1.1 New and emerging technologies

List 2 advantages to industry that have derived from new technologies

- Greater efficiency, Maximise product production, less human error
- Reduction of price, Improved outcomes

Explain one reason why unemployment in the UK may rise as new and emerging technologies develop.

- Less demand for low skilled workers on assembly lines (Car production for example)

What is meant by the term Demographic movement?

- Changes in a countries population having lost or gained numbers. Employment or lack of employment can encourage people to migrate

Give one advantage and one disadvantage to demographic movement

Advantage - Fewer people to house and feed

- disadvantage- Loss of the young and most abled workers

What is meant by the term 'enterprise business'?

A person taking a risk to invest, set up and run a business. A good example can be set up through crowd funding (e.g. Kickstarter- Know what it is!)

Give an example of a crowd funded company

- https://www.kickstarter.com/discover/advanced?category_id=337&staff_picks=1&sort=magic&seed=2564996&page=1

New and emerging technologies are responsible for alternative power sources such as:

- Biomass/Biodiesel (organic matter)
- Tidal/Wind/Solar (Nature)
- Hydroelectric (Dams)

Give 2 examples of how new technologies have improved the lives of the disabled

- Prosthetic limb technology - Voice recognition technology
- Stem cell therapy – Screen reader for the blind

Employing migrant workers would benefit a company because

Fills skills gaps in businesses and services

Attracts younger, innovative personnel

Discuss the impact that new and emerging technologies have had on society as a whole _____

Advantages: Flexible working hours

Less commuting

Less office space needed

Disadvantages: Lack of routine

Less morale in the work place

Security of information risk

Blurs work-life balance

(6)

What is meant by the term Internet of Things?

Using new and emerging technologies to control and run households and businesses. Interrelated technologies that can switch on the oven or central heating, can alert homeowners of cold callers at the door

Give 3 examples of new devices derived via the internet

- Video conferencing (Skype)
- Mobile banking- Online bank accounts BACS payments
- One click ordering via smart TV's

Video conferencing

Possible advantages	Possible disadvantages
Meetings and training can take place without leaving the office	May not be as productive as a discussion around a table
Travel costs and the time taken to travel can be reduced or eliminated	Confidential documents may need to be viewed and signed in person
Meetings can be called instantly at multiple locations with little notice	May be a high set-up cost
Speeds up decision making and problem solving	May be difficult to find a suitable time across time zones
	People may not pick up on non-verbal information such as body language

Waste disposal

Businesses must manage any production waste or try and eliminate it using new technologies, for example by:

- using efficient manufacturing processes
- reusing waste within the same manufacturing process
- recycling waste in a different manufacturing process
- designing products so that the whole or parts of them can be reused or recycled
- harnessing any waste energy such as heat and using it elsewhere.

Technique/ system	Description	Example	Advantages	Disadvantages
Standardised design and components	• The same components or modular systems are used across many designs • Usually an individual part, manufactured in large numbers, to an internationally accepted standard	• Electronic (e.g. resistors), or mechanical (e.g. nuts and bolts) components	• Consistent safety and quality • Speeds up product development as parts already exist • Workforce can be easily trained to deal with standard components • Cost saving	• Difficult to customise • Quality of a product may suffer
Just-in-time (JIT)	• Computerised stock control ensures that parts are only received when they are needed in the production process and go straight to the production site rather than being stored	• Car manufacturers (e.g. production line) • On-demand publishing (e.g. photos, greeting cards)	• Can increase efficiency and reduce waste • Enables changes to production runs to meet demand	• Any break in the supply chain holds up production • Cost of more frequent deliveries • Fewer bulk-buying discounts
Lean manufacturing	• Reducing or eliminating waste in design, manufacturing, distribution and customer services	• Eliminating overproduction • Minimising defects • Reducing storage, movement or processing of parts or products	• Multi-skilled teams (cells) are each responsible for part of the production process, which can improve efficiency as workers share their skills and expertise	• Requires time-consuming data analysis • Requires disruptive changes to existing processes
Batch production	• A set number of products are manufactured that are made in limited quantities or for a limited time	• Olympic medals • Books with limited print run	• Could lower capital costs • Reduces inventory/storage space	• Downtime when reconfiguring the production system

