PRODUCT ANALYSIS

Product analysis is where existing products are studied to gather information about their purpose, design and methods of manufacture. Product analysis is useful in resistant materials technology for the following reasons:

It can help to generate additional ideas.

It provides case study examples of good or bad industrial design and manufacture.

It can identify why a product is successful and what important decisions have been made during the design and development stages.

DESIGN IDEAS

Designs are rarely totally new. Most designs are adaptations, modifications and updates of existing products. Changes to a product might include using new materials, having a different style, making it more efficient and keeping in line with new safety standards.
It is, therefore, useful to study a range of existing products in the initial stages of project work.

PRODUCT ANALYSIS CHECKLIST

When carrying out an analysis use a checklist to help identify the important elements. These can include:

- a description of the product
- its purpose
- its working principles
- aesthetic, ergonomic and safety features
- manufacturing routes and costs
- environmental issues.

Where possible, disassemble the product to gain an understanding of how it works and how the parts fit together. Sketch or photograph parts for future reference. It is worthwhile paying particular attention to how parts fit together. Look for clips on plastics casings, how screws and fasteners are held in place and how components such as batteries and motors fit into the main body. Taking the product apart can help determine which materials and manufacturing processes have been used.

SUITABLE PRODUCTS

There are many products that can be used for an analysis.

Electric kettles, garden tools, lamps, cameras, watches, bicycles, portable tools, sewing machines, food packaging, hairdryers, children's toys, playgroup equipment, personal stereos.

INDUSTRIAL AND MANUFACTURING PROCESSES

Examiner's Top Tip
Use the product analysis checklist to evaluate some of the common products listed.

Most products will be made in industry. They will, generally, be made in batches or in large continuous quantities. Factors to consider in an analysis might be how many components are made, why this number is made in relation to the market, what types of production systems are used in the manufacture and how the products are packaged and marketed.

What to include in an analysis

Materials
What materials are used?
Reasons for their choice.
Details of finishing.

Assembly
Description of the fixings that are used.
How parts locate in place.
How can the product be taken apart for maintenance and changing parts.

Manufacturing
What are the main production routes?
Reasons for choosing the routes.
Details of quantities manufactured/sold.

Environmental issues
Can parts of the product be recycled?
Are any parts made from biodegradable materials?
Is the product safe to use?
Are any environmentally unfriendly processes used in its production?

Working principles
Does the project incorporate any mechanisms?
If so, how does it work?
How are the mechanisms maintained?
How reliable is the product?

Aesthetics and ergonomics

Background to the product
The name and type of product.
A description of its intended use.
How the product works and how it is used.
Photographs, sketches, diagrams of product.
Short description of the parts and how it is assembled.
Exploded views of the parts.

INTERNET
www.design-process.co.uk

QUICK TEST

1. How can product analysis aid design and technology?
2. What factors can be studied during an analysis?
3. What types of products make suitable case studies?
4. What materials factors would you look for in an analysis?

1. Helps with design ideas, helps understand some aspects of manufacture, identifies design decisions.
2. Product description, its purpose, working principles, aesthetic and ergonomic factors, safety factors, manufacturing routes, environmental issues.
3. Examples include kettles, children's toys, garden furniture and hairdryers.
4. What materials are used, what they are used for and how they are finished.

GENERATING DESIGN PROPOSALS

Generating a design proposal is the first stage of a design and technology project.
Generating a proposal is made easier by having a sequence of activities to work through.
Design proposals start from having a project need.
In industry there are a number of inventive ways in which a design need may occur.
In schools a project need is best generated from a range of real situations.

Examiner's Top Tip
Remember to consider both manufacturing process and product specifications.

