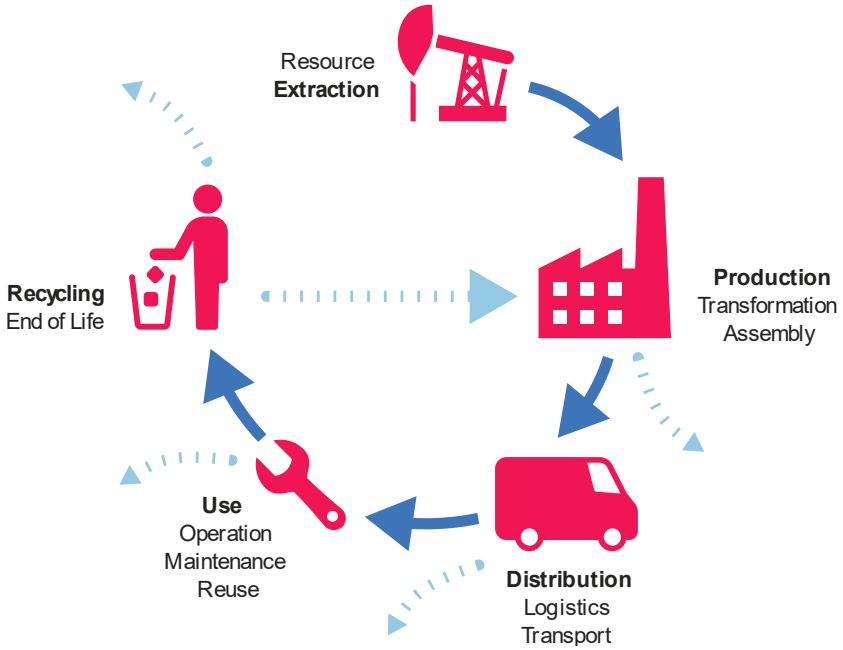

**Carbonated beverage in a 600ml Polyethylene (PET) Bottle**

# Worksheet 3

- Complete **Task 1**
  - How can lifestyle choices add to or reduce an individual's carbon footprint?

# Life Cycle Assessment

- Conducting an LCA will evaluate the environmental impact on a product
  - What factors would you consider at each stage of the LCA?
  - What can a company learn by assessing their products' lifespan in this way?
  - How can they use this to make future improvements?



# Product manufacture

- How does the manufacture of everyday products affect carbon emissions?

# Distribution

- The YARA Birkeland will be the world's first fully electric and autonomous container ship
  - Unlike ordinary diesel cargo ships, it has zero emissions
  - Who will this technology benefit or hinder?
  - How does this affect an items 'product miles'?

# Recycling

- What products are designed to be recycled or reused?
  - What makes them suitable for recycling?
  - What products are easily upcycled?
- What are the benefits of recycling to:
  - The company?
  - The customer?
  - The planet?
- How much recycling does your household produce each week?

# End of life

- Responsible end of life design should include:
  - as few materials as possible
  - recycled and recyclable materials where possible
  - easy-to-separate materials avoiding permanent bonding methods
  - built-in reusability where possible

# Life Cycle Assessment

- Complete **Task 2** of the worksheet

# Plenary

- Consider the following:
  - Are bicycles a carbon neutral product?
  - Why might biofuels be considered carbon neutral?
  - How could the carbon footprint of a school be reduced?
  - Why might organic foods be better for the environment?
  - How could packaging be redesigned to reduce environmental impact?
  - How might low pay increase risk factors for workers?

# Edexcel GCSE

## Design and Technology 1DT0

1

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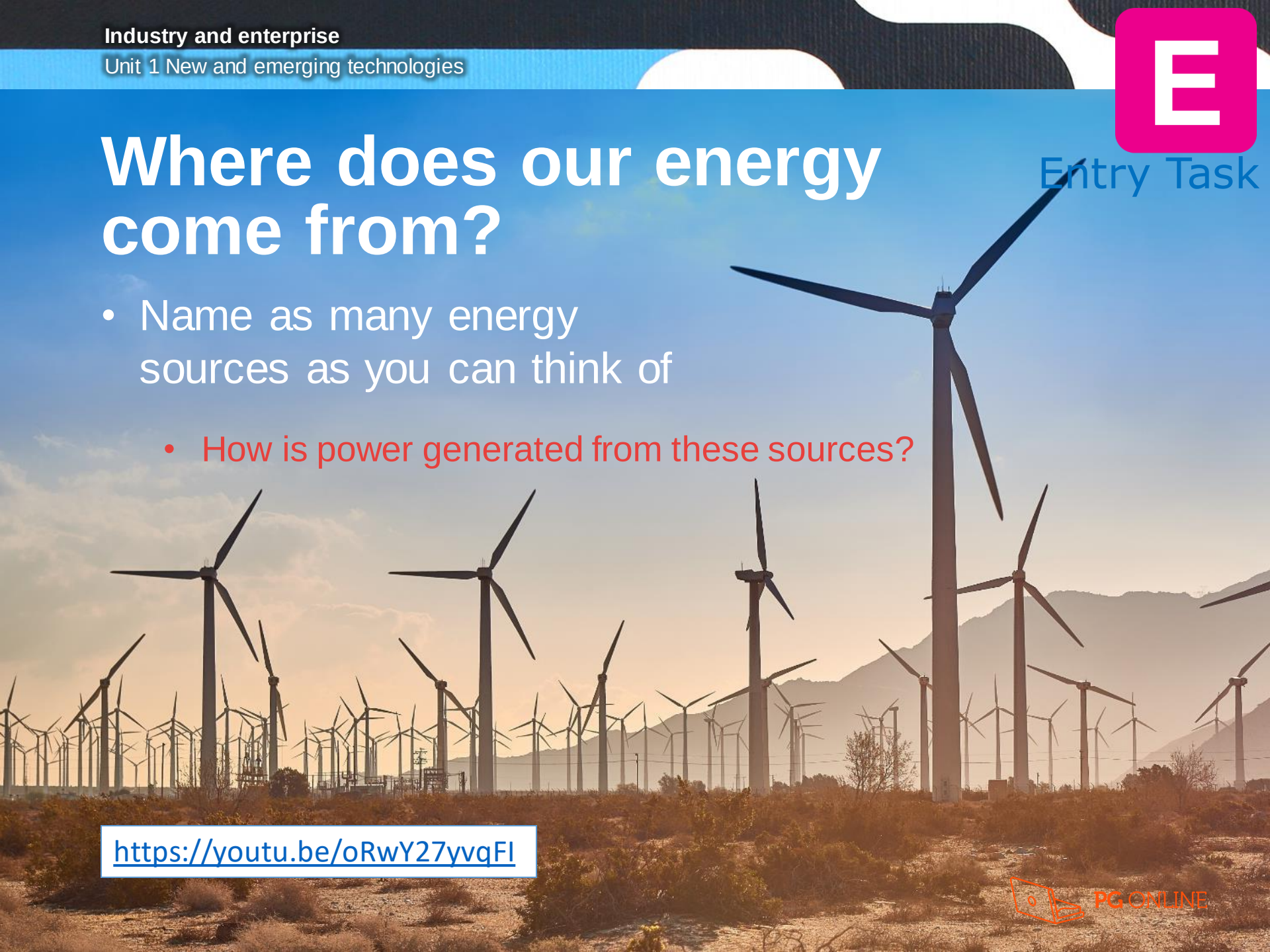
Entry Task

# Where does our energy come from?

- Name as many energy sources as you can think of
  - How is power generated from these sources?



https://youtu.be/oRwY27yvqFI

# CQ

# Challenge Question

- Understand how power is generated from fossil fuels and a range of renewable sources
- Know the advantages and disadvantages for a range of power sources

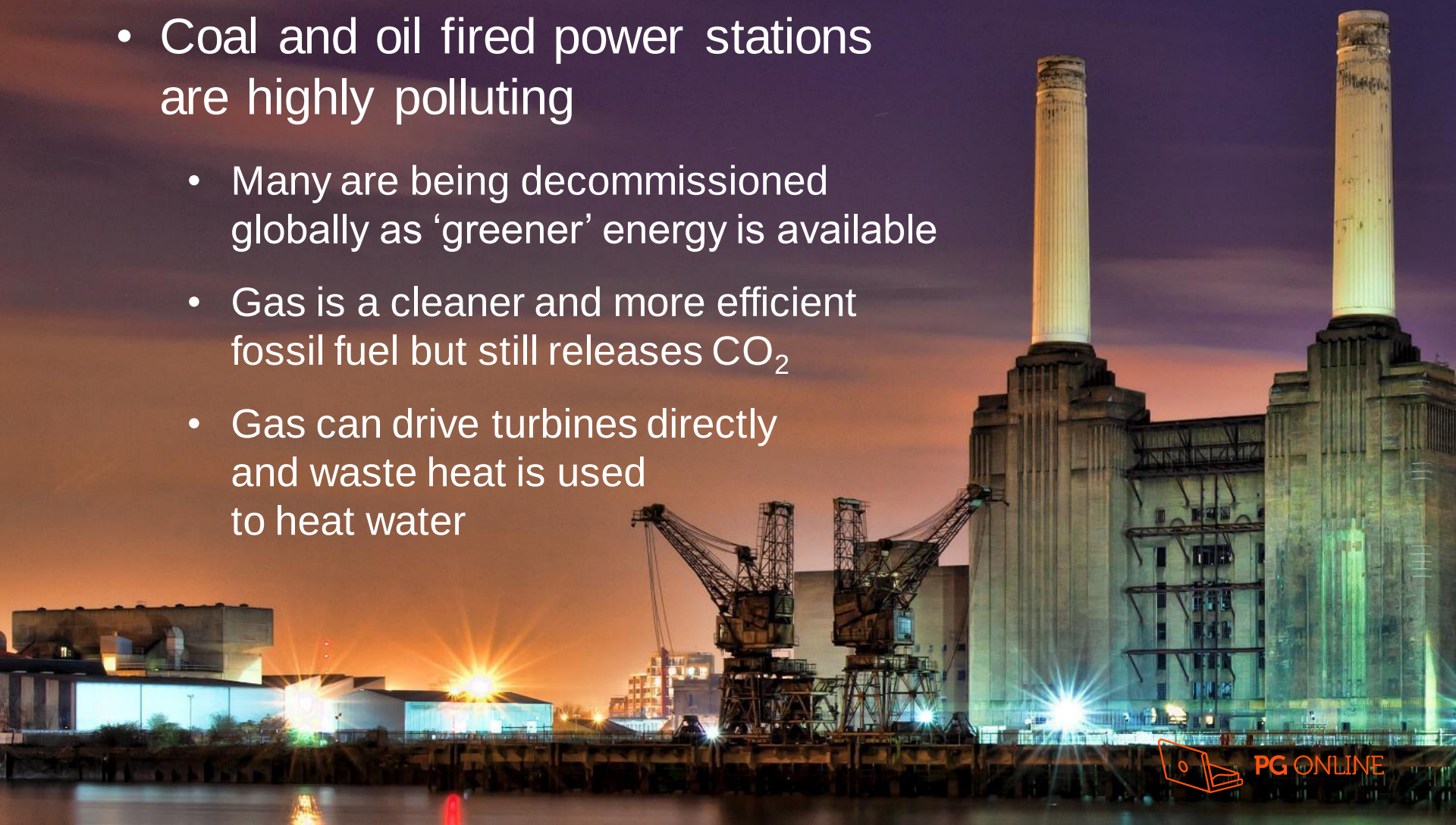
# Fossil fuels

- Fossil fuels are formed from the fossilised remains of plants and animals over millions of years
  - **Coal**, **oil** and **gas** are extracted through mining and drilling
  - Why are fossil fuels considered a **finite** resource?
  - Why are they so relied upon for power generation?

https://www.youtube.com/watch?v=zaXBVYr9Ij0

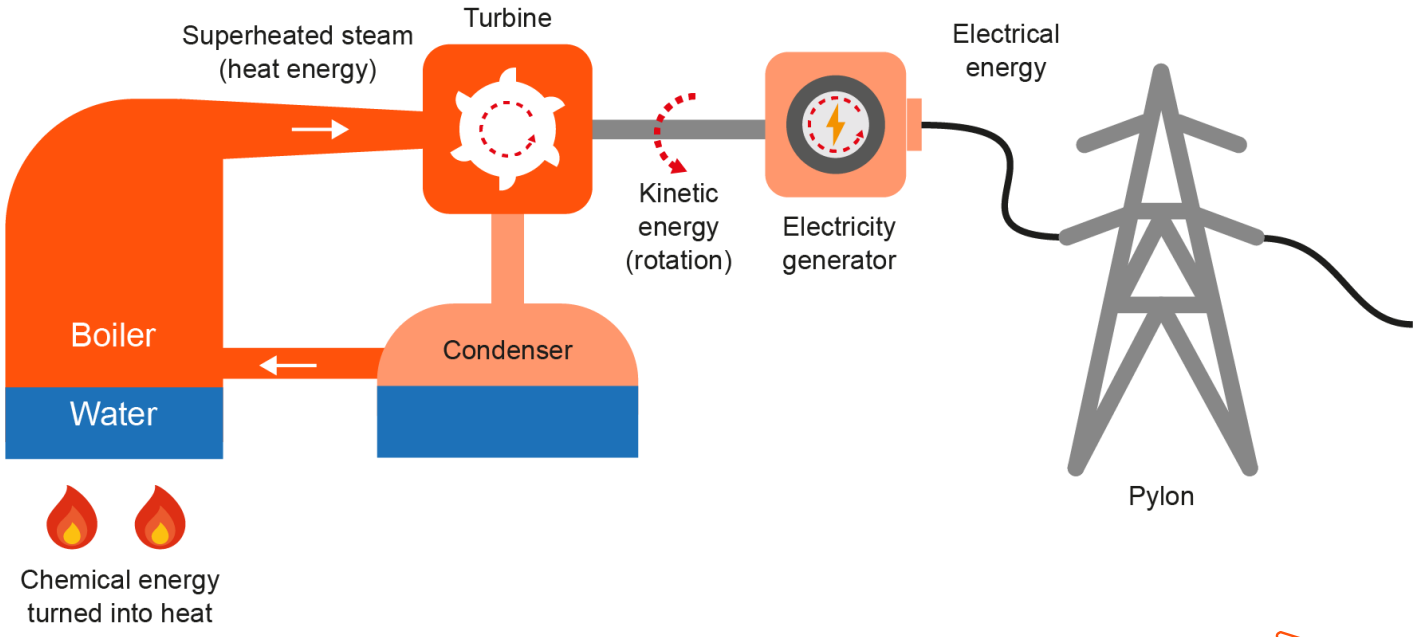
# Coal, oil and gas power stations

- Coal and oil fired power stations are highly polluting
  - Many are being decommissioned globally as ‘greener’ energy is available
  - Gas is a cleaner and more efficient fossil fuel but still releases $CO_2$
  - Gas can drive turbines directly and waste heat is used to heat water



# Energy generation

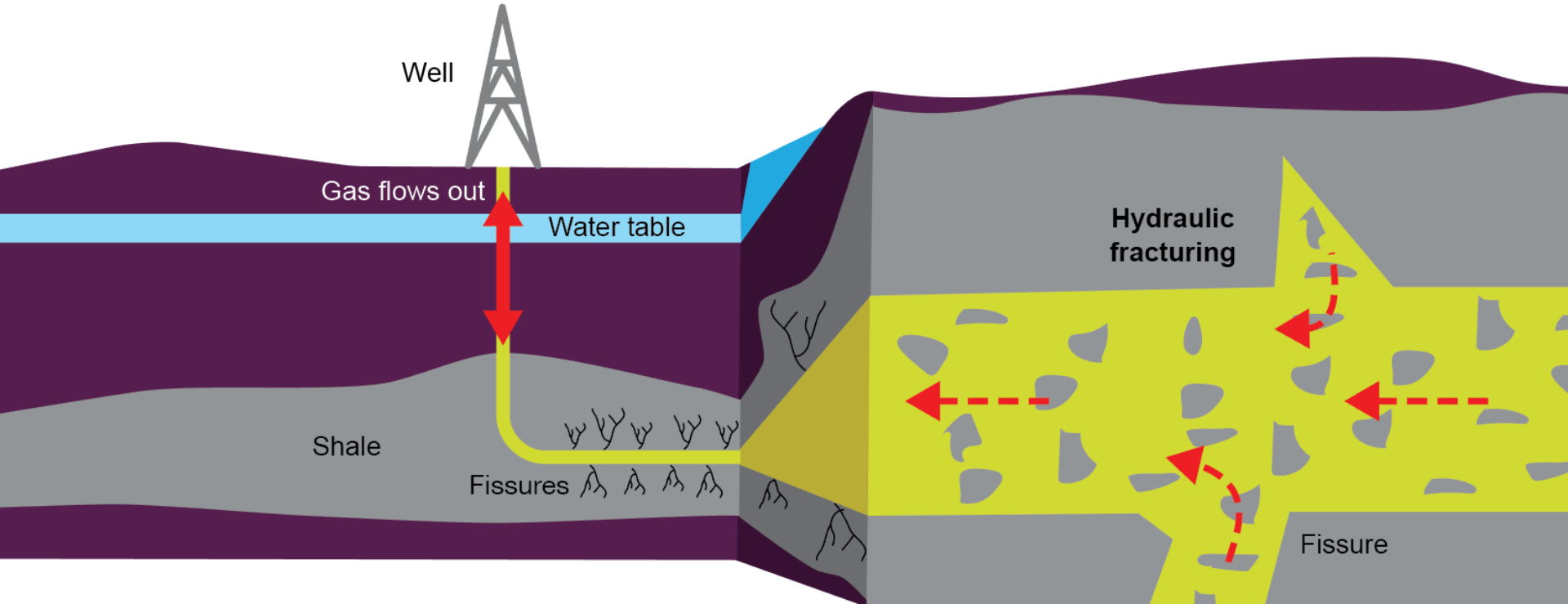
- Fossil fuels can be burned to superheat water under pressure, which in turn drives turbines
  - How is the energy stored in fuel converted to electricity?



https://youtu.be/Io8o2nTXhb0

# What is fracking?

- Fracking involves drilling into layers of shale rock deep in the earth to release pockets of gas
  - Water, sand and chemicals are injected into a well in order to force gas back up – what could go wrong?



- Renewable alternatives to fossil fuels include:

- Why are these classified as 'renewable' sources?

https://youtu.be/T4xKThjcKaE

https://youtu.be/yHWcddUZ35s

# Biofuel - *Biomass*

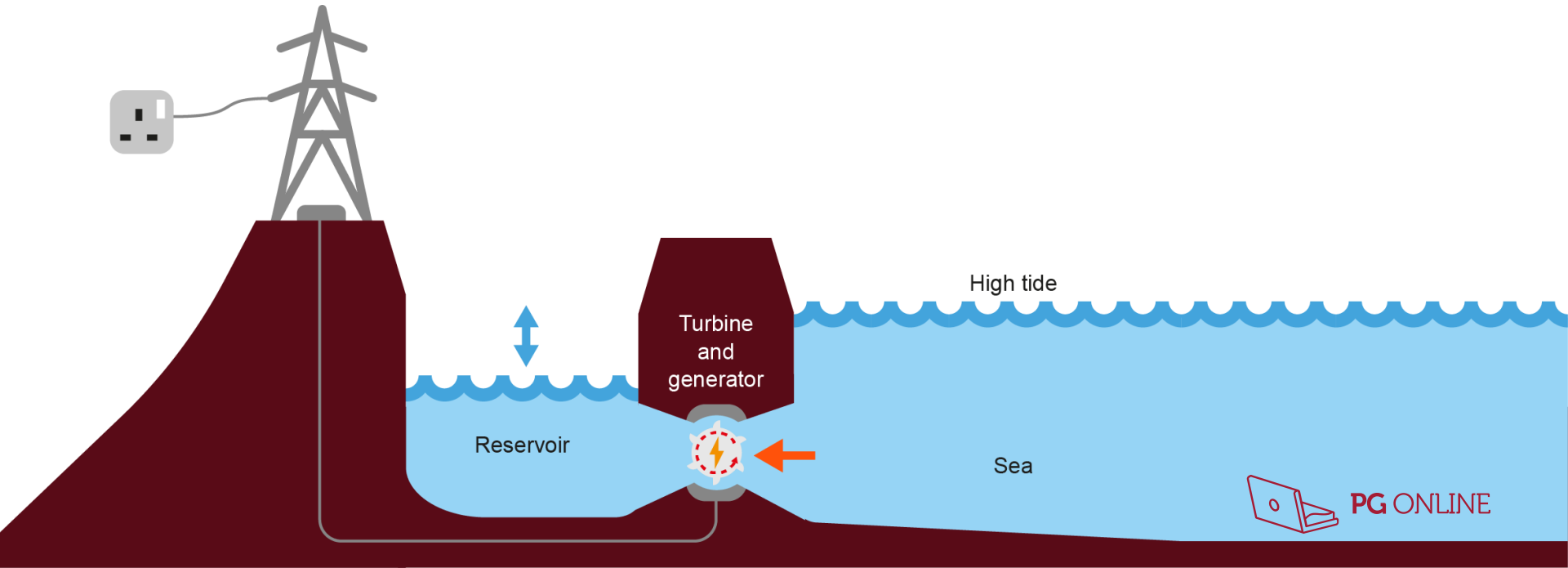
- Biomass is a solid fuel created from organic matter which is burned to generate power
  - Biomass fuels include food and farm waste, compost and wood chips or compressed pellets
  - Why is biomass considered to be carbon neutral?

- Biodiesel is liquid fuel created from organic matter

# Tidal energy

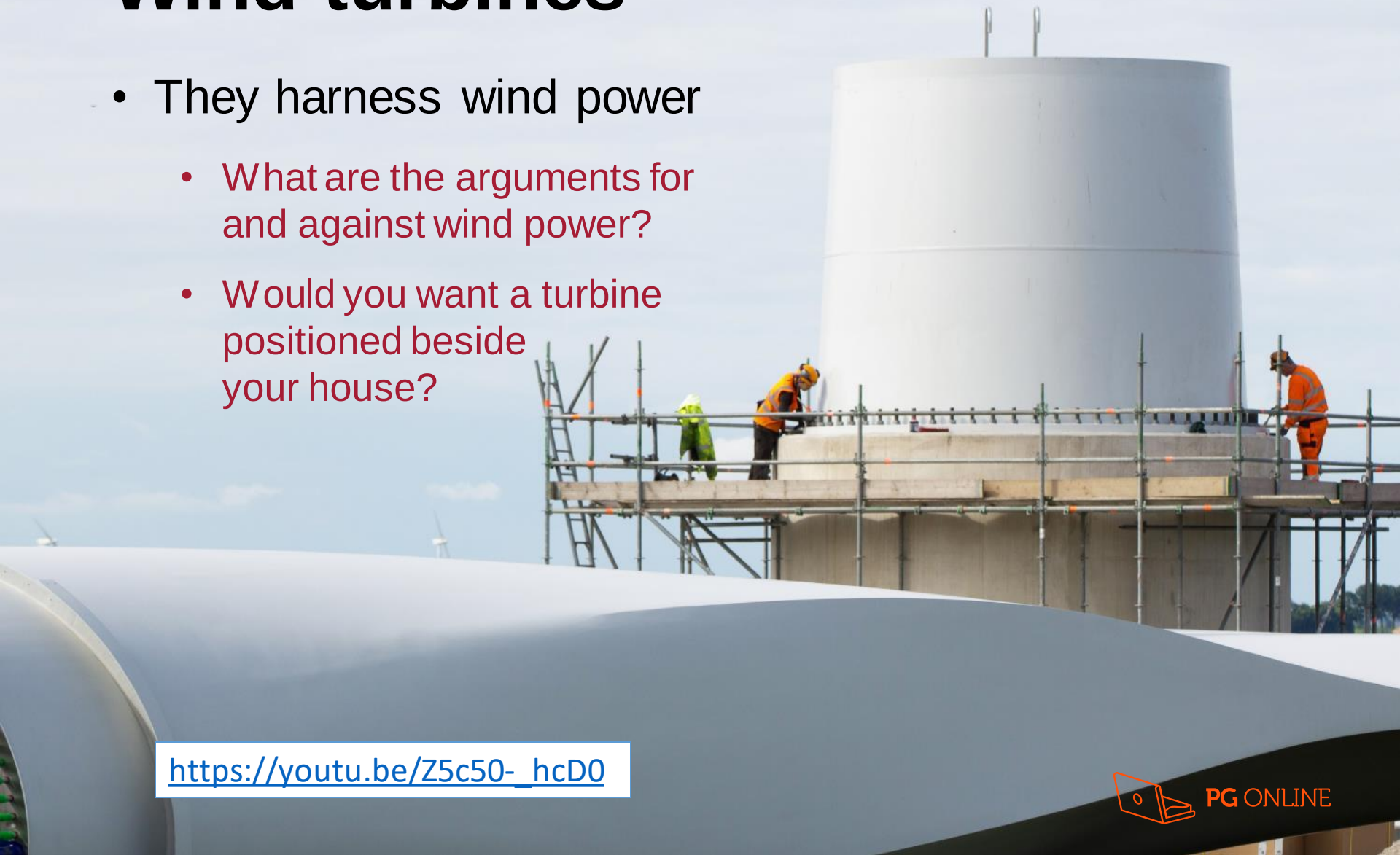
https://youtu.be/VkTRcTyDSyk

- The rise and fall of the tide forces water through turbines which drive generators to produce electricity
  - What are the advantages and disadvantages of this system?



# Wind turbines

- They harness wind power
  - What are the arguments for and against wind power?
  - Would you want a turbine positioned beside your house?



https://youtu.be/Z5c50-_hcD0

# Wind turbines

- What are the arguments for and against wind power?

| For | Against |
| --- | --- |
| | |
| | |
| | |
| | |

# Wind turbines

Answers

- What are the arguments for and against wind power?

| For | Against |
|---|---|
| Low maintenance | Only work when windy |
| Clean energy | Eyesore to some |
| Higher winter output | Hazard to birds |
| Low cost energy | Noise |

https://youtu.be/yFwGpiCs3ss

# Solar cells (Photovoltaic, PV)

- Light photons hit the PV cell which allows electrons to flow, creating an electric current
  - Where are PV cells used?
  - What are the advantages and disadvantages of PV cells?

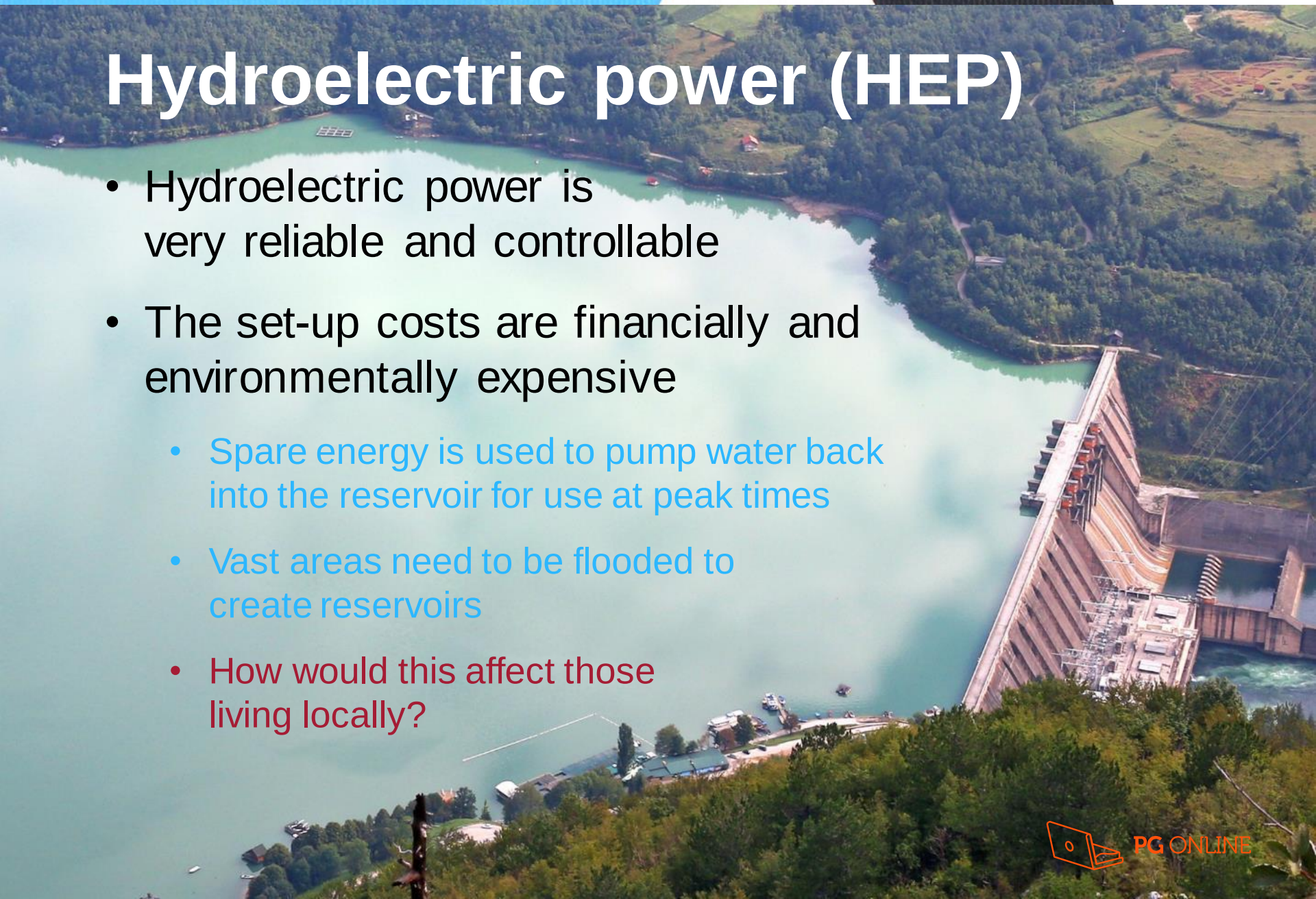
# Solar energy

- The advantages and disadvantages of using PV cells to harness solar power include:

| Advantages | Disadvantages |
|---|---|
| Low maintenance | Seasonal fluctuations |
| Clean energy | No power generated at night |
| Relatively low-cost | Complex positioning issues |

https://youtu.be/q8HmRLCgDAI

# Hydroelectric power (HEP)



- Hydroelectric power is very reliable and controllable
- The set-up costs are financially and environmentally expensive
  - Spare energy is used to pump water back into the reservoir for use at peak times
  - Vast areas need to be flooded to create reservoirs
  - How would this affect those living locally?

https://youtu.be/44ovdxOvP_A

# Nuclear power

- Nuclear power accounts for over 11% of the world's electricity
  - Is nuclear power a renewable energy source?

# Worksheet 1

- Complete **Tasks 1** and **2** of the Worksheet

# Plenary

- Explain the role heated water plays in producing electricity along with turbines
- Explain how a mixture of energy sources can provide a reliable supply of electricity
- Explain why fossil fuels are a finite resource
  - What is their connection with greenhouse gases?