Technique/ system	Description	Example	Advantages	Disadvantages
Continuous production	• Manufacturing of identical high-demand products, 24 hours a day	• Production of sheet materials, such as glass, or standard components, such as nuts and bolts	• Removes the cost of stopping and starting the production process • Materials can be cheaper in high quantities	• Automation can lead to staff redundancy • High-capital input • Low flexibility in changing product/ design • A fault in production can stop the whole process
One-off production	• A single, unique product made by skilled workers	• Complex, large-scale products (e.g. a yacht) or smaller-scale crafted products (e.g. specialist furniture)	• High-quality products	• Products are expensive as cost of materials is higher and production is labour intensive • Production times are longer
Mass production	• Efficiently and consistently producing many products at a low cost per unit • Often automated, with parts added in sequence	• Toy manufacture	• Materials can be cheaper in high quantities	• Initial set-up costs can be high • If a production line breaks, manufacture is halted • Repetitive

1.2 Evaluating technologies-Informing design decisions

Key terms

Carbon footprint: the amount of CO_2 emissions that can be directly or indirectly attributed to an individual's or company's activities. The larger the carbon footprint, the greater the environmental impact.

Life-cycle analysis: an analysis of all the environmental impacts related to a product from the extraction of the raw material to its use and disposal.

Life-cycle analysis

A **life-cycle analysis** (LCA) is a systematic inventory of environmental impacts at every stage of a product's life, including:

- raw material extraction and processing
- product / part manufacture and assembly
- product / part transportation and distribution
- product / consumer use
- product disposal or recovery at the end of its useful life.

Governments are moving towards requiring businesses to carry out LCAs so that they can identify opportunities for environmental improvements in the life cycle.

1.2 Evaluating technologies-Informing design decisions

Having drilled and extracted oil from under the sea, describe the possible environmental impacts of transporting it to refineries (investigate)

Oil leaks in to the sea
Via leaks in piping
Or Tankers could spill

Harmful to the environment

Endangers and kills Sea life

Oil is burnt off the surface releasing toxins into the atmosphere

1.3 Energy: generation, storage and choosing appropriate sources

Non-renewable energy sources are fossil fuels that were formed from the remains of animals and plants that lived millions of years ago. They cannot be replenished quickly and will eventually run out.

Coal Oil Gas

Source	What it is and how it is converted into energy	Advantages	Disadvantages
Biomass	• Organic matter derived from organisms, such as wood, crops, rubbish, landfill gas and alcohol fuels • Can be used directly via combustion (of wood or biodegradable wastes) to produce heat, or converted to electricity	• Waste from plants and farming can be used	• Large areas needed to cultivate crops • Emits fumes that add to global warming
Biodiesel	• Made from natural elements such as plants, vegetables and fermented waste cooking oil • Can be used in diesel-powered vehicles without modifying the engine	• Uses waste from plants and farming • Does not give off harmful chemicals	• Large areas needed to cultivate crops
Tidal	• Turbines generate electricity from the movement of tidal water • Artificial tidal barrages are constructed across tidal rivers, bays and estuaries, for example – the water is trapped and then released through turbines as the water levels change	• No emissions • Powerful • Tides are predictable and stable • Barrages can have a secondary purpose such as a bridge	• Lower energy output than fossil fuels • Large barrages may have an ecological impact • Expensive to build • Only available in coastal areas
Wind	• Wind turbines use propeller blades, which spin a shaft to create electricity through a generator	• Freely available • Can be used in remote areas • No emissions	• Could restrict shipping traffic when placed in the sea • Wind can be unpredictable • Wind farms are often regarded as unsightly • Expensive to set up
Solar	• Solar (**photovoltaic**) panels convert sunlight into electricity • Solar thermal power plants use the sun's rays to heat a fluid that is circulated through pipes, transferring heat to water and producing steam • Steam is converted into mechanical energy in a turbine, which powers a generator to produce electricity	• Reliable source of power in warmer countries • Homes can have their own electricity supply • More electricity is produced in stronger sunshine	• Could change ecology when large solar farms replace traditional farms • Expensive to set up • Effectiveness of power generation depends on geographical location
Hydroelectric	• A dam traps water that flows through tunnels and turns turbines to make electricity	• Large amount of low-cost power • Can have secondary purpose such as a water reserve	• Expensive to set up • Construction may damage the environment

You are providing power to a community in the remote countryside. Choose an appropriate power source and justify your choice.

