TECHNOLOGY
GRADE 8

Name:____

Contents

Learning outcomes explained

Learning Outcome 1: Technological Processes and Skills
The learner will be able to apply technological processes and skills ethically and responsibly using appropriate information and communication technology.

Assessment standards
We know this when the learner:

Investigates

- Investigates the background context, the nature of the need, the environmental situation, and the people concerned when given a problem, need or opportunity set in a nationally relevant context.
- Compares existing products relevant to the problem situation based on:
  - safety;
  - suitability of materials;
  - fitness for purpose;
  - cost.
- Develops and performs practical tests in the technological knowledge areas (Structures, Processing,and Systems and Control).
- Uses appropriate technologies and methods to:
  - collect relevant data from different sources or resources;
  - extract relevant data;
  - make meaningful summaries;
  - use information to justify and support decisions and ideas.

Designs

- Writes or communicates a short and clear statement or a design brief in response to a given or identified situation for the development of a product or system.
- Lists product and design specifications and constraints for a solution to an identified or given problem, need or opportunity based on most of the design key words listed below:
  - people: age, target market, human rights, access;
  - purpose: function, what the product will do;
  - appearance: colour, shape;
  - environment: where the product will be used or made, impact on the environment;
  - safety: for users and manufacturers;
  - cost: cost of materials, wastage, cost of manufacture, maximum selling price.
- Generates several alternative solutions and writes notes, ideas that show some links to the design brief, specifications and constraints.
- Chooses possible solutions based on well-reasoned argument and develops the chosen idea to include more specific details using graphic and/or modelling techniques.

Makes

- Develops a plan for making that outlines all of the following:
  - resources needed (e.g. materials lists, tools, people, costs);
  - sketches showing the necessary dimensions or quantities;
  - all the steps necessary to making the product.
- Chooses and uses appropriate tools and materials to make products by measuring, marking, cutting or separating, shaping or forming, joining or combining, and finishing different materials accurately using appropriate techniques.
- Changes and adapts designs in response to checks in order to improve the quality of the finished product.
- Uses safe working practices and shows awareness of efficient ways of using materials and tools.

Evaluates

- Tests and evaluates the products or system with some objectivity, based on objective criteria linked to the design brief, specifications and constraints, and suggests sensible improvements or modifications.
- Evaluates the efficiency of the plan of action followed with some objectivity, identifies areas of strength and weakness, and suggests sensible ways of improving personal performance.

Communicates

- Presents ideas (in a project portfolio) using two-dimensional or three-dimensional sketches, circuit diagrams or systems diagrams that include all of the following features:
- use of South African drawing conventions (e.g. dimension lines, labelling, line types, symbols);
- notes to clarify and communicate design features and reasoning; enhancement of significant sketches like final solution drawings (e.g. colour, shade, texture, shadows, thick and thin lines).
- Chooses and uses appropriate technologies to produce project portfolios, poster presentations or reports that present graphical and written information clearly in a form mostly suitable for the target audience.

Learning Outcome 2: Technological Knowledge and Understanding

The learner will be able to understand and apply relevant technological knowledge ethically and responsibly.

Assessment standards

We know this when the learner:

Structures

- Demonstrates knowledge and understanding of frame structures:
    - the use and application of basic structural components (e.g. columns, beams, arches, buttresses, struts, stays, guys, ties);
    - reinforcing techniques for frame structures (e.g. triangulation, webs and fillets, orientation and cross-sectional area of members);
    - how frame structures can be made strong (e.g. relationship between the size and shape of the base, the centre of gravity and stability).

Processing

- Demonstrates knowledge and understanding of how materials can be processed to change or improve their properties by adapting them to suit particular purposes:
    - to withstand forces (e.g. tension, compression, bending, torsion, shear);
    - to increase strength or life-span;
    - how specific properties suitable for packaging can be achieved.

Systems and Control

- Demonstrates knowledge and understanding of how mechanical systems (e.g. pneumatic or hydraulic systems, gears, belt drive systems, pulley systems, linked lever systems) convert motion and force to give mechanical advantage, and represents them using systems diagrams.
- Demonstrates knowledge and understanding of how electrical circuits with more than one input or control device will work based on different logic conditions ('AND' and 'OR' logic), and represents them using circuit diagrams, systems diagrams and truth tables.

Learning Outcome 3: Technology, Society and the Environment

The learner will be able to demonstrate an understanding of the interrelationships between science, technology, society and the environment.

Assessment standards
We know this when the learner:

Indigenous Technology and Culture

- Compares how different cultures have solved similar problems and relates the differences to the culture and values of their societies.

Impact of Technology

- Expresses and details opinions about the positive and negative impacts of products of technology on the quality of people's lives and the environment in which they live.

Bias in Technology

- Produces evidence that details opinions, backed up by factual evidence, about the effect of technological solutions on human rights issues (e.g. age, disability).

STRUCTURES

- Demonstrates knowledge and understanding of frame structures:
  - the use and application of basic structural components (e.g. columns, beams, arches, buttresses, struts, stays, guys, ties);
  - reinforcing techniques for frame structures (e.g. triangulation, webs and fillets, orientation and cross-sectional area of members);
  - how frame structures can be made strong (e.g. relationship between the size and shape of the base,the centre of gravity and stability).

WHAT IS A STRUCTURE?

- A structure is something that will support an object or a load.
- A structure must be strong enough to support its own weight and whatever load is put on it.

TYPES OF STRUCTURES

➢ **Mass Structures**
Mass Structures are solid structures which rely on their own weight to resist loads. A single brick is a mass structure but so is a large dam wall.

➢ **Frame Structures**
Frame structures are made from many small parts (called members), joined together. Bridges cranes and parts of this oil rig are just a few examples.

➢ **Shell structures**
Shell structures are made or assembled to make one piece. Tin cans, bottles and other food containers are often good examples of shell structures, but larger things such as car and aeroplane bodies are examples of more complicated shell structures. Most shell structures are made from thin sheet material (which makes them light) and most have ridges or curves moulded into them (to make them strong).

✳ **Natural Structures**
Structures are not new, nature produced the first structures long before humans were able to. A leaf is a natural structure. Its veins provide support and carry nutrients. A tree has to carry the weight of its own branches as well as resisting strong winds.

✳ **Manufactured structures**
A manufactured structure is quite simply a structure built by human beings. Many of Nature's structures have been copied by humans. The shell of a snail and the body of a modern car are both shell structures designed to protect their occupants.

FUNCTIONS OF STRUCTURES

Supporting a load

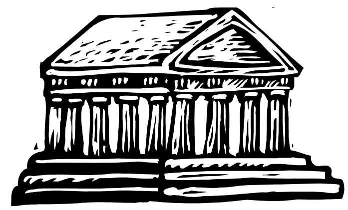
A structure must be able to support its own weight and the load it has to carry. A load can be a person, an object or a force. A moving load is known as a dynamic load. A stationary load is known as a static load.

Spanning a gap
The most common structure fulfilling this function is a bridge. Bridges fulfills another function - supporting a load - they have to carry their own weight and the weight of whatever travels over them.

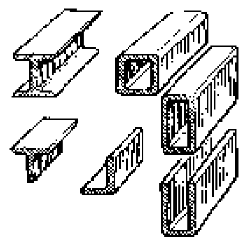
Enclosing people, animals or objects
All containers fulfill this function, as well as most buildings. Natural objects include shells, caves, hollow tree trunks etc.

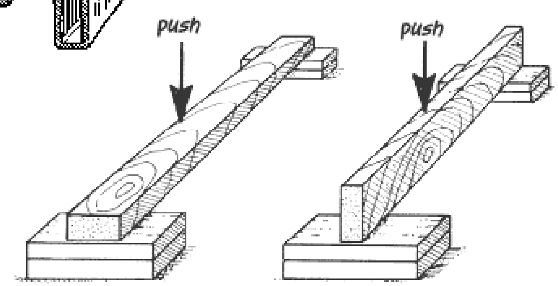
STRUCTURAL MEMBERS

Columns are vertical structural members.

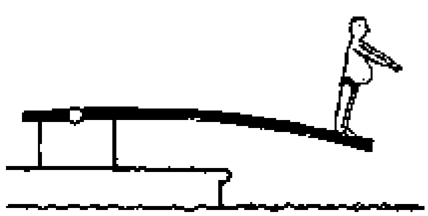


Beams are horizontal structural members. Beams often spread a load across two or more columns. How well the beam works depends the material it is made from and its shape. If you lay a beam flat and push down at the center, t gives easily. If the beam is on its side and you push down at the center, the beam is much more rigid. Beams used in larger structures take many different forms, some are simply solid, some are hollow, and others have special cross-sections to provide strength and rigidity.

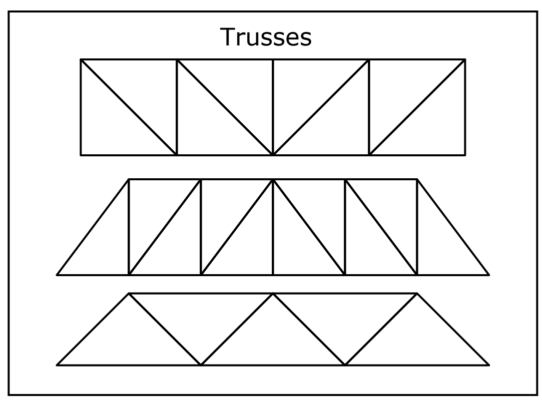


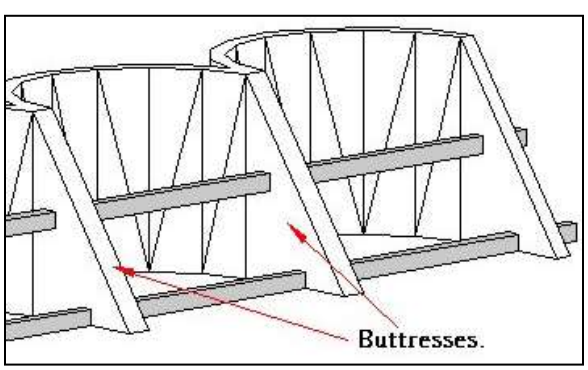


A **cantilever** is a structural member which sticks out like an arm form the main structure. A cantilever is a beam which is supported at one end only.



A **truss** is a structure made up of triangles.





A **buttress** is a structure built against or projecting from a wall which serves to support or reinforce the wall.

PROPERTIES OF STRUCTURES

DEFINITIONS:

Rigidity - the ability not to buckle or distort.

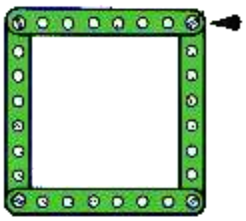
Stability - the capacity of an object to maintain or return to its original position; the state of being balanced in a fixed position.

Strength - the capacity to withstand forces that tend to break an object or change its shape; it is an object's ability to hold its shape without collapsing.

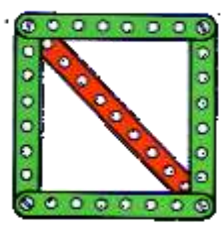
RIGIDITY

Making Structures Rigid

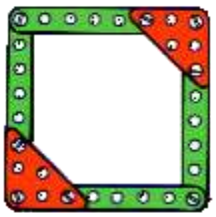
If you look at some pictures of familiar frame structures like cranes, electricity pylons or roof supports you may notice that triangulation is used to make them rigid.



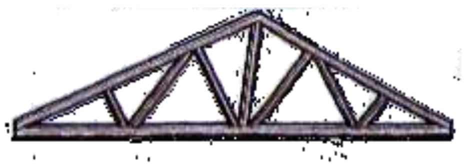
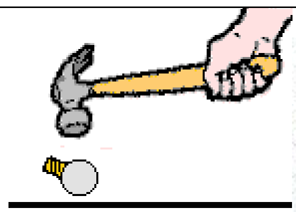
When forces are applied to a simple four-sided structure it can be forced out of shape quite easily. A structure which behaves in this way is said to be non-rigid.



By adding an extra bar or member (usually a strut) corners A and B are prevented from moving apart. The structure then cannot be be forced out of shape, and is said to be rigid. This forms two triangles in the structure.



An alternative to triangulation is to use a gusset plate. A gusset is simply a piece of material used to brace and join the members in a structure.

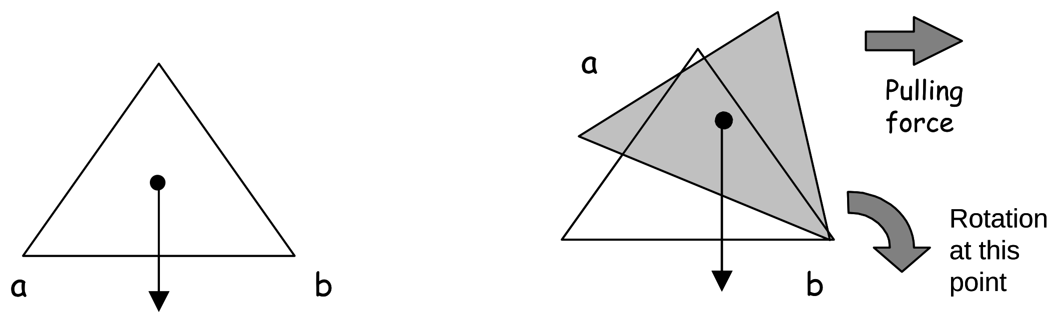
Framed structures achieve most of their **strength** and **rigidity** from the way they are assembled. Most frameworks are built using a combination of struts and ties to make triangles. Triangles make very strong and rigid structures. Using triangles in this way is called **triangulation**.	
Most shell structures achieve their **strength** and **rigidity** from the way they are shaped. Shell structures very rarely have large flat surfaces they tend to be designed and made with ribs to act as stiffeners. Egg and light bulbs containers are good examples.	 