# Edexcel GCSE

Design and Technology 1DT0

2

## Powering systems

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Entry Task

# What is energy?

- Energy is the capacity to do work
  - What is meant by ‘work’?
  - Energy comes in different forms and can be stored





CQ

# Challenge Question

- Be able to identify alternative ways to power systems
- Understand the use and limitations of mains power, batteries, solar cells and wind power
- Be aware of the financial cost and environmental impact of powering systems
- Understand how systems are connected and power can be portable

# Forms of energy

- Potential energy (stored)
  - Chemical
  - Mechanical
  - Nuclear
  - Gravitational
- Kinetic energy (motion)
  - Movement
  - Electricity
  - Heat
  - Sound
  - Light

# Potential energy

- Potential energy is stored in objects not in motion, that will move once released
- Examples include:
  - water in a reservoir ready to turn a turbine for HEP
  - pressure in a fire extinguisher
  - What other forms of potential energy can you think of?

# Kinetic energy

- Kinetic energy involves motion and movement, for example:
  - electricity when travelling throughout a circuit
  - heat radiating from a fire
  - sound coming from a speaker
  - projected light
  - atoms vibrating
- Discuss examples of kinetic energy found using electrically powered tools

# How is energy stored?

- Mechanical storage
  - Compression
  - Tension
  - Motion
- Chemical storage
  - Batteries
  - Gases
  - Solid fuel
  - Food
- How else can we store chemical energy?

# Chemical energy storage

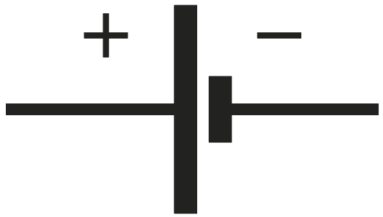
- Chemical energy storage includes:
  - batteries (electro-chemical)
  - canisters / bottles of gas
  - flammable gels and liquids including petrol and diesel
  - hydrogen fuel cells
- How can compression reduce the size of a gas bottle?

# Did you know…?

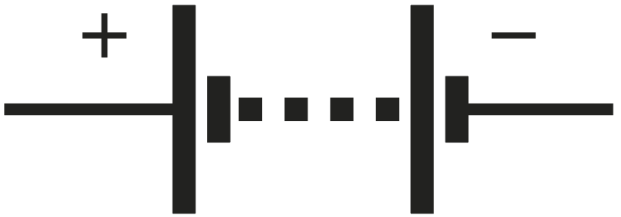
- Energy can change between forms, however it is never destroyed or created
  - What energy transformations occur when you eat?

# Cells and batteries

- A battery stores chemical energy in a series of cells
  - Each cell is usually 1.5V (rechargeable cells are 1.2V)
  - Each battery has a positive and negative terminal
  - Batteries supply direct current (DC)
  - How many cells would a single 9 Volt PP3 battery contain?



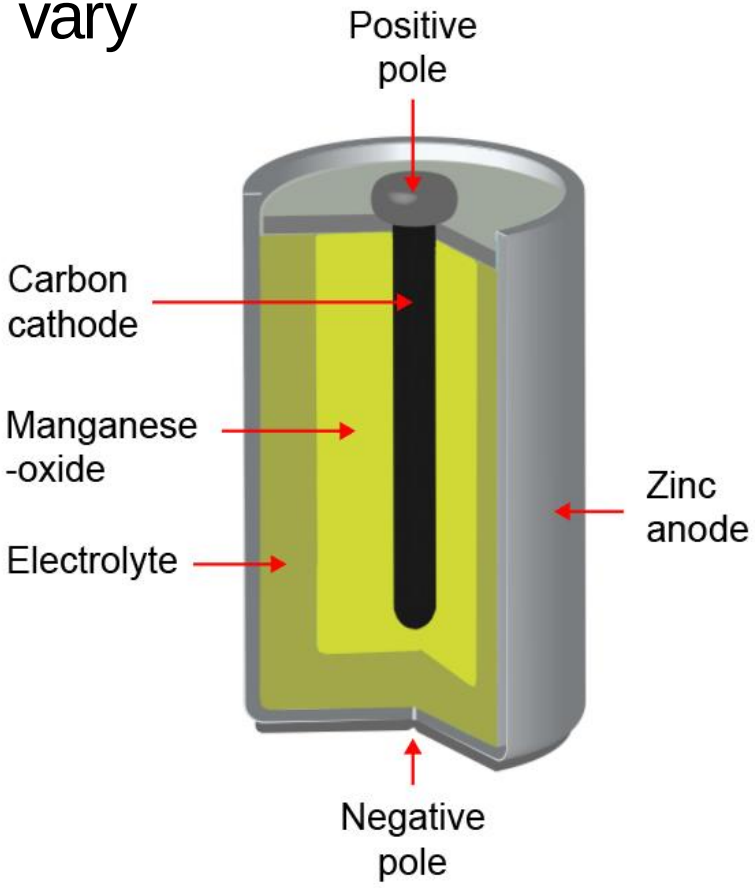

Single cell




Battery of cells

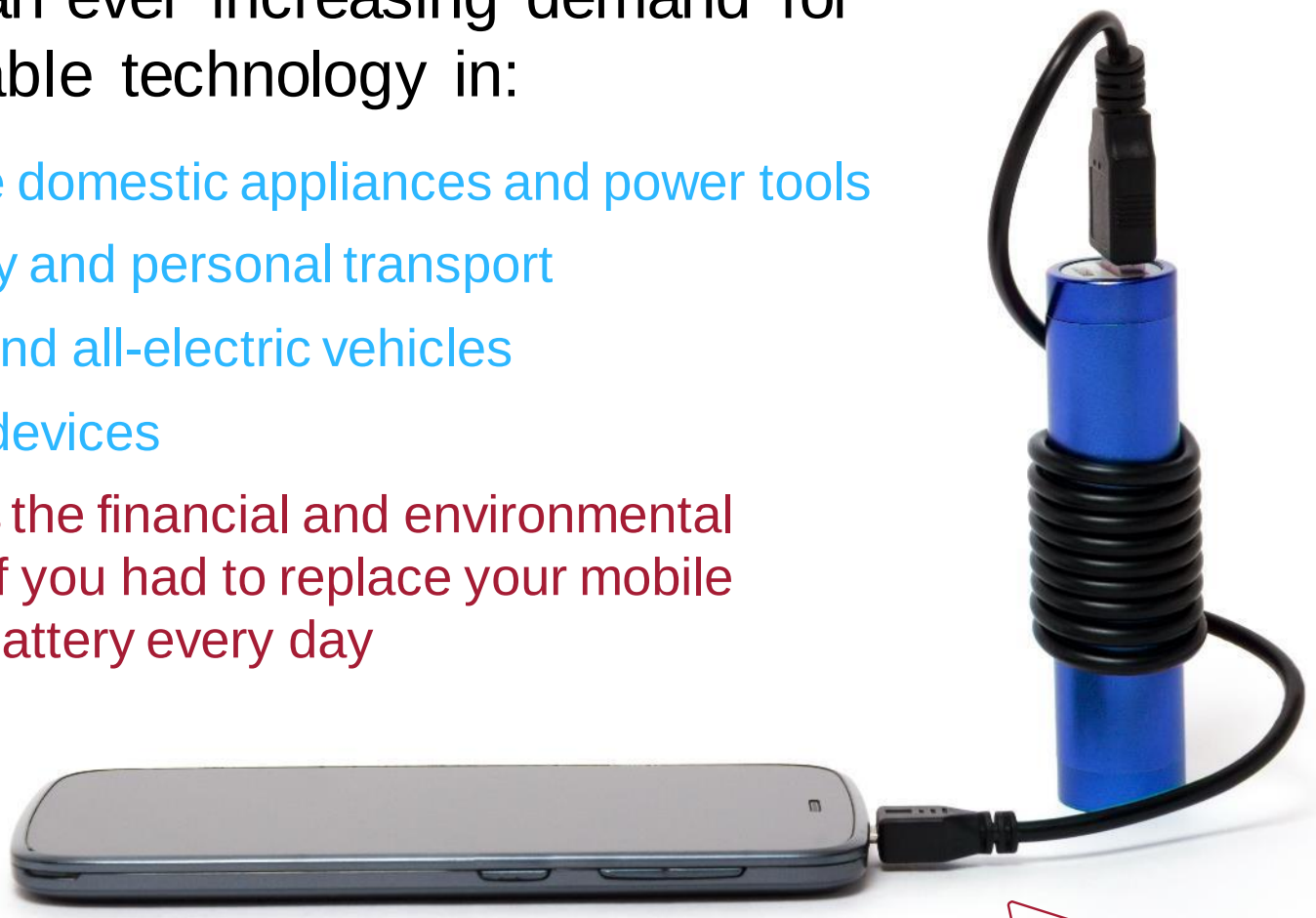
# Alkaline batteries

- The anatomy of batteries can vary
  - Alkaline batteries are more efficient and have a higher capacity when compared to traditional lead-acid varieties
  - More charge can be stored in the same size battery
  - They hold their charge well
  - How has battery development assisted the miniaturisation of electronic products?



# Rechargeable batteries

- There is an ever increasing demand for rechargeable technology in:
  - portable domestic appliances and power tools
  - disability and personal transport
  - hybrid and all-electric vehicles
  - mobile devices
  - Discuss the financial and environmental impact if you had to replace your mobile phone battery every day



# Emerging battery technology

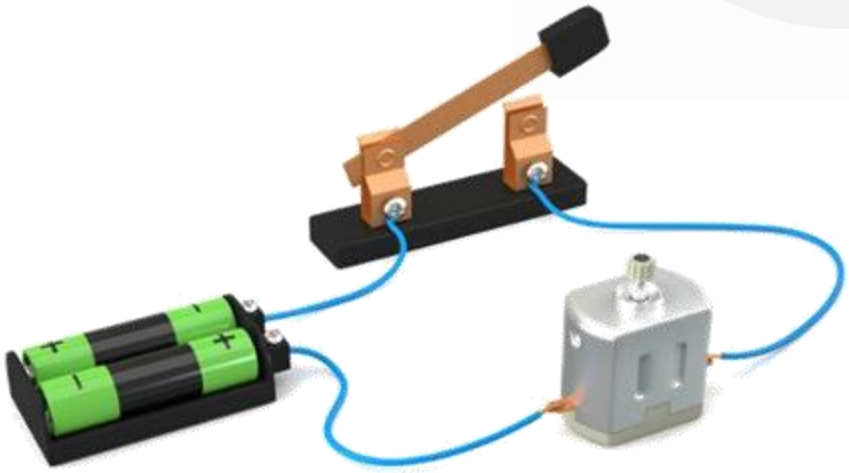
- Flow batteries are large units used to help smooth demand on the National Grid
- Sodium and glass batteries are super-fast charging and very high capacity
  - What would be the impact to world transportation if batteries could be fully charged in only five minutes?

# Disposal of batteries

- Batteries contain toxic chemicals and metals which:
  - leach into the soil and water table
  - are harmful to wildlife and the natural habitat
  - need specialist recycling
  - Where can you safely dispose of batteries?

# Worksheet 2

- Complete **Task 1** looking at types of energy converted from a battery



# Mains electricity

- The **National Grid** is responsible for delivering mains power electricity to our homes
  - It comes via cables, both over and underground
  - Our domestic supply is 230 Volts and is AC (alternating current)
  - In the UK we use three-pin plugs
  - What do they use in Europe?

# Balancing supply and demand

- Electricity from power stations must be used instantly
  - Surplus electricity is wasted unless it can be stored
  - The National Grid is investing in new technologies that can store surplus energy. Methods include:
  - thermal energy storage
  - compressed gas (air)
  - flywheel storage
  - pumped HEP
  - battery farms

# Power output

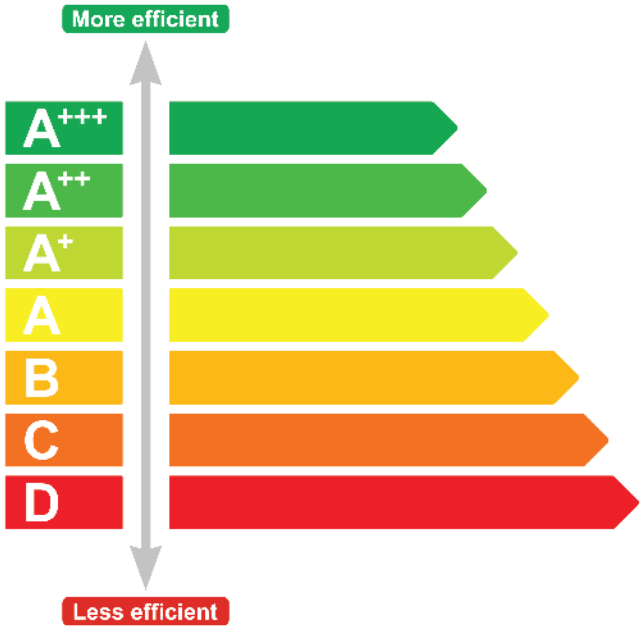
- Electrical power is measured in kilowatt-hours (kWh)
  - It measures energy used over a period of time (1 hour)
  - 1 unit of electricity, known as 1 kWh = 1000 watts for 1 hour
  - This is equivalent to having a 42 inch TV on for about 13 hours
- Energy meters record how much energy our homes use
  - How much do you think a unit of electricity costs?

# Cost of energy

- Energy is easily wasted through appliances being left on when not needed or through inefficiency
  - LED bulbs are around six times as efficient as older style incandescent bulbs
  - Smart meters can help households monitor their energy usage
- How can smart devices help to reduce energy consumption?

# Energy efficiency

- Designers need to consider what the 'lifetime' cost of their product might be
- Where possible electrical products should:
  - be low-powered
  - have auto turn-off/standby
  - have very low-power needs in standby mode
  - incorporate alternative energy supplies such as solar cells



# Circuit and system connections

- There are many different connectors available
  - Designers need to consider the way their products and systems connect to a power source
  - Some are specifically for audio signals, some video and some for power
  - Increasingly, these are being combined together
  - The USB port is a very popular connector however it has a very low power output which restricts its use
  - What issues do you think Apple had to overcome when they decided to remove the 3.5mm headphone jack?

# Portability of the power source

- Many of us use USB power packs to top up our devices during a busy day
  - Solar cells play an increasingly important roll for both commercial and domestic use away from a mains supply
  - Applications include:
    - street lamps
    - ticket machines
    - electric fences for farms
    - solar backpacks
  - Discuss the benefits of working without wires

# Case study - WaterLily

- Using an adaptable turbine, the WaterLily uses both air and water movement to generate power
  - It can charge mobile devices and power packs via USB
  - It can provide up to 15 Watts of continuous power
  - Although mainly aimed at the adventurer, how could devices like this be used to support people in developing countries?

Visit WaterLilyturbine.com for more information

# Environmental impact of power

- All energy generation has some environmental impact
  - Energy is used in the making of solar cells and wind turbines
  - Large areas are flooded to produce hydroelectric power
  - Coastlines are developed to create tidal power
- How does this compare to burning fossil fuels?
  - Mining and drilling have many issues
  - $CO_2$ is produced at all stages

# Plenary

- Complete **Task 2** of your Worksheet

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# Modern and smart materials

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# Modern and smart materials

Entry Task

- New and improved materials are constantly being discovered and developed
- Modern and smart materials can help to solve:
  - design issues
  - technical constraints
  - environmental issues
  - Which non-stick modern material is used to coat some kitchen equipment?

# CQ

# Challenge Question

- Be able to recognise and characterise a range of modern and smart materials
- Describe the advantages and disadvantages of using modern and smart materials for different applications

# Modern or smart?

- What's the difference between a modern material and a smart material?
- A **modern material** is a material or element that has been relatively recently discovered
  - It may also be used or combined in a way that is different from its normal function
  - It might be blended, coated, alloyed or treated to improve its functional or aesthetic properties
- A **smart material** reacts to an external stimulus by changing its characteristics and/or properties


EURO
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# Transformers

- Which stimulus is changing the colour of the mug?
  - Which material is changing colour?
  - Why does the handle stay black?

# Smart materials

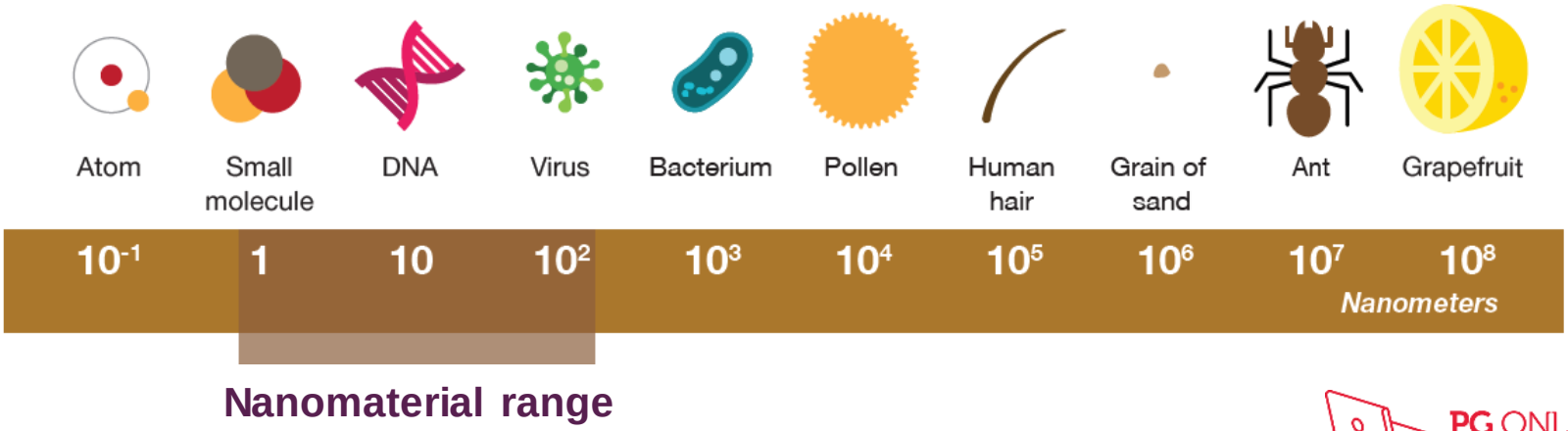
- What different stimuli can make changes occur in smart materials?

# Shape memory alloy (SMA)

- Nitinol is an SMA of nickel and titanium
  - Nitinol needs to be ‘set’ into a shape which requires a high temperature of around 540°C
  - Once set, the alloy can be deformed into a different shape
  - Heat or electricity is used to trigger a response in its shape
  - When reheated to around 70°C it will go back to its pre-set shape
  - How might nitinol be used in dentistry, eyewear or heart surgery?

# Nanomaterials

- Exactly how small are nanomaterials?
  - From the chart below, you can see a grain of sand is roughly one million times larger than a nanometre
  - Nanomaterials range from 1 to 1000 nanometres
  - Nanomaterials benefit from their scale and increased surface area, but what do they actually do?



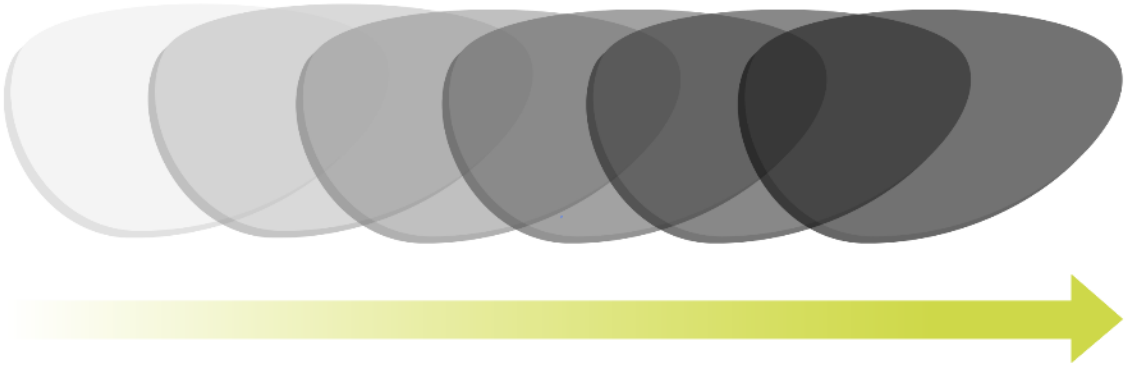
# Reactive glass

- Reactive glass darkens very quickly when subjected to very bright light
  - It is used in eye protection applications such as this welding helmet
  - A light sensor switches on a voltage that darkens the normally clear LCD panel almost instantly
  - Note the sensitivity dial on the side which allows for adjustments

- **Smart glass** works in a similar way and is used for privacy in offices and homes

# Photochromic particles

- Ultraviolet light reacts with photosensitive silver halide particles within glass
  - This reaction is commonly seen in prescription sunglass lenses that darken in bright sunlight and return to clear indoors
  - The reaction can take up to two minutes to complete
  - Over time the particles can lose their ability to revert to clear



# Piezoelectric material

- Piezoelectric material works in two ways:
  - subject it to movement or stress and it produces electricity
  - attach an electrical signal to it and it moves
- How might it be used to detect vibrations?

# Piezo transducer (sounders)

- Using a thin layer of piezoelectric material, small transducers vibrate when an electrical signal is sent through the contacts
  - These are used in mobile phones and other small electronic devices and toys to send and receive audio signals
  - When tapped or spoken into they produce a small electrical charge that can be amplified to create sound or trigger a response in a circuit

# Heat responsive polymers

- There are many different polymers in this category
  - Some change colour with a change in temperature
  - Some can be moulded and remoulded at very low temperatures
  - Some are a liquid at a low temperature but can solidify with a relatively small rise in temperature

# Thermochromic pigments

- Hot and cold temperatures trigger a change of colour in special thermochromic dyes
- Applications include:
  - Fever scan strips used on infants
  - Room thermometers
  - Children's cutlery and crockery
  - Novelty goods and colour changing clothing
- Some pigments have a permanent change
  - How might these be useful in the medical or food industry?

# Polymorph and Coolmorph™

- Polycaprolactone (PCL) is a low temperature, hand-mouldable polymer
  - Polymorph fuses at 62°C, although Coolmorph™ bonds together at just 42°C making it easier to use
  - They are both biodegradable, non-toxic and can be coloured
  - Great for modelling as they can be shaped using only hand pressure
  - They can be reused and remoulded multiple times
  - How could PCL be used to make repairs to household items?

# Liquid, gel or solid?

- Poly(N-isopropylacrylamide) (PNIPAM) is an interesting temperature responsive polymer that changes from a liquid to a solid when heated
  - This is the opposite reaction that most polymers have to heat
  - In a cool liquid the polymer hydrates, but when heated to above 32ºC it expels up to 90% of its mass and becomes dehydrated
  - It is used for medical applications due to its ability to transform near to the temperature of the human body
  - It is used for delivering drugs inside the body, tissue engineering and for making advanced gels and microgels

# Conductive ink

- A special ink that contains conductive particles and enables circuits to be printed or drawn by hand
  - It dries very quickly creating an electrical connection
  - It works on many non-conductive surfaces including paper and plastic
  - Non-toxic versions can be used on skin
  - It's available in pots or pens
  - How might this be used on sports clothing?

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## Composite materials

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# Entry Task

Entry Task

- Is duct tape a single material?
  - What are its component parts?
  - How is it constructed?
  - How has it been reinforced?
  - How would the tape respond under tension without any reinforcement?

# CQ

# Challenge Question

- Understand how material characteristics and properties can be enhanced by combining two or more materials
- Understand the advantages and disadvantages for a range of composite materials
- Have an awareness of the applications for a range of composite materials

# What is a composite material?

- A material that has enhanced properties and/or characteristics (physical or chemical) through combining two or more significantly different materials
  - What materials are used to make concrete?
  - How can concrete be made even stronger to resist compressive and tensile forces?

# Reinforced concrete

- Steel rods are embedded into the concrete mixture
  - This gives increased tensile strength which is normally quite weak in concrete
  - If fractures occur, the steel prevents total failure
  - Which architectural features do you think this type of reinforcement allows?

# Plywood

- Plywood is a manufactured board
  - Thin layers of natural wood called veneers are bonded together with a strong adhesive
  - The veneers are laid with the grain perpendicular to the next, to increase overall strength, rigidity and stability
  - Flexible versions are available made with very thin veneers (flexiply)
  - It has an odd number of layers so the grain of the outer layers travel in the same direction
  - The outer layers can be an expensive hardwood, improving aesthetics whilst saving money and valuable or rare resources

# Fibre reinforced polymers

- The two main types of fibre reinforced polymer are:
  - glass reinforced plastic (GRP)
  - carbon fibre reinforced plastic (CRP)

# Glass reinforced plastic (GRP)

- GRP uses woven glass fibre matting, bonded with a thermosetting plastic resin
  - It is very lightweight and has a high strength to weight ratio
  - Moulds and formers are used to create the desired shape and involves a labour intensive process
  - Used for boat hulls and liquid storage tanks

# Carbon reinforced plastic (CRP)

- CRP is like GRP, but uses carbon fibres instead:
  - The woven carbon fibre matting not only gives this ultra-lightweight material a sought after aesthetic, but makes it even stronger and rigid than GRP
  - CRP is used for components that need a very high strength to weight ratio

# Using GRP and CRP

- What are the main the differences between the two types of reinforced plastics?
  - For which applications might CRP function better than GRP?
- A hardener or 'catalyst' is added to the resin to make it harden or 'cure'
  - Both methods use thermosetting resins which produce volatile organic compounds (VOCs)
  - What precautions should you take when working with products containing VOCs?

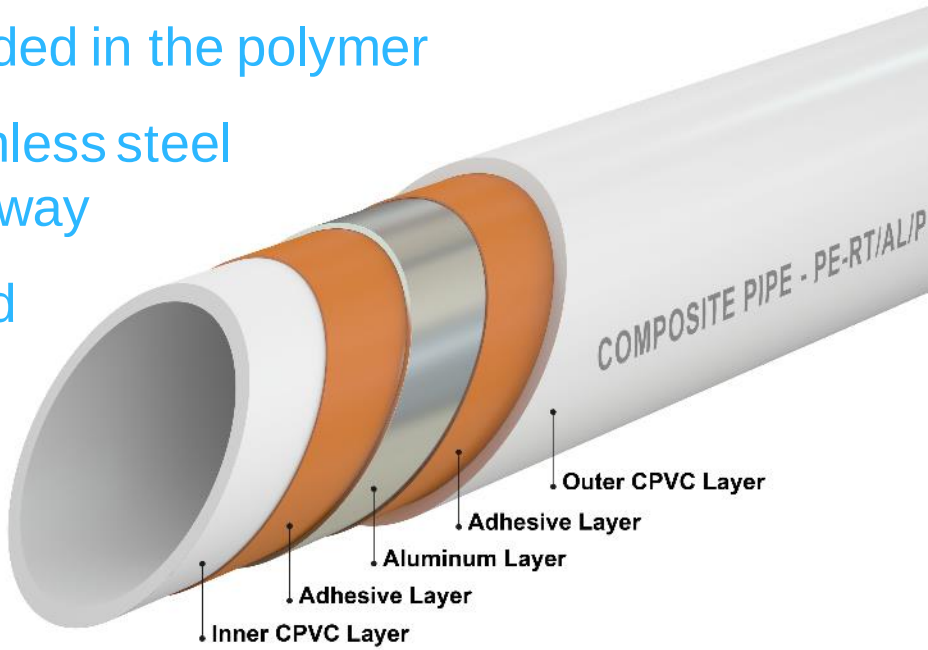
# GRP (CRP) process

- Step by step process to construct a GRP (CRP) part

1. Prepare the mould or former
2. Apply a release agent to the mould
3. Apply a gel coat for GRP (or first resin coat for CRP)
4. Apply the glass fibre matting (or woven carbon fibre)
5. Work a second coat of resin into the material
6. Repeat layers of matting and resin coats to achieve correct thickness for the specific application
7. Clamp and leave a GRP workpiece to cure (seal a CRP workpiece in a vacuum bag and heat in an oven to cure)
8. Release from the mould, trim and finish the workpiece

# Reinforced polymers

- Polymers are reinforced to improve working properties
  - Fibres are commonly embedded in the polymer
  - Metals fibres, especially stainless steel and aluminium are used this way
  - Lamination is another method
  - The composite pipe pictured has a layer of aluminium sandwiched between two layers of flexible polymer




  - The layering allows it to bend with reduced kinking and offers increased thermal insulation
  - Name a use for this reinforced polymer

# Robotic materials

- This is currently a theoretical area of study however it is believed that materials will be able to 'think'
  - Robotic materials will act like mini-computers
  - They will be able to sense, process and output data or actions
  - Biomimicry is used to copy the way nature processes information and responds to its environment, like the camouflage of a cuttlefish

# Worksheet 4

- Complete **Tasks 1** to **3** of your Worksheet

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## Technical textiles

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# Entry Task

Entry Task

- Where might textiles be used in this apartment and for which uses?

CQ

# Challenge Question

- Be able to recognise and characterise a range of technical textiles in use
- Describe the advantages and disadvantages of using technical textiles for different applications

# How might textiles differ here?

- Which textiles might swimmers use?

# And the allotment or garden?

- What about protective clothing?

# Types of textiles

- There are many different categories of textiles to discover including:
  - environmentally friendly textiles
  - construction textiles
  - protective textiles
  - domestic textiles
  - sports textiles
  - agro-textiles
  - geo-textiles

# Multiple use textiles

- Some textiles can be used for many applications across a range of categories and industries
  - Name some uses for the woven tarpaulin style textile pictured

# Agro-textiles

- Agro-textiles are mainly used for agricultural purposes
  - They are efficient barriers against weather and pests
  - They can also retain moisture and suppress weeds

# Woven and non-woven types

- These are often made from polyethylene or PVC which is UV stabilised to prolong its use
  - Woven netting comes in many sizes and protects crops from flying and climbing predators and pests
  - Netting also shades plants from too much sun and defends crops from poor weather, such as hail storms
  - The weed suppressant pictured allows water to pass through, but stops weeds growing and prevents moisture escaping
  - Why is this particularly useful under paths & patios?