INDUSTRIAL PROJECTS

The are a number of reasons why design projects are generated in industry.
Many companies need to continually generate design ideas so that the company is able to keep in business. For example, the continuous updating of mobile phones, computers, kitchen products and computer games consoles.
There may be fashion changes which create design opportunities. These are a response to changes in people's tastes.
Companies often use planned obsolescence to make products outdated or break down after a certain number of years.
A new technology can be a stimulus to new forms of design. For example, the invention of the silicon microchip has allowed many thousands of products to be designed and manufactured over the last 30 years.
Design opportunities can also arise through improvement of existing products.
This might include using better materials, safety features, making the product more environmentally friendly and making the product more energy-efficient.
A design need can therefore be for a large number of reasons.

INTERNET
www.designtechnology.org

SCHOOL PROJECTS

School projects are best generated from real situations.
Real situations can come from a wide range of areas or contexts. Here are a few:
- Garden centres, playgroups, the home, schools, youth clubs, leisure activities, leisure centres, old people's homes and small businesses.
- Projects are often based around one of these situations.

Research can be carried out to find a specific need for a project.
Choosing an area and finding a need will be the starting point for the project.

STAGES IN GENERATING A PROPOSAL

- Choose an area of study (context) from which a project need can be found.
- Define the project need – purpose of the project.
- Prepare a design brief.
- Write the specification for the project.
- Carry out research to help in the initial design stages.
- Use graphics, annotated notes, diagrams, photographs, tape recordings and other methods to generate initial design ideas.
- Use cardboard and other suitable materials to make models to test early designs.
- Select the best idea or ideas for further development. Give reasons for choices and rejection.

Examiner's Top Tip
Learn the difference between a design brief and specification.

DESIGN BRIEF

This is a statement of the problem to be solved. In industry it is the set of instructions that are passed on to the designer. In the school situation the design brief is a written statement outlining the design problem.
A design brief should include a product specification which gives specific details about the product.
Specifications usually include information about how a product should perform. These can be factors such as:

- temperature ranges
- weight of the product
- maximum dimensions of a product
- speed of rotation
- target cost
- safety specifications.

PRODUCT SPECIFICATION DETAILS

Other less measurable factors that can be included in a specification include:

- how the product will be used
- colour
- size and shape
- ergonomic factors
- reliability factors
- maintenance requirements
- the manufacturing specifications.

THE MANUFACTURING PROCESS

This will influence the design. Factors might include:

- the quantity of products to be made
- which machines are available
- the quality specifications for the product
- the timescale for manufacture
- the cost (budget) limitations.

RESEARCH

Plan research carefully. Make sure that you:

- know what you want to find out
- where to get information
- who to talk to
- evaluate products on the market
- research the needs of the product
- use the design specification to plan research.

QUICK TEST

1. What is a design brief?
2. What is a product specification?
3. What might be included in a manufacturing specification?
4. What are the stages in generating a design proposal?

1. A statement of the problem to be solved.
2. Gives specific details about a design project.
3. Quantity of products made, machines available, quality factors, timescale.
4. Design brief, detailing the specifications, proposed manufacturing route, research.

PRODUCT DEVELOPMENT AND PLANNING

During product development, work is carried out to transform the initial design proposal into working drawings ready for manufacture.
Development makes use of sketches, further research and mock-ups to refine ideas.
Planning is essential to plan the manufacturing route, the manufacturing times and how quality and other factors will be controlled.
Computer-aided drawing is widely used to produce the final working drawings.

DEVELOPMENT

It is important to develop an idea into a practical solution.
This involves:

- further drawing of how parts fit together
- selecting the materials
- making mock-ups
- using mock-ups to test ideas
- gathering information from people or groups
- producing development
- sketches and working drawings.

MOCK-UPS

Mock-ups can be used so that accurate measurements can be worked out. They can also help with aesthetic and ergonomic decisions. Mock-ups are quicker and cheaper to produce than the final products and can help reduce problems during manufacturing. Mock-ups are used for many applications in industry from clay models of cars through to models of kitchen equipment. These help designers to visualise the product in its three-dimensional form. Computer modelling has replaced the need for hard modelling in many instances.