STABILITY

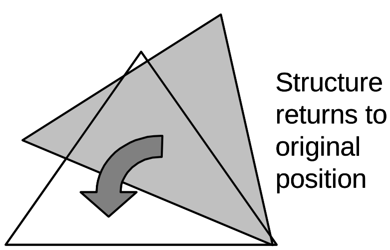
We say that a structure has high stability if, when it is loaded, it tends to return to, or remain in, the same position. The degree of stability depends on the relationship between the base, the height and the weight of the structure. The weight of an object is due to the force of gravity pulling down vertically on the mass of the object. The invisible position of the mass through which the force of gravity pulls is called the centre of gravity. If the position of the centre of gravity is low and lies well inside a large base area, the object is said to be very stable. If the centre of gravity lies to one side of the base area, the object is much less stable. If the centre of gravity is outside the base area, the object is very unstable and may require further support. A tall object tends to be unstable because its centre of gravity is in a very high position. Because of this, it can be more easily moved outside the base area by the application of external loads.

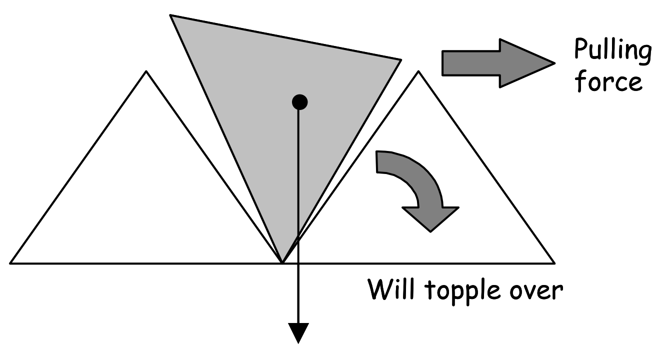
The relation between stability and centre of gravity

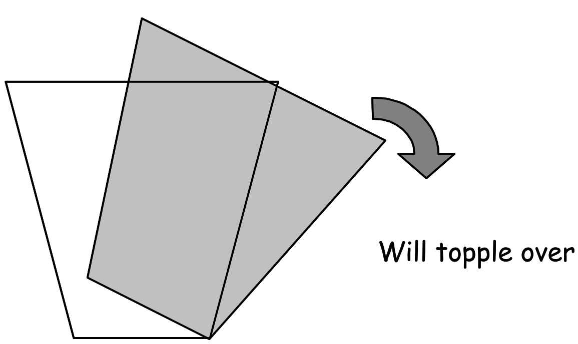
The stability of a structure is related to the position of the centre of gravity for that structure. As indicated in the diagram below, as the structure is tilted, its centre of gravity rises. It is rotated about point b, caused by the pulling force.



If the structure is stable, on release of the pulling force the structure will return to its original position.





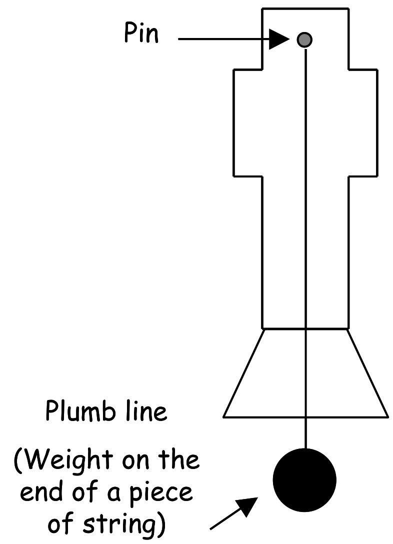


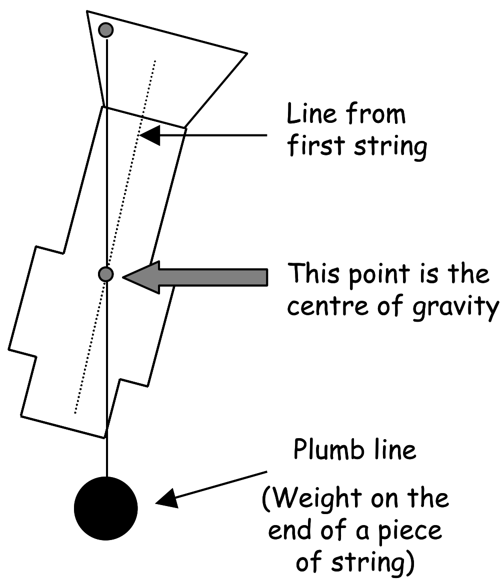
However, it must be noted that this will only be the case if the centre of gravity <u>remains inside the base of the structure</u>. When the structure is tilted to such a degree that its centre of gravity is outside its base, then the structure will become unstable as gravity acts on it and causes it to topple over.
If an unstable object is rotated as shown, when the pulling force is removed the structure will continue to rotate and will eventually topple over.

LET'S TRY IT !

Accurately determining the centre of gravity.

The method that was previously explained for finding the centre of gravity of an object is by trial and error, and therefore is only a approximation. For a more accurate approach try this exercise.
Use a piece of thick card and cut out an irregular shape as shown opposite. Hang the string and a plumb line from a pin as shown. Mark the position of the plumb line with a pencil.



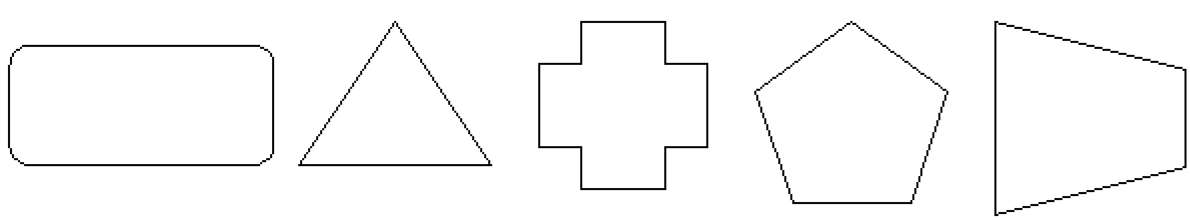


Repeat the process again, but this time place the pin at a different location, and mark the position of the plumb line string. Where the two pencil lines cross is the centre of gravity of the shape.

APPLY YOUR KNOWLEDGE

The above method of determining the centre of gravity of an object, is very accurate, and will work with any irregular shaped object.

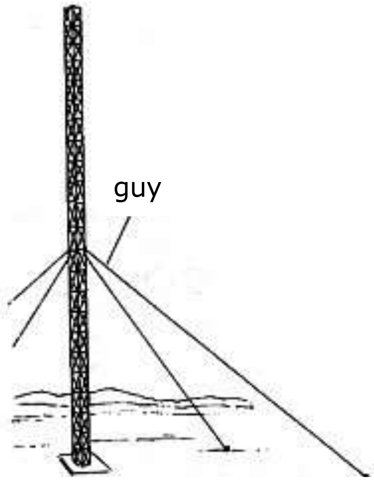
Can you determine the centre of gravity of these objects.



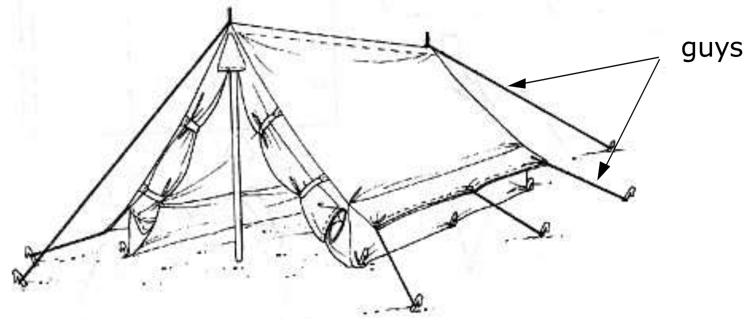
Make a structure more stable by:

- using struts and guys to hold it
- making the base wider
- making the base heavier
- using a foundation

More Structural Members

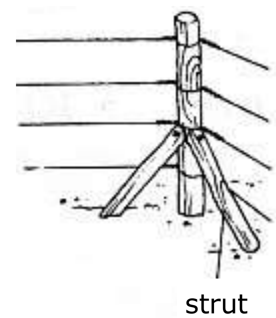


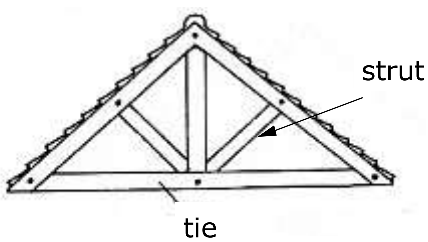
Structures like high towers and tents can also be made stable by anchoring it to the ground with guys. **Guys** are ropes, cables or chains (flexible members) that hold a structure firmly in place by pulling on it.



STRUTS and TIES

All structures have forces acting on them. Ties, guys and struts are structural members used to make structures stable. The part of the structure that has a tensile force acting on it is called a **TIE** and the part that has a compressive force acting on it is called a **STRUT**.





A **tie** (usually inflexible) holds other members in place by pulling on them. Many frame structures have members called **struts** (always inflexible). Struts hold members in position by pushing against them. Struts are made of materials like wood or steel that do not bend.

Strength

> The strength and rigidity of a structure depend on its ability to **resist force**.

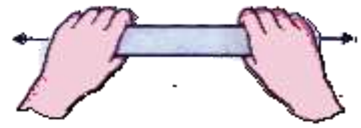
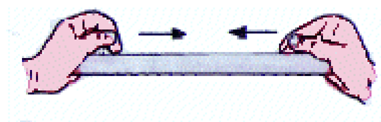
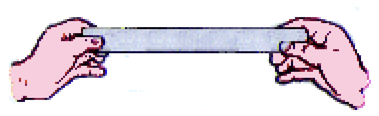
Forces acting on structures

Forces can be either **static** (stationary) or **dynamic** (moving).

Static forces are usually forces caused by the weight of the structure and anything which is permanently attached to it.

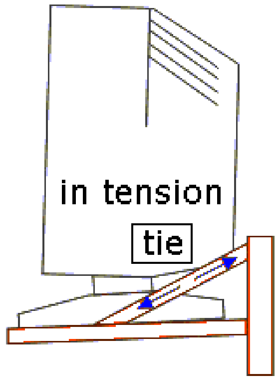
Dynamic forces are caused by things such as wind, waves, people, and vehicles. Dynamic forces are usually much greater than static forces and are very difficult to predict. These are the most common reason for structural failures.
An **external force** is a force placed on the structure from outside, by the wind perhaps or perhaps by someone sitting or standing on it.
Internal forces are the forces which the structure must provide within itself to resist the external forces placed upon it. If the external forces are greater than the internal forces, a structure will collapse.

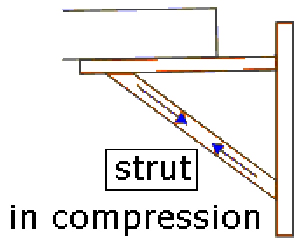
External forces or loads cause internal stresses to be set up in a structure. Not all forces or loads act in the same way. This year we will only deal with tension and compression.

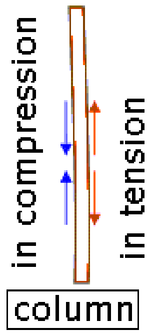
Tension: Is a force which tries to pull something apart. A structural member in tension is called a tie. A tie resists tensile stress.	
Compression: Is a force which tries to squash something together. A structural member in compression is called a strut. A strut resists compressive stress.	
Torsion: Is the name given to a turning or a twisting force.	
Shear: A shear force is created where two opposite forces try to cut tear or rip something in two.	
Bending : Bending is a word you will have met before. A structure which is subjected to bending is being stretched and squashed at the same time.	

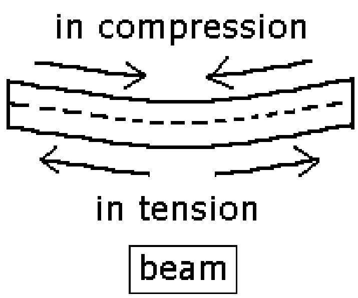
Identifying structural members

Under load, a **beam's** top surface is pushed down or **compressed** while the bottom edge is stretched or placed under **tension**, the same happens to a **column** - one side will be in **tension** and the other side in **compression**. **Struts** are always in **compression** and **ties** are always in **tension**.