# Non-woven plastic mulch film

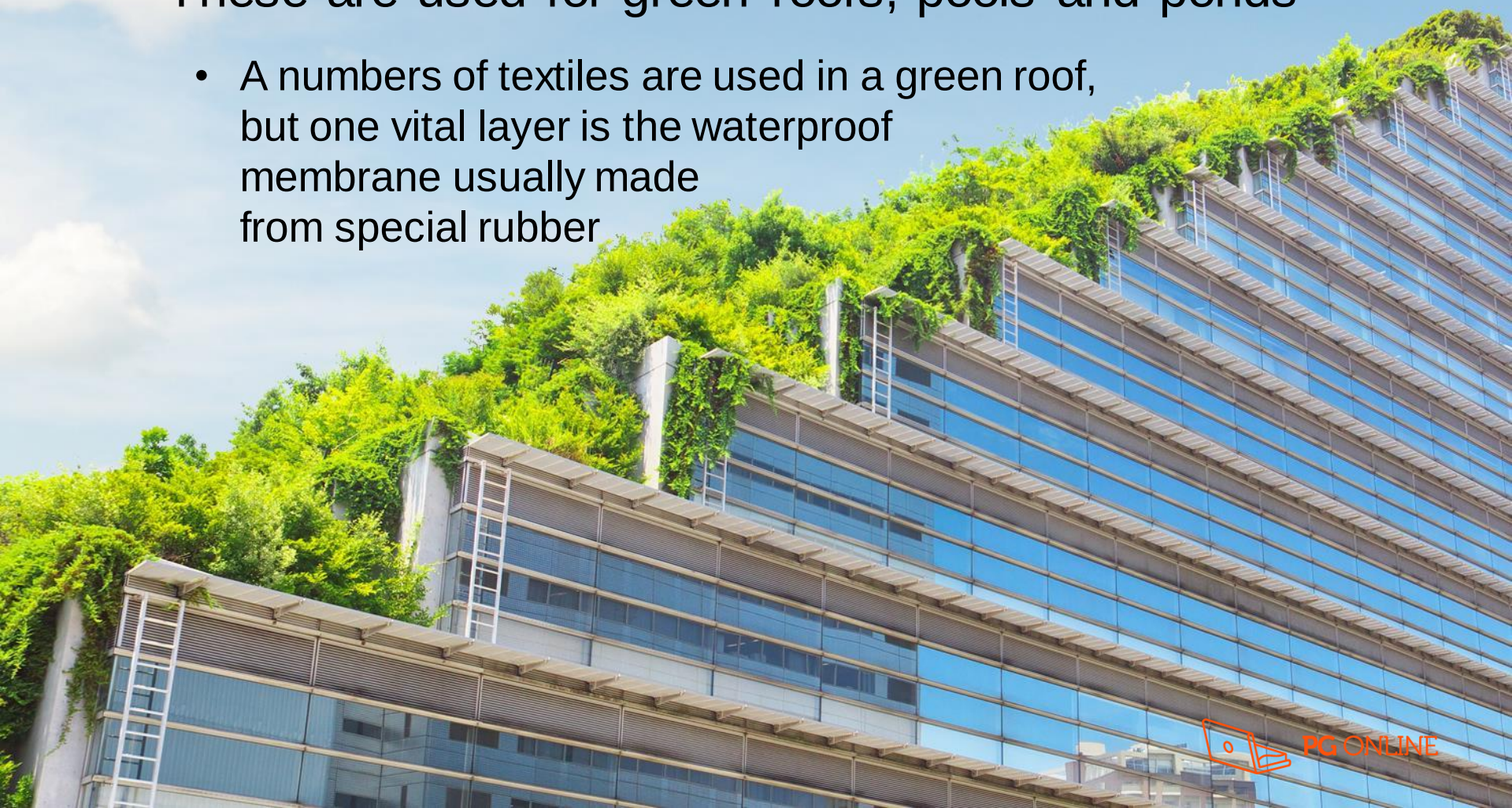
- Used to suppress weeds and prevent evaporation
  - It keeps fruits and crops from spoiling on the ground
  - PVC and biopolymer versions available

# Construction textiles

- Many are similar to agro-textiles
  - Netting is used to offer shade and privacy to construction workers as well as protection to passers-by from falling debris

# Waterproof membranes

- These are used for green roofs, pools and ponds
    - A numbers of textiles are used in a green roof, but one vital layer is the waterproof membrane usually made from special rubber



# Specialist construction textiles

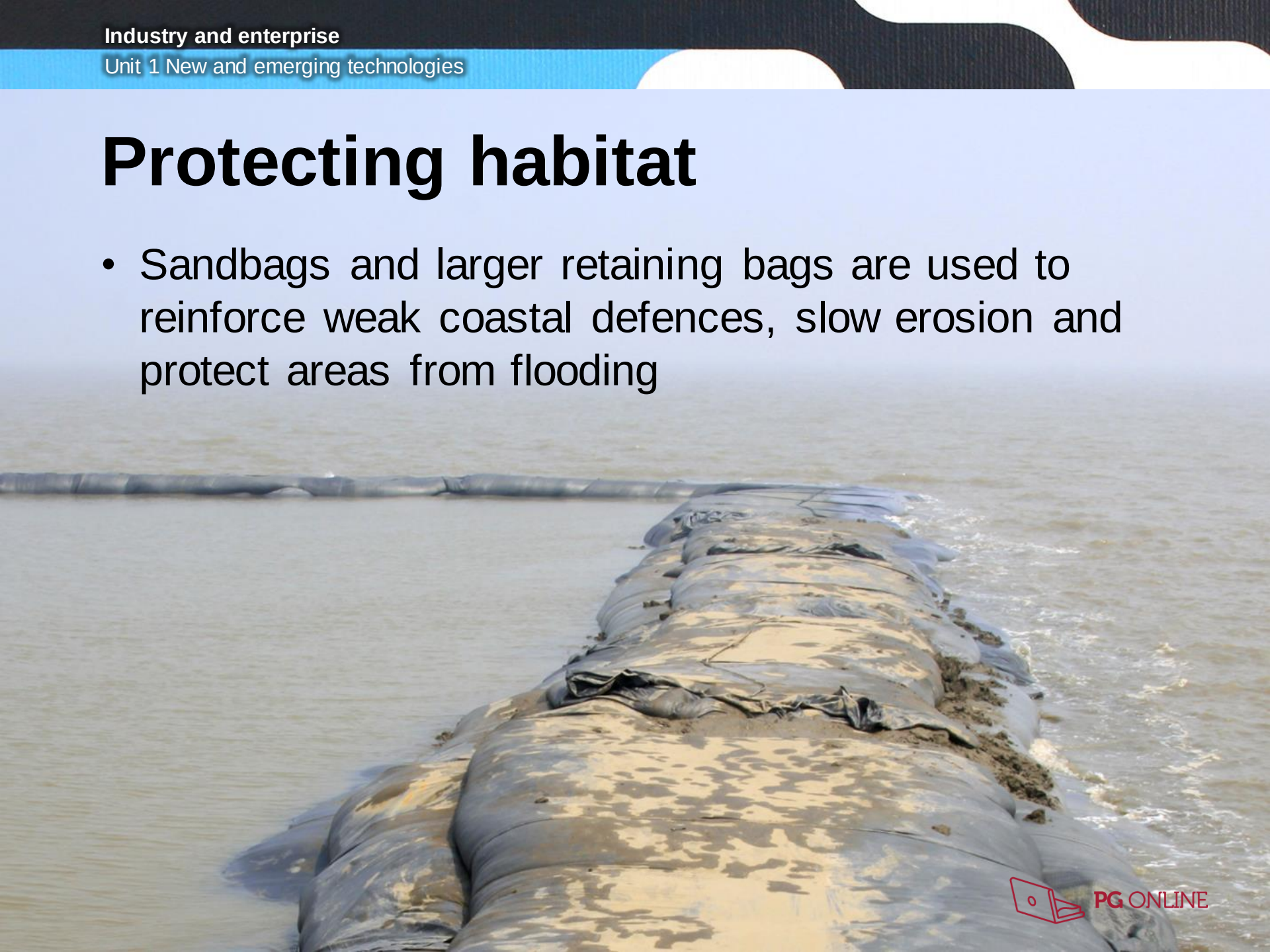
- Some construction tasks need very strong and resistant textiles
  - These are often bonded textiles, resistant to UV degradation and adverse weather and can be very expensive to produce

# Geo-textiles

- Geo-textiles are used to keep soil, sand and other aggregates in place

# Protecting habitat

- Sandbags and larger retaining bags are used to reinforce weak coastal defences, slow erosion and protect areas from flooding



# Separate layers

- Geo-textiles are used to separate layers of aggregate in roads and civil engineering projects
  - Another use is to filter water or other particles, but retain the position and structure of the main product being retained
  - Which applications are better for woven and non-woven varieties?
  - Why are some geo-textiles perforated?

# Domestic textiles

- This category can be used in the home
  - Applications include cleaning fabrics, padding and home furnishings
  - Both non-woven and woven varieties used

# Microfibre

- Microfibre cloths are an example of domestic textiles
  - Although microfibre has numerous domestic and commercial uses, it is often used for cleaning cloths and quick-drying towels
  - The microfibre structure allows dust and moisture to be easily trapped and removed making it very efficient
  - What are the environmental concerns regarding the use of microfibre products?

# Worksheet 5

- Complete **Task 1** of your Worksheet identifying domestic textiles around the home

# Environmentally friendly textiles

- Technical textiles that have no impact on the earths' resources can be classed as environmentally friendly
  - These are mainly abundant natural fibres from plants & animals
  - They should be grown or reared organically and sustainably avoiding vast areas of monoculture and intensive farming

# The impact of natural textiles

- Wool and silk can have a low environmental impact as animal-based technical textiles, however some plant-based varieties can be quite high
  - Cotton canvas is used for awnings, sails and tents - Why might cotton be less environmentally friendly in certain parts of the world than others?
  - Discuss whether wool can be considered environmentally friendly for technical sportswear or eco-insulation for the home

# Technical uses for natural fibres

- Jute, hemp, bamboo, cotton, coconut and linen are amongst the most popular plant-based fibres
  - Many of these fibres are used in other categories e.g. coconut is used for doormats and agricultural applications and jute is used to make coffee sacks
  - What animal fibre was traditionally used to make a parachute?

# Can you sleep on a tree?

- Lyocell is a natural man-made textile using wood pulp
  - It is considered very environmentally friendly, recyclable and biodegradable
  - Unfortunately, it is very expensive to produce and is not as easy as many textiles to dye
  - It is used in domestic and commercial furnishings and bedding supplies such as mattress protectors, sheets, duvets and quilts

# Recycling textiles

- Using textiles again increases their sustainability
  - Good clothes and textile goods can be given to charities and resold
  - Lower quality items can be shredded and made into rugs or cleaning cloths
  - Some items are ground and matted to make matting that is used as thermal or sound insulation or used as an agro- or geo-textile
  - What happens to different fibres if they are sent to landfill?

# Protective textiles

- There is a wide range of protective textiles ranging from bulletproof vests to a chefs apron
  - In the medical profession they are used as a microbial barrier to reduce infection rates
  - Where else might they be used in a hospital?
  - Where are protective textiles used in a design and technology workshop?
  - How might they be used for filtration?

# Extreme protection

- The emergency services need protective textiles that might save their lives
  - Firefighters and riot police can be subject to extreme conditions
  - Their clothing needs to protect them from impact and fire
  - Incredibly tough and flame retardant **aramid** fibres are often used in these situations
  - Cut, stab and bulletproof clothing can be made that is lightweight and relatively comfortable

# Sports textiles

- Technical textiles used for sports are very far reaching and include:
  - Thermal insulation
  - Waterproofing
  - Breathability
  - Wicking fabrics
  - Elasticity

# Keep fresh and healthy

- Some sportswear puts up with a lot of bad treatment
  - It may need to be impact resistant and very hard wearing
  - It may need to be UV-resistant
  - It may need to be anti-fungal, anti-bacterial and even mosquito repellant
  - The last group can be added to textiles through microencapsulation
  - Which sports textiles do you use?

# Pushing the boundaries

- Research into textiles and performance ensures new and improved materials are constantly being developed
  - What fibre has been used to made this bike frame and cycle helmet?
  - Where else are textiles used in sports equipment?

# Plenary

- Complete **Task 2** of your **Worksheet**

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# Mechanical devices

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CQ

# Challenge Question

- Understand the principles and performance of a range of mechanical devices
- Be able to apply the principles of different types of movement to influence changes in magnitude and direction through levers and rotary systems
- Be able to calculate mechanical advantage and velocity ratio for a range of mechanical devices

# Entry Task

Entry Task

- How would you define a mechanical device?
  - Is a hammer a mechanical device?
  - How about a pair of scissors?

# Movement and motion

- Motion is the action of something being moved
  - Motionless is something at rest
  - There are different types of motion which can be added together and even changed from one to another
  - How would you describe the motion acting upon the ball bearings in a Newton's cradle?

# Linear motion

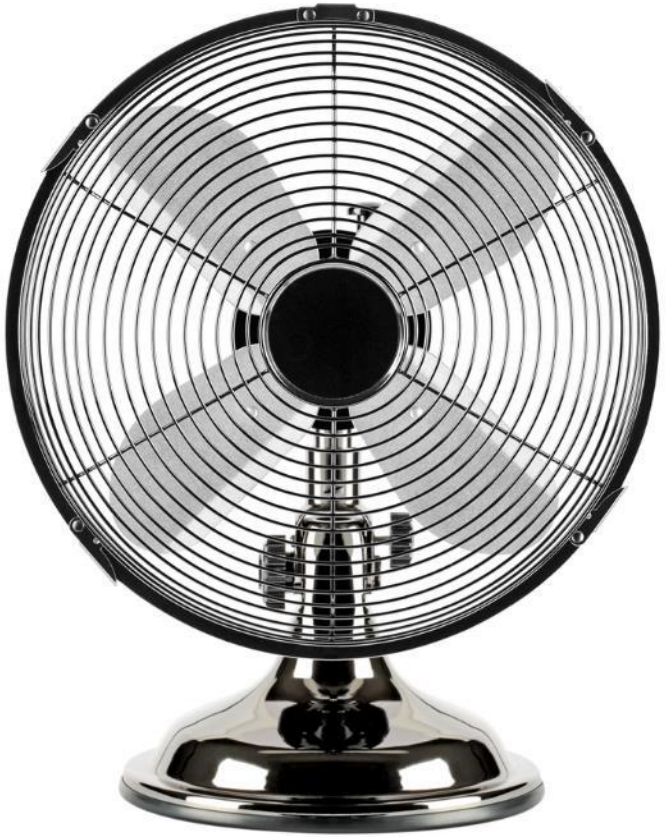
- Movement in one direction along a straight line

# Reciprocating motion

- A repetitive back-and-forth or up-and-down linear action
  - A reciprocating saw blade cuts by travelling back and forth along the same path at high speed
  - What else moves like this?

# Rotary motion

- Objects moving in a circular motion usually around a fixed axis
  - Can you name parts on a car or the power tools in a workshop that rotate?



# Oscillating motion

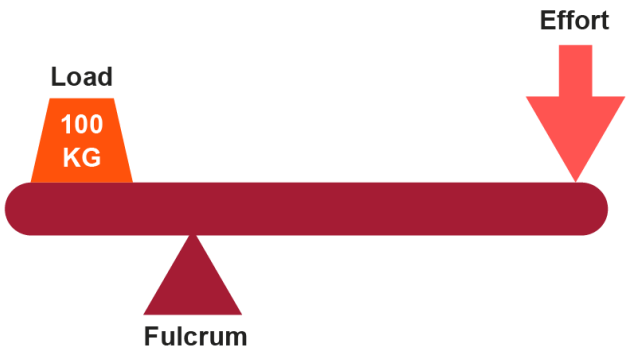
- A repetitive back-and-forth motion along a curved path
  - The pendulum on a grandfather clock oscillates to keep time
  - Which rides in a children's playground also oscillate?

# What is a lever?

- Levers have **two** parts – a **bar** and a **pivot** or **fulcrum**
  - Levers can move a load by using effort around the fulcrum
  - The **load** is the weight being moved, lifted or squeezed
  - The **effort** is the energy used to move the load
  - The **fulcrum** is the point at which the lever balances, grips or pivots around
  - Name some different types of levers

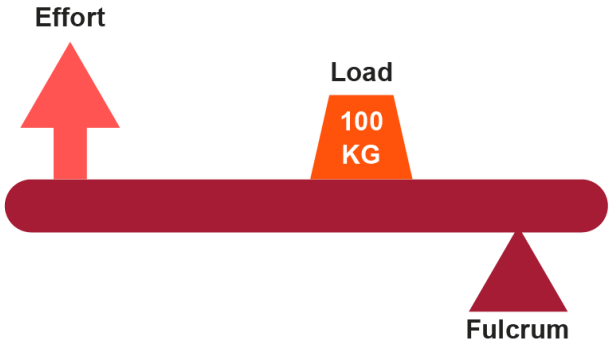
# First order lever (Class 1)

- Class 1 levers act in a seesaw or scissor action
  - The load and effort are at opposite sides with the fulcrum positioned at any point between
  - What would happen if the fulcrum of the scales was moved to the left?



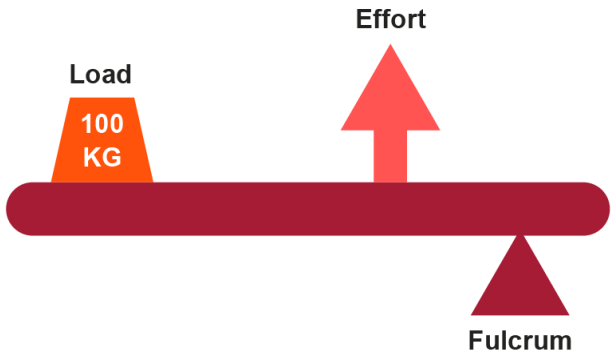

# Second order lever (Class 2)

- Class 2 levers act in a wheelbarrow action or that similar to a nutcracker
  - The effort is at the opposite end to the fulcrum, with the load positioned between
  - Identify the effort, load and fulcrum on the nutcrackers




# Third order lever (Class 3)

- Class 3 levers have a pincer-like action seen with tweezers and tongs
  - The load is at the opposite end to the fulcrum, with the effort positioned between
  - Explain how the acts of fishing or sweeping the floor could be class 3 levers

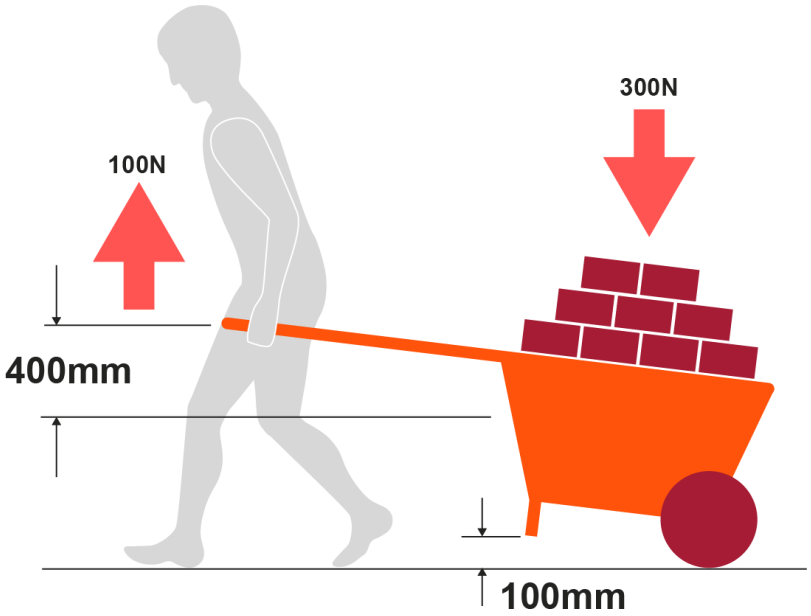



# Mechanical advantage (MA)

- Levers help provide **mechanical advantage**
  - Identify the **three** elements at work on the wheelbarrow: the **effort**, the **load** and the position of the fulcrum
  - To calculate the MA, use the formula:

$$MA = \frac{\text{Load}}{\text{Effort}} = \frac{300N}{100N} = \frac{3}{1}$$

  - Also written as 3:1 or MA of 3

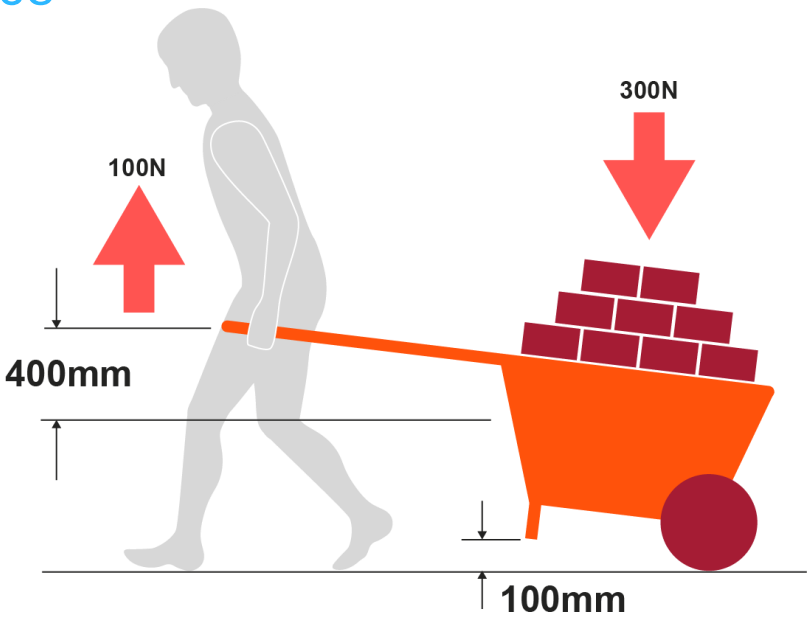


# Velocity ratio (VR)

- **Velocity ratio** is similar to mechanical advantage, but is measuring distance travelled
  - For the same wheelbarrow scenario, the distance moved by effort is 400mm and the distance the load has moved is 100mm
  - To calculate the VR, use the formula:

$$VR = \frac{\text{Load}}{\text{Effort}} = \frac{400\text{mm}}{100\text{mm}} = \frac{4}{1}$$

  - Also written as 4:1 or VR of 4



# Efficiency

- Efficiency is the measure of a machines actual performance compared to its ideal performance
  - Mechanical devices are never 100% efficient due to **friction**
  - Heat build-up, air resistance, vibrations, wear and tear and even noise can make machines less efficient
  - We can calculate the efficiency or inefficiency using the formula:

$$\text{Efficiency} = \frac{MA}{VR} \times 100\%$$

# Efficiency calculation

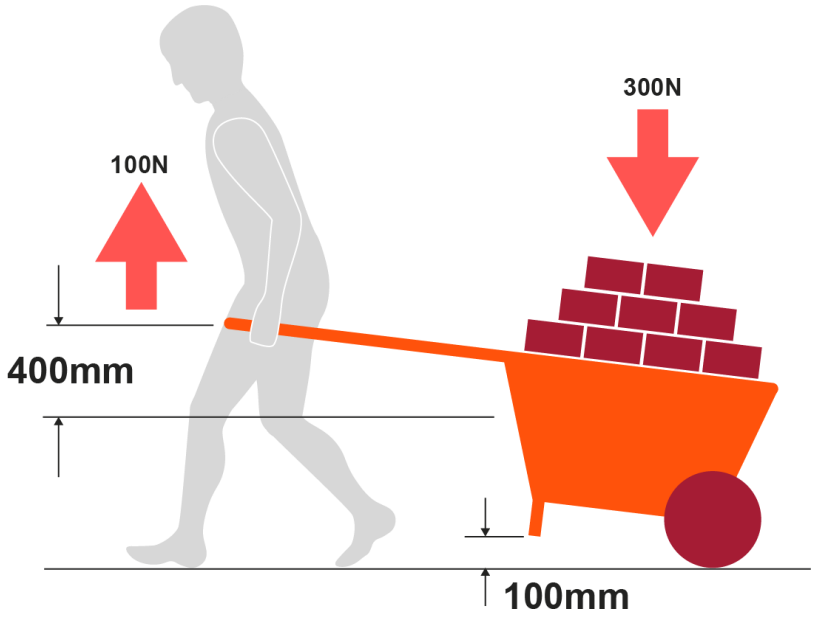
- Lets say the rusty wheelbarrow in the last slide has an MA of 3 and its VR is 4
  - The formula is:

$$\text{Efficiency} = \frac{\text{MA}}{\text{VR}} \times 100\%$$

  - Therefore:

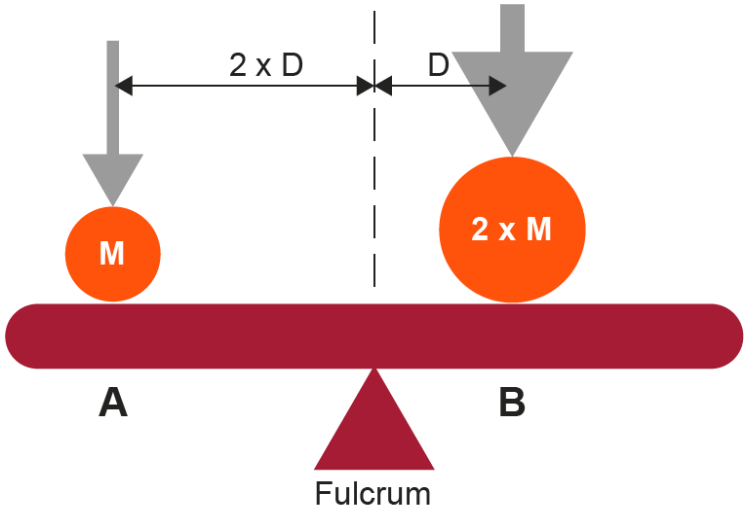
$$\frac{3}{4} \times 100\% = 75\%$$

  - Meaning that 25% of the energy going into operate the wheelbarrow is lost



# Equilibrium

- When the effort and the load are equal, equilibrium can be created in a mechanism
  - If two people of the same weight, both sat equidistant from the fulcrum of a seesaw, what would happen?
  - What happens if one person moves further away?
  - To make a seesaw balance, where would you need to sit if you had twice the mass as the other person?



# Worksheet 6

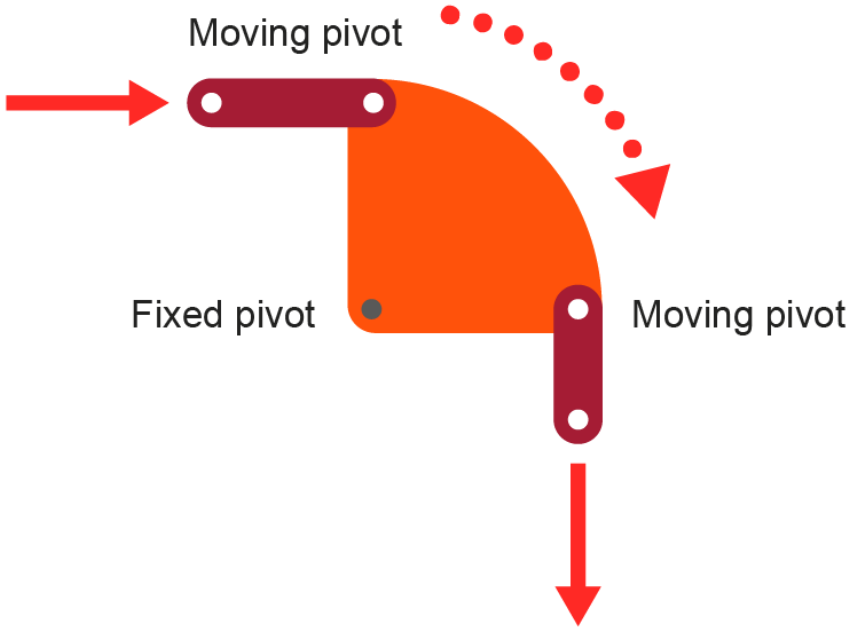
- Complete **Task 1** and **2** of your Worksheet

# Linkages

- Linkages are mechanisms that use rigid parts to:
  - change the magnitude of a force
  - change the direction of a force, or
  - transform it into a different motion

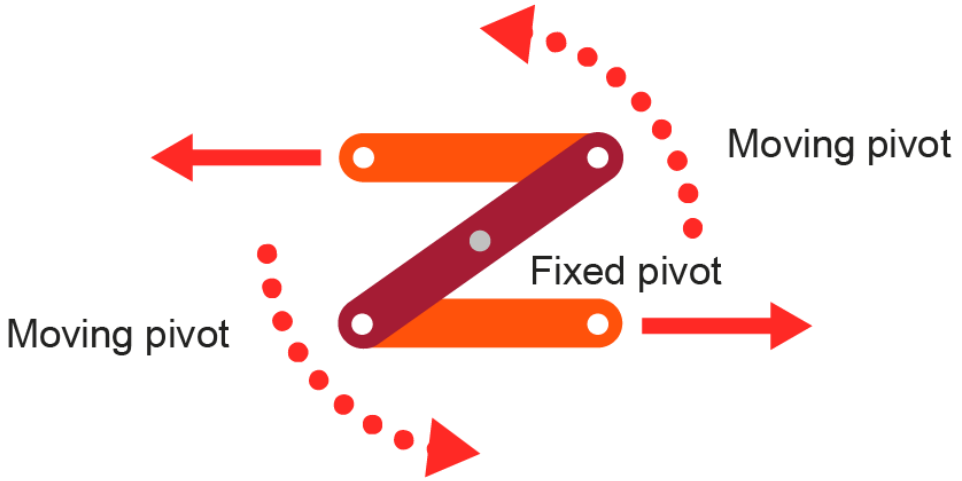
# Bell crank linkage

- Input direction is converted through 90 degrees
  - It changes horizontal motion to vertical and vice versa
  - Often found in steering and throttle mechanisms on vehicles



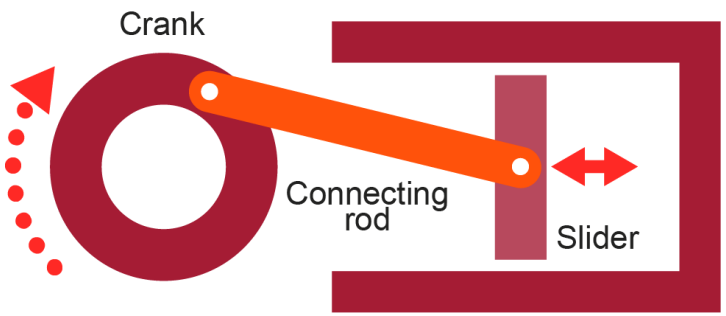

# Reverse motion linkage

- This changes the direction of the input motion
  - If the input is pulled, the output will push
  - The linkage uses a fixed central pivot
  - Do the input and output rods move in straight lines?



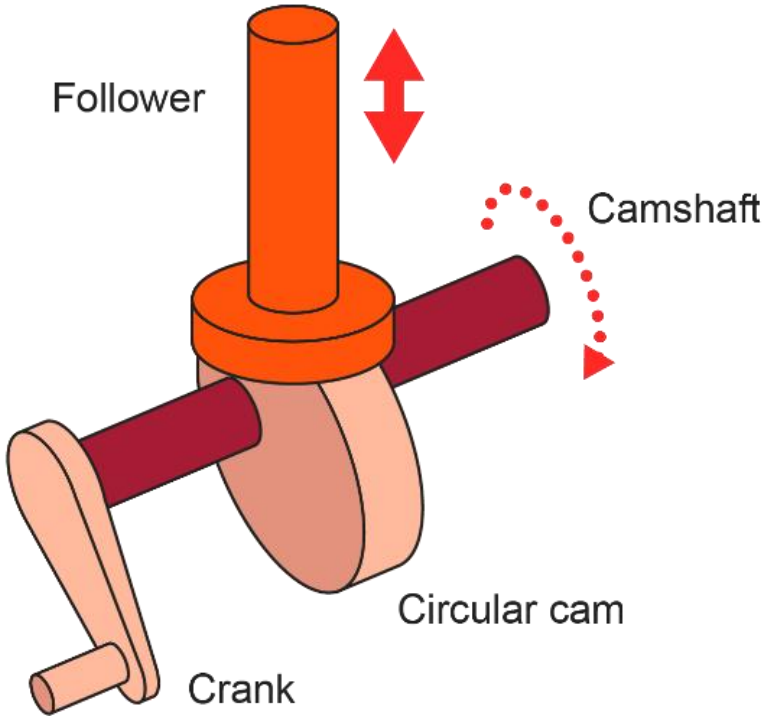
# Crank and slider

- Crank and sliders convert rotary motion into reciprocating motion and vice versa
  - A linkage commonly found in engines to transfer the energy from pistons
  - The slider is guided along a set path
  - How could this linkage be used in a pump to create pressure?