Wind power would be a good choice for power supply to a remote area in the countryside. Wind is freely available and is also renewable, making it a sustainable source of power.
A group of wind turbines can produce sufficient power for a small community with limited disadvantages. Although expensive to set up, once running the power source is self sufficient.

No energy source is completely clean, what other impacts do renewable energy sources have?

The sounds of generators can cause passive impact
The unsightliness of wind farms can cause passive impact

What is a power system?

A power system is a network of components that supply, transfer and use electric power.

Power systems can include batteries, cells, solar cells wind power and mains electricity

Give a suitable power system for each product

Solar

Mains

Batteries

Wind

Explain why solar farms are not welcomed by all communities.

Passive impacts on the environment, some deem them unsightly

They are expensive to set up

Can be unreliable depending on the geographical location

Smart materials are existing or modern materials with physical properties that can be varied by an external input such as temperature, light, moisture, force or electrical current. They sense and respond to conditions in their environment and some can return to their original state when the conditions change.

Photochromic glass is used in aircraft because it is reactive or responsive to UV light. When exposed to light a chemical reaction occurs and changes the colour of the glass.
The darkening of the glass protects the pilots eyesight allowing them to work effectively.

Material	Description	Applications	Advantages	Disadvantages
Shape-memory alloys (SMAs)	• Can be plastically deformed (have their shape changed, stretched or crumpled) and will return to their original shape when heated or a current is applied • Examples include nickel-titanium (nitinol), gold-cadmium and iron-nickel-cobalt-titanium	• Glasses frames • Greenhouse window openers • Medical stents • Tweezers and hooks • Orthodontic wires	• Lengthen life of product • Reduced overall size, less complexity	• Expensive • Continuous use can cause metal fatigue
Nanomaterials	• Made of tiny components less than 100 nanometres (nm; a millionth of a millimetre) in at least one direction • May be particles, nanowires, nanotubes or thin films and surface coatings	• Fire-retardant materials • Sunscreen • Tennis rackets • Motorcycle helmets • Car bumpers	• Larger relative surface area can improve their strength, elasticity, magnetic, electrical, thermal conductivity and absorbent properties • Can combine properties, e.g. lightweight but robust and scratch-resistant	• Unusual physical and chemical properties – may need specialist risk assessment relating to health and the environment
Photochromic glass	• Darkens when exposed to light and reverses in the dark • Tiny particles of silver halide are added to glass; these react with ultraviolet light, causing a chemical reaction that changes the glass's colour	• Sunglasses • Plane cockpit windows	• Adapts easily to changing conditions • Can undergo thousands of cycles without performance change	• May be slow to react • User cannot control reaction
Reactive glass	• Uses electrochromatic technology to change from transparent to opaque by applying voltage while allowing light to pass through from both sides	• Welding masks and goggles • Windows	• Retains heat, so reduces energy bills • Instant privacy without permanent blocking of light	• Expensive • Requires electricity source
Piezoelectric materials	• Generate a small electric charge when compressed (sensors) • Can work in reverse, generating movement when an electric charge is applied (actuators)	• Generating energy • **Sensors**: burglar alarms, keyless car entry, seat belt sensors, keypads, microphones • **Actuators**: for precise position control, e.g. digital cameras, fast-acting valves and nozzles	• Sustainable • Low maintenance • Compact size especially useful in micro-electronics • In actuators, high response speed and can create a large force	• Wear out • Has temperature, load and voltage limitations
Temperature-responsive polymers, e.g. poly N-isopropylacrylamide (PNIPAM)	• Can change physical properties with a change in temperature, so they are useful in many scientific applications	• Can deliver drugs, cells or proteins to patients in a controlled way when mixed with liquid polymer • When injected into a patient, a gel deposit forms; the drug is released in a controlled way when the temperature is increased • Can be used as sensors and gel activators	• Useful in biomedical applications	• Still being researched so wider application may take time
Conductive inks	• Contain pigments that allow small currents to flow through even when dry • Made with silver, carbon, graphite or other precious metal-coated base material • Used in a pen on any suitable material	• Drawing working circuits on polyester, polycarbonates and paper • Improvising or repairing circuits on printed circuit boards • Printing RFID tags for tickets etc.	• Easy to use • Lighter and more economical than traditional circuit boards • Low waste • Ink can be folded, so you can draw a circuit, fold the paper and unfold it to find the circuit still works	• Silver is expensive • Difficult to get circuits right