WORKING DRAWINGS

From sketches and models working drawings can be made. These are drawings of the components ready for manufacture.
Computer-aided design (CAD) is used to produce working drawings.
The purpose of working drawings is to ensure that all the information to make the product is given. This includes the dimensions of the product, the surface finishes required and the types of materials used. Where tolerances are required these are added.
A cutting list is required so that production can be planned.

CHECK LIST

Design development should:

- clearly show how the final product will function
- consider the aesthetic and style details
- finalise cost and price
- consider the ergonomic principles
- finalise materials
- consider the health and safety issues
- consider the environmental issues
- design for easy assembly at the manufacturing stage.

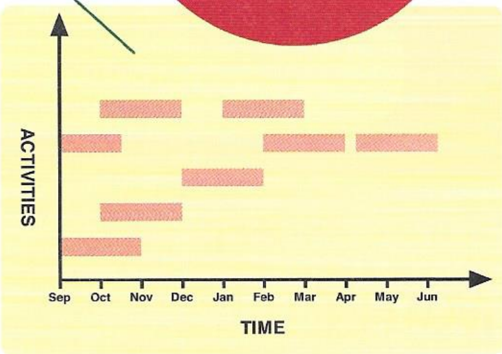
PLANNING

Most planning will be for batch manufacture. Standardised parts can be used to simplify the production route and reduce costs.

Examiner's Top Tip
Take time out to plan projects carefully prior to starting.

Planning includes:

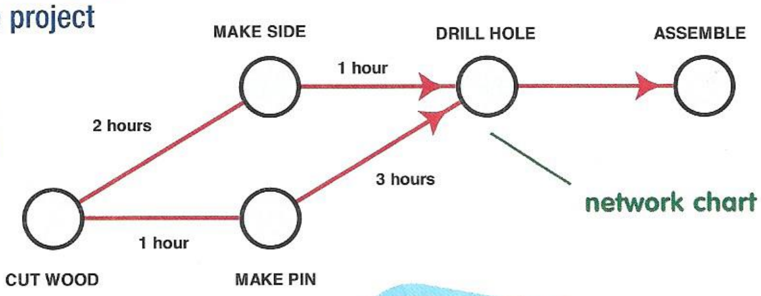
- planning the stages of manufacture to fit the time available
- deciding the best sequence for the operations to be carried out
- planning to have materials ready in time for the operations.



PLANNING CHARTS

Gantt charts and network charts are used to help plan and record production.

A Gantt chart is a graph which shows the project stages on a timescale. Gantt charts are used widely for managing projects. The charts give a visual plan of the project stages. Gantt charts can be used to check whether the stages of the project are being carried out on time. If not, measures can be taken to speed the process up.



Network charts are activity charts which can be used to show the route through a manufacturing system. The arrows on the chart indicate the flow of materials and show the order in which the work will be carried out.

INTERNET
www.tep.org.uk

AESTHETICS

This is concerned with the appearance of the product. It is concerned with aspects such as the colour and texture of the product, the style, shape and proportions.

ERGONOMICS

Ergonomic factors relate the product to the user. This might include ensuring that dimensions are appropriate for the user's height or size of hands, switches can be seen and that the product is not too heavy. Anthropometric data can be used for the ergonomic aspects of a design.

QUICK TEST

1. What types of activities are carried out during product development?
2. What is meant by aesthetics?
3. Why are working drawings needed?
4. What type of charts can be used for planning?

4. Gantt and network charts.
3. To ensure that all the information to make the product is given.
2. The appearance of the product – style, colour, texture, shape and proportions.
1. Sketches, further research, making mock-ups, further drawings of how parts fit together.

SOCIAL AND ENVIRONMENTAL CARE

It is important to design products so that they are socially acceptable and do not have any adverse effects on the environment. Technology should be used in a responsible way.

RECYCLED MATERIALS

Many materials can be recycled in one form or another. This helps the total stock of a material from becoming scarce. Examples of recycled materials include card and paper, metals and thermoplastics. Manufactured boards are made from reconstituted and recycled timber reducing the use or over-use of trees.