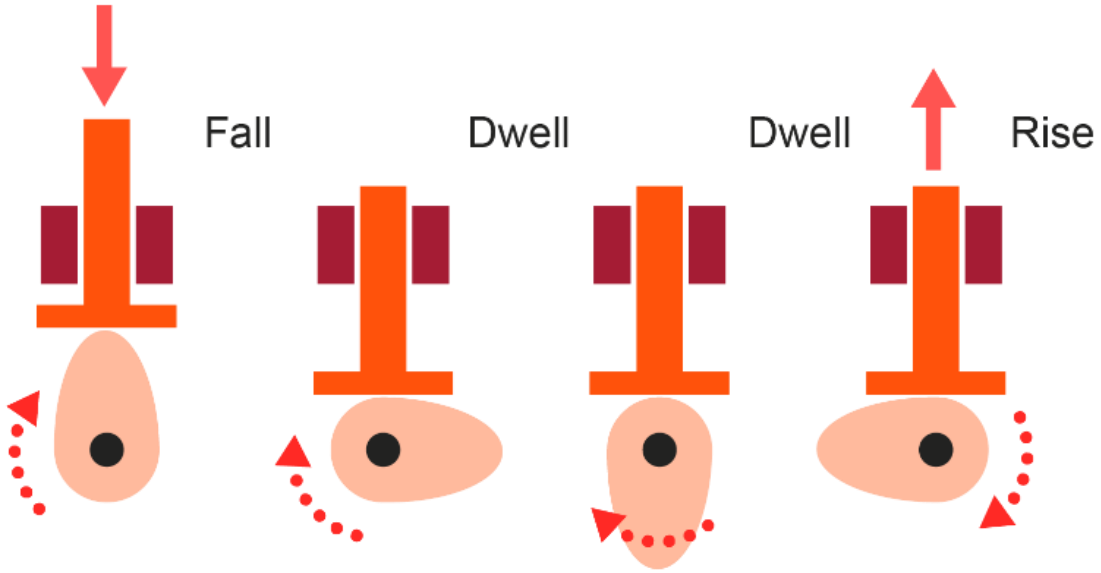

# Rotary systems

- Rotary systems drive mechanisms in machinery and equipment
  - A rotating axle called a camshaft is used to drive, or is driven by, other mechanical components
  - Cams are shaped pieces of material that are attached to the camshaft
  - Cams change rotary motion into reciprocating motion through a follower



# A cam and follower in action

- When a cam rotates, it lifts and lowers the follower
  - The lift it is known as the **rise**
  - When it lowers it is known as the **fall**
  - What is the **dwell** phase?



# Types of cams

- Different shaped cams are used for different tasks:

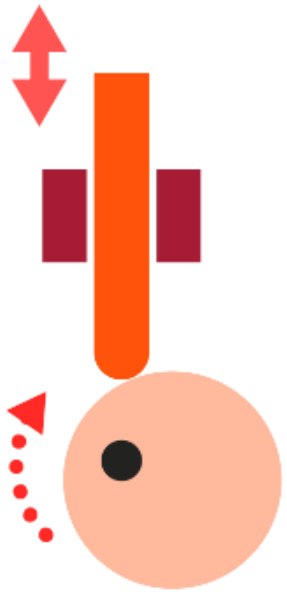
Eccentric cam

Pear cam

Snail cam

# Eccentric and snail cams

- Eccentric cam
  - Also known as a circular cam
  - It has a steady rise and fall with little dwell
  - Used in pumps for fuel and medical applications
- Pear cam
  - A pear cam has a rise and fall for half of the rotation followed by a long dwell
  - Used in engines to control valves



Eccentric cam

Pear cam

# Snail (drop) cam

- Snail cam also known as drop cam
  - A snail cam has a steady rise followed by a sudden fall
  - It has a long dwell
  - Why can a snail cam only be used in one direction?
  - What applications might this cam be useful for?

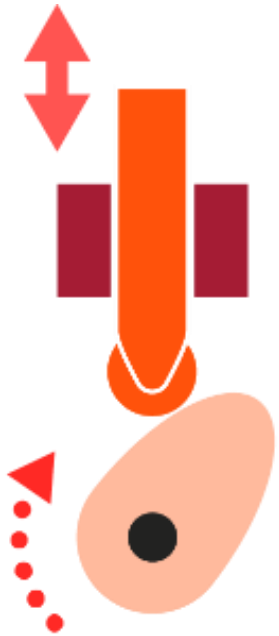
Snail cam

# Types of followers

- When would you need to use different followers?
  - What are the benefits and issues with each type?

Flat follower

Knife-edge follower

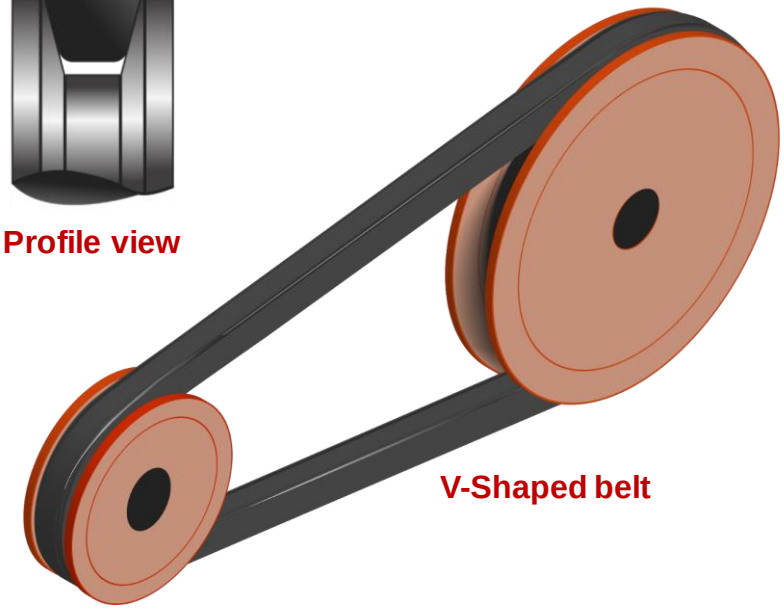


Roller follower

# Pulleys and belts

- Drive belts are used to transfer drive from one pulley to another
  - Belts rely on friction to grip the pulley and are often made from rubber
  - A pulley is usually grooved to help increase the friction on the belt
  - V-shaped belts are used to increase surface area contact between the belt and the pulley and to help keep them in place

Profile view



V-Shaped belt

Grooved pulley

# Pulley and belt systems

- Belts can travel along complex routes linking multiple pulleys
  - V-shaped and toothed belts are used with engines and motors
  - Belts are often reinforced with steel for added strength
  - Belts can stretch and become loose causing poor drive and an irritating squealing noise

# Gear or gear train?

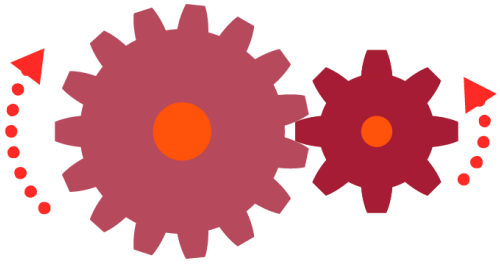
- A **gear** is a toothed cog wheel that is fixed to a shaft which rotates
  - When the teeth of two or more gears are interlocked (meshed together) they form a **gear train**

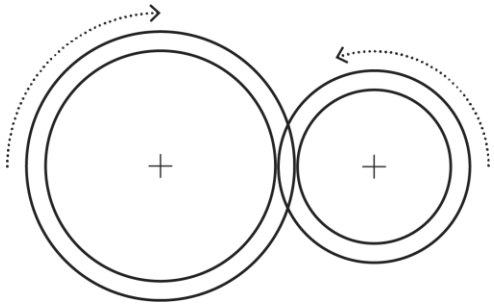
# Why gear trains are useful

- Gear trains can:
  - allow a change in the direction of the output motion compared to the input motion
  - create a change to the speed of movement
  - enable the direction of movement to change through 90 degrees
  - produce a non-slip drive train

# Simple gear train

- A simple gear train has a drive cog or ‘gear’ which rotates the ‘driven gear’
  - The velocity ratio (VR) or gear ratio can be worked out by comparing the number of teeth on each gear
  - If the drive gear has 20 teeth and the driven gear has 10, then the driven gear will rotate twice for each turn of the drive gear
  - This is a gear ratio of 1:2



*Graphical representation of gears*

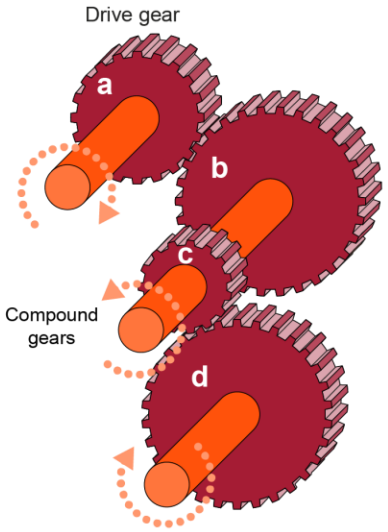
# Compound gears

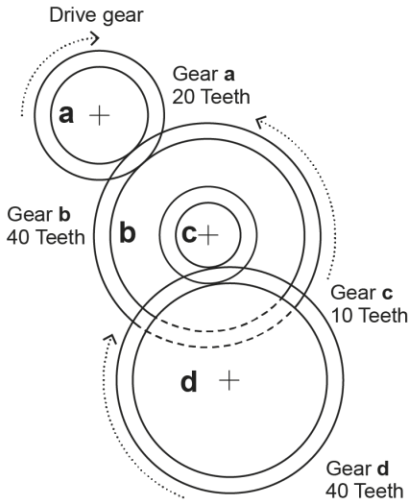
- **Compound gears** speed up or slow down the output
  - Pairs of gears are positioned on the same axle
  - To find the total VR of the compound gear train, work out each pair separately

The 1st pair (a-b) are: 20 teeth & 40
The 2nd pair (c-d) are 10 & 40

$$\frac{40}{20} \times \frac{40}{10} = 8:1$$

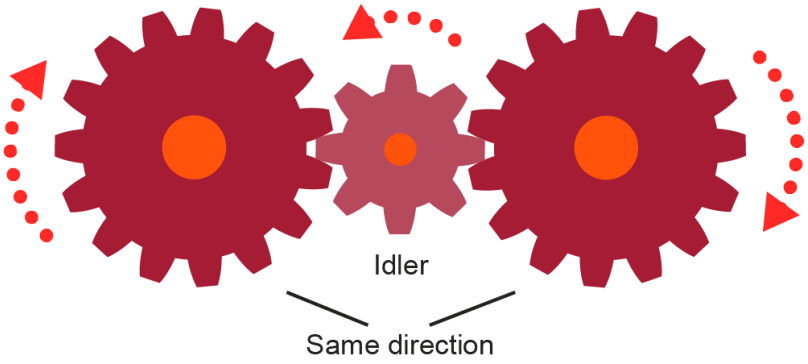
Where might compound gears be used?

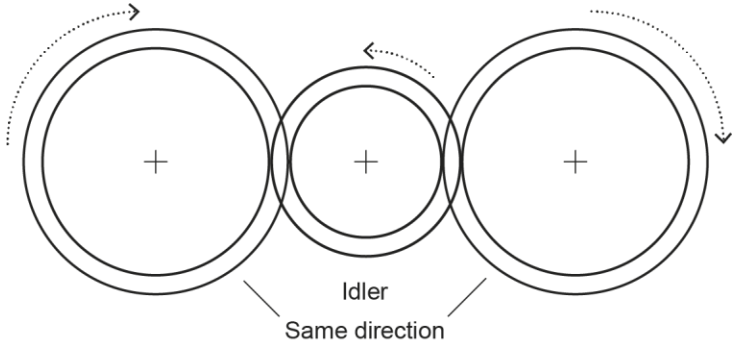


# Idler gear

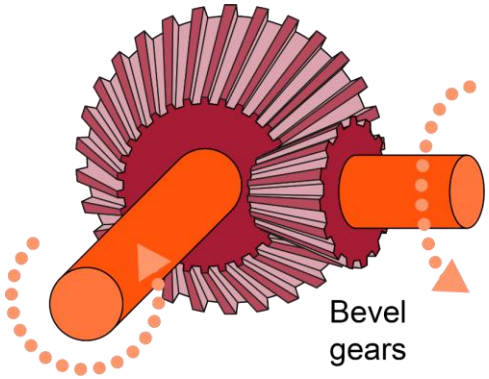
- An idler gear ensures that the direction of the drive gear and the driven gear are the same
  - The idler gear sits between the two gears and directly transfers the drive
  - Does the size of the idler gear affect the gear ratio?

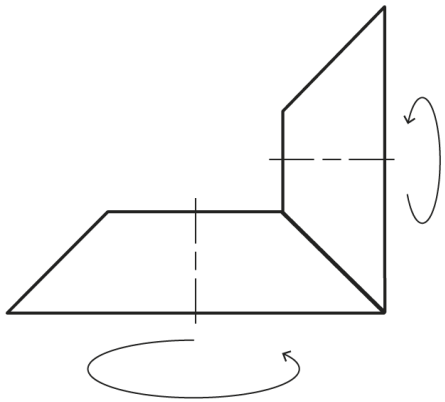


# Bevel gears

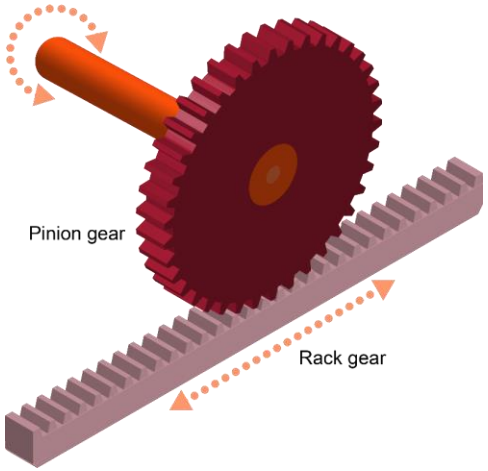
- **Bevel gears** change the input direction through 90 degrees
  - They are used on many power tools and hand drills
  - Where else might these be used?

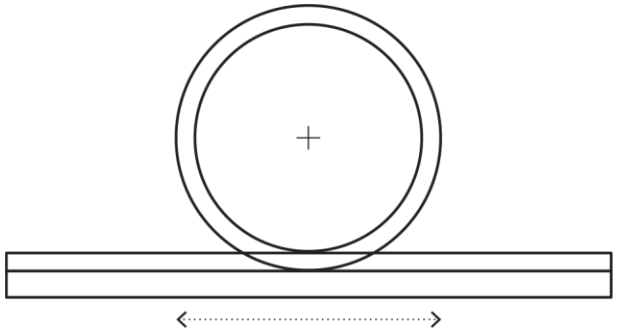


# Rack and pinion

- It converts rotational motion into linear
  - The rotation of the pinion gear makes the rack gear move left or right
  - Often found in steering systems and used for adjusting the height of the table on pillar drills
  - If the pinion gear pictured was connected to the steering system on a go-kart, what would be the effect of using a half size pinion gear?

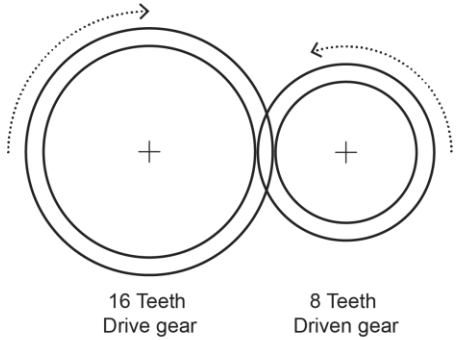


# VR for pulleys and gears

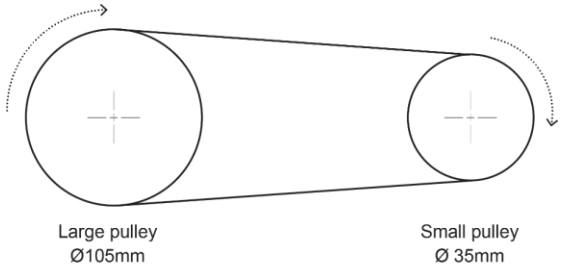
- To calculate the velocity ratio (VR) for pulleys and gears we use the following formulae
  - **VR formula for gears use:**

$$VR = \frac{\text{No. of teeth on driven gear}}{\text{No. of teeth on drive gear}} = \frac{8}{16} = \frac{1}{2} = 1:2$$




  - **VR formula for pulleys use:**

$$VR = \frac{\text{Diameter of driven pulley}}{\text{Diameter of drive pulley}} = \frac{35}{105} = \frac{1}{3} = 1:3$$




  - What happens if the gears or pulleys swap position?

# Input and output speeds

- To calculate the output speed of a gear or pulley system we use the term revolutions per minute (rpm)
  - **Output speed for gears:** Say the input speed is 300 rpm

$$\text{Output speed} = \frac{\text{Input speed}}{\text{Gear ratio}} = \frac{300}{1/2} = 300 \times 2 = 600 \text{ rpm}$$

  - **Output speed for pulleys:** Say the input speed is 150 rpm

$$\text{Output speed} = \frac{\text{Input speed}}{\text{Velocity ratio}} = \frac{150}{1/3} = 150 \times 3 = 450 \text{ rpm}$$

# Worksheet 6

- Complete **Task 3** of your Worksheet

# Plenary

- Name **four** different forms of motion
- Give an example for each of the **three** classes of levers
- Describe **two** linkages and their characteristics
- What is meant by mechanical advantage (MA)?
- What is the difference between a drive gear and a driven gear?

# Edexcel GCSE

Design and Technology 1DT0

7

# Electronic systems

PG ONLINE

# What is an electronic system?

Entry Task

- An electronic system is a series of parts or components that control a process, task or activity
  - Many products contain electronic systems
- Think about a security light:
  - What is the input?
  - What is the output?
  - How does the system make a decision to operate?

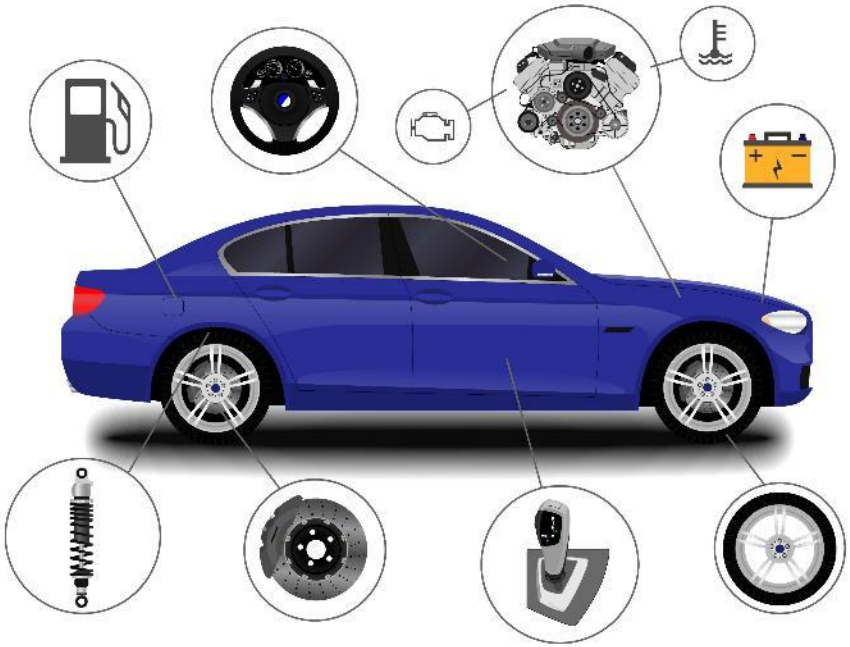
CQ

# Challenge Question

- Understand how electronic systems provide functionality to products and processes
- Know the working characteristics, advantages and disadvantages for a range of sensors, control devices and outputs

# Subsystems

- Subsystems or subtasks are events or tasks that happen within a system
- A car's systems include:
  - steering
  - braking
  - electrical
  - power and drive
  - entertainment
  - navigation
  - safety and many more



# Systems diagram

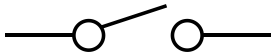
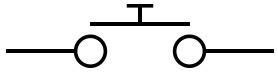
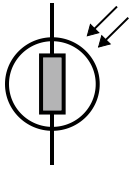
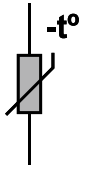
- Explaining how a system works can be confusing, so a simple block diagram is used
  - Separate inputs, processes/decisions and outputs are placed in individual boxes
  - They are linked with arrows to create a system or subsystem
  - The arrows show the direction (flow) within the system

# Using sensors in systems

- Systems and devices are triggered either manually or automatically using switches and/or sensors
  - Switches are a common form of an input control device
  - Sensors detect stimuli such as heat, light, movement and sound

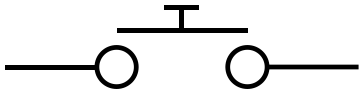
# Inputs

- Below are the circuit symbols for input components used in electronic circuits called schematic diagrams
  - What does it mean if a component has polarity?
  - Which input component detects heat?

| **Toggle switch** (latching) | **Push to make switch (PTM)** Normally open | **Push to break switch (PTB)** Normally closed | **Light dependent resistor (LDR)** | **Thermistor** |
|---|---|---|---|---|
|  |  |  |  |   |

# Push switches

- A **push to make (PTM)** switch can be used as a digital input device, found on phones and keyboards
  - It will produce a **1 (on)** when pressed and a **0 (off)** if released
  - A **push to break (PTB)** switch works the other way round
  - PTM and PTB switches are known as a **momentary switches**

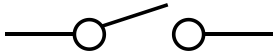


Push to make

Push to break

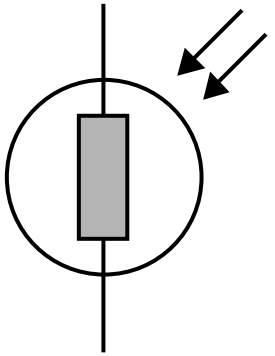
# Latching switches

- There are many different types of switches available
  - A **latching switch** can be turned **On** and stays **On** until physically turned **Off.** Often used as a power switch
  - **Toggle** and **rocker** style switches are both latching switches
  - The symbol shown is a single pole single throw (SPST) switch

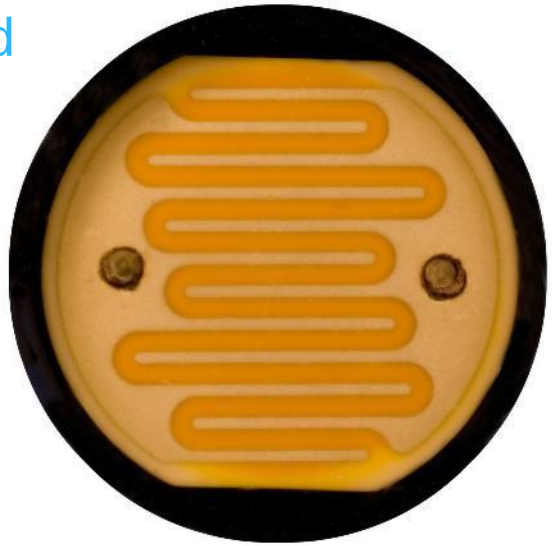


SPST

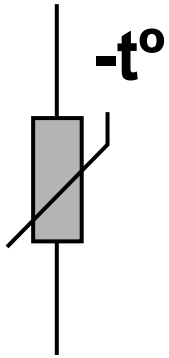
# Light sensor



- A **light dependent resistor (LDR)** is a component that changes its resistance in different light levels
  - It is a special type of resistor that is used to detect light and/or dark conditions
  - Its resistance decreases as more light falls on the sensor
  - Common uses include street lamps, solar garden lights and light meters for sports and photography applications
  - How could LDRs be used to save energy?

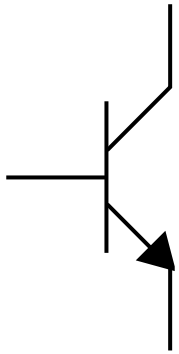


# Heat sensor

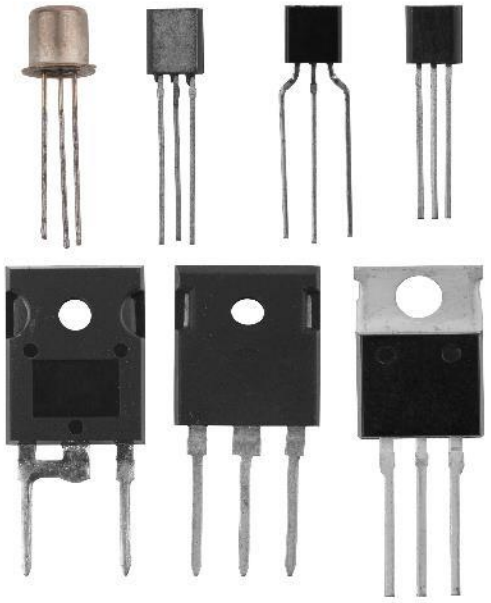



- A **thermistor** is an input component that changes its resistance level at different temperatures
  - It is a special type of resistor that can be used to detect hot and/or cold
  - Usually, its resistance decreases the warmer it gets
  - Common uses include central heating systems and washing machines
  - How might thermistors be used in a hospital or a hotel to aid health and safety?

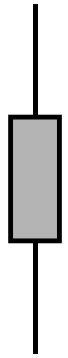
# Transistor



- A **transistor** is a small semiconductor made from silicon and has many forms
- It has two main applications:
  - **Electronic switch** – The transistor detects a tiny current and allows a much larger one to flow e.g. touch sensitive lighting
  - **Amplifier** – The transistor receives a tiny (input) current and turns it into a much larger (output) current
  - Which type would be used to make a microphone audible through a speaker?



# Resistors



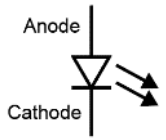
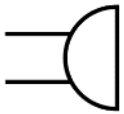
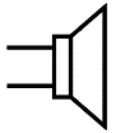
- A resistor limits the amount of current flowing in an electrical circuit
  - The unit of resistance is called **ohms (Ω)**
  - Resistors are used to protect sensitive components such as LEDs, restricting the amount of current flowing through them
  - They are used to stabilise digital input switches
  - They are also used in potential dividers to provide a specific voltage in a circuit

# Using outputs in a system

- Electronic products usually have an output device that produces an action such as making sounds
  - What different types of outputs does a laptop have?
  - What additional outputs could it be connected to?

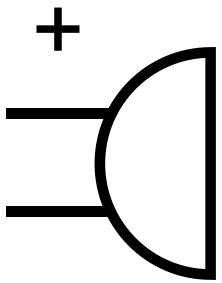
# Output components

- Output components change electrical energy into other forms such as light, sound, heat and movement
  - Some output components require lots of energy to operate, e.g. heating elements and large electric motors
  - Most higher powered outputs will require transistors or similar components to boost or amplify the power needed

| Light emitting diode (LED) | Lamp | Buzzer | Speaker |
|---|---|---|---|
|  |  |  |  |

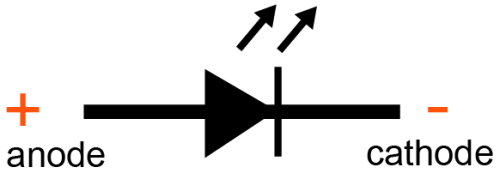
# Buzzer

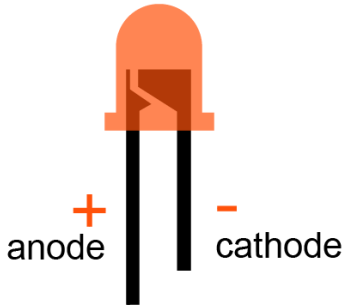
- Buzzers make a loud single frequency buzzing sound as electrical energy is converted into movement
  - A magnet resonates against a hard surface to create sound
  - Most have polarity meaning they must be connected correctly
  - Different buzzers can produce different frequencies of sound and can operate on different supply voltages




# Light emitting diodes

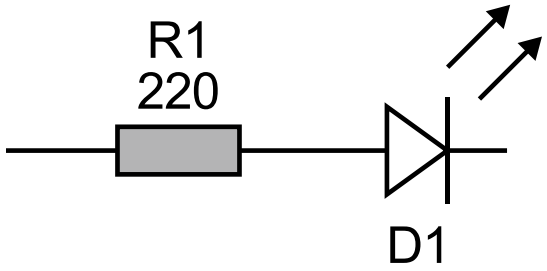
- A **light emitting diode (LED)** is usually a small, low powered output component
  - LEDs use very little current compared to filament bulbs
  - LEDs are **polarised**, meaning they have positive and negative legs
  - The long leg is the **anode** and is connected to positive **+**
  - The short leg is the **cathode** and is connected to negative **–**
  - Why are LEDs harder to replace than bulbs if they stop working?