Describe the following terms:

Compressive strength is the ability of a material to resist squashing

Tensile strength is the ability of a material to resist stretching

Concrete has an excellent compressive strength, however its tensile strength is poor.
Explain how its tensile strength could be improved

The tensile strength of concrete can be improved by embedding steel rods to form reinforced concrete

Give 2 reasons why glass reinforced plastic (GRP) is used for racing car body parts

- Lightweight
- Easily formed into shapes

Plywood is a strong and stable manufactured board, explain how it gains its strength

Plywood is a strong manufactured board due to the way it is constructed. Layers are built up both horizontally and vertically at 90 degree angles. This gives it strength in both directions and prevents it from twisting.

What composite material is used for the manufacture of canoes, car bodies, small swimming pools, water tanks, surfboards and small boat hulls?

Glass reinforced plastic (GRP)

What is Kevlar? Describe the physical properties and some practical applications of this composite material.

Kevlar is a liquid, converted into a fibre and woven into a textile material. Extremely strong, lightweight, corrosion and heat resistant.

Has a high tensile strength to weight ratio, far exceeding steel, carbon fibre and specialist alloys.

Uses when combined with other materials: bullet proof jackets, armour for military vehicles and planes. Formula 1 fuel tanks.

Technical Textiles

Use the internet to investigate the following materials, give other examples and products

Material	What it does	Example as a product or a task it performs
Agrotextiles		Shade cloth Insulation
Construction textiles		Roofing felt
Geotextiles		
Domestic textiles		Memory foam
Environmentally friendly textiles		
Protective textiles		Kevlar/armour
Sports textiles		High technology swimwear

What is Kevlar, what are its properties _____

_____

_____

_____

_____

1.5 Mechanical devices used to produce movement

Sketch the 4 types of motion

Linear	**Reciprocal**	**Rotary**	**Oscillating**

Levers

Sketch a class one lever	Sketch a class two lever	Sketch a class three lever

EFL the ELF FEL over

Give 3 examples of each type of lever

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-
-

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Describe the term Mechanical advantage_____

_____

$$\text{Mechanical advantage} = \frac{\text{Load}}{\text{Effort}}$$

Calculate the mechanical advantage of the wheel barrow

_____

Complete the formula:

Efficiency =

Explain the purpose of a linkage, give an example in your answer_____

_____

_____

_____

_____

Sketch a bell crank

Sketch a reverse motion linkage that transfers rotary motion to reciprocal motion

Give an example of where one can be found _____

Cams transfer _____ motion into _____ motion.

Sketch the following:

Pear shaped cam

Eccentric cam

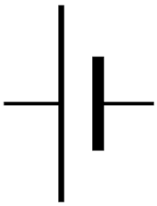
Drop cam

Sketch and label a simple gear train

Sketch a rack and pinion

1.6 Electronic Systems

Name the following circuit symbols:
Investigate and label the symbols
What do they do?