CHECK LIST

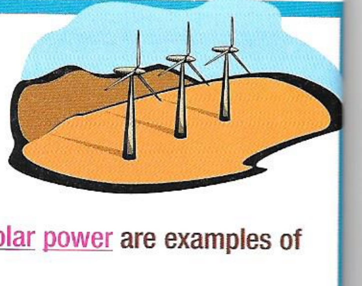
The following items should be considered:

- What impact will the product have on the environment?
- Can use be made of recycled resources?
- Can non-renewable resources be reduced?
- Can waste be reused?
- Can biodegradable products be used?
- Is the design energy efficient?
- Are there any toxic waste products?
- Are there any harmful components in the design?
- Is the product safe, user-friendly and unlikely to be misused?

IMPACT ON THE ENVIRONMENT

There are many ways in which a design can have an impact on the environment. For example, a product may use up scarce resources, its production process may produce harmful wastes or the product may contain toxic substances.
Designers need to be aware of environmental problems and develop designs which are environmentally friendly. There are now a number of national and international regulations that govern environmental issues.

RENEWABLE AND NON-RENEWABLE RESOURCES



A renewable resource is one which can be renewed in a relatively short time period. Examples are timbers and materials from plants and animals. Wind, water and solar power are examples of renewable energy sources.
Softwoods grow quicker than hardwoods and renew at a faster rate.
Metals are non-renewable. Their ores have taken many years to form. They will not be formed in the same way again. As the supply of the metal is used up the stock will eventually disappear. In a similar way plastics are made from oil which is again non-renewable.

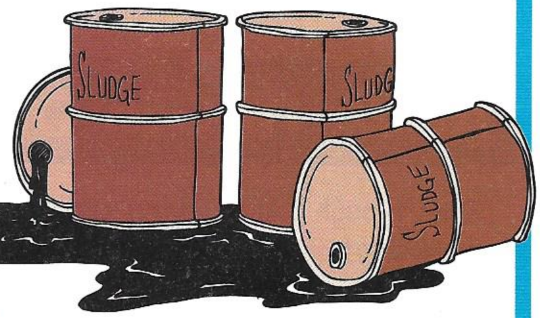
REDUCING WASTE AND ENERGY

Waste can be reduced by selecting and using materials wisely. When using sheet materials make sure that they are marked out to produce minimum waste. Templates can be arranged on top of the sheet in the most efficient way. When machining use the nearest size stock bars to reduce the levels of wasted materials. Standard components can help reduce the need to use specially made components. Processes that use plastics, often, require less energy than making parts out of metals. This helps reduce the amount of wasted energy in the form of heat and electricity.

BIODEGRADABLE MATERIALS

These are better for the environment than ones that may take many years to decompose. Parts of a design can be made from biodegradable materials so that they can be disposed of easily. This is an important factor in the design of packaging where the materials are thrown away without any further use.

TOXIC PRODUCTS AND HARMFUL COMPONENTS



Care must be taken to avoid using products that are harmful to people, animals, and plant life. Small components in toys can be swallowed by children. Paints that have lead are also dangerous. Harmful waste needs to be disposed of carefully and in appropriate containers.

Examiner's Top Tip
Always include environmental considerations when designing and making.

QUICK TEST

1. Give two examples of materials that can be recycled.
2. Is a metal a renewable or non-renewable resource?
3. What are biodegradable materials?
4. Which timbers are more environmentally friendly: hardwoods or softwoods?

1. Paper, card, metals, thermoplastics.
2. Non-renewable.
3. Materials which decompose quickly and are not harmful to the environment.
4. Softwoods.

USE OF CAD

CAD stands for computer-aided design. CAD is widely used in schools and industry. CAD is particularly good for producing working drawings and three-dimensional computer models. These can be used in school projects.

Examiner's Top T
Know the advanta
of using CAD fo
school-based
projects.