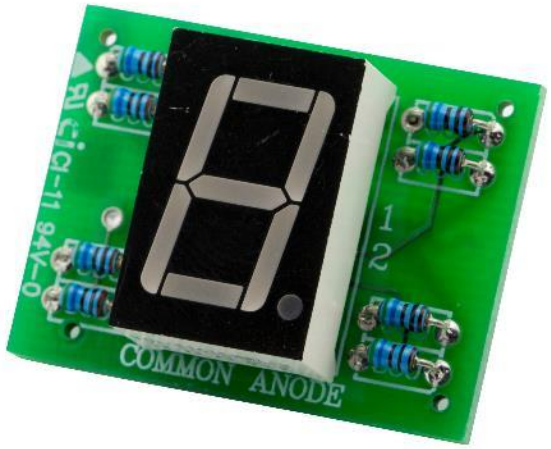



# Using LEDs

- LEDs are used in many products to provide light, but also as power, information and warning indicators
  - LEDs come in many styles and are used in 7-segment displays
  - LEDs are usually connected in series with a resistor which protects it from excessive current which can cause it to blow




Current limiting resistor & LED in series



# Worksheet 7

- Please complete **Tasks 1** to **3** of your Worksheet to consolidate your understanding

# Edexcel GCSE

Design and Technology 1DT0

8

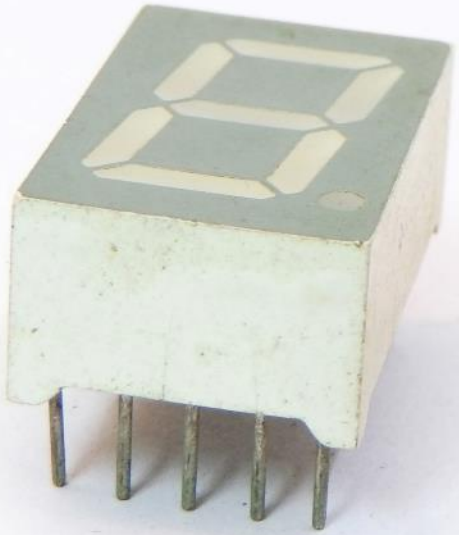
## Programmable components

PG ONLINE

E

# Do products make decisions? Entry Task

- How do electronic dice know which number to display?
- What is a process?
  - Timing
  - Counting
  - Amplifying
  - Comparing
  - Name some other electronic processes you have come across



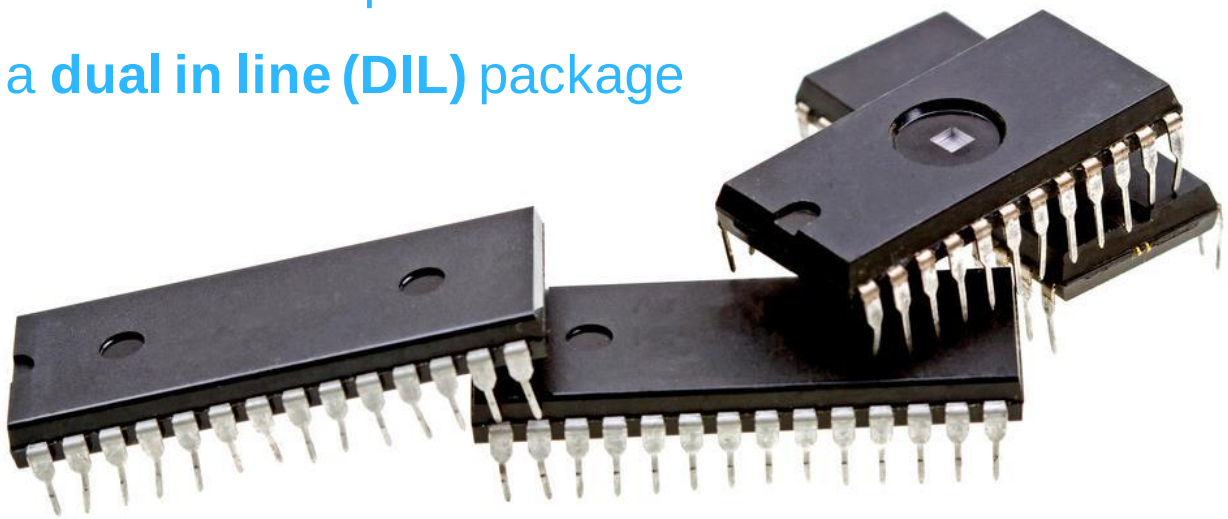
# CQ

# Challenge Question

- Understand how programmable components provide embedded functionality to products
- Be aware of the performance and functional capabilities of programmable components
- Understand how flowcharts are used to simplify the programming of components
- Understand the difference between the processing of digital and analogue inputs

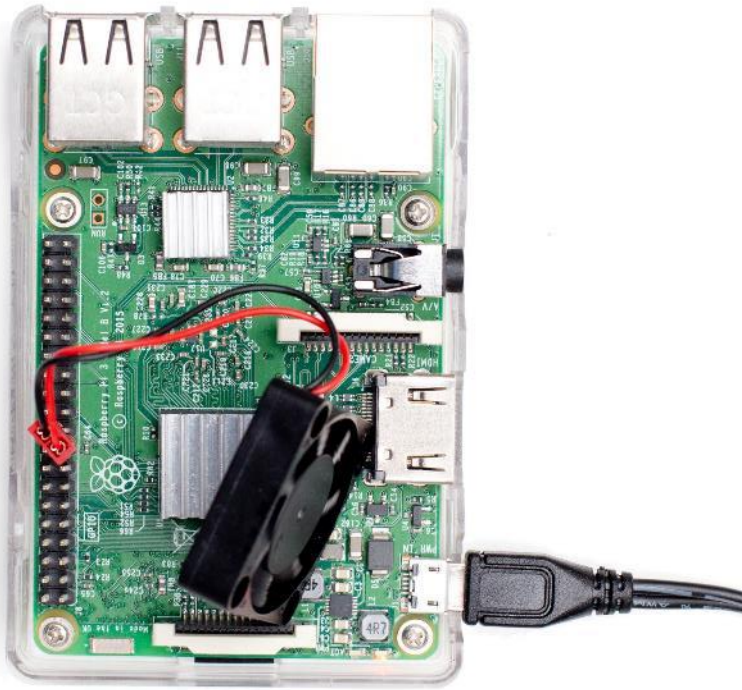
# Integrated Circuit (IC)

- Also known as microchips, ICs are capable of performing specific tasks
  - There are many different types of IC
  - A programmable IC is called a **microcontroller**
  - ICs can come in different shapes and sizes
  - Most come in a **dual in line (DIL)** package



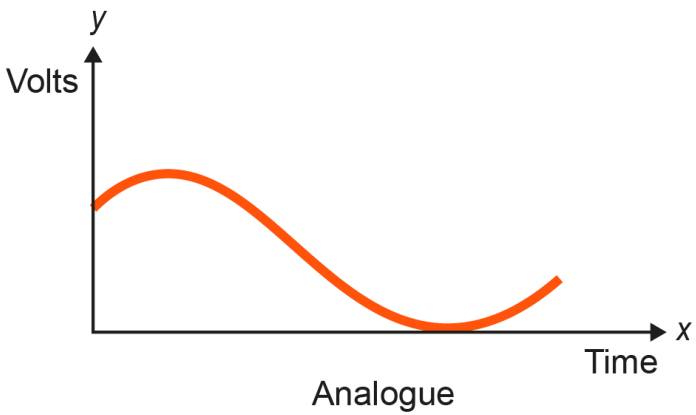
# Microcontroller IC

- A microcontroller IC is known as a peripheral interface controller (PIC)
  - These programmable ICs are very adaptable
  - They can be programmed to perform multiple processes
  - This reduces the number of components needed to perform a task (component redundancy)
  - What are the benefits of having a smaller circuit board?

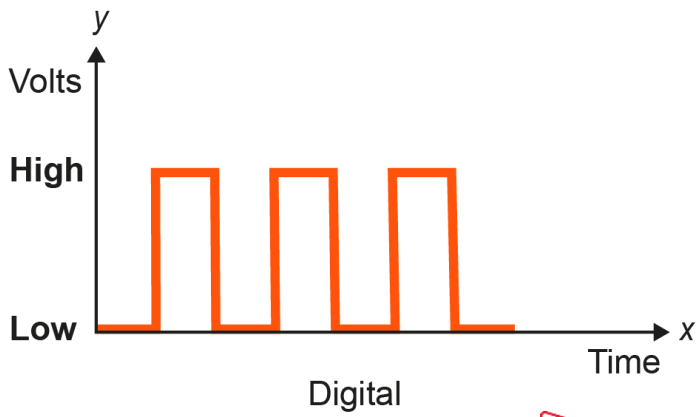


# Digital vs analogue

- There are two types of signal in electronic systems:
  - Analogue signals have an infinite range of values between the minimum and maximum points
  - Digital signals are either on or off, and are usually represented by a **0** for off and a **1** for on
- Which type of signal is a switch likely to produce?



Analogue



Digital

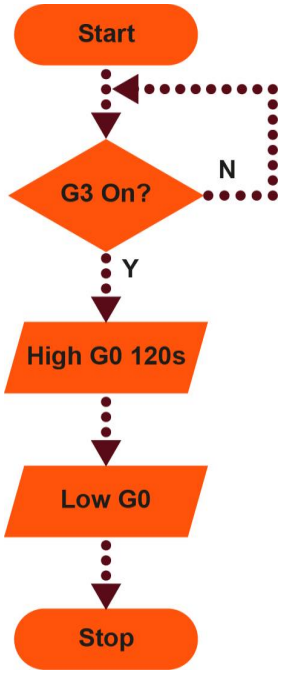
# Flowcharts

- Flowcharts are a more detailed way to graphically represent systems than systems diagrams
  - They can also be used when programming microcontrollers
  - Common flowchart symbols include:

| Start / End | Arrows | Input / Output | Process | Decision |
|---|---|---|---|---|
|  |  |  |  |  |

# Programming a PIC

- A PIC's functions are controlled by a program or code that is usually received via a download cable
  - Specialist software enables the program to be drawn graphically as a flowchart
  - It can also be written in a coding language, such as BASIC
  - Most PICs can be reprogrammed multiple times, allowing for corrections and updates
  - What might be the drawback of using a PIC for a simple one-off task?

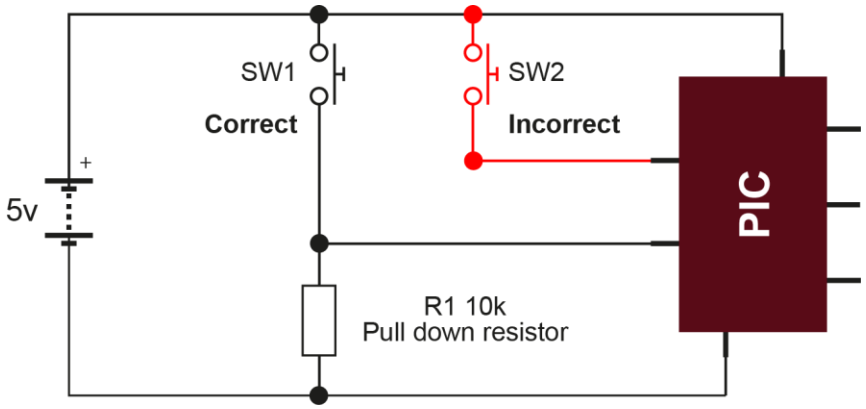


# Digital or analogue inputs?

- When programming PICs, the type of input required will need to be considered, for example:
  - Switches are input components that give a digital signal
  - Components such as thermistors, LDRs and microphones require an analogue input
  - Why is a digital input easier to process than an analogue one?

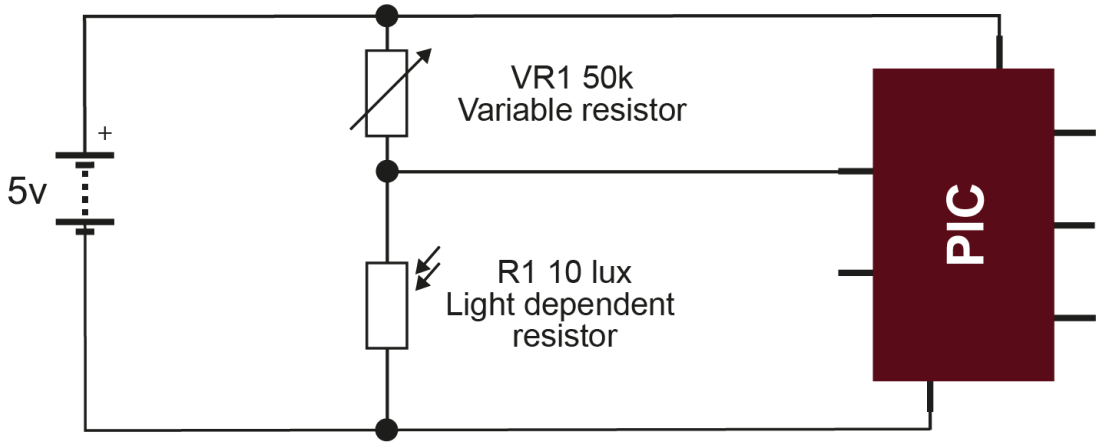
# Connecting inputs

- Most input components, especially sensors, work best in a potential divider
  - The input is connected to both the positive and negative of the power supply through appropriate components
  - It helps to provide a consistent signal to an input pin
  - A resistor is used to **pull-up** or **pull-down** an input pin to avoid it floating, which can cause erratic errors



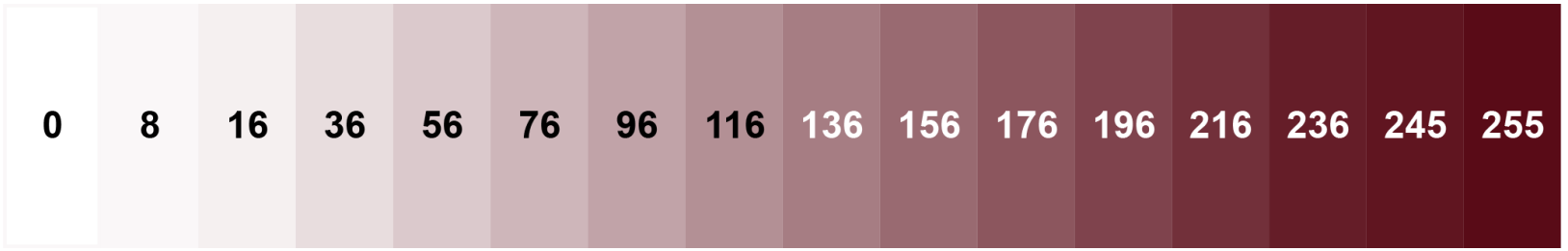
# Using analogue inputs

- Analogue components give out varying signal levels
  - A potential divider is used to provide the desired voltage in response to changing environmental conditions
  - For example, a street lamp needs to be turned on at dusk
  - The dark detector below uses a variable resistor which allows the sensitivity of the device to be adjusted



# Using analogue sensors

- PICs cannot process the infinite range of values that analogue inputs provide so it is divided into smaller parts
  - Analogue inputs divide a signal in to 256 equal sections
  - The range is labelled 0 to 255
  - When the input signal reaches a particular value or intensity, the PIC will function as the program dictates



# Worksheet 8

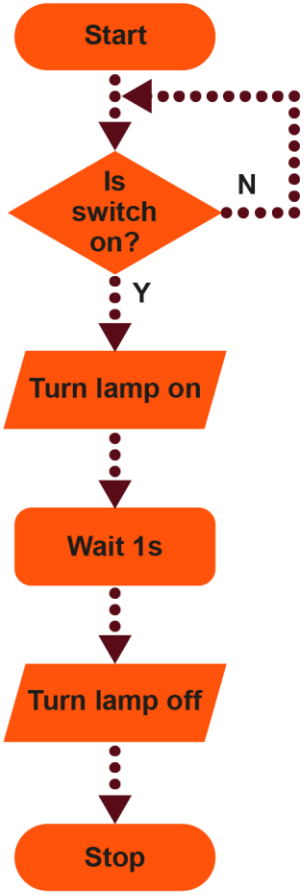
- Complete **Task 1** of your Worksheet

# Timing circuits

- There are two main types of timing circuits:
  - Delay timers that go on once and turn off, such as a doorbell chime being activated for a few seconds only
  - Repetitive timers go between on and off states so many times per second or minute etc., such as flashing road safety devices

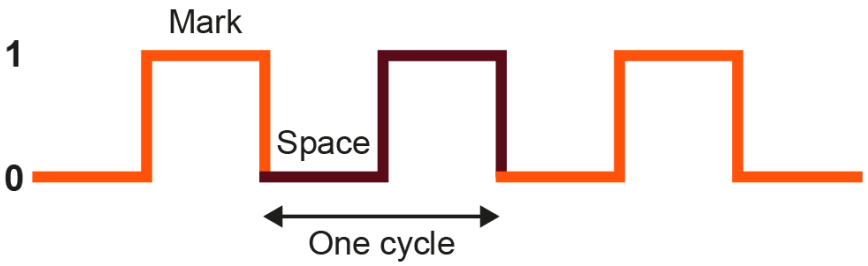
# Monostable device

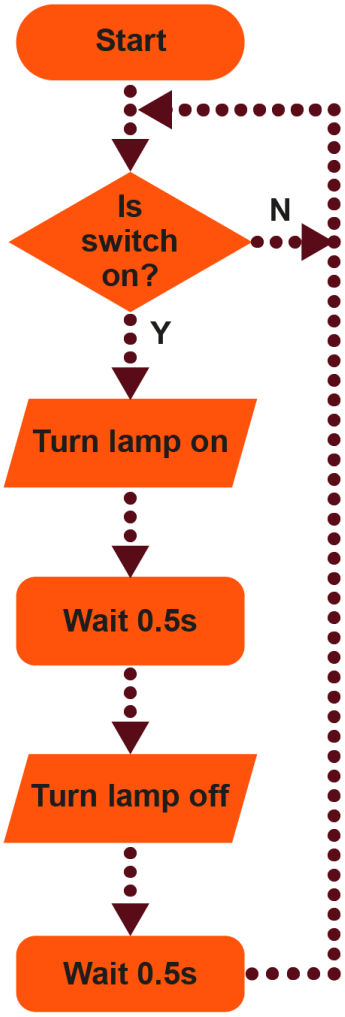
- The time delay (pulse) produced is usually triggered by a switch or sensor
  - The length of the delay can be varied by changing the delay time
  - Monostable devices are used for timing how long events occur such as an automatic door opening and shutting
  - Where else might one be used?

# Astable device

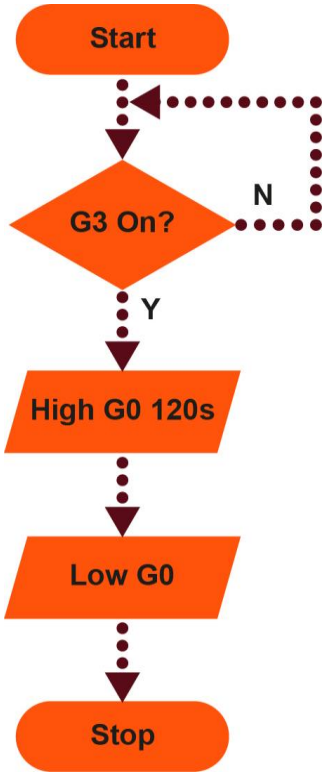
- The repetitive stream of pulses produced are oscillating and constant
  - One **cycle** is the time a single pulse takes to go from **0** (off) to **1** (on) and back to **0**
  - The speed of the pulses is known as the frequency and is measured in **hertz (Hz)**
  - Flashing lights are used on tall buildings and aircraft – where else are they used?



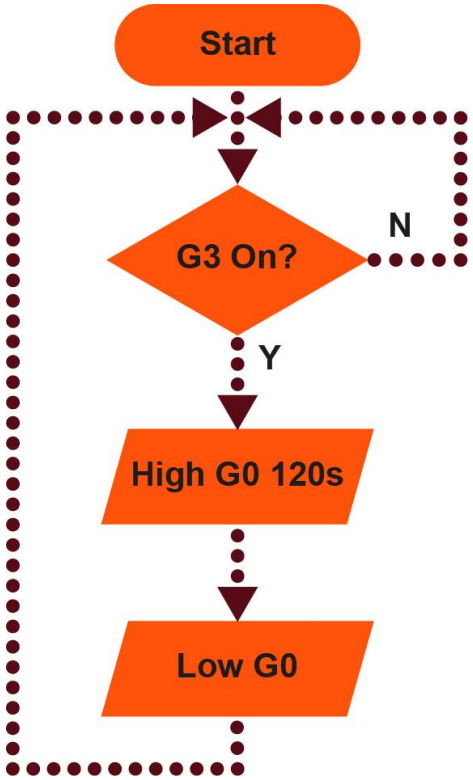
# Open loop system

- This flowchart shows an **Open loop** system
  - When the program has been triggered, the flowchart will perform the routine **once** and then **Stop**
  - It will only work again when the whole program has run
  - Can you think of a situation where this type of system would be useful?



# Closed loop system

- The flowchart shown here is a **Closed Loop** system since it never appears to Stop
  - Once turned on, the flowchart will perform the routine continuously until the system is turned off
  - Each time the output goes **Low** it will go back to the top of the flowchart
  - It runs in a loop until the input is triggered again, and continues to do this
  - Where might this system be seen?

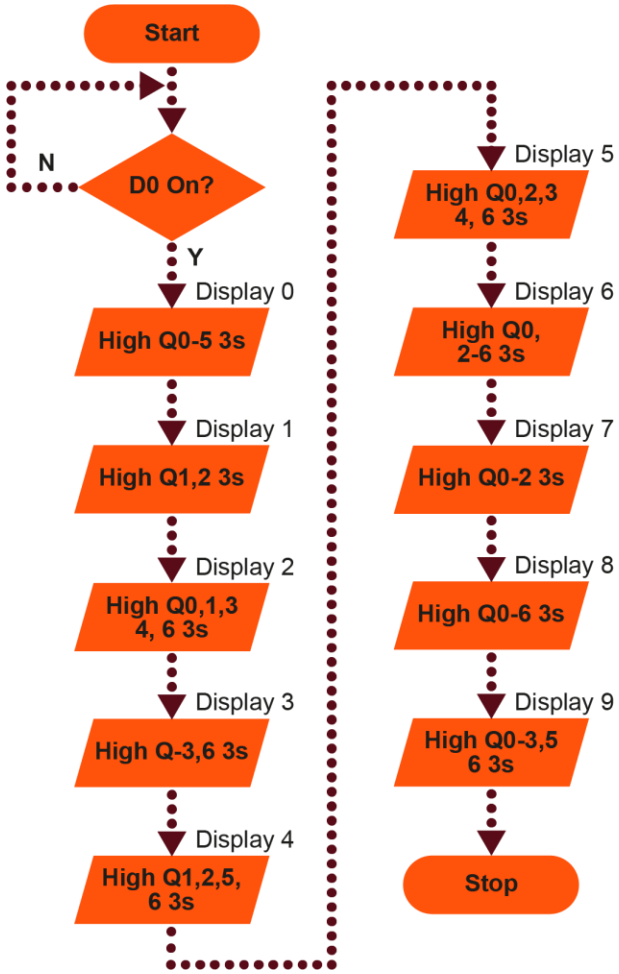


# Counting

- PICs can be programmed to count up and down, and can take over the roles of many traditional ICs
  - PICs and other components can count pulses
  - Popular counters include decade counters which have 10 outputs and count up or down by one on each pulse
  - 7-segment display decoder converts pulses into numbers and outputs to a 7-segment display

# Counting with PICs

- PICs can easily be set to look for a signal in an input and then run a given program
  - Here input **D0** is waiting for a high
  - Once triggered it will run through a series of outputs displaying the appropriate numbers between 0-9 using LEDs on a 7-segment display
  - Is this running as an open or closed loop system?



# Plenary

- Complete **Task 2** and **3** of the **Worksheet 8**

# Edexcel GCSE

Design and Technology 1DT0

1

## Ferrous and non-ferrous metals

PG ONLINE

# Objectives

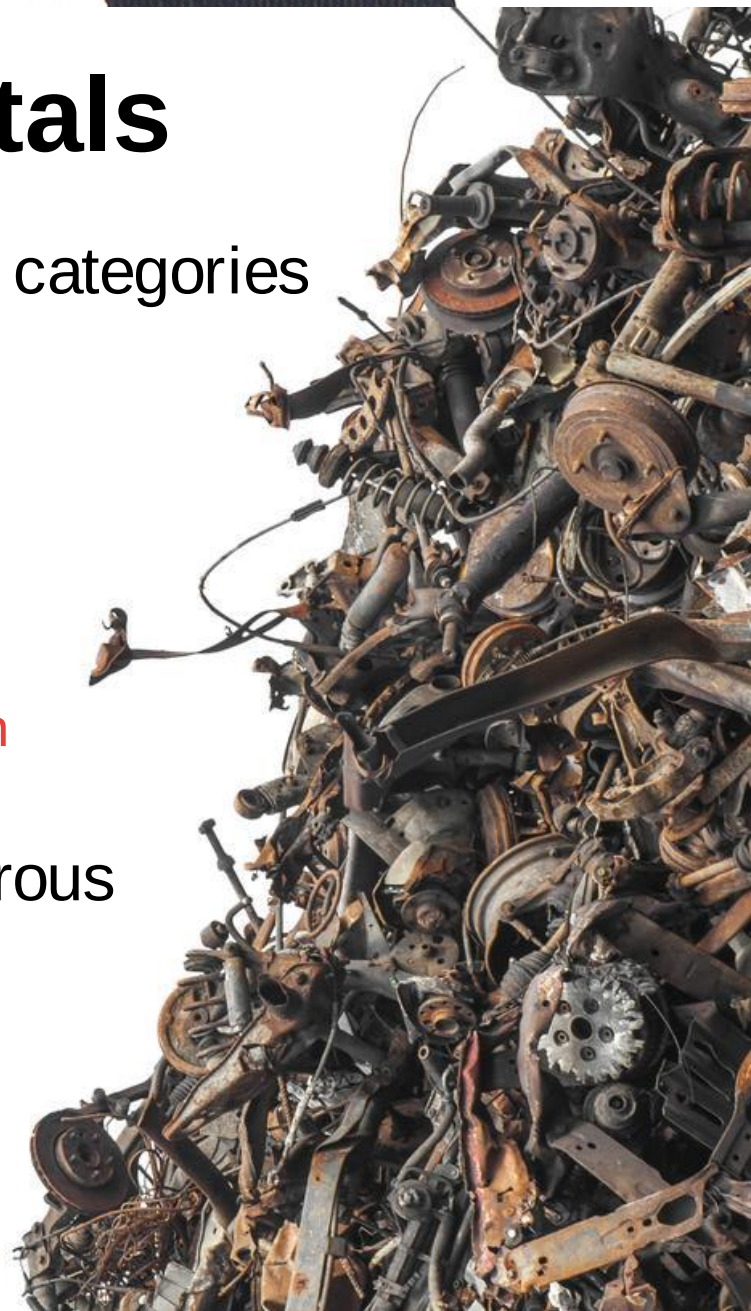
- Know the primary sources of materials for producing metals and alloys
- Be able to recognise and characterise different types of metals and alloys
- Understand how the structure and working properties of a range of metals and alloys affect their performance

# Starter

- Padlocks are traditionally attached to bridges or landmarks to signify enduring love and friendship
  - How might these padlocks age over time?

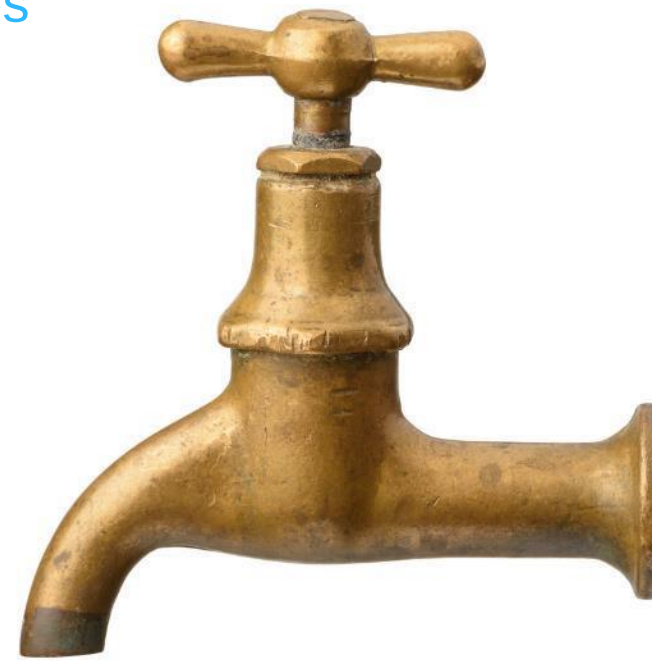
# Classification of metals

- Metals are divided into two main categories
  - Ferrous metals
  - Non-ferrous metals
  - Ferrous metals contain the element **iron**, also known as **ferrite** (Fe)
  - Non-ferrous metals don't contain iron
- You also need to know about ferrous alloys and non-ferrous alloys
  - What is an alloy?



# Alloys

- Metals are rarely used in their pure form
- Alloys are made by combining two or more elements
  - This helps improve the working properties and appearance
  - Brass and stainless steel are common alloys
  - By combining certain elements, alloys can be protected from oxygen – what will this help prevent?
  - Name some other advantages of creating alloys

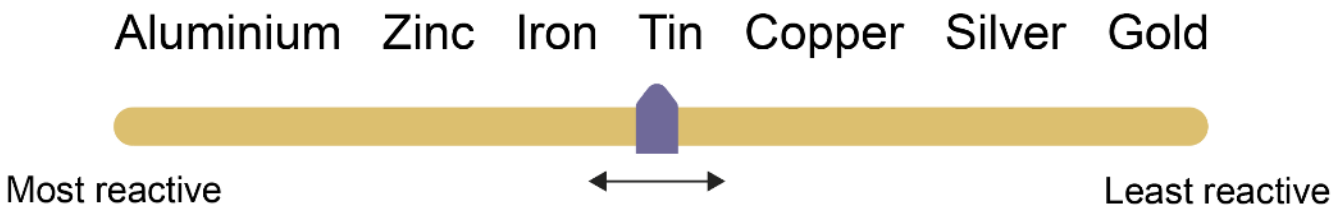


# Metal origins

- Metals have been essential in the development of civilisation
  - The word ‘metal’ comes from the ancient Greek word ***metallon*** which means to mine, excavate or extract from the ground
  - Prehistoric man used metals to make tools and weapons
  - Which common metals might you find in a domestic kitchen?