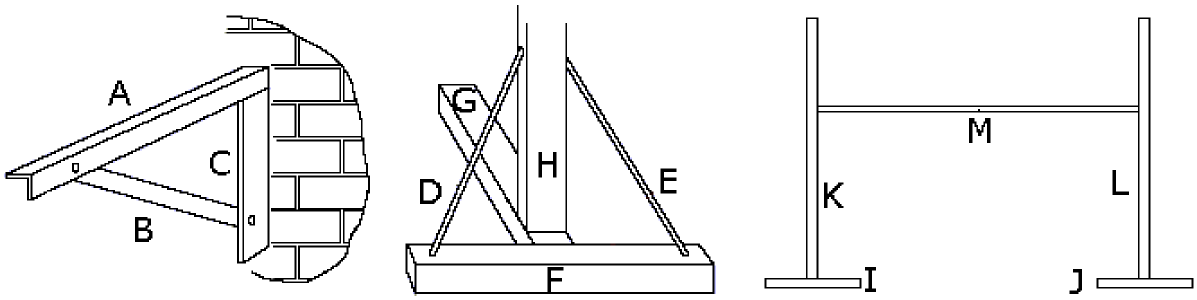






APPLY YOUR KNOWLEDGE

Identify the structural members, properties and forces in the following drawings.



Structural members:

A: ____________________________ B: ____________________________

C: ____________________________ D & E: ____________________________

H: ____________________________ K & L: ____________________________

M: ____________________________

Forces:

A: ____________________________ B: ____________________________

C: ____________________________ D & E: ____________________________

H: ____________________________ K & L: ____________________________

M: ____________________________

What is the purpose of the structural members F, G, I & J ? Explain.

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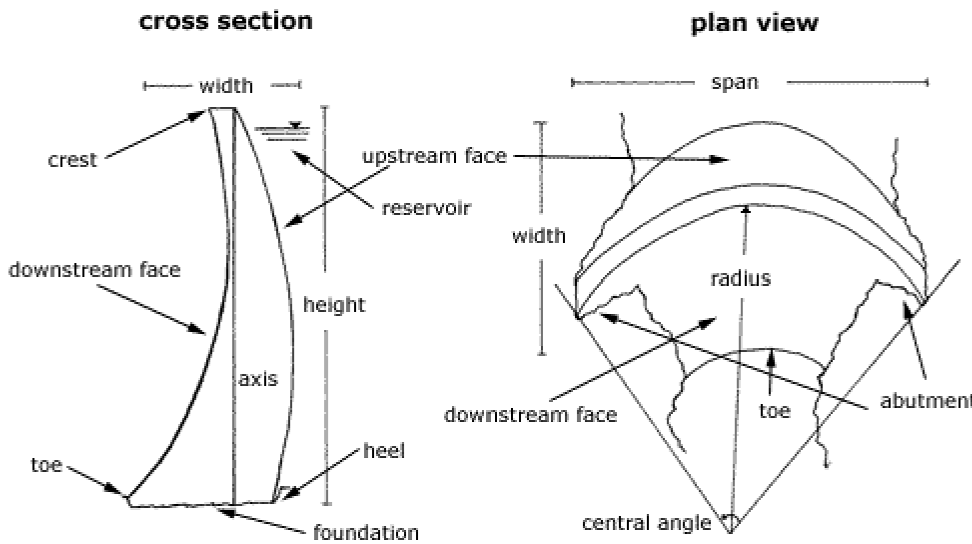
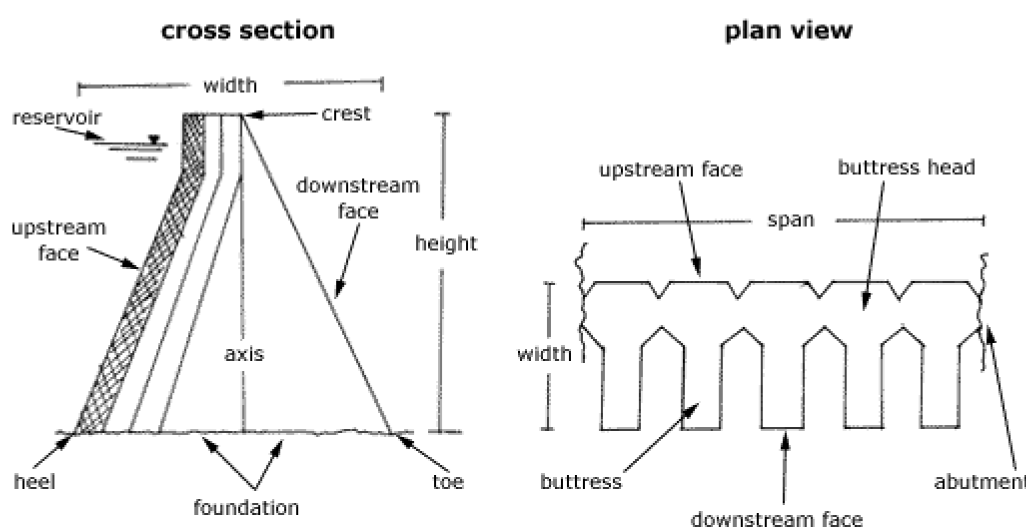
TYPES OF DAMS

There are four major types of dams:

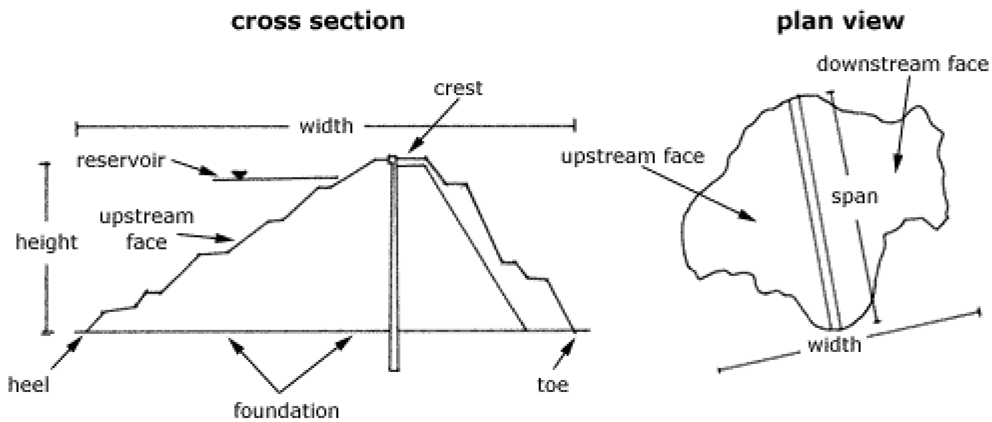
ARCH DAMS
Arch dams are made from concrete. They are curved in the shape of an arch, with the top of the arch pointing back into the water. An arch is a strong shape for resisting the pushing force of the water behind the dam. Arch dams are usually constructed in narrow, steep sided valleys. They need good rock for their foundations, and for the sides of the valleys, to resist the forces on the dam.



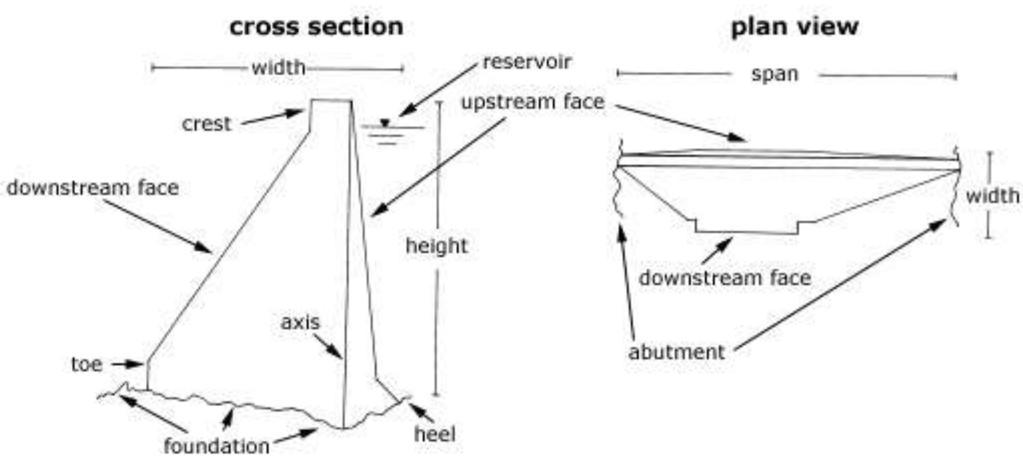
BUTTRESS DAMS
Buttress dams are made from concrete or masonry. They have a watertight upstream side supported by triangular shaped walls, called buttresses. The buttresses are spaced at intervals on the downstream side. They resist the force of the reservoir water trying to push the dam over. The buttress dam was developed from the idea of the gravity dam, except that it uses a lot less material due to the clear spaces between the buttresses. Like gravity dams, they are suited to both narrow and wide valleys, and they must be constructed on sound rock.



EMBANKMENT DAMS
Embankment dams are made mainly from natural materials. The two main types are *earthfill dams* and *rockfill dams*. Earthfill dams are made up mostly from compacted earth, while rockfill dams are made up mainly from dumped and compacted rockfill. The materials are usually excavated or quarried from nearby sites, preferably within the reservoir basin.
A cross-section (or slice) through an embankment dam shows that it is shaped like a bank, or hill. Most embankment dams have a central section, called the core, made from an impermeable material to stop water passing through the dam. Clayey soils, concrete or asphaltic concrete can be used for the core.
Rockfill dams are permeable. They can have a core or an impermeable cover on the upstream face. Materials used for the cover include reinforced concrete and asphaltic concrete.
Embankment dams are usually chosen for sites with wide valleys. They can be built on hard rock or softer soils, as they do not exert too much pressure on their foundations.



GRAVITY DAMS
A gravity dam is made from concrete or masonry, or sometimes both. It is called a gravity dam because gravity holds it down to the ground stopping the water in the reservoir pushing it over.
A cross-section (or slice) through a gravity dam will usually look roughly triangular.
Gravity dams are suited to sites with either wide or narrow valleys, but they do need to be built on sound rock.

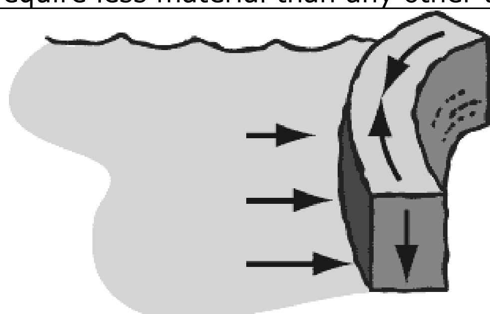


Dams

With the exception of the Great Wall of China, dams are the largest structures ever built. Throughout history, big dams have prevented flooding, irrigated farmland, and generated tremendous amounts of electricity. Without dams, modern life as we know it would simply not be the same. Since the first large-scale dam was built in Egypt more than 5,000 years ago, engineers have devised various types of dams to withstand the forces of a raging river.

Arch dams...

are good for narrow, rocky locations. They are curved, and the natural shape of the arch holds back the water in the reservoir. Arch dams, like the **El Atazar Dam** in Spain, are thin and require less material than any other type of dam.

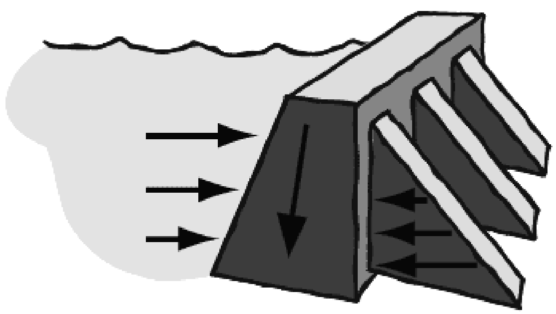


Arch Dam: Forces

The arch squeezes together as the water pushes against it. The weight of the dam also pushes the structure down into the ground.

Buttress dams...

may be flat or curved, but one thing is certain: a series of supports, or **buttresses**, **brace** the dam on the downstream side. Most buttress dams, like the Bartlett Dam in Arizona, are made of **reinforced concrete**.

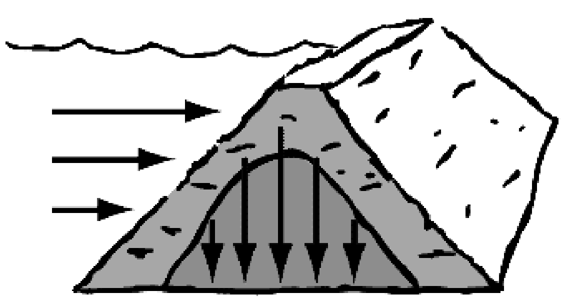


Buttress Dam: Forces

Water pushes against the buttress dam, but the buttresses push back and prevent the dam from toppling over. The weight of the buttress dam also pushes down into the ground.

Embankment dams...

are the most commonly built dams in the United States. They are massive dams made of earth and rock. Like gravity dams, embankment dams rely on their heavy weight to resist the **force** of the water. But embankment dams are also armed with a dense, waterproof core that prevents water from seeping through the structure. Tailings dams -- large structures that hold back mining waste -- are a type of embankment dam.

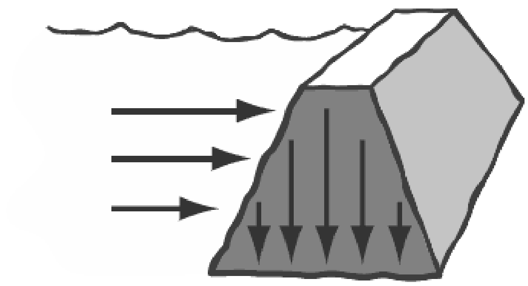


Embankment Dam: Forces

Water pushes against the embankment dam, but the heavy weight of the dam pushes down into the ground and prevents the structure from falling over.