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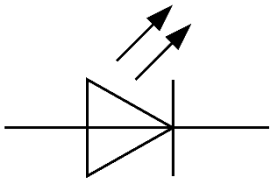

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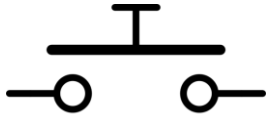

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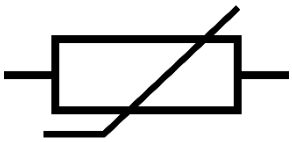

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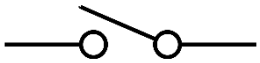

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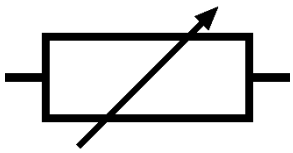

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Electronic components notes:

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Draw a schematic diagram that contains the following components:

- Cell
- Lamp
- Push switch

1.6 Electronic Systems

Sketch the following circuit symbols

Buzzer	Transistor	Motor	Light dependent resistor

Draw a schematic diagram that contains the following components:

- Cell
- Lamp
- Push switch

1.8 Ferrous and non-ferrous metals

Ferrous metals are metals that contain iron.
They are magnetic and are vulnerable to rust when exposed to moisture.

Type	Properties	Composition	Melting point	Example uses
Mild steel	Tough, ductile, malleable, magnetic, high tensile strength, easily joined, poor corrosion resistance	Iron + 0.1–0.3% carbon	1400°C	Screws, nails, bolts, girders, car body panels
Stainless steel	• Corrosion resistant, hard, tough, sometimes magnetic, resists wear, difficult to cut • Specific properties can be altered by varying the alloyed metals	**Alloy**: Carbon steel + 10.5–18% chromium 8% nickel 8% manganese	1400°C	Kitchenware, sinks, cutlery, medical equipment
Cast iron	Hard skin, brittle, soft core, good in compression, self-lubricating, magnetic	Iron + > 2–6% carbon	1200°C	Machine parts, vices, brake discs, manhole covers

Non-ferrous metals are metals that do not contain iron.
They have a higher resistance to rust and corrosion.
They are not magnetic and tend to be more malleable than ferrous metals.

Type	Properties	Composition	Melting point	Example uses
Aluminium	Greyish white: corrosion resistant, malleable, ductile, easily machined, good heat/electrical conductor, excellent strength-to-weight ratio, polishes well	Pure metal	660°C	Aircraft, foil, window frames, engine parts, drinks cans
Copper	Reddy brown: corrosion resistant, malleable, ductile, tough, easily machined, good heat/electrical conductor, good hot or cold working, polishes well	Pure metal	1100°C	Electrical wire, gas and water pipes, printed circuits, roofing
Brass	Yellow: corrosion resistant, easily machined, good heat/electrical conductor, casts well, harder than copper, polishes well	Alloy: 65% copper 35% zinc	900–940°C	Plumbing fittings, door fittings, locks, musical instruments

An alloy is a mixture of 2 or more metals or elements. By mixing the elements the properties or characteristics are improved

Stainless steel

Brass

Aluminium

Copper

Stainless steel

Aluminium would be a good choice of material for the ladder. Aluminium is lightweight and has a good strength to weight ratio meaning it would easily bare the load of a human body. It would be easier to move and extend than a heavier material. It is a non ferrous metal which doesn't contain iron, meaning it would be resistant to rust in an outdoor environment.

Copper would be a good choice of material for the pipework. Copper is a malleable metal which means it could easily be bent to shape without splitting or cracking. Copper is a non-ferrous metal so it would be resistant to corrosion whilst carrying water.

Key terms

Ductility: ability of a material to deform by bending, twisting or stretching; ability to be drawn out without breaking. Ductility in metals increases with temperature.

Malleability: ability of a material to be permanently deformed in all directions without fracture. It increases with temperature.

Hardness: ability of a material to resist deformation, indentation or penetration. Hard materials can resist abrasion, drilling, impact, scratching, and wear and tear.

A ductile metal is Copper/Aluminium/Mild steel

A Malleable metal is Aluminium/Copper/Mild steel

A hard metal is Stainless steel/Brass