# Ore

- The Earth's crust contains many types of rock
  - Metallic minerals are found naturally in rock or ore
  - Ore is obtained by mining, and the metals contained within it are extracted
  - The method used for extraction depends on the metal's reactivity with air, water or acids
  - The more reactive the metal, the more expensive it is to extract

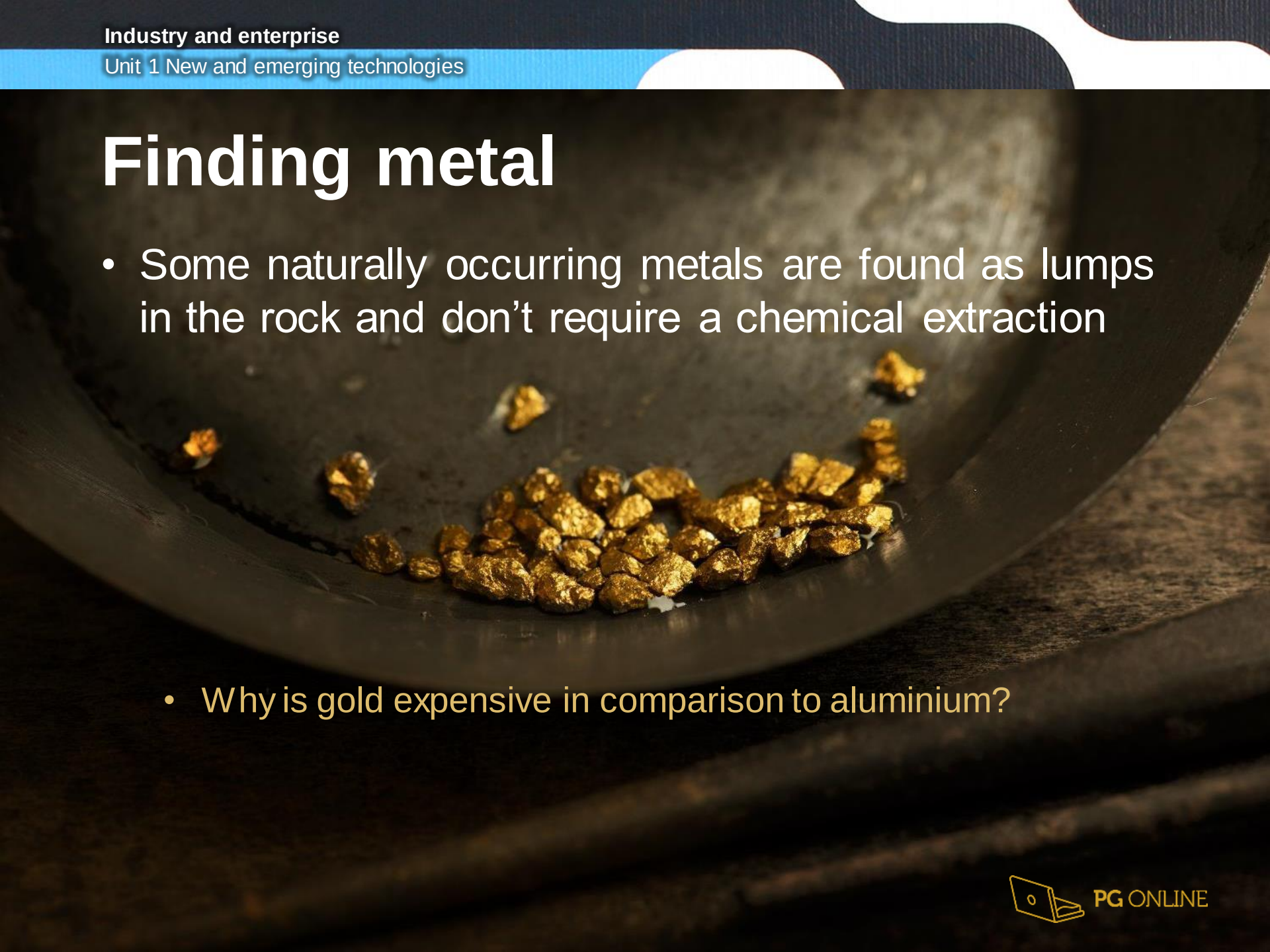


# Extraction processes

- Once an ore is mined from the ground, metal must be extracted before it is processed into stock forms
  - Most metals are **smelted** in a blast furnace
  - **Electrolysis** is used to extract metals such as aluminium

# Finding metal

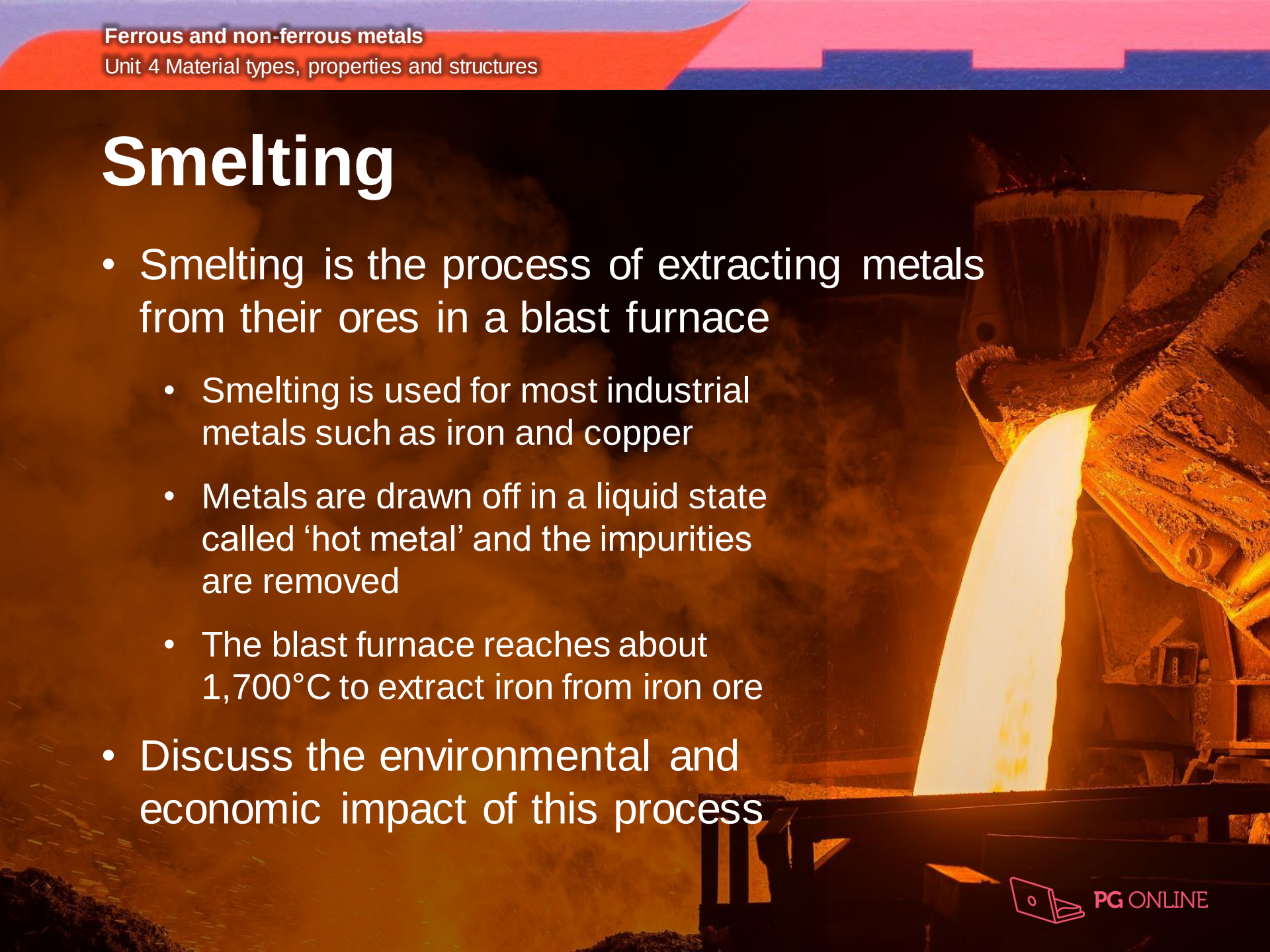
- Some naturally occurring metals are found as lumps in the rock and don't require a chemical extraction



- Why is gold expensive in comparison to aluminium?

# Smelting

- Smelting is the process of extracting metals from their ores in a blast furnace
  - Smelting is used for most industrial metals such as iron and copper
  - Metals are drawn off in a liquid state called ‘hot metal’ and the impurities are removed
  - The blast furnace reaches about 1,700°C to extract iron from iron ore
- Discuss the environmental and economic impact of this process



# Worksheet 1

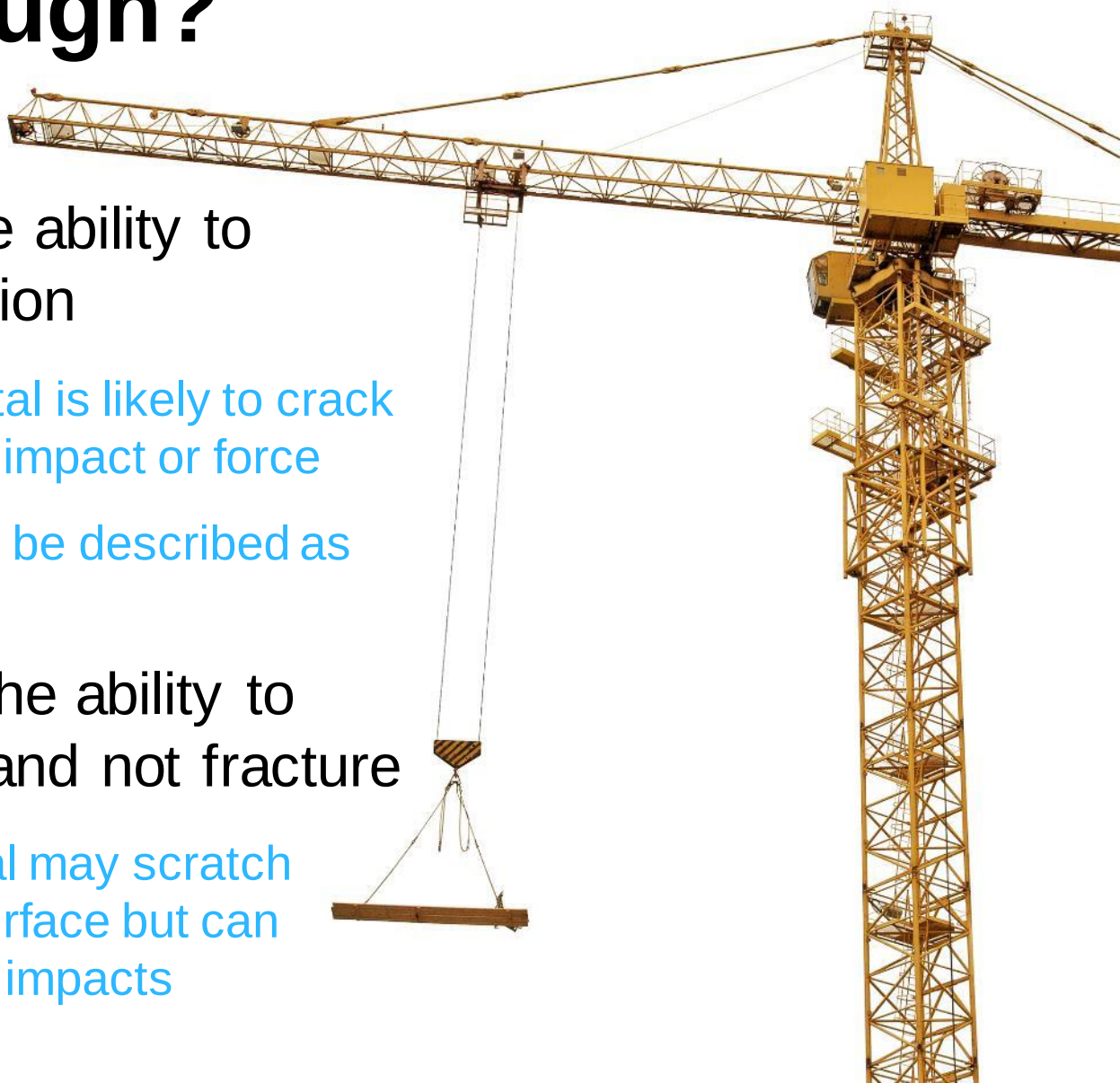
- Consider this image of an iron ore mine then complete **Task 1**

# Material properties

- Ductile metals
  - Will stretch without being damaged
  - Can be drawn or stretched out into long wires
  - Copper is highly ductile and can be drawn into long, thin wires

- Malleable metals
  - Can be hammered into a shape without breaking
  - Can be rolled or pressed into sheets easily but will deform if compressed
  - Name the malleable metal used to make foil

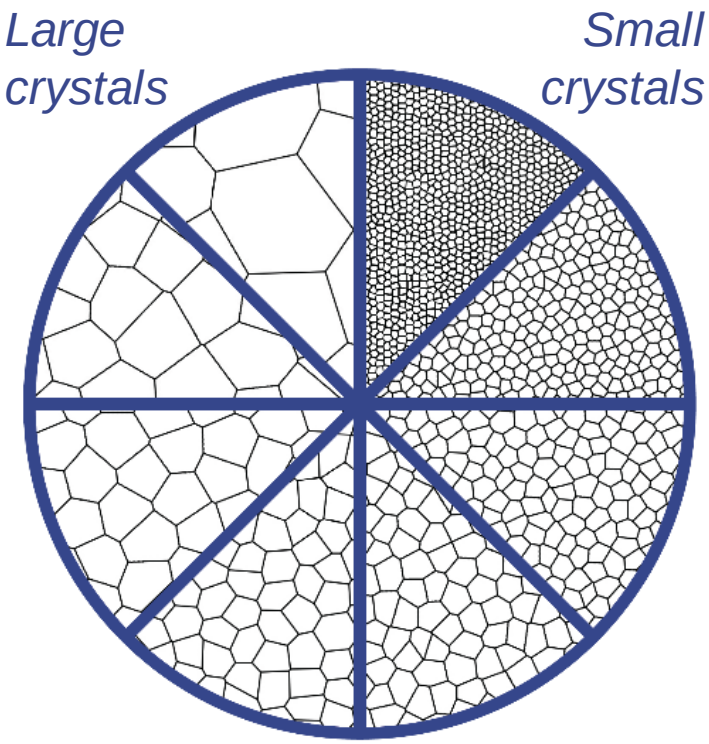
# Hard or tough?



- **Hardness** is the ability to withstand abrasion
  - A very hard metal is likely to crack or shatter upon impact or force
  - Cast iron would be described as hard but brittle
- **Toughness** is the ability to absorb energy and not fracture
  - A tough material may scratch easily on the surface but can withstand large impacts

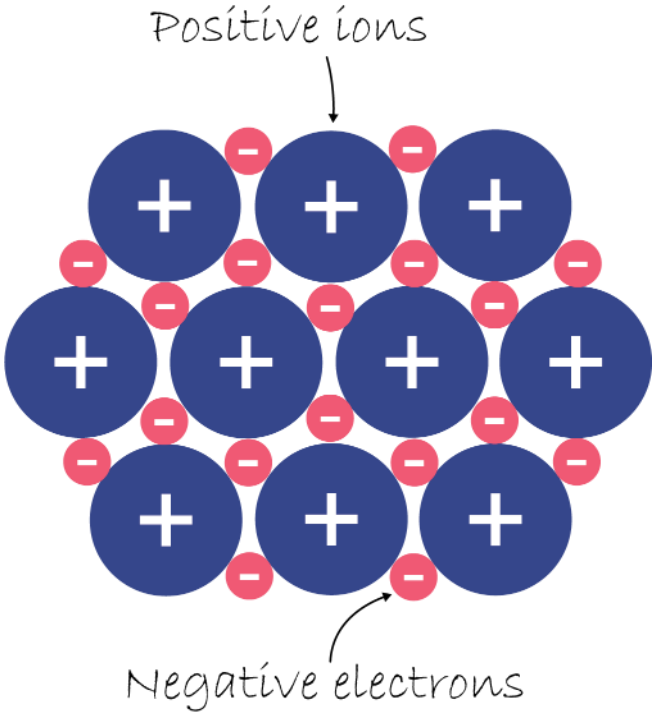
# Physical structure of metal

- The structure of metals helps explain its properties
  - The crystalline structure of metals can be modified through heat treatments
  - The larger the grains; the tougher and more ductile the material



# Molecular structure of metal

- The atomic structure of metals shows the tight bonds between atoms
  - Strong bonds between the ions and electrons give metals strength and high melting points
  - Positive ions in a sea of free-moving electrons make metals good electrical conductors



# Ferrous metals

- Ferrous metals contain iron and may rust
  - Iron and steel can corrode – this is known as rust
  - Rust is a compound called iron oxide and is formed when iron and oxygen react in the presence of moisture
  - Most ferrous metals are magnetic
  - Name **two** types of protective layer that could be added to ferrous metals to help prevent rust

# Iron and carbon

- Steel combines iron and carbon which can also be alloyed with other elements
  - **Cast iron** 2.4 - 4% carbon
  - **Mild steel** 0.05 - 0.3% carbon
  - Medium carbon steel 0.4 - 0.7% carbon
  - High carbon steel 0.6 - 1.5% carbon
  - **Stainless steel** **Alloyed with:** Chromium, nickel, magnesium
  - High speed steel **Alloyed with**: Chromium, tungsten, vanadium
- Different element combinations and ratios give different properties

# Cast iron

- Cast iron has a relatively high carbon content which makes it hard but brittle
  - Ornate and complex designs are possible through the casting process, but it's hard to machine
  - Uses include manhole covers, vices, G-clamps, radiators and post boxes
  - What could happen if you tried to machine cast iron?

# Stainless steel

- Stainless steel has a high resistance to corrosion, staining and friction
  - It's one of very few ferrous metals which do not require a coating to make it resistant to corrosion
  - Stainless steel is an alloy of carbon, chromium, nickel and manganese
  - These elements give the characteristic properties of hardness and toughness
  - Name **three** everyday uses for stainless steel

# Mild steel

- Mild steel is tough, ductile and easy to machine, braze and weld
  - A relatively cheap material used in engineering and construction e.g. girders, nails, nuts, bolts
  - These properties make it particularly suitable for car bodies and bike frames
  - Which alternative materials can be used to make bicycle frames?

# Worksheet 1

- Complete **Task 2** on your Worksheet

# Non-ferrous metals

- Non-ferrous metals do not contain iron and most are not magnetic
  - How else do they differ from ferrous metals?
  - Aluminium, copper and brass are all non-ferrous metals
  - List some household items made from non-ferrous metals

# Oxidisation

- Non ferrous metals, such as copper and bronze, don't rust but may oxidise
  - Oxidising can be caused by corrosion or weather exposure over a period of time
  - The thin layer of tarnish that appears on the surface of the metal is called a patina
  - The green-turquoise **patina** occurring on copper is called Verdigris
  - Do all metals oxidise?

# Non-ferrous properties

- Non-ferrous metals are often more expensive than ferrous metals owing to their desirable properties which include:
  - Lightweight
  - Good conductivity
  - Ductile and malleable
  - Resistant to corrosion
- Why is **brass** used to make many wind instruments?

# Brass

- Brass refers to a **range** of copper and zinc alloys with differing properties
  - The hardness of brass depends on the ratio of copper to zinc
  - Its machinability and corrosion resistance can be adjusted by adding lead or aluminium
  - Used for low-friction applications such as padlocks, gears, valves and bearings as well as musical instruments
  - Prized for its decorative properties, it is hard, ductile, resistant to wear and is antimicrobial

# Aluminium

- Aluminium is a hugely versatile material used in a myriad shapes and forms
  - Aluminium ore known as bauxite, is the most common ore found in the Earth's crust
  - A light grey metal, efficient thermal insulator and doesn't degrade when recycled
  - What other properties make it suitable for use in an aircraft fuselage?
  - List some common uses for aluminium

# Conductive copper

- Electrical conductivity is how easily an electrical current can flow through a metal


  - Copper is such an efficient conductor, it's most common use is in electrical cabling

# Worksheet 1

- Complete **Task 3** on your Worksheet

# Making with metals

- Metal is so versatile that often more than one kind of metal is suitable for a given product
  - Consider the pros and cons of using aluminium alloy versus mild steel to make a bike frame
  - Complete **Task 4** of **Worksheet 1**

# Plenary

- What are metals commonly extracted from?
- Name **three** ferrous metals
- Which metal would you select for high conductivity?
- Explain the term ‘alloy’
- Describe the difference between hard and tough
- How can you protect metal from oxidisation?
- Justify the use of **one** metal when manufacturing kitchenware

# Edexcel GCSE

Design and Technology 1DT0

2

## Papers and boards

PG ONLINE

# Objectives

- Know the primary sources of materials for producing papers and boards
- Be able to recognise and characterise different types of papers and boards
- Understand how the working properties and structure of a range of paper and board products affect their performance

05:00

# Starter

- Think of the range of papers and boards you will have encountered today
  - Make a list of all the different types and suggest their characteristics, for instance rigid, opaque, smooth
  - Suggest materials that could be used to make papers and boards

E

- Entry Task

# What is paper?

- Papers and boards are made from natural fibres (cellulose), usually sourced from wood
  - Other sources of fibre include bamboo, flax, hemp, kenaf, straw and sugarcane
  - Wood fibres are mostly sourced from faster growing softwoods rather than hardwoods
  - Rag paper is made using cotton which gives it superior strength and durability

- Is paper a sustainable material?

# Pulp

- The first stage in the production of paper and board is to make pulp
  - The natural cellulose fibres are mixed with water
  - This mixture is cooked which produces a fibrous liquid known as pulp
  - Pulp is fed onto a mesh conveyor which allows excess water to drain away
  - It then makes its way through a series of rollers which help to press, form and dry the pulp into a continuous sheet which is either rolled or cut to size for commercial processing

# Treatments and finishes

- The final finish of paper or board depends upon:
  - the type of fibre used to make the pulp
  - any chemicals added during the manufacturing process
  - the addition of layers, different coatings or laminates
  - bleaching level which decreases the natural colour so it becomes ‘brighter’ or whiter
  - how much sizing it receives, as this reduces absorbency
- The final product is then cut and sold in rolls, reams or sheets

# Paper weight

- Paper is classified by both weight and size
  - Weight is measured in grams per square metre (GSM)
  - Paper sizes are set globally using the A, B and C series
  - Understanding the different types and sizes of paper available will help you select the right material for the job
  - How might the properties of a paper change with its weight?

# Copier paper

- A thin, smooth, uncoated paper used primarily in printers and photocopiers
  - An 80gsm, everyday, cheap paper that takes colour well
  - Suitable for drawing or writing and available in bright white as well as a range of colours
  - Consider some of the limitations of copier paper

# Cartridge paper

- A thick, opaque, quality paper with a slight texture
  - It's used particularly for pencil and ink drawings and paintings
  - Available in a range of weights from 120-200gsm, a heavier 200gsm paper is suitable for watercolour and acrylic painting
  - Would this type of paper be given a coating? Justify your answer

# Translucency

- Tracing paper is strong, smooth and translucent
  - Commonly 60-90gsm, but ranging from 40gsm up to 280gsm for specialist uses
  - The translucent finish is achieved either by beating paper pulp to remove air **or** by passing ordinary paper through acid
  - This increases the translucency, and it also increases the stability of the paper
- It's less absorbent and resists water and grease
- As well as for tracing, suggest where else you may find this type of paper in use

# Worksheet

- Complete **Task 1** of **Worksheet 2**

https://www.youtube.com/watch?v=7IP0Ch1Va44&list=PLjWnuPPcBJHTYKGzluIAtWbkDh5ZW0GJx

# When is a paper a board?

- Paper-based materials that weigh more than 220gsm are usually classified as boards
  - Board is measured by weight (GSM) and/or by thickness
  - Board thickness is measured in microns (µm)
  - 1000 microns is equal to 1mm

# Boards

- Cards and boards are available in a range of thicknesses and strengths
  - Board can be made from recycled paper
  - Boards can be laminated to other materials or layered to enhance its strength or its surface finish or durability
  - These characteristics make board very versatile
  - Suggest some innovative uses of cardboard

# Corrugated cardboard

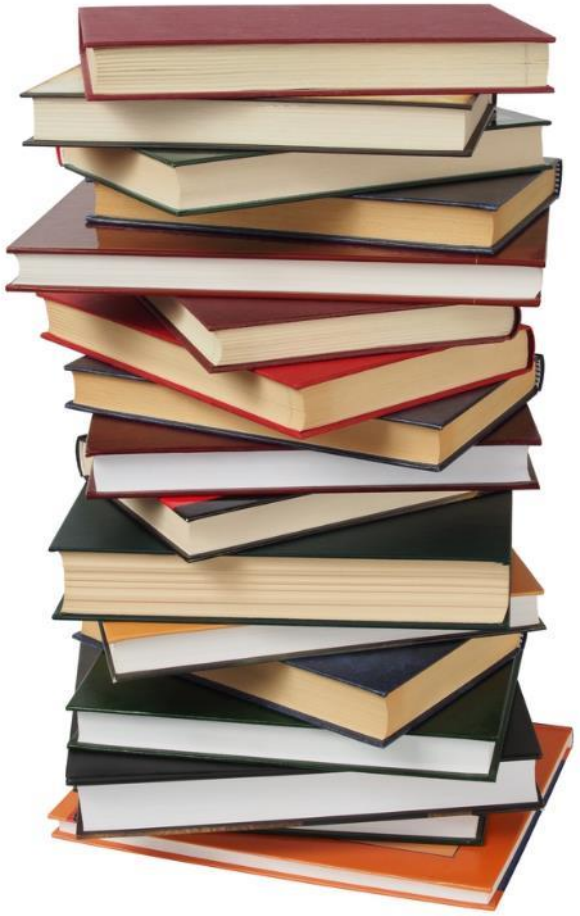
- Corrugated board is made up of one or two outer flat layers and a corrugated layer
  - Shock-absorbing, lightweight cheap and a thermal insulator
  - Flexible or rigid depending on the structure and direction of force
  - With a smooth surface, it can easily be printed on
  - Suggest a common use in the catering industry for this board

# Folding box board

- Folding box board (FBB) is a ubiquitous card primarily used in packaging
  - Comprised of a printable top coat with thin bleached and unbleached layers
  - At about 400-600µm thick, it folds and scores effectively
  - It gains structural strength from the shape of the folded package
  - Uses include packaging for food, cosmetics and toys
  - The top surface can be embossed and can take a range of print finishes

# Solid white board

- Solid white board is a high quality board with a bright white finish
  - Weights range from 200gsm – 500gsm or 650-2000µm thick
  - It's strong, smooth surface makes it suitable for hard book covers and high-end product packaging
  - It accepts printing and surface finishes
- What process will the wood pulp undergo to produce this bright white board?



# Properties

- Biodegradability, flexibility and printability are some key properties to consider when selecting materials
  - Discuss some definitions for these key terms

# Lined and coated boards

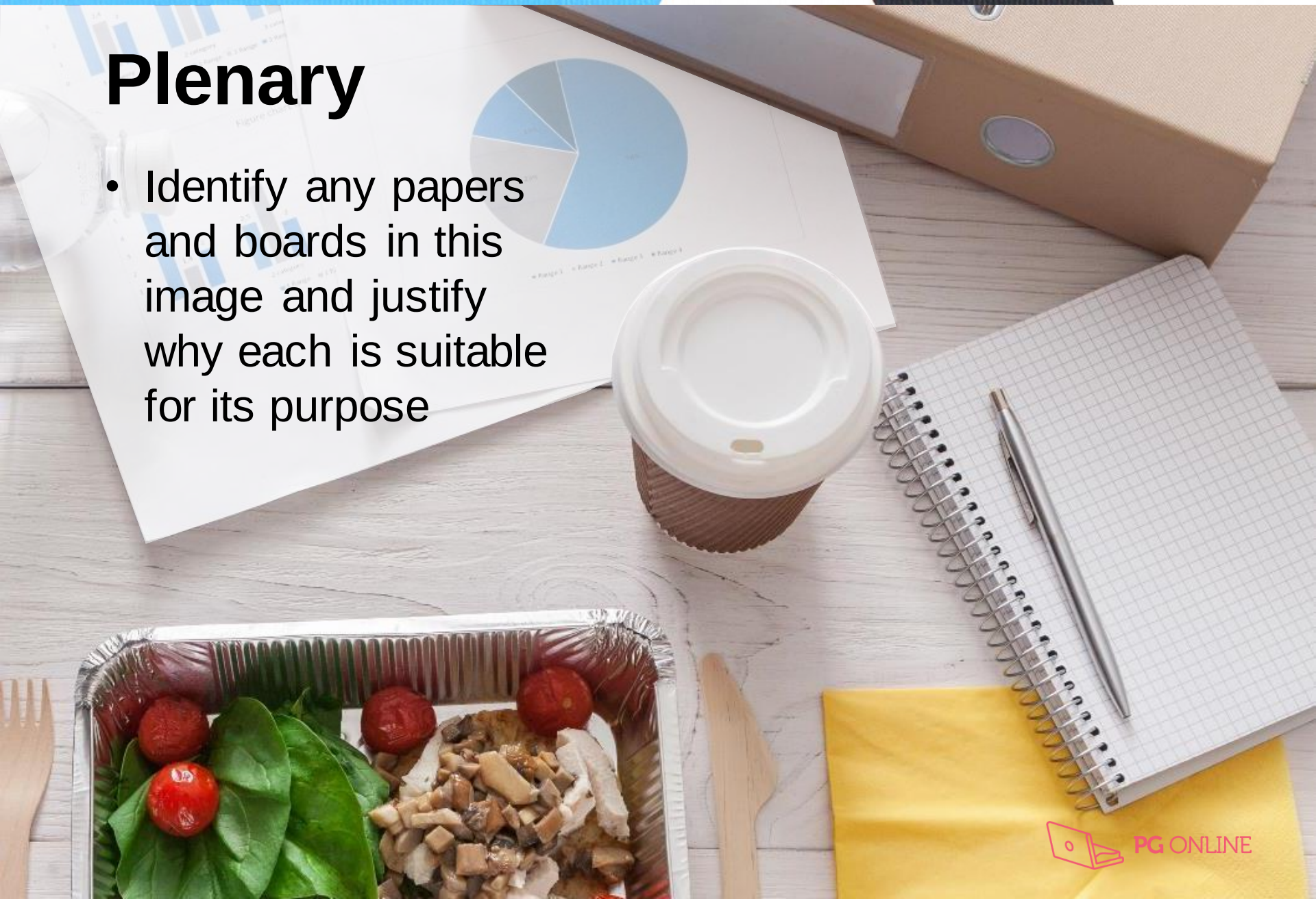
- Some boards are coated or laminated with other materials to enhance their working properties
  - Suggest the common uses for foil-coated boards
  - How would a wax coating or a foil lining affect the properties of a material?
  - How could combining materials in this way affect biodegradability?

# Worksheet

- Complete **Tasks 2** and **3** of the Worksheet

# Plenary

- Identify any papers and boards in this image and justify why each is suitable for its purpose



# Edexcel GCSE

Design and Technology 1DT0

3

## Polymers

PG ONLINE

# Objectives

- Know the primary sources of materials for producing polymers
- Be able to recognise and characterise different types of polymers
- Understand the working properties and structure of a range of thermoforming and thermosetting polymers

# The age of plastic

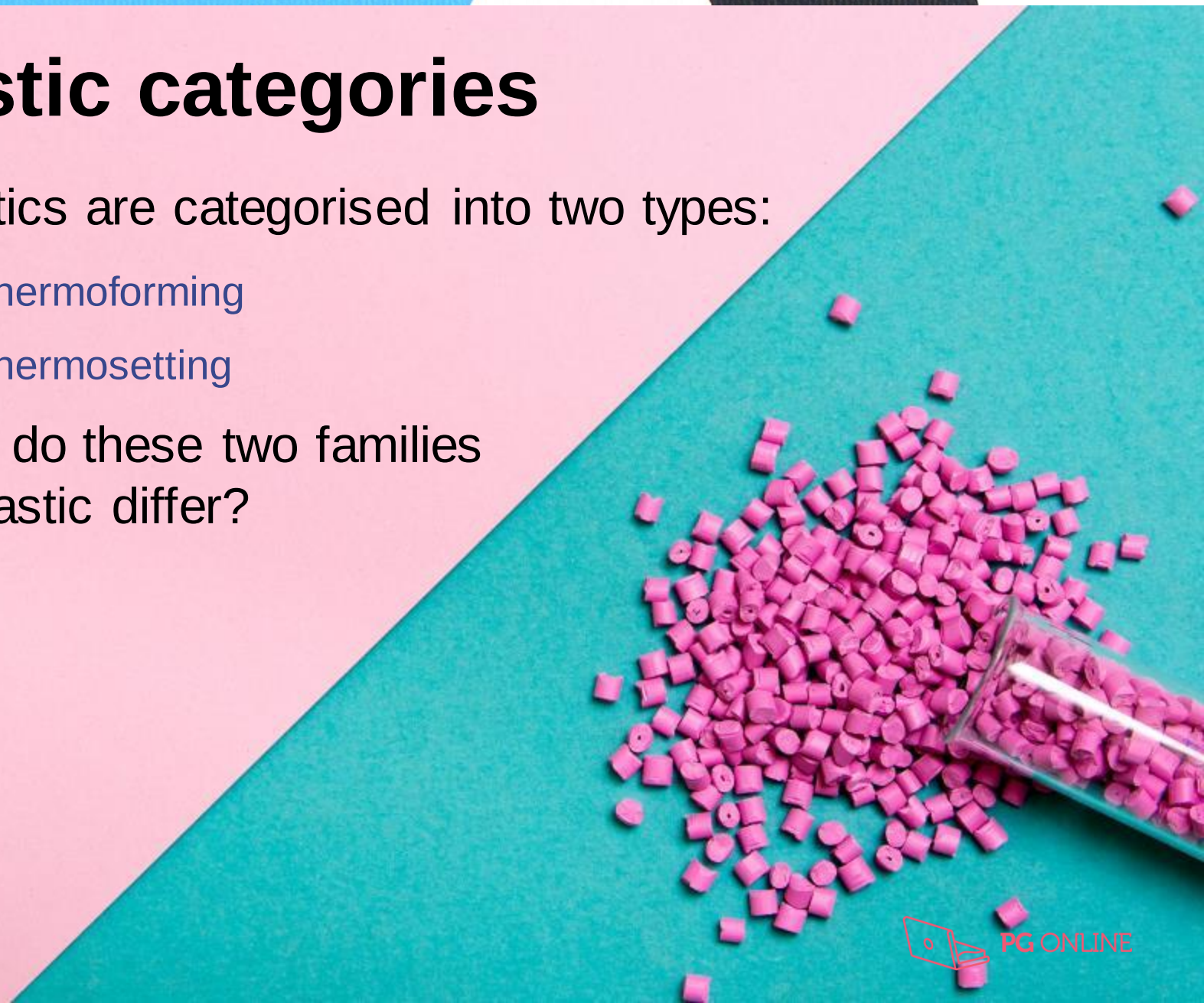
- For more than 50 years, the global production and consumption of plastic has continued to rise
  - Over 300 million tons of plastic is produced globally each year
  - Plastic is relatively inexpensive to produce and very versatile
  - Name a range of products you regularly use that have been made from plastic and try to identify some of their properties
  - Which of these are single use plastics?