Gravity dams...

are massive dams that resist the thrust of water entirely by their own weight. Most gravity dams, like the **Grand Coulee Dam** in Washington, are expensive to build because they require so much **concrete**. Still, many people prefer its solid appearance to the thinner arch and buttress dams.



Gravity Dam: Forces

Water pushes against the gravity dam, but the heavy weight of the dam pushes down into the ground and prevents the structure from falling over.

All dams -- whether they're embankment, buttress, arch, or gravity -- must be maintained as they get older. Without proper maintenance, **spillways** (an overflow channel that allows dam operators to release lake water when it gets high enough to threaten the safety of a dam) can clog and concrete can crack. Some dams are even removed because they block the migration of fish.

When should dams be taken down? When should they be repaired? Engineers must consider the services that each dam provides and the environmental impact that each dam creates before they make this decision -- and this isn't easy. Oftentimes, there is no right answer.

More info:

A disaster took place on Memorial Day in 1889, when the **South Fork Dam** in western Pennsylvania broke. The dam held back a private resort lake for wealthy families, but it was old and the spillways were clogged. When the dam collapsed, 20 million gallons of water hit the neighboring village of Johnstown with the force of a tidal wave. More than 2,000 people died in the flood.

There is more to dam removal than just knocking a structure down. When an old dam is removed, all of the debris and silt behind the structure is released for the first time in years. Teams of environmental engineers must monitor the silt and debris as it flows downstream.

Large dams all over the world, like the **Grand Coulee Dam** in Washington, have endangered salmon populations. But these dams also provide a significant chunk of electric power to millions of people.

In 1999, the **Edwards Dam** in Maine was knocked down against the owner's will. The dam generated a percentage of Maine's electrical energy, but it totally wiped out the salmon population in the river. For the first time in dam history, the federal government decided that the power produced by a dam did not outweigh the environmental damage it caused. The Edwards Dam decision has encouraged government officials to remove other river-damaging dams across the United States.

According to the U.S. Army Corps of Engineers, there's a way to keep the dam without killing the salmon. You can do this by building fish ladders. Fish ladders look like a series of small waterfalls alongside a dam. Salmon swim upstream, and they "jump" from one waterfall to the next, until they reach the reservoir at the top of the dam. Fish ladders help salmon swim upstream -- but environmentalists say they don't really fix the problem because they don't restore dwindling fish populations.

In 1989, engineers in Austria used waterproof glue and built supporting buttresses to repair the cracking **Kolnbrein Dam**. Unfortunately, the repairs were very expensive.

In January 2000, a disaster happened at the **Baia Mare Tailings Dam** in Romania. A tailings dam is a type of embankment dam, designed to contain mining waste. Melting snow and pounding rain caused the wall of the dam to give way, releasing tons of cyanide into a local stream. The cyanide poisoned the drinking water of more than two million people in neighboring Hungary. Today, an international coalition of governments is working to make tailings dams safer for the environment and for local communities.

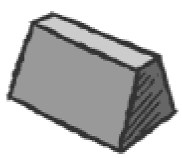
Now that you know more about different types of dams, make some of your own decisions about troubled dams in the **Dam Challenge**!

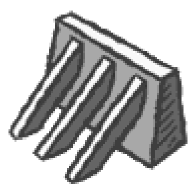
Dams don't last forever. Hot and cold weather makes them crack. Water erodes their foundations. They create environmental problems. Eventually, every dam must be repaired, removed, or replaced.

You are a consulting dam engineer, and today, four dams need your attention. It is your job to advise the dam owners whether their dams must be repaired, taken down, or simply left alone. Listen to what the supporters and opponents of each dam have to say.
Like all dam engineers, you must weigh the pros and cons before you make your final decisions. Good luck!

The Problem Dams:

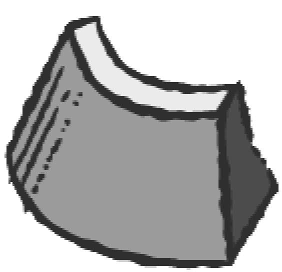

Arch dam near a big city


Gravity dam holding back a reservoir


Buttress dam on a scenic river


Embankment dam at a gold mine

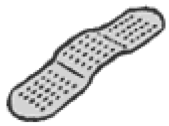
Arch dam near a big city



Type: Arch dam
Material: Concrete
Location: Five miles from big city
Age: 10 years
Purpose: To provide electric power to a large city; to prevent flooding
Problem: Big crack
Budget: $200 million

The Opinions:
"You can't take our dam down! The turbines in our dam generate enough hydroelectric power to serve 1.3 million people! Without this dam, the entire city would go dark!"
-- Mayor of big city
"You've got a real problem on your hands. This dam is going to burst any second, and there are over a million people living just five miles away. If you don't take this dam down or repair it real soon, the entire city will be underwater."
-- Dam safety official

Options:

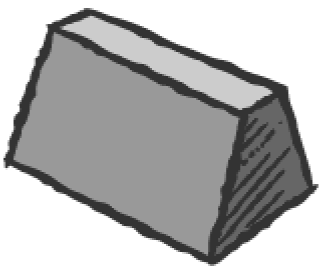


Repair it!

Remove it!

Leave it alone!

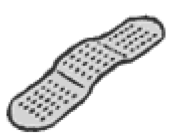
Gravity dam holding back a reservoir



Type: Gravity dam
Material: Reinforced concrete
Age: 150 years
Purpose: To create a recreational area and promote tourism
Problem: Spillway is damaged
Budget: $1 million

The Opinions:
"This dam is a danger to society! One of the spillways is clogged with trees and other floating debris, so the dam isn't releasing as much water as it should. The reservoir is becoming dangerously high. It's only a matter of time before the reservoir spills over the dam and the whole thing collapses!"
-- Dam safety official
"Excuse me, but you cannot possibly take this dam down. Don't you see that we have a resort to run here? Dozens of families vacation at our resorts and use the reservoir for boating and fishing. Without the dam, there is no reservoir. Without the reservoir, the local tourist industry will be ruined!"

Options:

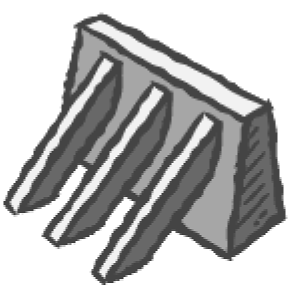


Repair it!

Remove it!

Leave it alone!

Buttress dam

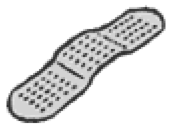


Type: Buttress dam
Material: Concrete
Age: 50 years
Purpose: To provide electric power to a large rural state
Problem: Fish are disappearing from the river
Budget: $200 million

The Opinions:
"This dam is killing the fish! Salmon normally swim upstream to grow and mature, but this gigantic dam is blocking their migration route. Before the dam was built, thousands of fish lived

in this river. Today, they're almost extinct and the river is dying. Remove the dam! Restore the river!"
-- Big River Environmental Group
"According to our records, this dam provides 10 percent of the total amount of electric power to this state. The other 90 percent comes from coal, petroleum, and nuclear power plants. We believe that this dam provides a significant amount of power to this state. It should not be taken down."
-- U.S. Energy Information Administration

Options:

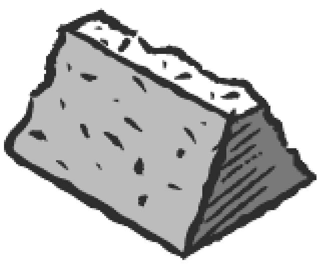


Repair it!

Remove it!

Leave it alone!

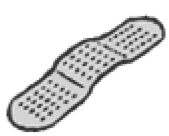
Embankment dam at a gold mine



Type: Embankment dam
Material: Sand and rock
Location: Gold mine
Age: 30 years
Purpose: To contain cyanide and other toxic waste produced at the mine
Problem: The dam walls are crumbling, and the waste is spilling over the top
Budget: $100 million

The Opinions:
"If that dam collapses, four million tons of poisonous sludge will gush down the mountainside and destroy our village completely. The gold mine isn't even productive anymore. Please remove the poisonous sludge and take that dangerous dam down for good. Our lives are at stake!"
-- Mayor of local village
"You can't take our dam down! Okay, so maybe the gold mine isn't as productive as it used to be. And maybe our dam wasn't built by a qualified engineer, but it won't collapse. I promise!"
-- President of gold-mining company

Options:



Repair it!

Remove it!

Leave it alone!

- Demonstrates knowledge and understanding of how mechanical systems (e.g. pneumatic or hydraulic systems, gears, belt drive systems, pulley systems, linked lever systems) convert motion and force to give mechanical advantage, and represents them using systems diagrams.

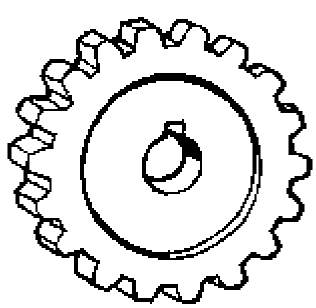
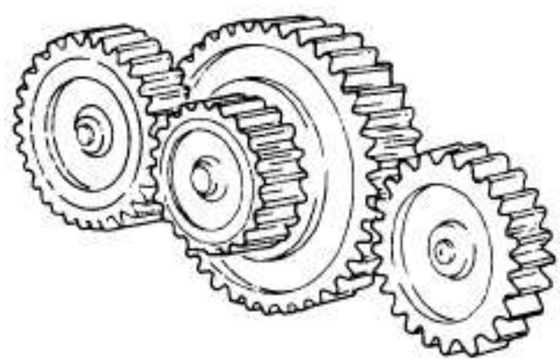
GEARS

Gears are wheels with teeth. Gears can be used to slow things down or speed things up, change direction and/or control several things at once. Gears are wheels whose perimeter is made up of evenly sized and spaced teeth. The teeth of one gear mesh with those of an adjoining one and transmit rotary motion between the two gear . The driven gear always rotates in an opposite direction to the driving gear. If both gear have the same number of teeth, they will rotate at the same speed, however if they have different numbers of teeth then the gear with fewer teeth will rotate more quickly. A gear system is a combination of two or more gears working together. Two gears connected together turn in opposite directions; the gear upon which the effort force is being applied is the DRIVER gear and the other gear is the FOLLOWER (driven gear). By placing a gear (IDLER) between the driver and the follower gear, you can make the driver and follower gear turn in the same direction. The smaller driver gear connected to a larger follower gear, results in slower speed, but greater force in the follower gear (gearing down). A larger driver gear, connected to a smaller follower gear results in faster speed, but less force in the follower gear (gearing up).

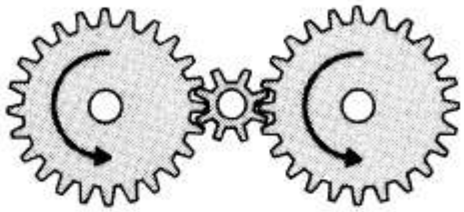
There are different types of gears: spur gear, bevel gear, worm gear, rack and pinion.

TYPES OF GEARS

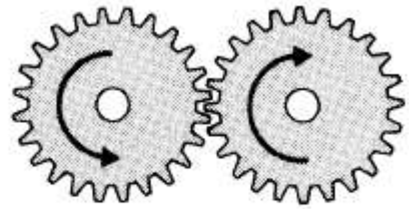
Spur gears

 The **spur gear** is the simplest kind of gear. It is a wheel with teeth around its circumference.	Multiple gears can be connected together to form a gear train. 

If there are an odd number of gears, the output rotation will be the same direction as the input.



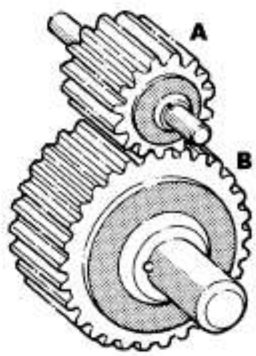
If there is an even number, the output will rotate in the opposite direction to the input.

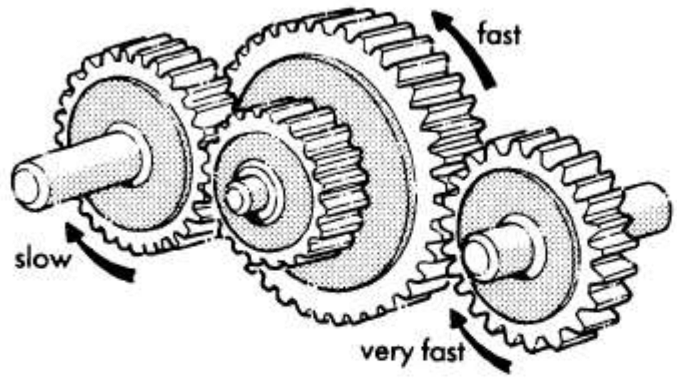


A Small driver
B Large follower

Result: decrease in speed or gearing down

Gear B turns more slowly than gear A and has a greater turning effect (torque).