COMPUTER-AIDED DESIGN

CAD systems are used in schools for a range of applications. These are:

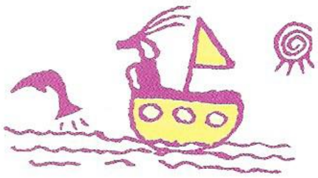
- 2-D and 3-D drawings
- solid models of the project
- materials databases.

Some CAD systems allow designs to be automatically downloaded to computer-aided machines. This eliminates the need to program the machine before machining can commence.

ADVANTAGES OF CAD

Even though CAD systems are relatively expensive they have a number of advantages over manual drawing methods:

- They produce high-quality and consistent drawings.
- Information can be stored easily.
- Standard parts can be held in a parts library reducing the time it takes to draw them.
- Once people are used to the systems CAD can be quicker than drawing complex assemblies by hand.
- Changes to a drawing can be easily made.
- Many packages will automatically dimension components.
- Solid modelling allows the product to be rotated and viewed from a number of angles.



CAD should not be a total substitute for sketching as a design tool. Freehand sketching is quick, allows freedom of thought and is especially suitable for work in the initial design and development stages.

OTHER BENEFITS OF CAD

Many computer packages allow images to be scanned into the system and photographs to be imported. This can help in many areas of project work.
Plotter cutters are used for cutting out shapes in sheet material and engraving machines can be used to produce flat models of a product.

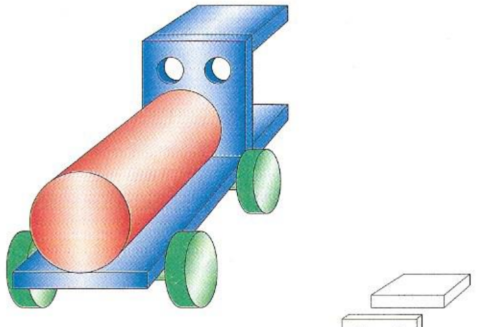
TYPES OF DRAWINGS

These include pictorial, exploded and orthographic drawings.

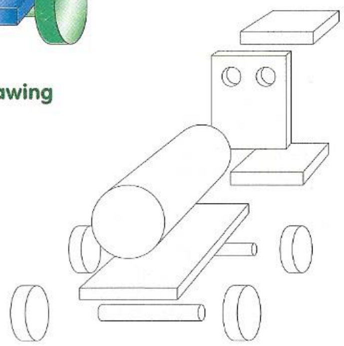
Pictorial drawings give the most realistic idea of the product. They can be easily drawn using solid-modelling packages.

Exploded drawings show how the product fits together. They are useful to show how a product will assemble during manufacture.

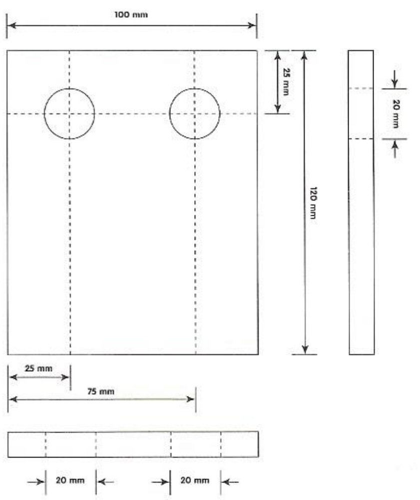
Orthographic drawings are working drawings which are used when manufacturing the product. They contain all the necessary dimensions. They can be drawn using 2-D CAD packages.



pictorial drawing



exploded drawing



orthographic drawing

QUICK TEST

1. What does CAD stand for?
2. How can CAD be used in schools?
3. Give three advantages of using CAD.
4. What types of drawings are widely drawn using CAD?

Examiner's Top Tip
Where possible use CAD to produce some drawings for your project work.

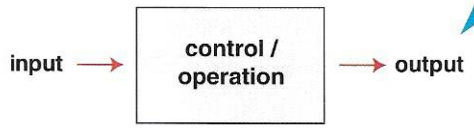
INTERNET
www.data.org.uk

1. Computer-aided design.
2. 2-D and 3-D drawings, solid modelling, materials databases.
3. High-quality drawings, storage, standard parts held in parts library, quick, changes made easily, automatic dimensioning, solid modelling.
4. Pictorial, exploded, orthographic.