# What are polymers?

- Polymers are usually made from synthetic materials
  - Mainly derived from **crude oil** or other finite resources, such as coal or natural gas
  - More renewable and sustainable materials such as vegetable starches are being used to make bio-plastics
- What are the benefits of using renewable materials?

# Plastic categories

- Plastics are categorised into two types:
  - Thermoforming
  - Thermosetting
- How do these two families of plastic differ?



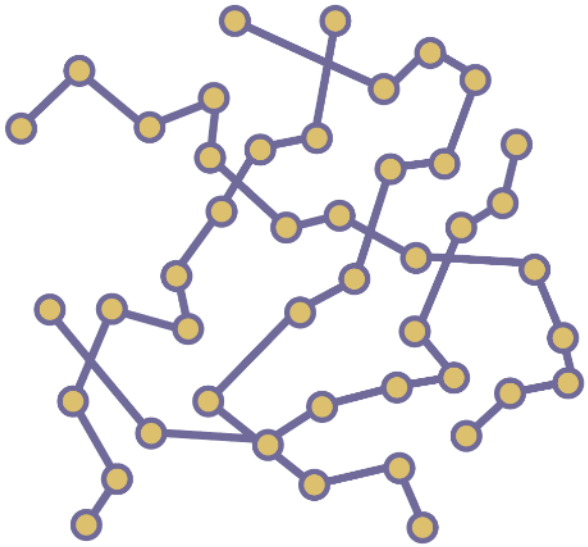
# Plastic categories

| Thermoforming | Thermosetting |
| --- | --- |
| Also known as thermoplastics, when heated the plastic becomes **soft** and **flexible** | Also known as thermosets, this plastic cannot be reformed once **set** in to shape |
| Thermoplastics can be remoulded without affecting the material's physical properties | Thermosets have strong chemical bonds between the molecules, which do not separate on heating |

- Which of these two plastic types can be recycled easily and why?

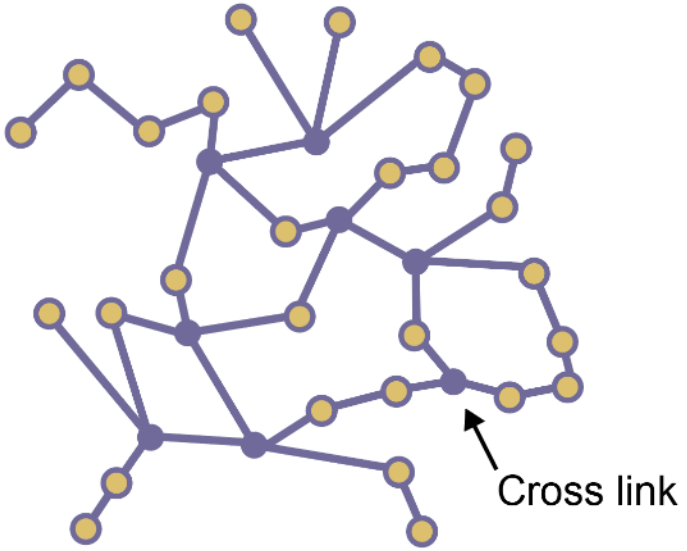
# Molecular structure

## Thermoforming plastics



Individual monomers join to form long polymer chains, which have no fixed structure or pattern

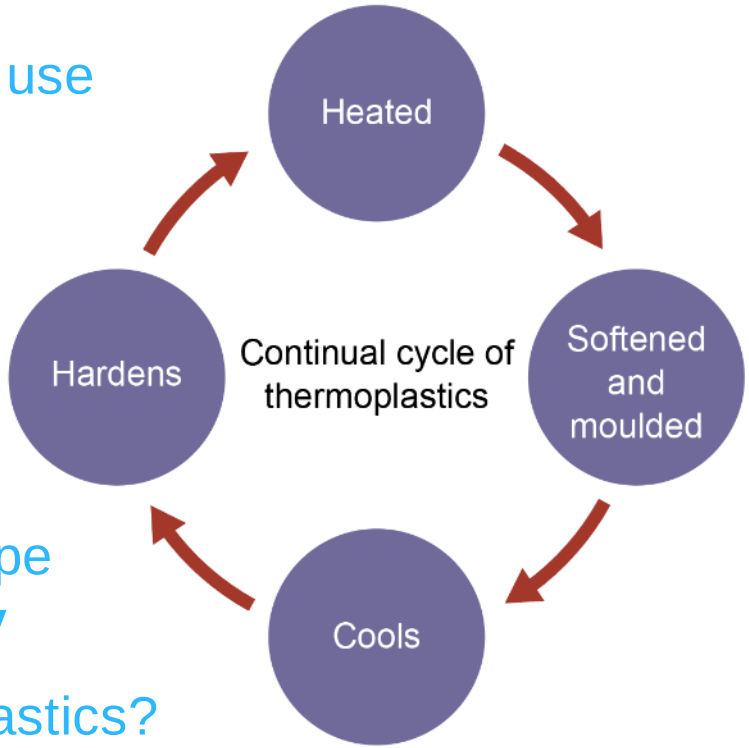
## Thermosetting plastics




Chains of polymers are cross linked resulting in a rigid molecular structure

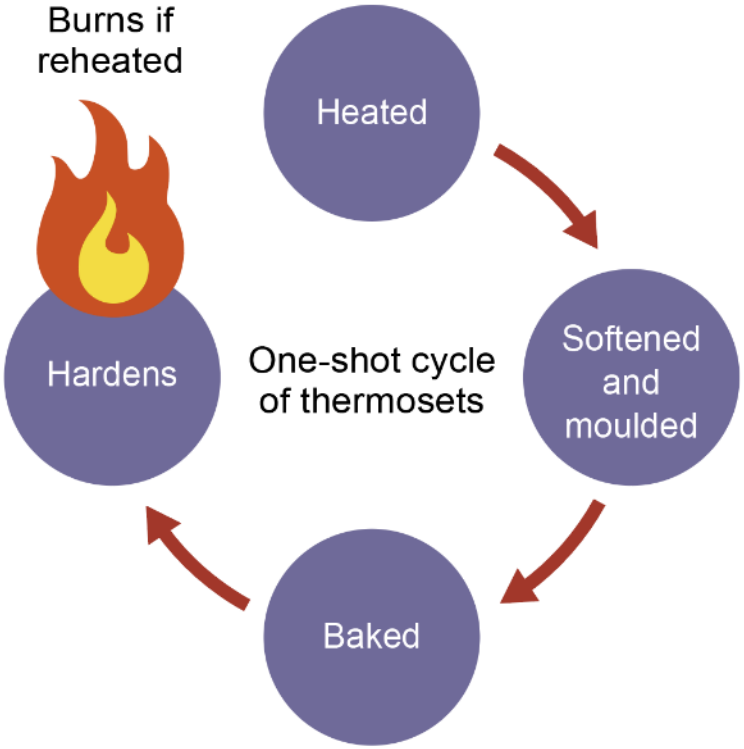
# Thermoplastic pros and cons

- Thermoplastics can be repeatedly heated and moulded
  - Thermoplastics are not suitable for use in areas of heat or UV sensitivity
  - A good surface finish can be achieved for superior aesthetics
  - Most can be recycled easily
  - Each time the plastic is reheated it will try to return to its original shape – this is known as **plastic memory**
  - What are the benefits of reusing plastics?



# Thermosets pros and cons

- Thermosets are hard and durable with good structural rigidity
  - Able to withstand higher temperatures
  - A good electrical insulator
  - They cannot be remoulded
  - Commonly used in adhesives to make composite materials such as glass reinforced plastic



# Worksheet 3

- Complete **Task 1** of your Worksheet

# Moulding and forming

- Plastics can be formed using a variety of processes
  - **Blow moulding** – forming hollow plastic items
  - **Extrusion** – creating objects with a uniform cross-section profile
  - **Injection moulding** – injecting softened plastic into a mould
  - **Vacuum forming** – softened sheet plastic formed over a mould
- Which process has been used for the following items?




# High Impact Polystyrene

6
PS

- HIPS is shatterproof and a good insulator
  - It's flexible and lightweight so ideal for vacuum forming
  - Impact resistant, it is suitable for food containers particularly yoghurt pots and fast food containers
  - HIPS is easily mouldable and has a good gloss finish
  - It is often used in schools for vacuum formed projects
- What other items would be suitable to be made from HIPS and why?

# Acrylic


## (Polymethyl-Methacrylate)

- This versatile and tough plastic comes in a variety of thicknesses and colours
  - It's a tough plastic, but scratches easily and becomes brittle if thin
  - Acrylic fibres can be spun into threads for weaving and knitting
- Name some items of clothing that may utilise acrylic

# Resin identification codes

- Thermoplastics must be recycled separately to enable effective processing
  - In order to easily separate items, thermoplastics are marked with a common code

| | |
|---|---|
|   | Polyethylene terephthalate |
|   | High-density polyethylene |
|   | Polyvinyl chloride |
|   | Low-density polyethylene |
|   | Polypropylene |
|   | Polystyrene |
|   | Other plastics, such as acrylic, nylon and polycarbonate |

# Polyester resin

- Polyester resin is a viscous, clear polyester solution and the addition of a catalyst hardens the resin
  - The hardened resin is tough with high abrasion resistance which makes a high-performance coating for areas of high wear
  - Clear polyester resin is suitable for embedding objects, casting clear sculpture and jewellery making
  - Resin replicas such as anatomical models can also be cast and painted

# Composite adhesive

- Polyester resin is commonly used with composite materials such as fibreglass
  - Lightweight and weatherproof, it's used to adhere layers of fibreglass in the making of boat hulls, vehicle parts and panels for caravans

# Urea formaldehyde (UF)

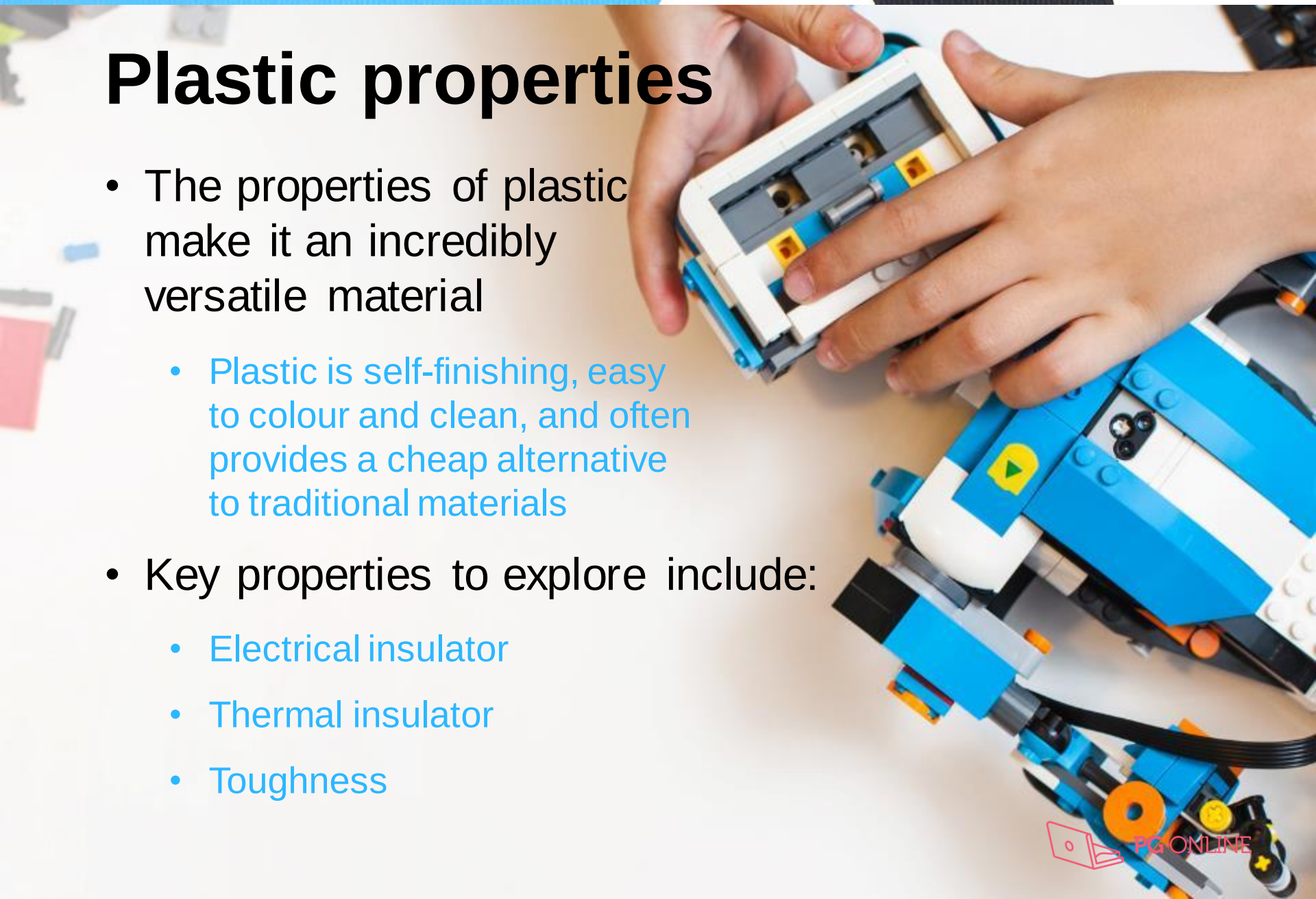
- Urea formaldehyde is a good electrical insulator
  - With good heat resistance it is used for manufacturing electrical fittings
  - The textiles industry treats some fabrics with UF resins to promote easy care properties such as anti-wrinkling
  - The paper industry uses UF to improve tear strength
  - The timber industry uses UF resin to bind particles in the making of manufactured boards such as MDF

# Worksheet 3

- Complete **Tasks 2** to **4** of your Worksheet

# Plastic properties

- The properties of plastic make it an incredibly versatile material
  - Plastic is self-finishing, easy to colour and clean, and often provides a cheap alternative to traditional materials
- Key properties to explore include:
  - Electrical insulator
  - Thermal insulator
  - Toughness

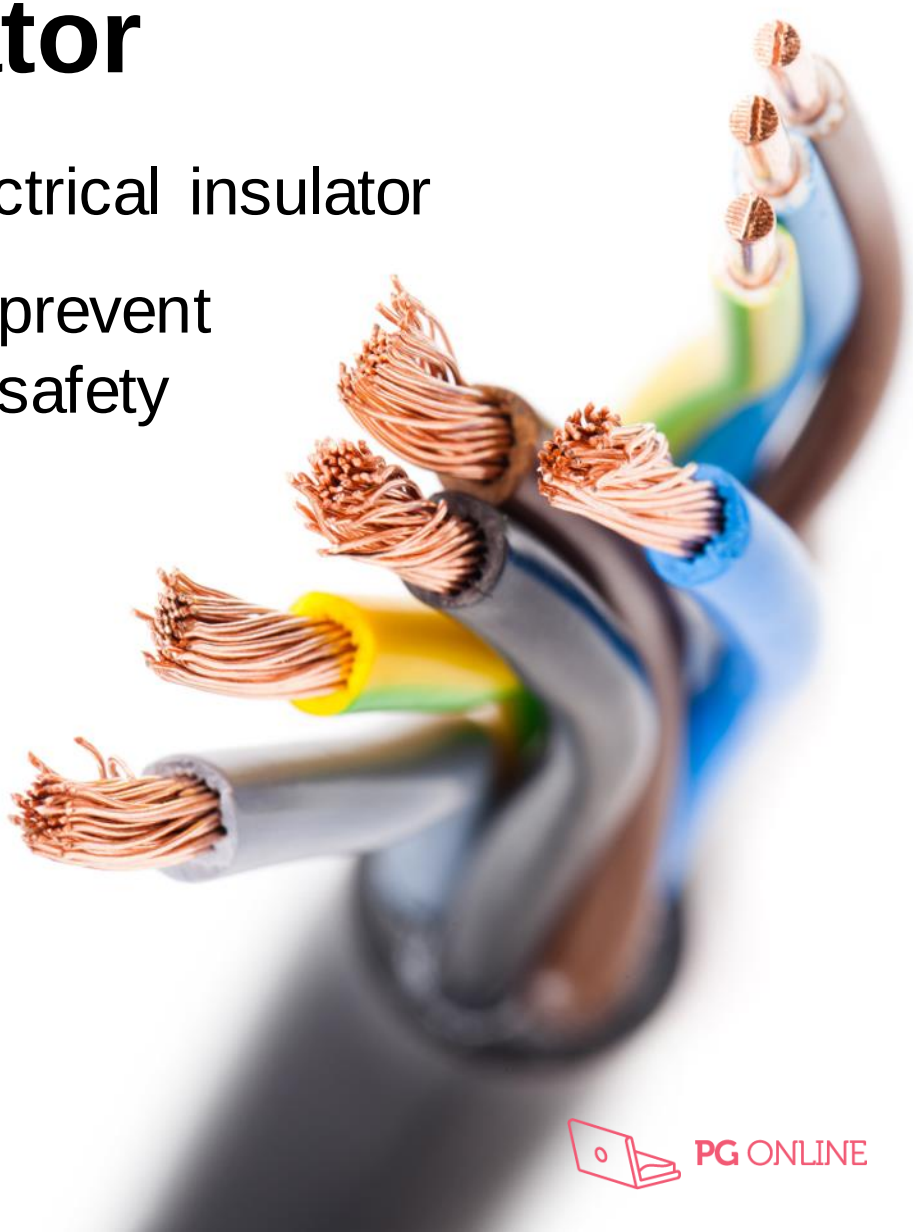


# Thermal insulator

- Plastic has excellent properties as a thermal insulator
  - Suggest a definition for this term
- How can thermal insulators be used to:
  - increase safety?
  - increase hygiene?
- How does the structure of expanded polystyrene increase thermal insulation?

# Electrical insulator

- Plastic is an excellent electrical insulator
- It is used in electricals to prevent short circuits and ensure safety
  - Electrical wires are covered in a flexible PVC coating and **urea formaldehyde** is used in plugs
  - Why are thermoset plastics suitable for electrical applications?



# Toughness

- Toughness is the ability to absorb the force of an impact
  - Name some plastic products prized for their toughness
  - What is the difference between hardness and toughness?
  - Why is it more important for a riot shield be tough rather than hard?

# Plastic problems

- Plastic is prized for its tough and durable properties
- It combines easily with other materials to create mixed materials with enhanced working properties
  - Why might these factors have a negative impact on the environment?
  - How could the environmental impact of plastics be reduced?

# Biodegradable polymers


- Biodegradable polymers are part of the solution to reduce damage to the environment
  - Biopol® is a **thermoplastic** produced by the action of microbes on plant matter
  - It biodegrades within months
  - It is suitable for take-away food and drinks packaging as it is non-toxic with a high melting point
  - Biopol® sinks in water which aids biodegradation and reduces risk of harm to sea life

# Worksheet 3

- Complete **Task 5** of the Worksheet

https://www.youtube.com/watch?v=FjT8GG0ETQg

# Plenary

- State the **two** categories of plastics
- Name **one** finite resource from which polymers are derived
- What is the most environmentally effective way of disposing of plastic?
- Suggest a plastic which is particularly good electrical insulator
- Name a plastic which is suitable for food packaging

# Edexcel GCSE

Design and Technology 1DT0

4

## Textiles

PG ONLINE

# Objectives

- Categorise textiles based on their primary sources
- Recognise and characterise different types of textile
- Understand how the working properties and structure of a range of textiles affect their performance

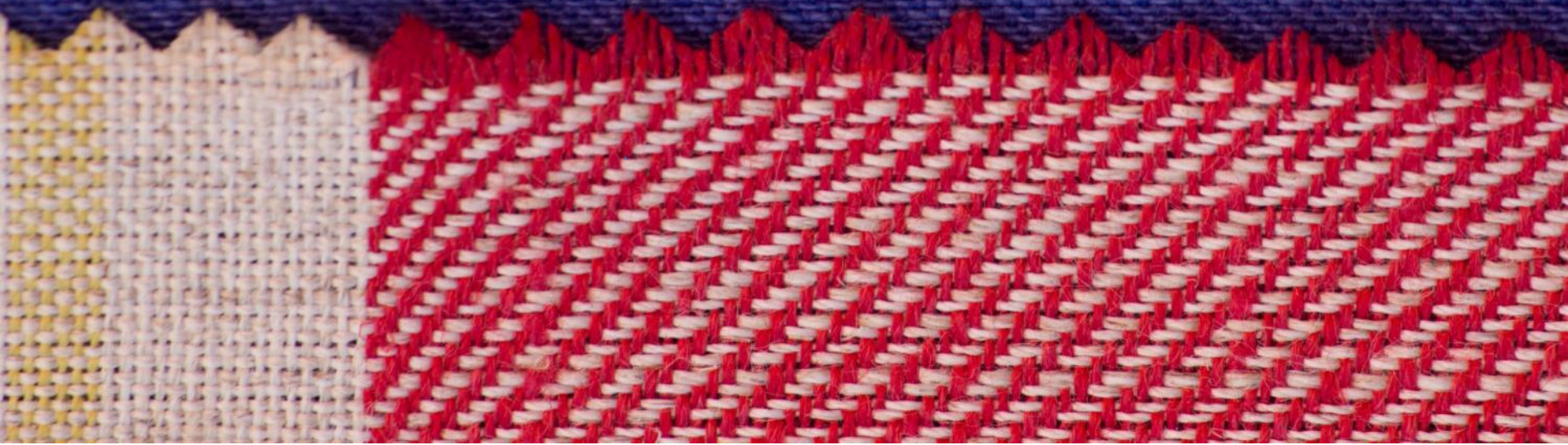
# Name some common fabrics…

# Common textiles

- The most common textiles we use every day are:

| | | | |
|---|---|---|---|
| **Wool** | **Cotton** | **Linen** | **Silk** |
| **Leather** | **Felt** | **PVC** | **Polyester** |
| **Elastane (Lycra®)** | | **Acrylic** | **Nylon** |

  - How could these be categorised?



# Textile categories

- Textiles can be manufactured to exhibit a variety of properties depending on the blend of fibres
- Categories include:
  - Natural fibres
  - Synthetic fibres
  - Blended and mixed fibres
  - Woven and non-woven fabrics
  - Knitted textiles

# Fabric types

- What do the words in **bold** have in common?

| **Wool** | **Cotton** | **Silk** |
|---|---|---|
| Felt | Polyester | Elastane (Lycra®) |
| Polycotton | Nylon | Acrylic |

- Can you find a connection between the remaining items?

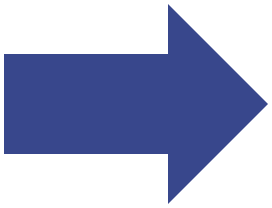
# Fabric types

- Fabrics are categorised into **natural fabrics** and **synthetic fabrics** based on their raw materials

| | | |
|---|---|---|
| **Wool** | **Cotton** | **Silk** |
| Felt | **Polyester** | **Elastane (Lycra®)** |
| Polycotton | **Nylon** | **Acrylic** |

- How would you categorise felt and polycotton?

# Where do fabrics come from?



# Cotton

- The fruit of a cotton plant is a capsule called a 'boll'
  - The mature seed splits open to reveal the short fibres
  - Once harvested, the cellulose fibres are spun into yarn
  - Cotton is soft, durable and easy to wash, but will crease easily
  - Name **two** industries that utilise cotton

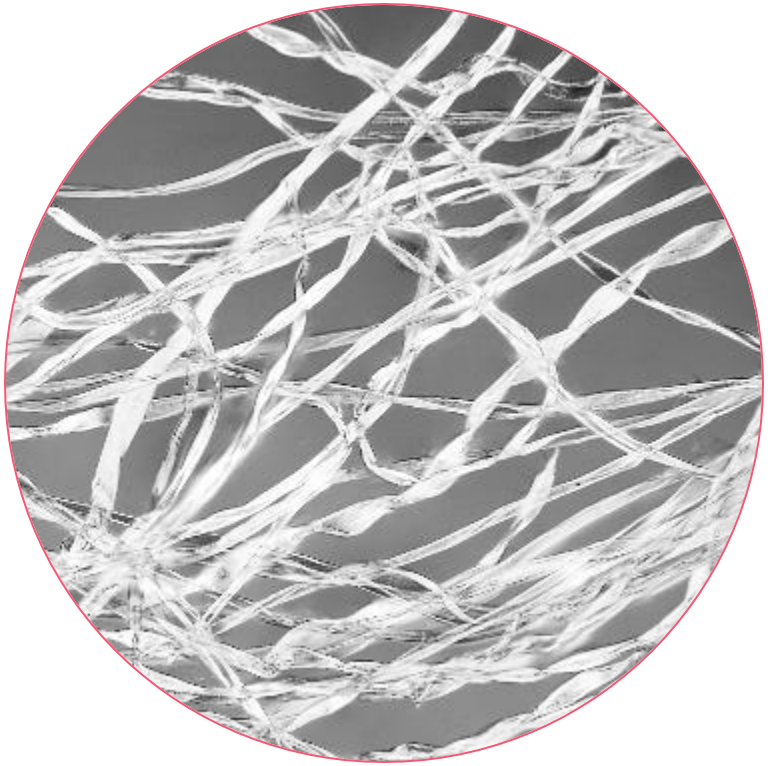
# Wool

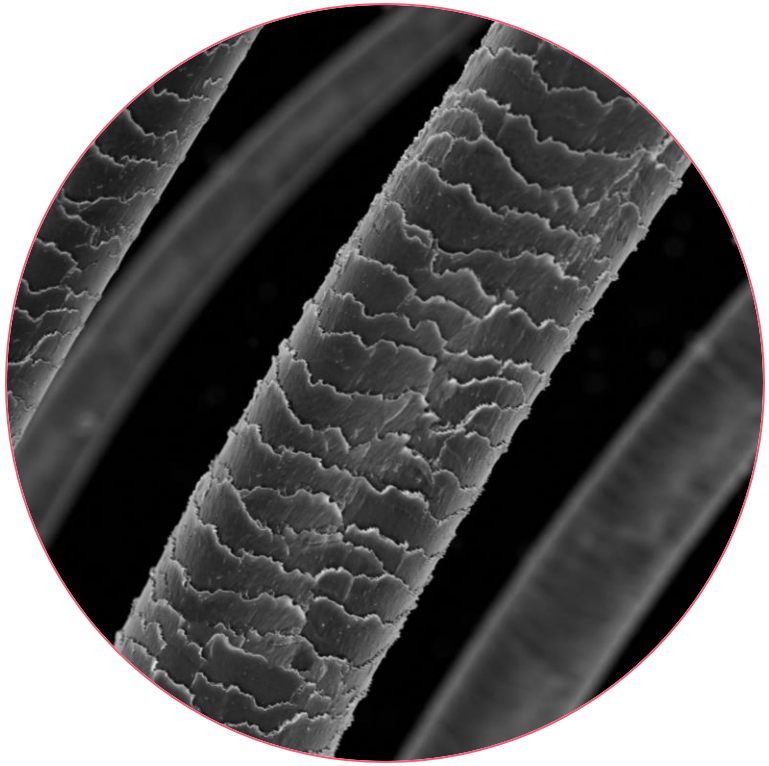
- Wool fibre is sourced from animal fleece
  - Depending on the source of the wool, it can feel coarse or soft
  - Easily spun, woven or knitted
  - Naturally crease resistant and absorbs dyes very successfully, but can shrink
  - Wool absorbs vapours and keeps a layer of dry air next to the skin, which helps retain body heat
  - What factors make natural fibres renewable and sustainable?

# Worksheet 4

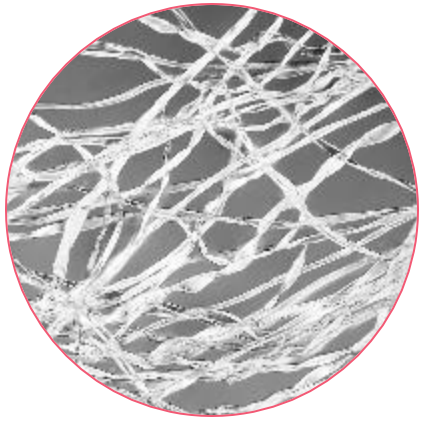
- Complete **Task 1** of the Worksheet

# What are you looking at?



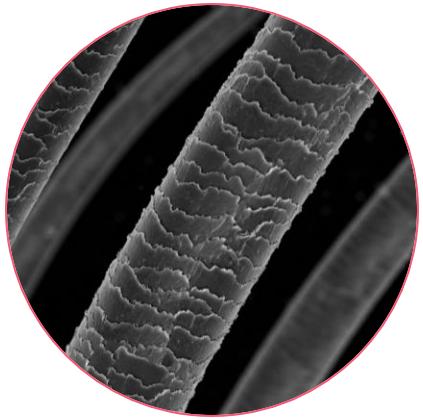


# Structure of cotton and wool



## Cotton

- Plant fibres made from cellulose
- Fibres take the form of a twisted ribbon
- Strong, durable and absorbent



## Wool

- Animal fibres made from protein molecules
- Short scaly fibres
- Trap air for thermal insulation

# Synthetic fibres

- These fabrics are made from different types of polymer, derived from petrochemicals
  - Dyes can be added at the manufacturing stage, so a wide range of colours can be easily produced
  - Polyester, Acrylic and Polyamide (Nylon) are:
    - Strong and durable
    - Non-absorbent and wash well
    - Easily blended with other fibres
  - What do **polymers** have to do with **monomers**?

# Polyester

- Polyester fabric is highly durable, crease and stain resistant and strong when wet or dry
  - Polyester is often blended with other fibres e.g. polycotton
  - Commonly used for seat belts, rain jackets and fleeces

# Acrylic

- Fabric made from acrylic is lightweight, quick-drying and crease resistant
  - Often used to mimic natural fabrics, such as wool or cotton
  - Commonly used in knitwear and sportswear
  - Why use acrylic to make a jumper instead of wool?
  - What are the advantages of blending fibres?

# Blended fabrics

- Many fabrics blend two or more fibres for enhanced properties
- Polycotton blends polyester and cotton
  - Lightweight, soft, absorbent
  - A durable fabric; suitable for bed sheets, pillow cases and a range of clothing
  - Why is a polycotton shirt easier to care for than a pure cotton shirt?

# Material Properties

- Material properties are key when selecting the right fabric for a product
- Important properties of fibres or fabrics include:
  - Elasticity
  - Resilience
  - Durability

# Elasticity

- Elasticity measures how much a material will stretch and return to its original shape

- Can you name any fabrics with elastic properties?
- By slowly increasing the load on fabric or fibres we can find the **elastic limit**
- What does elastic limit mean?

# Resilience

- Resilient fibres and materials will spring back into shape following a deforming or compressive force
  - Resilient materials are springy and crease resistant
  - Name some products or materials which are highly resilient

# Durability

- Durable fabrics resist wear and tear
  - Can withstand repeated use, washing and abrasion
  - Examples include polyester, nylon and leather
  - How could you test the durability of a fabric?