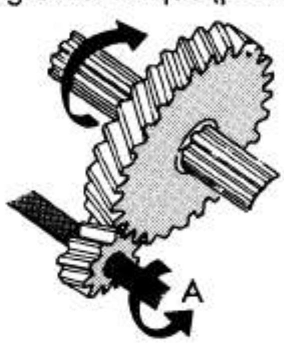




In a simple type of gear train, the number of teeth on the idler gears does not affect the overall velocity ratio, which is governed purely by the number of teeth on the first and last cog.

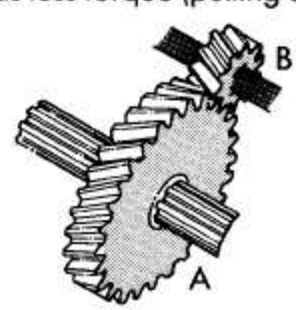
Gearing down

Small driver (A) Large follower (B)
Result: decrease in speed or gearing down.
Gear B turns more slowly than gear A and has greater torque (pulling ability).



Gearing up

Large driver (A) Small follower (B)
Result: increase in speed or gearing up.
Gear B turns much faster than gear A but has less torque (pulling ability).



Calculating mechanical advantage

Gearing up and down

When the driver gear is small and the driven gear is big, the big gear rotates slower—this is called gearing down because the output is slower than the input.
If the driver gear is big and the driven gear is small, the smaller gear rotates faster—this is called gearing up because the output is faster than the input.

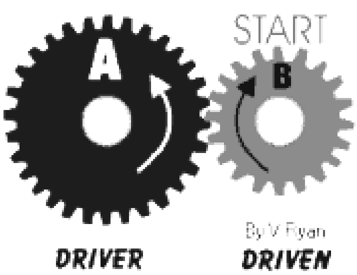
Understanding the mechanical advantage in gears

In Maths we have learnt that the circumference of a circle is proportional to the diameter of the circle. Another fact is that the teeth on any set of gear wheels, that mesh together, are all exactly the same size. If we put these two facts together, we can say that the number of teeth on any individual gear wheel (in a set of meshing gear wheels) is proportional to its diameter.

Formula:

$$\text{Mechanical Advantage} = \frac{\text{number of teeth on driven gear}}{\text{number of teeth on driver gear}} \quad \textbf{OR} \quad \frac{\text{diameter of driven gear}}{\text{diameter of driver gear}}$$

Example:



Gear 'A' has 30 teeth and gear 'B' has 20 teeth. If gear 'A' turns one revolution, how many times will gear 'B' turn ? Which gear revolves the fastest ?

$$\frac{\text{GEAR A} = 30\text{ TEETH}}{\text{GEAR B} = 20\text{ TEETH}} = \frac{30}{20} = 1.5\ (\text{GEAR B})$$

When gear 'A' completes one revolution gear 'B' turns 1.5 revolutions (1½ times)

You should have also found the gear 'B' revolves the fastest. A basic rule of gears is - if a large gear (gear 'A') turns a small gear (gear 'B') the speed increases.
On the other hand, if a small gear turns a large gear the opposite happens and the speed decreases.

Activities:

Use either formula to calculate the missing values.

	Gear pair 1	Gear pair 2	Gear pair 3
Diameter of driver gear (mm)	250		22
Diameter of driven gear (mm)		180	88
Teeth on driver gear	25		11
Teeth on driven gear		60	
Mechanical advantage	3	5	

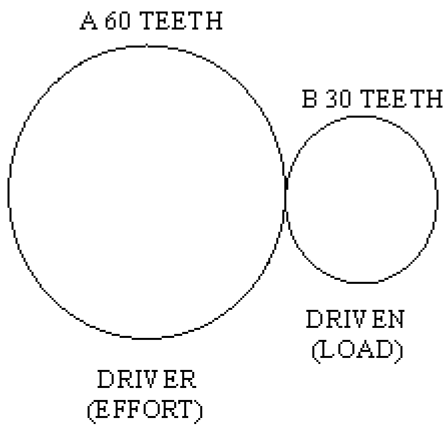
The gears in the table below can all mesh. Determine the missing values.

	Gear 1	Gear 2	Gear 3	Gear 4	Gear 5
Diameter of gear wheel (mm)	250	125		500	62,5
Teeth on gear wheel	40		60		

Below are examples of the way to work out '*revolutions per minute*', or *RPM* as it is usually called.

In the example below the DRIVER gear is large than the DRIVEN gear. The general rule is - large to small gear means 'multiply' the velocity ratio by the rpm of the first gear. Divide 60 teeth by 30 teeth to find the velocity ratio. Multiply this number (2) by the rpm (120). This gives an answer of 240rpm.

1A.



If A revolves at 120 revs/min what is B ?
(Remember large gear to small gear increases revs)

$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\text{60T (GEAR A)}}{\text{30T (GEAR B)}}$$

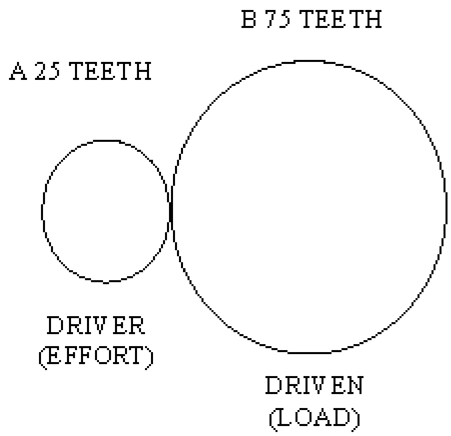
$$= \frac{1}{2} = \frac{\text{Input movement}}{\text{Output movement}}$$

= Driver : Driven

1 : 2

In the example below the DRIVER gear is smaller than the DRIVEN gear. The general rule is - small to large gear means 'divide' the velocity ratio by the rpm of the first gear. Divide 75 teeth by 25 teeth to find the velocity ratio.

2A.



If A revolves at 60 revs/min what is B ?
(Remember small gear to large gear decreases revs)

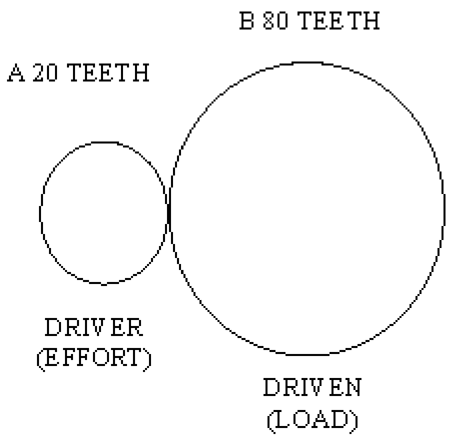
$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\text{25T (GEAR A)}}{\text{75T (GEAR B)}}$$

$$= \frac{3}{1} = \frac{\text{Input movement}}{\text{Output movement}}$$

= Driver : Driven

3 : 1

3A.



If A revolves at 100 revs/min what is B ?
(Remember small gear to large gear decreases revs)

$$\frac{\text{Distance moved by Effort}}{\text{Distance moved by Load}} = \frac{\text{20T (GEAR A)}}{\text{80T (GEAR B)}}$$

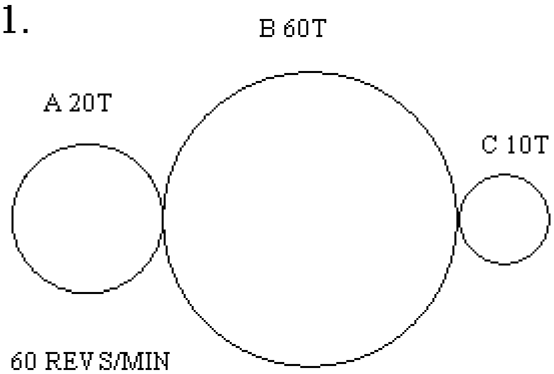
$$= \frac{4}{1} = \frac{\text{Input movement}}{\text{Output movement}}$$

= Driver : Driven

4 : 1

When faced with three gears the question can be broken down into two parts. First work on Gears A and B. When this has been solved work on gears B and C.

1.



The diagram above shows a gear train composed of three gears. Gear A revolves at 60 revs/min in a clockwise direction.
What is the output in revolutions per minute at Gear C?
In what direction does Gear C revolve ?

GEAR A	GEAR B	GEAR C
20 TEETH	60 TEETH	10 TEETH

First work out the speed at Gear B.

$$\frac{60}{20}\frac{B}{A} = 3$$

$$\frac{\text{60 REVS}}{3} = \text{20REVS AT B}$$

(Remember B is larger than A therefore, B outputs less revs/min and is slower)

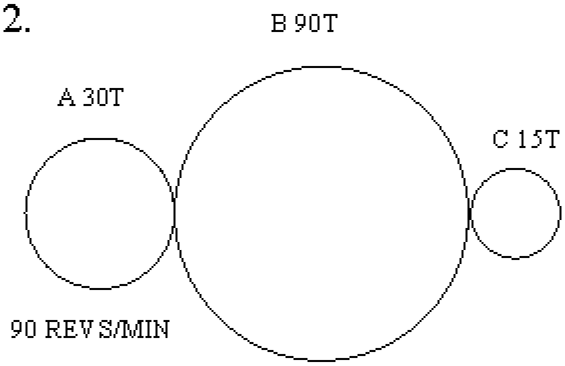
Next, take B and C. C is smaller, therefore, revs/minute will increase and rotation will be faster.

$$\frac{60}{10}\frac{B}{C} = 6$$

20 REVS X 6 = 120 REVS AT C

What direction does C revolve ?
A is clockwise, B consequently is anti-clockwise and C is therefore clockwise.

2.



Gear A revolves at 90revs/min. What is the output and direction at Gear C.

GEAR A	GEAR B	GEAR C
30 TEETH	90 TEETH	15 TEETH

First work out the speed at Gear B.

$$\frac{90}{30}\frac{B}{A} = 3$$

$$\frac{90 \text{ REVS}}{3} = 30 \text{REVS AT B}$$

(Remember B is larger than A therefore, B outputs less revs/min and is slower).

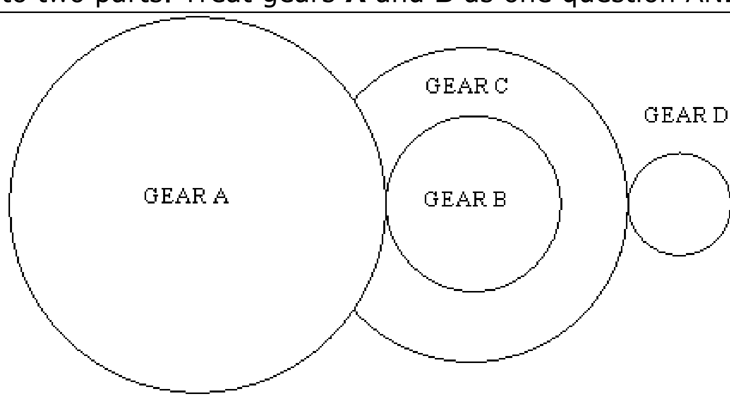
Next, take B and C. C is smaller, therefore, revs/minute will increase and rotation will be faster.

$$\frac{90}{15}\frac{B}{C} = 6$$

$$30 \text{ REVS} \times 6 = 180 \text{ REVS AT C}$$

What direction does C revolve ?
A is clockwise, B consequently is anti-clockwise and C is therefore clockwise.

Below is a question regarding 'compound gears'. Gears C and B represent a compound gear as they appear 'fixed' together. When drawn with a compass they have the same centre. Two gears 'fixed' together in this way rotate together and at the same RPM. When answering a question like this split it into two parts. Treat gears **A** and **B** as one question AND **C** and **D** as the second part.



This is an example of a "compound gear train". Gear A rotates in a clockwise direction at 30 revs/min. What is the output in revs/min at D and what is the direction of rotation ?