SYSTEMS AND CONTROL DESIGN

Systems diagrams are a common way of describing systems. Systems diagrams can be used to show how the parts of a product are linked together.
They can also be used to show how products and parts flow through a manufacturing system.
Common systems components that produce movements are levers, gears, cams and belt drives.

SYSTEM DIAGRAMS

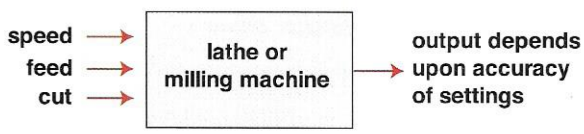


Systems consist of a number of parts, components or processes that work together to achieve an output.
A system can be broken down into a number of elements each of which can be represented by a block diagram.
Each system block has an input, performs an operation and has an output.

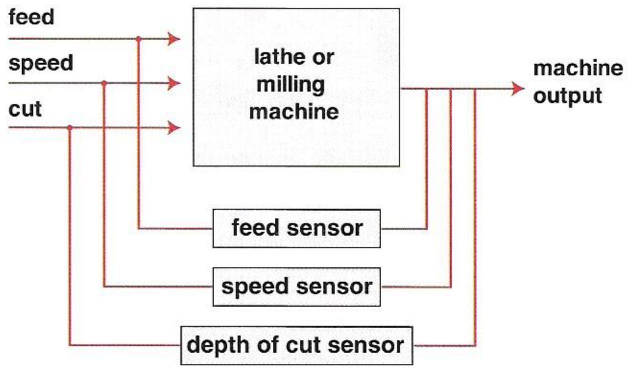
CLOSED-LOOP AND OPEN-LOOP SYSTEMS

An open-loop system is one where there is no feedback to help control the system. The accuracy of open-loop systems depends upon how well the system has been set up before it is operated.
Closed-loop systems have sensors that can sense the output values of the system. The sensors feed back information to the input and change the input values if necessary.

OPEN-LOOP SYSTEM



CLOSED-LOOP SYSTEM

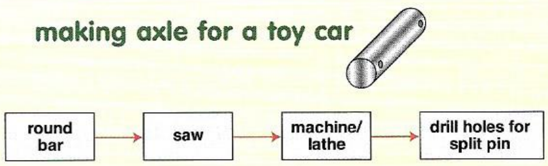


CLOSED-LOOP SYSTEMS

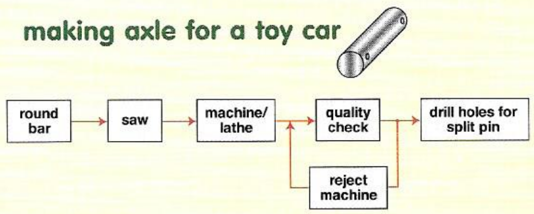
These are found in a number of situations.
An example is in the control of CNC lathes and milling machines.
When manual machines are used, the depth of cut, feed rate and speeds are set by the operator. The quality of the finish will depend upon how these have been set before the machines starts to cut. If the finish is poor the operator will have to manually re-adjust the controls to improve the quality of the finish.
Many computer-operated machines are able to make these adjustments automatically when the machine is cutting. Sensors are used to monitor depth of cut, feed rate and speed. If the cutter, for example, hits a hard spot in the material or the depth of cut is too great, the sensor will measure this and adjust the controls automatically. This can lead to better finishes.

THE PRODUCTION PROCESS AS A SYSTEM

A manufacturing process transforms a material or product from one shape to another. A system diagram can be used to show how a manufacturing system links together all parts of the manufacturing process.



Feedback loops can be built into manufacturing systems to make them more effective. For example, quality checks can be made at various points. If faults are found in the process the operation can be stopped and appropriate adjustments made.