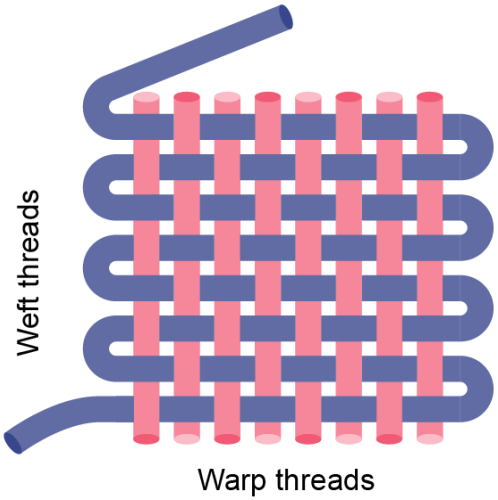
# Woven textiles

- Yarns are woven together to form fabric
  - A loom weaves two threads – the **warp** and the **weft** - at right angles to each other
  - The self-finished edge is known as the **selvedge** and stops the fabric from fraying

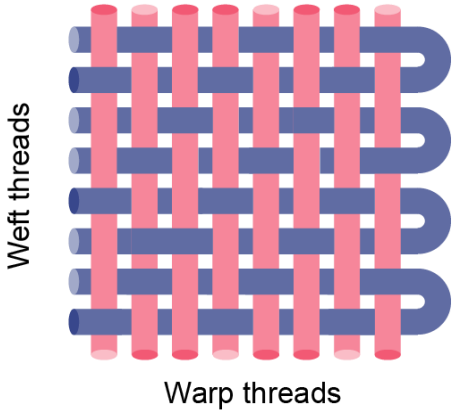
# Spot the difference

- The two most common types of weave are plain weave and twill weave

## Plain weave



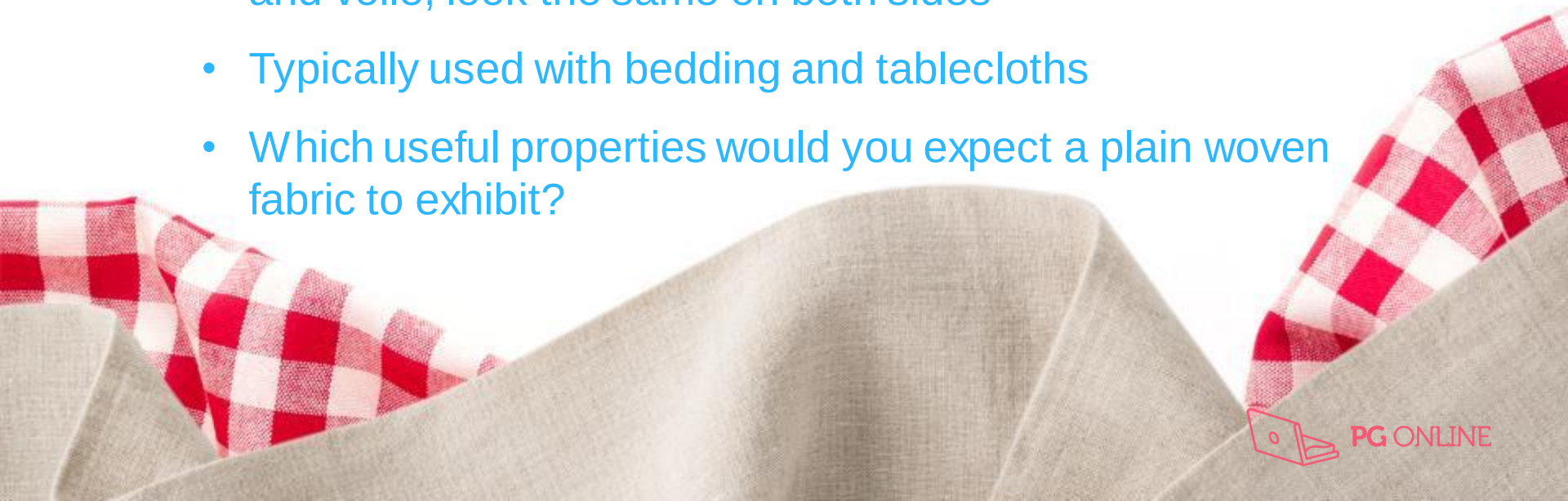

## Twill weave




- Can you spot the difference?

# Plain weave textiles

- Plain weave is easy to produce and stronger than more decorative weaves
  - Plain weave forms a stable fabric construction whatever the thickness of yarn used
  - Plain weave fabrics, such as **calico**, muslin, gingham, taffeta and voile, look the same on both sides
  - Typically used with bedding and tablecloths
  - Which useful properties would you expect a plain woven fabric to exhibit?



# Twill weave textiles

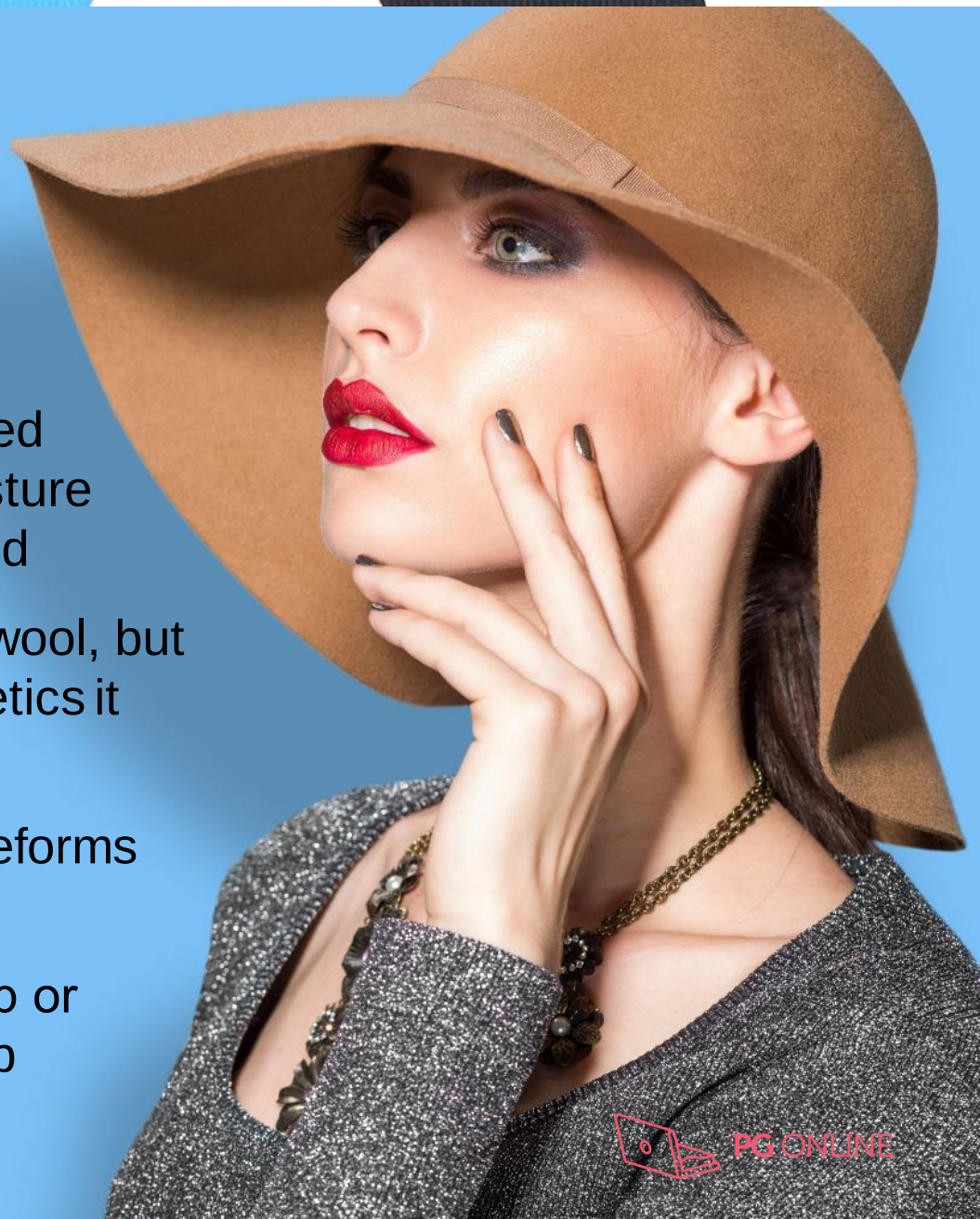
- Twill weave gives distinctive diagonal lines in the fabric
  - Makes a thicker fabric and is used for curtains and soft furnishings
  - Denim is a common fabric with a twill weave
  - What are the key properties of denim?

# Non-woven textiles

- A sheet or web of fibres are bonded thermally, chemically or mechanically
  - Made directly from fibres so they do not fray and no weaving or knitting is required
  - Non-woven fabrics have specific properties such as absorbency, sterility, stretch, softness, flame retardancy, cushioning, filtering and more
  - What do you think is the average life span of a non-woven or bonded textile?
  - Suggest industries that may use non-woven fabrics

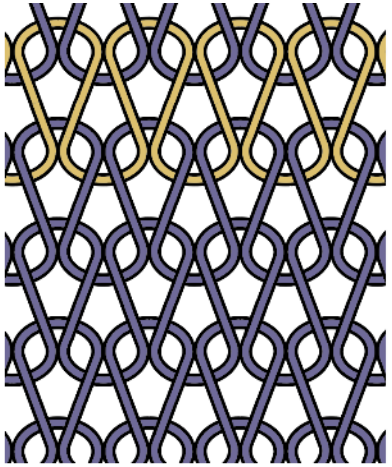
# Felted fabric

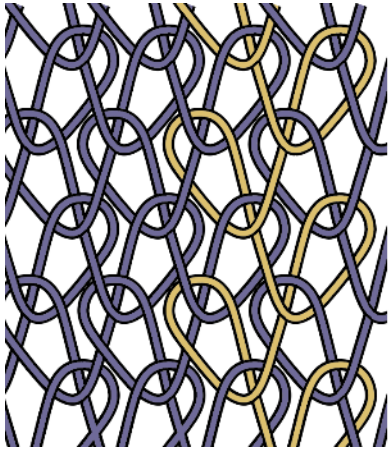
- Felt is a dense, non-woven fabric
  - Matted fibres are pressed together with heat, moisture to be shaped and formed
  - Felt is usually made of wool, but when mixed with synthetics it becomes more resilient
  - Felt is not elastic and deforms when wet
  - Felt doesn't have a warp or weft. How does this help when it is cut?



# Knitting

- A series of interlocking loops produces a knitted fabric
  - **Weft knitting** – the interlocking loops are formed horizontally, which enable it to stretch, but may lose shape
  - **Warp knitting** – the loops interlock vertically, so the knit keeps it shape and is less likely to unravel or ladder
  - Weft knits are suitable for close fitting garments as the stretch allows the wearer to move comfortably
  - Give **two** garments suitable for weft knitting





# Fabric selection

- How does the construction of a fabric affect its properties?
  - Look at the product groups and describe their properties

# Selecting fabrics

| Woven textiles | Knitted textiles | Non-woven or bonded textiles |
|---|---|---|
| Hard wearing | Stretchy and absorbent | Non-elastic |
| Will fray when cut | Unravel easily | Does not fray |
| Simple and most common weave | Thermal properties | Easy to shape and mould |
| Available in a variety of weights | Can lose shape easily without added Lycra® | Additional properties i.e. waterproof, sterile |
| Breathable | Prone to shrinking | Lacks strength |

# Worksheet

- Complete **Task 2** and **3** of your Worksheet

# Consider fabric properties

- Different types of fabrics have different properties
  - As a designer, what properties might you consider when selecting a fabric for a high performance cycling jacket?

# Fabric decisions

- Is it windproof?
- Is it waterproof?
- Should it be warm?
- Where will it be worn?
- How often will it be used?
- How can I increase visibility?
- How can I make it comfortable?
- How can I make it breathable?
- How often will it be washed?
- Should parts be elasticated?
- How much should it cost?

# Worksheet

- Complete the plenary **Task 4** on your Worksheet

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Design and Technology 1DT0

5

# Natural and manufactured timbers

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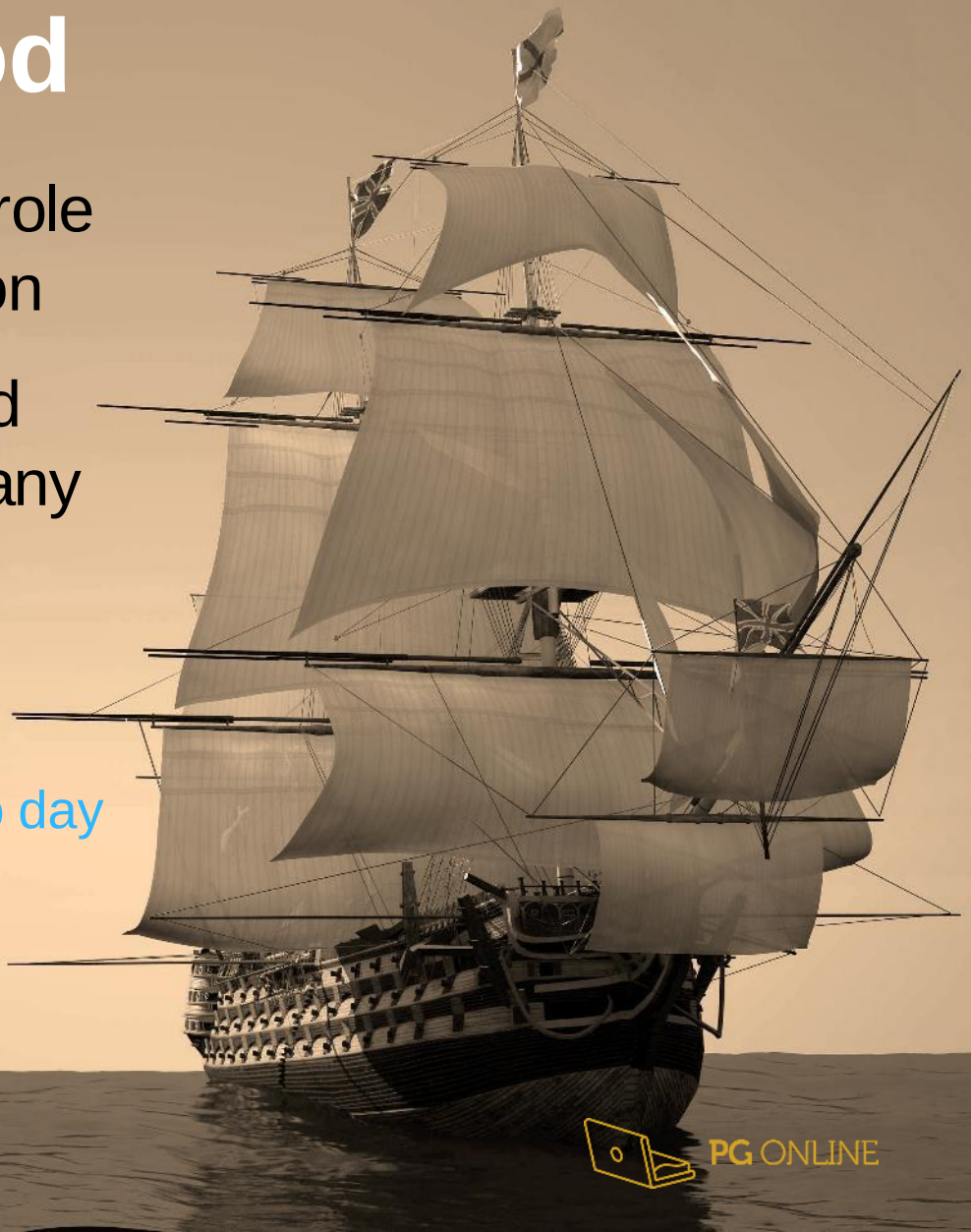
# Objectives

- Know the primary sources of materials for producing natural and manufactured timbers
- Be able to recognise and characterise different types of natural and manufactured timbers
- Understand how the working properties and structure of a range of natural and manufactured timbers affect their performance

# The role of wood

- Wood has played a key role in the history of civilization
- Humans have used wood over the centuries for many purposes, both practical and decorative
  - Give three examples of where wood is used day to day

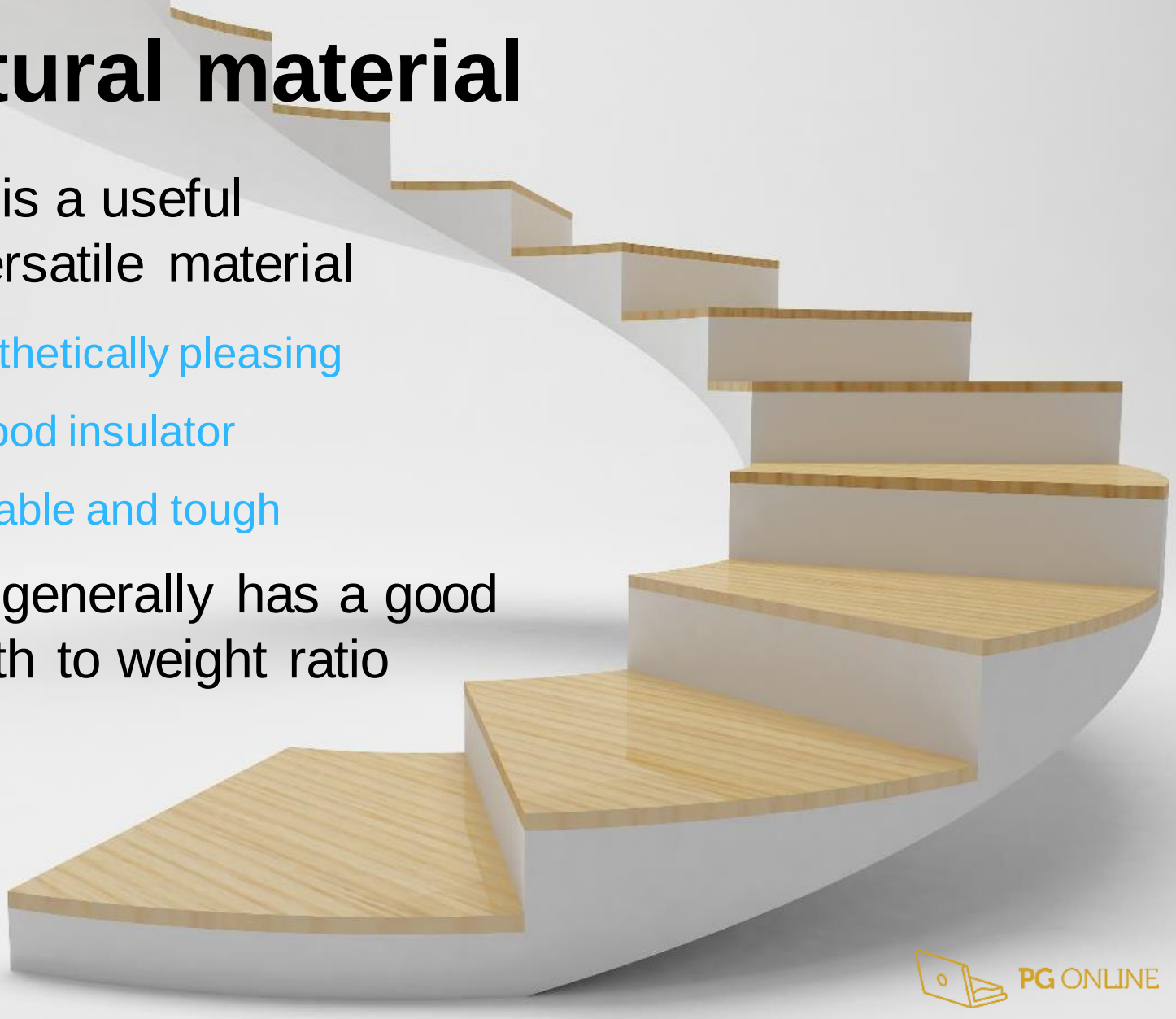


# Know your trees

- Natural wood is categorised as either hardwood or softwood
  - Most hardwood and softwood trees have characteristics that help us recognise them
  - Both types can be grown and harvested sustainably in managed forests
  - This makes wood a sustainable and biodegradable resource
  - How can you characterise each type?

# A natural material

- Wood is a useful and versatile material
  - Aesthetically pleasing
  - A good insulator
  - Durable and tough
- Wood generally has a good strength to weight ratio

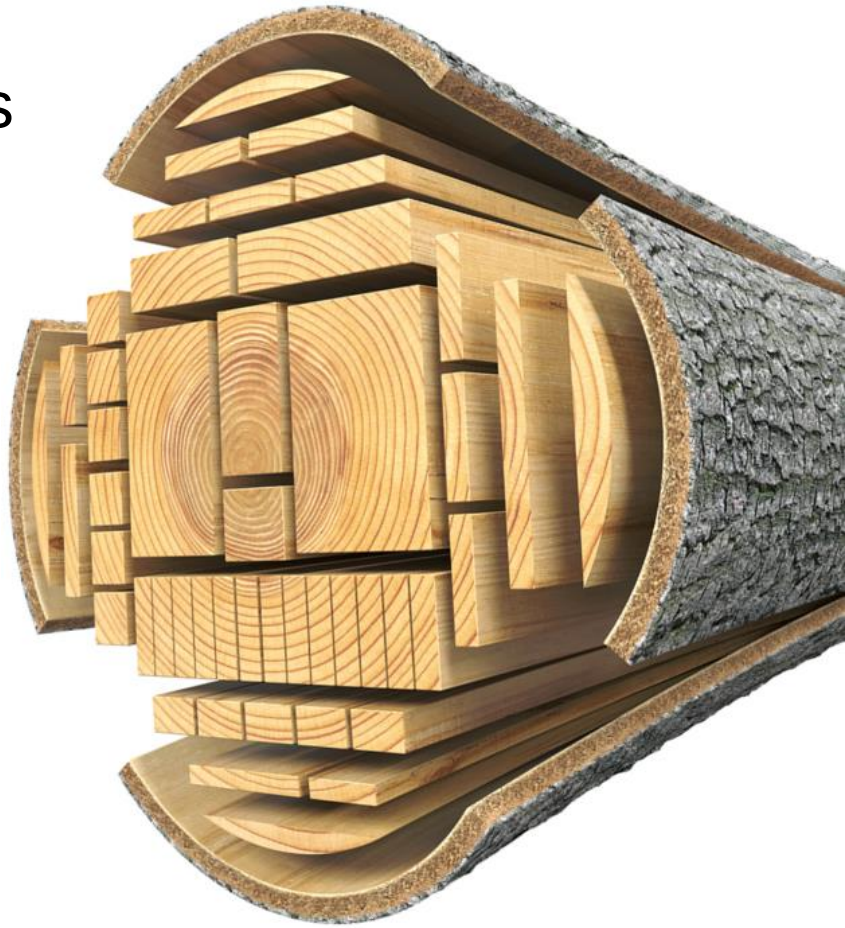


# Felling

- A tree is ‘felled’ when it is cut down
  - Traditional methods of felling used saws and axes
  - Chainsaws are used in modern felling
  - Agricultural logging uses machinery with large chainsaw attachments. These can fell, de-branch and log a tree in one swift action
  - Suggest the advantages of using fully mechanised felling methods instead of manual methods

# Processing and seasoning

- Once felled, natural timber is processed into standard sizes and seasoned
  - Seasoning involves reducing the moisture content of the timber to between 10-20%
  - Timber is left to dry naturally or dried artificially in kilns
  - Why is seasoning necessary?



# Natural or manufactured?

- Telling the difference between natural and manufactured boards can be tricky
  - Manufactured timbers are often easy to identify as the sheets, fibres or chips from which they are made are visible
  - While both manufactured and natural timbers can appear to have a grain, only the grain on natural timbers will **connect** seamlessly to the **end grain**
  - How are manufactured boards disguised to look like other materials such as natural wood, stone and plastic?

# Softwood

- Softwood comes from coniferous trees
  - Most coniferous trees are evergreen and have needle-like leaves
  - Most softwood trees grow faster than hardwood trees making it relatively cheap and readily available
  - The grain is wider making it generally more absorbent
  - What problems could this absorbency cause with the timber?

# Hardwood

- Hardwood is sourced from deciduous trees
  - Deciduous trees drop their leaves in the autumn and new leaves grow in spring
  - Hardwood is usually slower growing and is therefore more expensive
  - Sought after for its variety of colours and grains, it has good aesthetical and physical properties
  - Most varieties have a closer grain, making them more dense and hardwearing
- Which hardwoods are grown sustainably in the UK?

# Worksheet 5

- Complete **Task 1** of your Worksheet

# Working properties

- Consider the different properties of timber when selecting your material
  - **Durability** - Withstands wear and tear
  - **Toughness** - Absorption of energy through shock before splitting
  - **Hardness** - How easily do scratches and knocks damage the surface?
  - How could you increase the durability or hardness of a timber?

# Tough or hard?

- Hardwoods are used in a wide range of applications
  - Beech is tough and very durable with a fine finish
  - Oak is tough, hard and durable with a variable grain
  - Mahogany is durable and fairly hard with a distinctive grain
  - Cedar is very tough, but also flexible and shock resistant
  - Select a suitable wood for each object and explain your choice




# Balsa (Ochroma pyramidale)

- Balsa wood is a soft and lightweight material
  - Balsa trees are very fast growing which gives the wood a coarse, open grain
  - The living tree has large cells that fill with water – this gives the wood its spongy texture
  - Strong in relation to its weight and density, Balsa is used for lightweight, rigid structures such as prototypes, model bridges and model aircraft
- Is Balsa a hardwood or softwood?

# Desirable hardwood

- Mahogany is sought after for its durability, colour and aesthetics
  - Its deep, rich reddish brown hue gives beauty and warmth to furniture, musical instruments, boats and interior panelling
  - Unfortunately man's desire for mahogany has increased the destructive and illegal logging trade
  - What would be the result of continual illegal logging to the Amazon rainforest?
  - Why is it essential to source wood from sustainably managed forests?

# Useful softwood

- Softwood is cost effective and readily sourced, making it an ideal choice for the construction industry
  - **Pine** is lightweight and easy to work with
  - **Cedar** contains natural oils which offer natural water resistance
  - Why are softwood planks usually narrower than hardwood planks?
  - Why is cedar commonly used for outdoor furniture?

# Worksheet 5

- Complete **Task 2** of your Worksheet

# Tonewood

- Some woods possess tonal properties that make them ideal for use in instruments
  - Spruce is commonly used in violins, piano and guitars
  - Its high stiffness to weight ratio makes it ideal for the soundboard, which transmits the vibrations from the strings
  - Cedar is less dense than spruce and gives a richer tone favoured by classical guitarists
  - Mahogany is used for necks and sides of acoustic guitars and sometimes for the body of electric guitars

# Manufactured boards

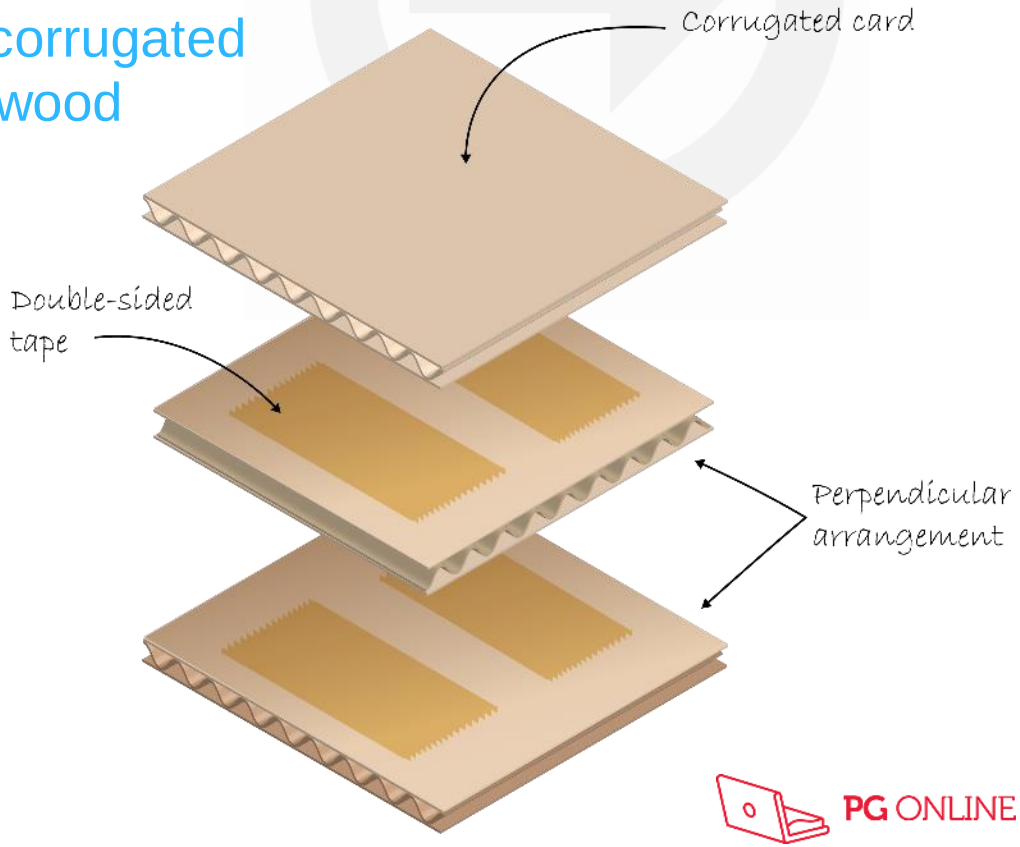
- These can be made from sawmill scraps, recycled wood, low grade timbers and even sawdust
  - Wood pieces are bound together with adhesives to make man-made / manufactured board
  - Manufactured board can be susceptible to moisture
  - Boards are rigid, stable and supplied in large sheets
  - What are the advantages of producing board in larger sheets?

# Manufactured board structure

- Each type of manufactured board is fabricated in a different way to give a variety of properties
  - **Plywood** is made up of an odd number of thin layers (or ply) arranged with the grain running in alternating directions at 90º
  - **MDF** is made from compressed sawdust and adhesive
  - Which of these boards is strongest and why?
  - Why do you think plywood is prone to splintering on its surface?

# Activity

- Plywood is extremely strong in all directions
  - Make a model using corrugated card to show how plywood gets its strength from its structure



# Common boards

| Medium density fibreboard (MDF) | Plywood |
|---|---|
| Very dense board which makes it tough | Made up of an odd number of alternatively rotated sheets of glued wood veneers |
| Its smooth surface makes it suitable for veneers and finishes | Available in various forms including marine ply for greater water resistance |

- Compare the aesthetics of hardwood planks with manufactured boards and suggest appropriate uses

# Improve the look

- Veneers and laminates can enhance the look of manufactured board
  - Veneers may be made from real wood, a man made finish, plastic or composite
  - Suggest another benefit of surface finishing a manufactured board

# Knotty problem

- Natural timbers can have natural defects
  - The most common natural defect is a knot
  - Softwoods such as pine, cedar and larch can also seep resin at the knot
  - What impact could knots have when working with timber?
  - How could knots be used to their advantage?

# Worksheet 5

- Complete **Task 3** of the Worksheet

# Plenary

- From the following list of products, select the most appropriate material for each:
  1. A highly polished wooden floor
  2. Flat-pack furniture
  3. Garden furniture
  4. A low cost dining table
- Explain your choices justifying what makes each wood suitable for the task
- What are the hazards of working with manufactured boards and how do you protect against them?