GEAR A	GEAR B	GEAR C	GEAR D
120 T	40 T	80 T	20 T

First find revs/min at B;

$$\frac{120}{40}\frac{A}{B} = 3$$

$$30 \text{ REVS} \times 3 = 90 \text{ REVS / MIN}$$

B is smaller therefore it rotates faster and revs/min increase.
C is fixed to B and therefore, rotates at the same speed. 90 REVS/MIN at C

Next find revs/min at D

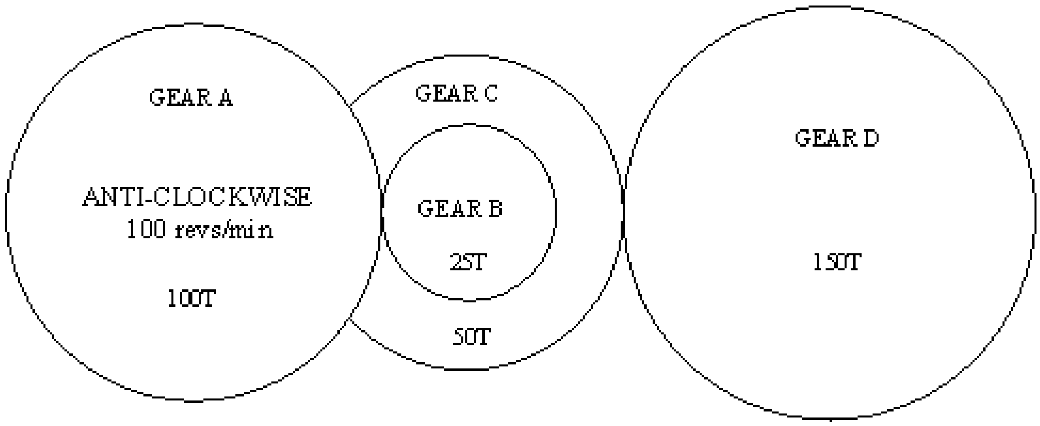
$$\frac{80}{20}\frac{C}{D} = 4$$

$$90 \text{ REVS (AT C)} \times 4 = 360 \text{ REVS / MIN}$$

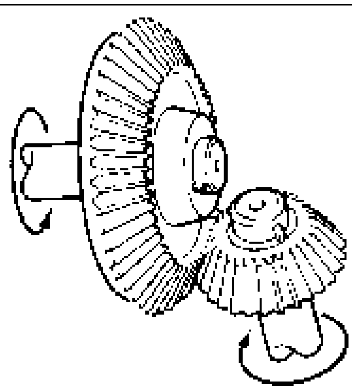
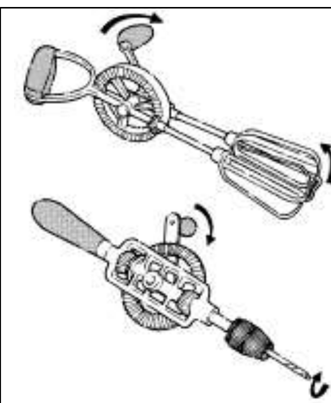
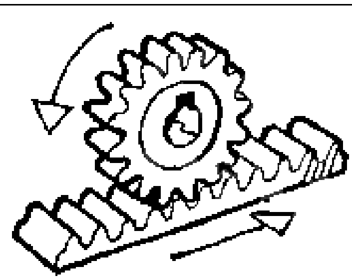
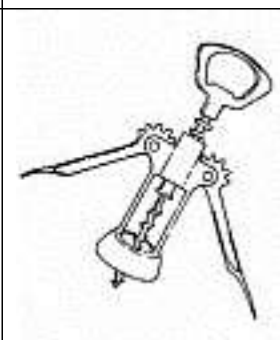
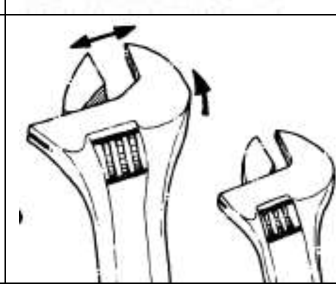
D is smaller than C, therefore rotates faster (increased revs/min).
A revolves in a clockwise direction, B is therefore anti-clockwise, C is fixed to B and is also anti-clockwise, which means D revolves in a clockwise direction.

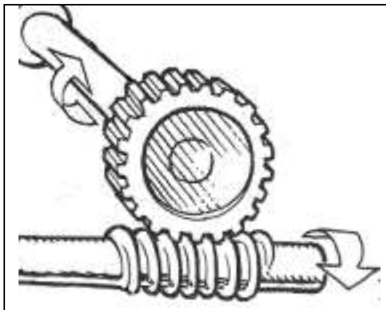
Try the following question:

What is the rpm at gear D and what is the direction?



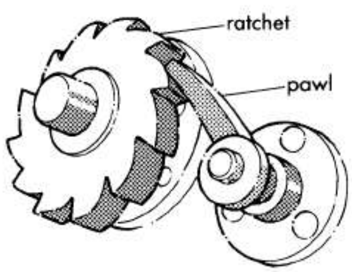
Other types of gears and their uses:

	**Bevel gears** Bevel gears are used to change rotational movement through an angle of 90°. Bevel gears will provide some mechanical advantage or increase in velocity ratio.	
	**Rack-and-spur gears** The rack-and-spur gear is used to convert between rotary and linear motion. Often the spur rotates in a fixed position and the rack is free to move. Alternatively, the rack may be fixed and the spur rotates moving up and down the rack. This latter arrangement on two-handled cork-pullers.	
Rack-and-worm gears The rack-and-worm gear changes rotational movement into linear movement. In a shifting spanner, the rack-and-worm system is used to adjust the position of the jaw of the spanner—to make the gap wider or narrower. The worm is turned to adjust the position of the spanner. So for each revolution of the worm, the rack advances the distance between two consecutive teeth on the rack.		



Worm-and-spur gears

A worm-and-spur gear is often used when a large speed reduction is required and not much power is needed. Unlike ordinary gears, the motion is not reversible, a worm can drive a gear to reduce speed but a gear cannot drive a worm to increase it. The velocity ratio of two adjacent cogs can be calculated by dividing the number of teeth on the driven gear by the number of teeth on the driving gear. The velocity ratio of a worm-and-spur gears is easily calculated because the worm has only one tooth. The worm gear is always the drive gear. For example, if the wheel gear has 60 teeth and the worm gear has 1 tooth, then the velocity ratio is 1/60 = 1:60

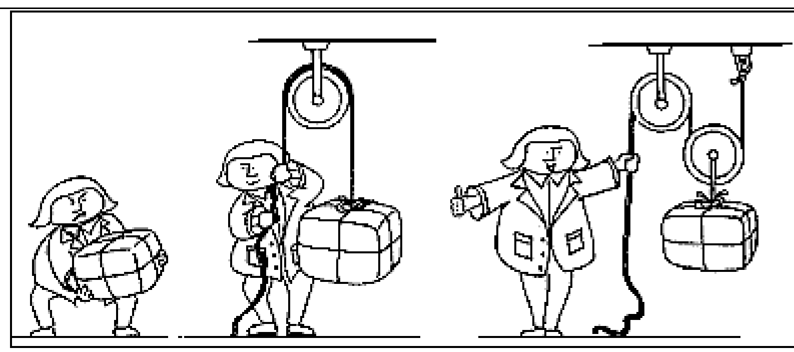


Pawl and ratchet

A ratchet mechanism is based on a wheel that has teeth cut out of it and a pawl that follows as the wheel turns. Studying the diagram you will see that as the ratchet wheel turns and the pawl falls into the 'dip' between the teeth. Ratchets can also be used to drive a motion in one direction and allow free-wheeling in the reverse direction.

The Pulley

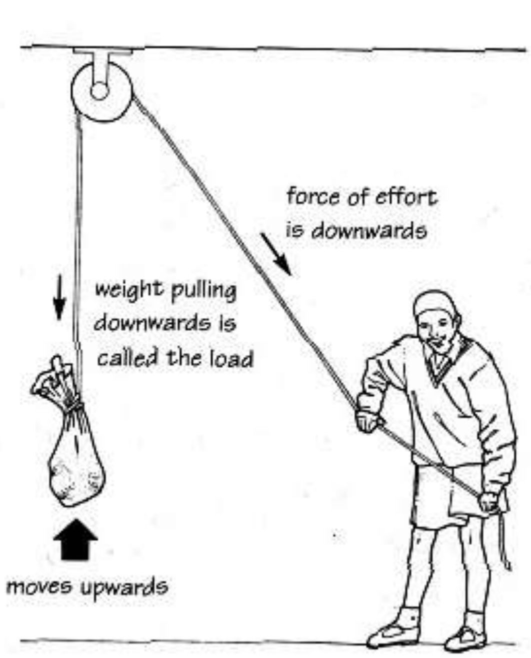
The pulley is a simple machine that consists of a grooved wheel and a rope. Like a lever, it provides a mechanical advantage in lifting a heavy load. There is a direct relationship between the number of ropes that form the pulley and its resulting advantage.

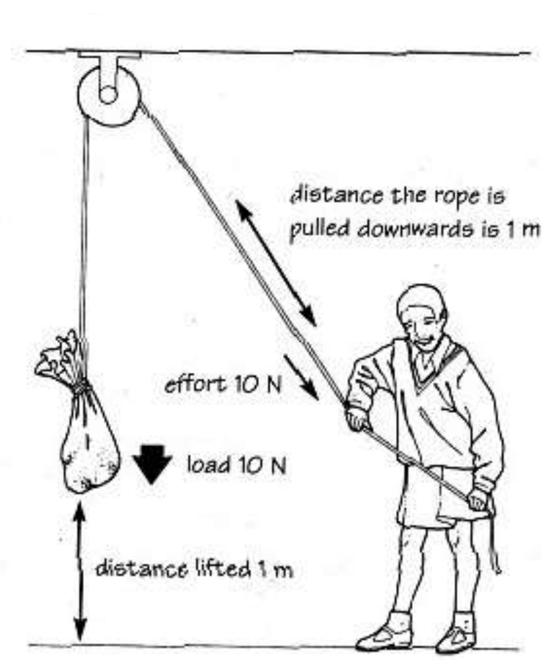


There are two basic types of pulleys. When the grooved wheel is attached to a surface it forms a **fixed pulley**. The main benefit of a fixed pulley is that it changes the direction of the required force. For example, to lift an object from the ground, the effort would be applied downward instead of pulling up on the object. However, a fixed pulley provides no concrete mechanical advantage. The same amount of force is still required, but just may be applied in another direction.

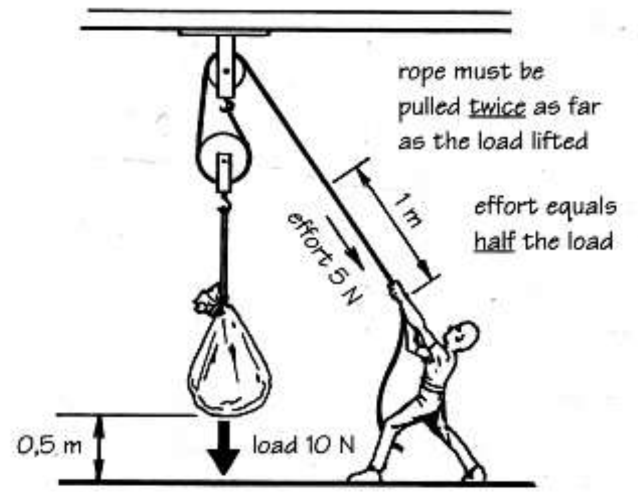
Another type of pulley, called a **movable pulley**, consists of a rope attached to some surface. The wheel directly supports the load, and the effort comes from the same direction as the rope attachment. A movable pulley reduces the effort required to lift a load. Moveable pulleys do provide a mechanical advantage. The effort needed to raise a load is reduced according to the number of ropes supporting the load.

Using a simple pulley, the effort needed to lift an object is about the same as the weight of the object. If the pulley rotated freely with no friction, then the effort would be equal to the load lifted. The object moves the same distance as the rope moves down. A simple pulley changes the direction of a force. The object is lifted up as the girl pulls the rope down.





These two types of pulleys can be combined to form double pulleys, which have at least two wheels. There are various combinations which can result in a double pulley, some of which will be explored in the student experiment. As the pulley becomes more complex, the total lifting effort decreases.
For example, a system consisting of a fixed pulley and a movable pulley would reduce the workload by a factor of two, because the two pulleys combine to lift the load. A **compound pulley** or **block and tackle** is a system of ropes and pulleys used for lifting heavy loads.



When you use a compound pulley, the effort needed to lift the load is the weight of the object divided by the number of falls. The rope has to be pulled the distance which the object is lifted multiplied by the number of falls.

One Newton (N) is the force exerted by gravity on a mass of 0,1 kg

100 g = 1 Newton

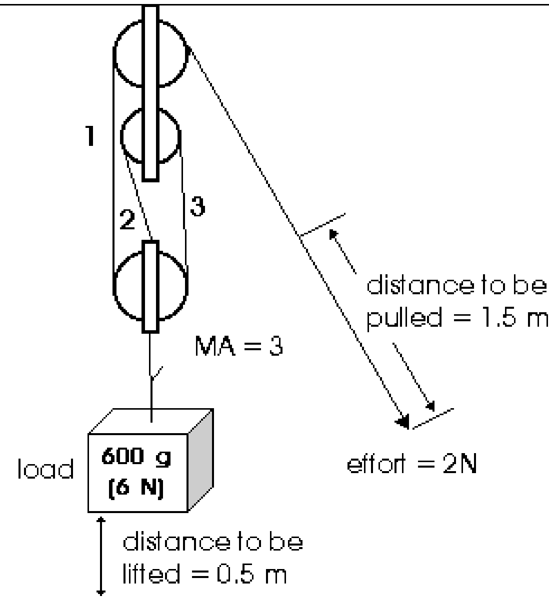
Mechanical advantage

You can calculate the mechanical advantage of different pulley systems using one of these methods:

MA = Number of falls supporting the load

Effort = $\dfrac{\text{Load}}{\text{Number of falls (MA)}}$

Load = Effort x Number of Falls (MA)



Try this:

1. Look at the examples in Figure 9. Count the number of falls in each case.
2. Work out an equation to calculate the effort needed to lift a known load, if the number of falls is known.