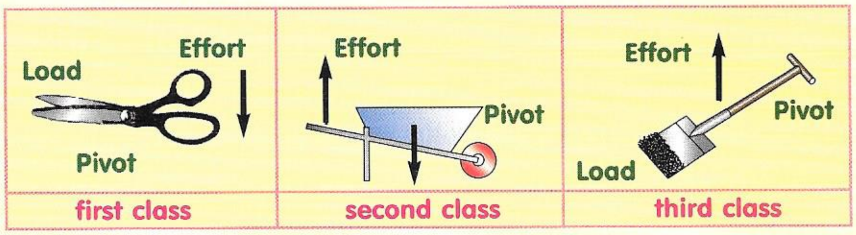


Quality monitoring in this way can be shown by including feedback loops into the manufacturing system diagram.

SYSTEM COMPONENTS

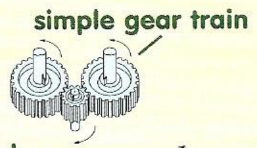
LEVERS

The leverage principle is commonly used for a number of applications. Levers can be classified as first-class, second-class and third-class levers.



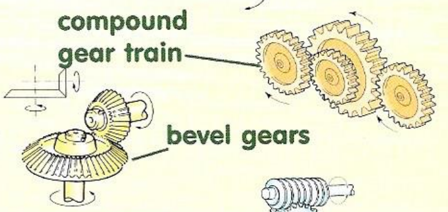
GEARS

These are used to transmit motion between shafts which are relatively close together. A simple gear train consists of two meshing gears. Here the shafts will turn in opposite directions. An idler gear can be used in a simple gear train to make the gears turn in the same direction.



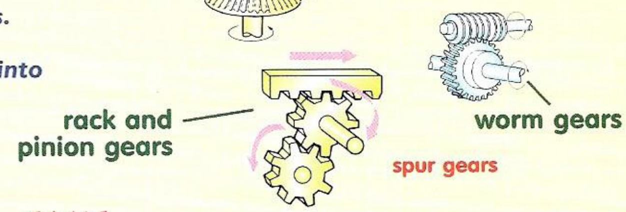
A compound gear train has more than two gears in a system.

Bevel gears are used to turn shafts which are at right angles to each other.



Worm gears and worm wheels are widely used in gear boxes.

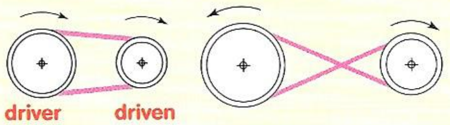
Rack and pinions are gears used to changed rotary motion into linear motion.



BELT DRIVES

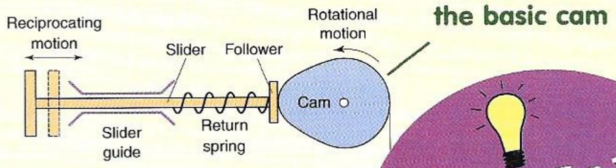
These are used to transmit motion and power between shafts which are relatively far apart. The shafts will rotate in the same direction unless the belts are crossed. The belts can have flat, round or vee cross-sections.

Toothed belts are used where no splippage of the belt should occur.



CAMS

These change rotary motion into linear motion. The cam follower is in contact with the surface of the cam and producing reciprocating movement.



Examiner's Top Tip
Be able to sketch simple cam and other mechanisms for simple projects such as children's toys.

QUICK TEST

1. What is a system?
2. What are the three elements of a block diagram?
3. What type of control includes sensors – open-loop or closed-loop?
4. What is the purpose of gears?
5. What do cams do?
6. Why are bevel gears used?
7. Why are crossed belts used on pulley systems?

1. A number of parts, components or processes that work together to give an output.
2. Input, transformation (work done), output.
3. Closed-loop.
4. To transmit motion between shafts which are close together.
5. Change rotary motion into linear motion.
6. To turn shafts at right angles to each other.
7. So that pulley shafts will rotate in opposite directions.