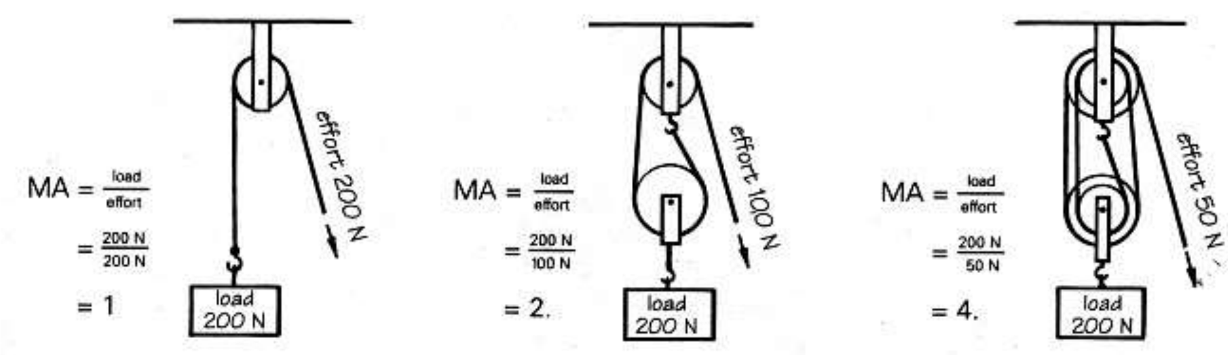
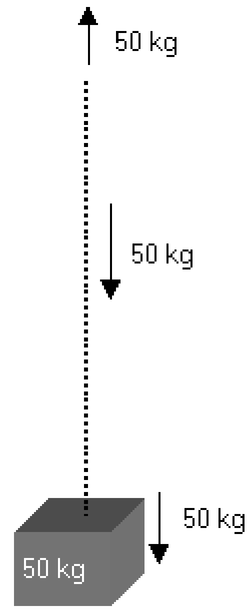


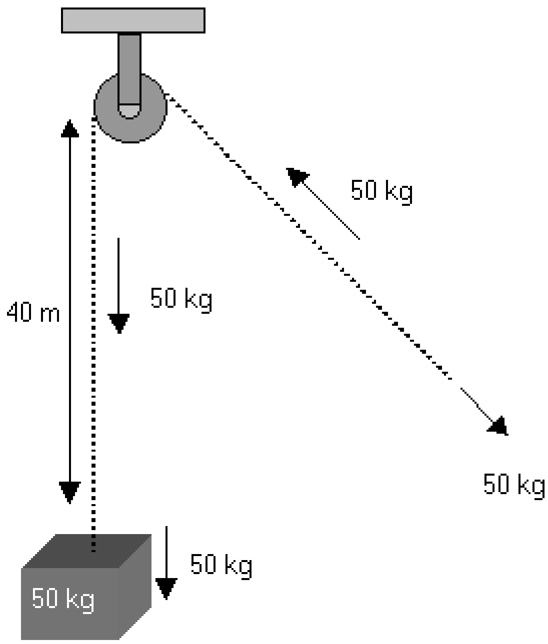
FIGURE 9(A) FIGURE 9(B) FIGURE (9C)

Exercises:

Imagine that you have the arrangement of a 50 kg weight suspended from a rope, as shown here:
In this figure, if you are going to suspend the weight in the air then you have to apply an upward force of 50 kg to the rope. If the rope is 40 m long and you want to lift the weight up 40 m, you have to pull in 40 m of rope to do it. This is simple and obvious.

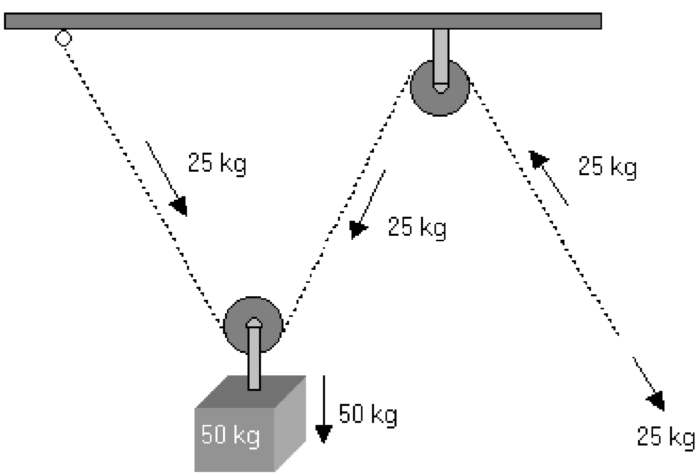


Now imagine that you add a pulley to the mix, as shown left:



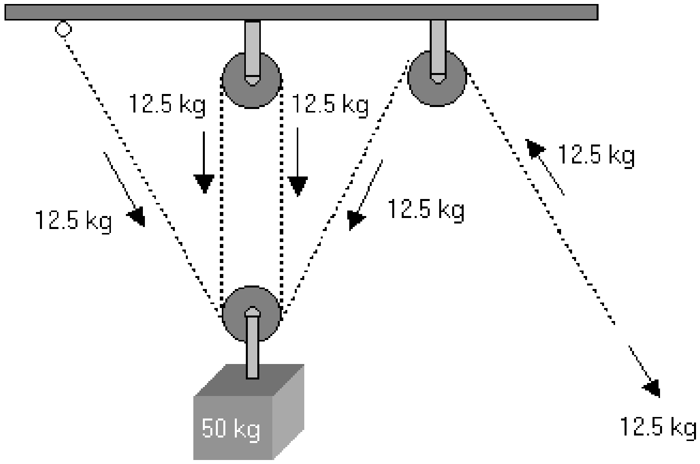
Does this change anything? Not really. The only thing that changes is the direction of the force you have to apply to lift the weight. You still have to apply 50 kg of force to keep the weight suspended, and you still have to reel in 40 m of rope in order to lift the weight 40 m.

The following figure shows the arrangement after adding a second pulley:



This arrangement actually does change things in an important way. You can see that the weight is now suspended by two ropes rather than one. That means the weight is split equally between the two ropes, so each one holds only half the weight, or 25 kg. That means that if you want to hold the weight suspended in the air, you only have to apply 25 kg of force (the ceiling exerts the other 25 kg of force on the other end of the rope). If you want to lift the weight 40 m higher, then you have to reel in twice as much rope - 80 m of rope must be pulled in. This demonstrates a force-distance tradeoff. The force has been cut in half but the distance the rope must be pulled has doubled.

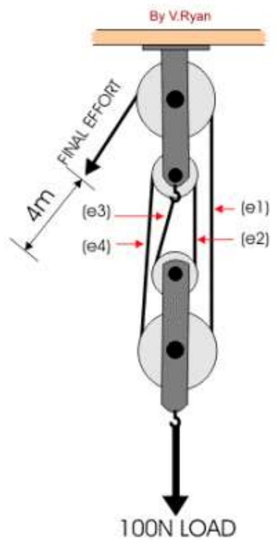
The following diagram adds a third and fourth pulley to the arrangement:

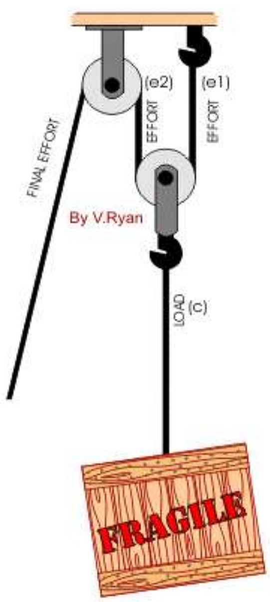


In this diagram, the pulley attached to the weight actually consists of two separate pulleys on the same shaft, as shown on the right. This arrangement cuts the force in half and doubles the distance again. To hold the weight in the air you must apply only 12.5 kg of force, but to lift the weight 40 m higher in the air you must now reel in 160 m of rope.

A block and tackle can contain as many pulleys as you like, although at some point the amount of friction in the pulley shafts begins to become a significant source of resistance.

1. The example opposite shows a pulley system used to lift a 100N load. Work out the mechanical advantage and velocity ratio.
2. What effort is required to lift the 100N load?
3. How far does the load move in compared to the 4m movement of the final effort?

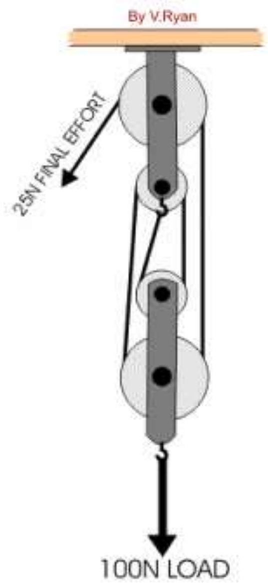




The pulley system opposite has 1:4 ratio (effort : load). An effort of 25N can lift a load of 100N.
Draw a pulley system that is capable of lifting 150N.
Work out the velocity ratio, the mechanical advantage
and the efficiency of the system.

The pulley system on the right is used to lift small loads from aground floor to an upper floor. The load being lifted is 200N.

a. What is the mechanical advantage of this pulley system ?
b. What is the velocity ratio of the system ?
c. What effort is required to lift the load ?
d. If the system moves the load 5 metes upwards, how far must the effort move ?

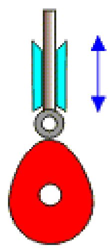
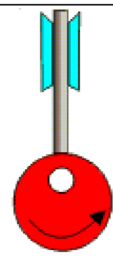
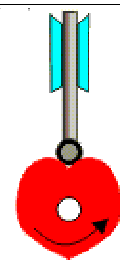
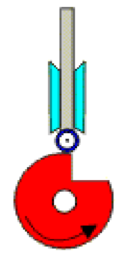


CAMS

A CAM changes the input motion, which is usually rotary motion (a rotating motion), to a reciprocating motion of the follower. The motion created can be simple and regular or complex and irregular. As the cam turns, driven by the circular motion, the cam follower traces the surface of the cam transmitting its motion to the required mechanism.

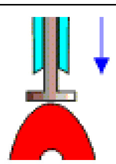
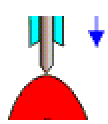
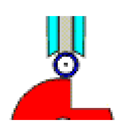
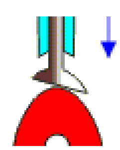
CAM PROFILES

Cams can be shaped in any number of ways and this is determined by the way the follower is to move. The shape of the cam is called the PROFILE. Cam follower design is important in the way the profile of the cam is followed. A fine pointed follower will more accurately trace the outline of the cam.

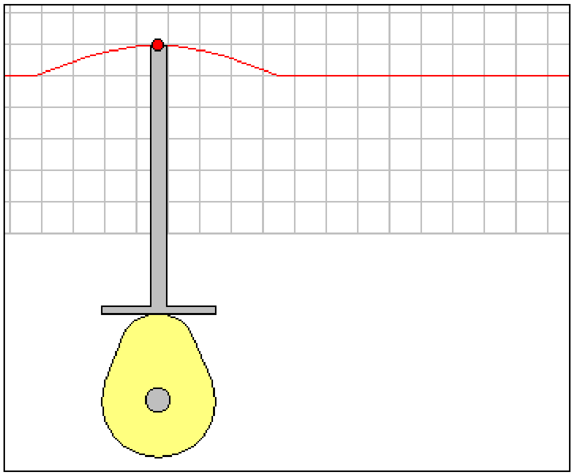
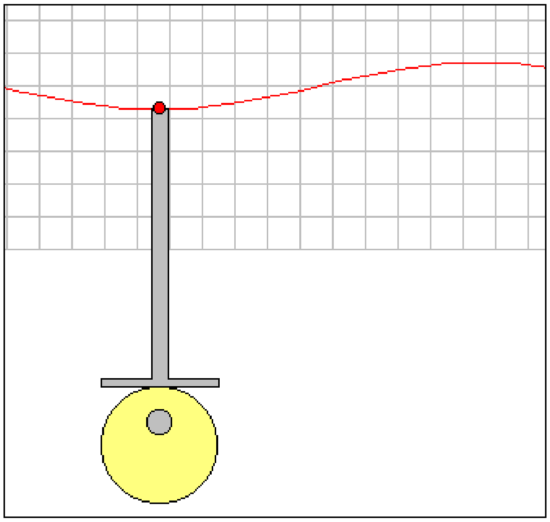
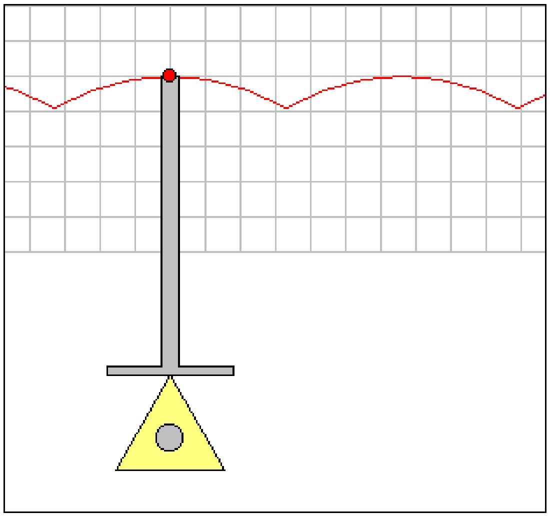
PEAR	**CIRCULAR**	**HEART**	**DROP**
			
When the narrow part is at the top any rod or follower will be pushed up and when the narrow part is at the bottom the follower will drop down. The follower remains motionless for about half of the cycle of the cam and during the second half it rises and falls.	Circular cams or eccentric cams produce a smooth motion similar to the pear shaped cam. These cams are used in steam engines.	Heart shaped cams allow the follower to rise and fall with 'uniform' velocity. With the heart shaped cam the follower will have 3 highs for every turn of the axle.	Drop cams produce a smooth motion three-quarters of the way, then drop quickly and resume the smooth motion.

TYPES OF FOLLOWER

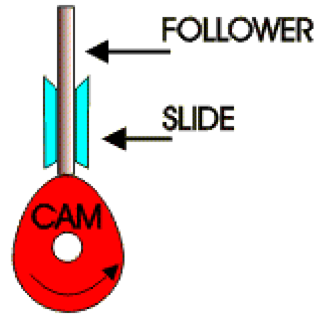
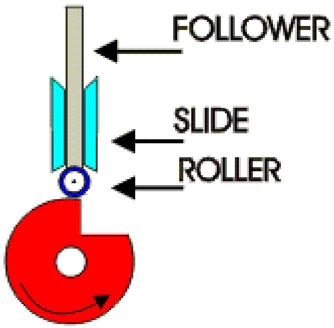
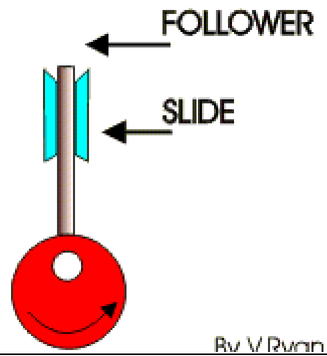
There are different types of follower but they all slide or roll on the edge of the cam. Various types are shown below.

 **FLAT**	 **POINT/KNIFE**	 **ROLLER**	 **OFFSET**

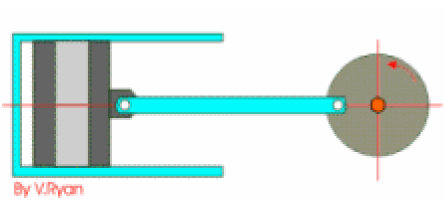
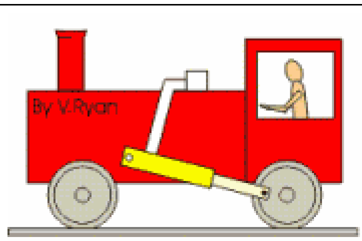
The distance that a follower moves when a cam turns through one complete rotation is called the stroke. The stroke is determined by the cam shape and the cam offset.

	Pear shaped cams make followers rise and fall for part of the cam rotation followed by a dwell period where the follower is stationary before rising again.
	Round cams make followers move in a smooth wave like motion.
	Triangular cams produce a repetitive wave shaped rise and fall with no dwell period.

As you have seen in the previous examples, cams can be used to change rotary motion into linear motion. Examine the cams on this page and explain how the various cam profiles control the movement of the followers.

	1. What is the name of this cam profile? Explain how it controls the movement of the follower.
	2. What is the name of this cam profile? Explain how it controls the movement of the follower.
	3. What is the name of this cam profile? Explain how it controls the movement of the follower.

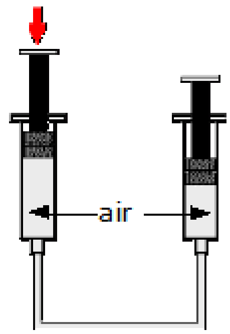
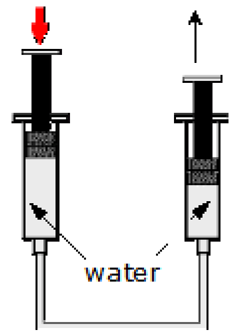
CRANK AND SLIDER MECHANISM

	This mechanism is composed of three important parts: The crank which is the rotating disc, the slider which slides inside the tube and the connecting rod which joins the parts together.
As the slider moves to the right the connecting rod pushes the wheel round for the first 180 degrees of wheel rotation. When the slider begins to move back into the tube, the connecting rod pulls the wheel round to complete the rotation.	
	One of the best examples of a crank and slider mechanism is a steam train. Steam pressure powers the slider mechanism as the connecting rod pushes and pulls the wheel round. The cylinder of an internal combustion engine is another example of a crank and slider mechanism

HYDRAULICS AND PNEUMATICS

Hydraulics and pneumatic systems basically work in the same way. The only difference is that **hydraulic** systems use an **incompressible liquid** to operate, while **pneumatic** systems use **compressed air** to operate.

How do these two systems really work?

In a **pneumatic system** the second syringe will stay in place to a certain extent when the first syringe is pushed down because air is compressible.		In a **hydraulic system** the second syringe will move upwards, when the first syringe is pushed down, even though it is held down because liquid can not be compressed.	

Hydraulic systems

Open and closed hydraulic systems

Hydraulics is about the flow of liquids in pipes and channels, and the pressure the liquids exerts. In an open hydraulic system, a fluid flows from one point to another if there is a difference in pressure. In a closed hydraulic system the fluid does not leave the container it is in. The pressure of the fluid in the container does the work.

Principles of hydraulics

Hydraulics is based on the principle that a force is transmitted through a liquid. This means that if a liquid, such as water or oil, is in a cylinder or tube, a force applied to the liquid at one end will be passed through the liquid. The force will then be exerted by the liquid at the other end. This happens because a liquid cannot be compressed. If the area of the disc of the output piston or pistons is the same size as the area of the input piston, then the output force is equal to the input force. But if the area of the output pistons is larger (say three times larger) than the input piston, then the output force is also larger (in this case three times larger). If the area of the output piston is half of the area of the input piston, then the output force is half of the input force.

ELECTRICITY

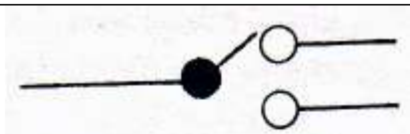
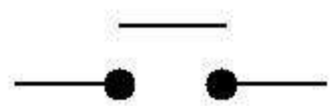
- Demonstrates knowledge and understanding of how electrical circuits with more than one input or control device will work based on different logic conditions ('AND' and 'OR' logic), and represents them using circuit diagrams, systems diagrams and truth tables.

Using switches to control electric current

Switches are used to control electric current. For example, a radio broadcaster in a studio uses switches to change from one sound source to another. You use a switch to turn a radio on or off. A switch is designed to break the flow of electric current in a circuit. There are several different types of switches. They all do the same job of breaking the flow of electric current, but they do it in different ways.

Using different switches

1 Look carefully at the symbols of the switches in Figures 8(A) and (B). The solid dot in the symbol is called the pole and the clear dot is called the throw.

 FIGURE 8(A)	 FIGURE 8(B)	 FIGURE 8 (C)
The symbol used in a circuit diagram to represent a single pole single throw switch (SPST).	The symbol used in a circuit diagram to represent a single pole double throw switch (SPDT).	The symbol used in a circuit diagram to represent a push-button switch.

2 Now look at the circuit diagrams in Figures 9(A) and (B). Discuss with your partner the difference in how these two switches work.

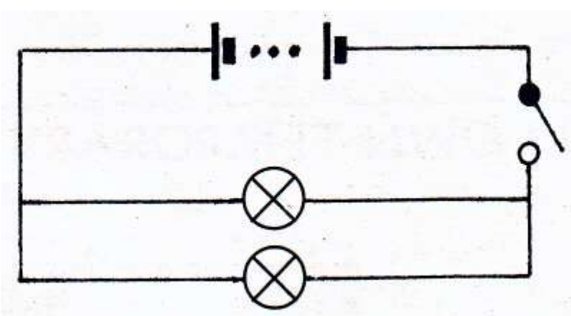


FIGURE 9(A)

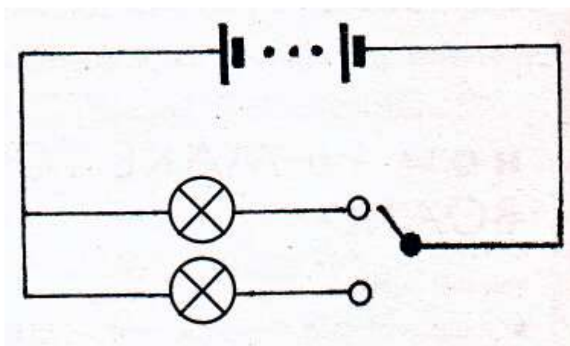


FIGURE 9(B)

3 Think of the wall switches that are used to switch on electric lights and the switch that is used to sound a doorbell. Explain the differences between the switches.
a) Which type of switch is used for a doorbell? Why?

b) Which type of switch is used for a bedside light? Why?

Using resistors to control electric current

> **NEW WORD**
>
> An **ohm** is the unit we use to measure how much resistance a resistor will offer to the flow of electric current which passes through it. The symbol for ohm is Ω.

Switches can only control current by switching it on or off, or switching from one component to another. So how do you control the volume coming from your radio? Or the amount of light coming from a bulb? A resistor is an electronic component which is designed to decrease the flow of the current. Resistors are also used to protect other components from being damaged by too big a current passing through them. When you connect a resistor in series with another component, there is a decrease of the electric current supplied to the component. The larger the value of the resistor, the more electric energy it takes away and the less current is supplied to the component. The resistor converts the electrical energy that it takes away into heat energy, leaving less electrical energy to be supplied to the component.

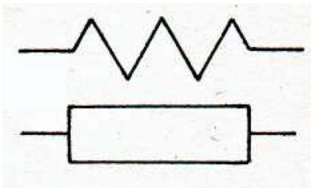


FIGURE 11(A)
The symbols used in a circuit diagram to represent a resistor.

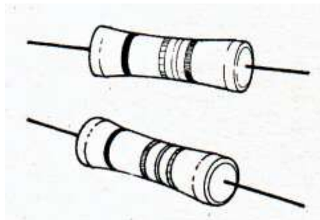


FIGURE 11(B)
Resistors.

Activity:

1. Copy the table below into your notebook and complete it. Do you think that all the components listed in the table can be regarded as resistors? Why or why not? Give reasons for your answers.

Component	**Function**
Bulb	Converts electric energy into heat and light energy
Buzzer	
Electric motor	
Resistor	

2. Look at the diagrams in Figure 12(a) and 12(B). Does it make a difference to the function of the resistor whether it is connected before or after the bulb?

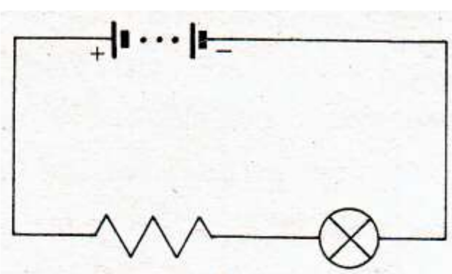


FIGURE 12(A)

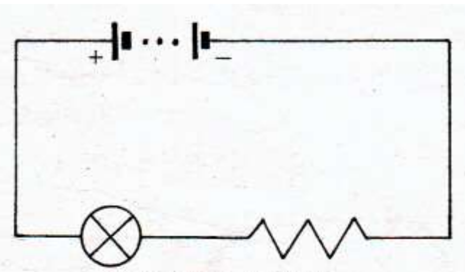


FIGURE 12(B)

Some of the components, such as the bulb, have other functions, but they also limit the current by converting the electric energy. The bulb converts electric energy into heat and light energy. The function of a bulb is to light up, but by converting the energy into light and heat, it also decreases the current.

How much resistance?

If we want to use resistors to control electric current, we need to know how much electric energy a resistor will convert into heat energy. In other words, we need to know how much it will limit, or resist, the current. The amount of resistance that a resistor offers to the current is measured in ohms, abbreviated by the Greek letter omega [Ω].
Have you noticed how small a resistor is? It is impossible to print a big value, such as 28 000 Ω on it. Instead, a colour code is used to indicate the value of a resistor. The "How to" box below shows you how to work out the value of a resistor using the colour code.

HOW TO DETERMINE THE VALUE OF A RESISTOR USING THE COLOUR CODE

1. The colour code uses a specific colour to represent a specific figure value. Study the table of colour codes for resistors.

Colour	Figure value
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Purple	7
Grey	8
White	9

2. Hold the resistor in your hand, with the gold stripe towards the right. Then read the coloured stripes from left to right.

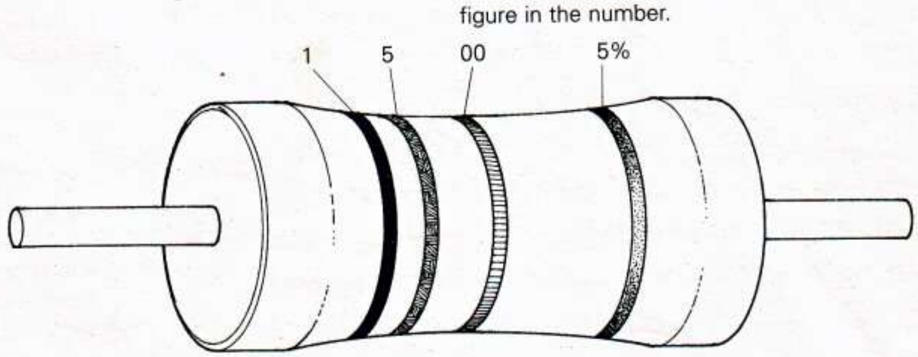
3. The gold stripe shows the tolerance of the resistor. This tells you how accurately it was made. The gold stripe represents ± 5% tolerance. If you measure the value of the resistor shown below, for example, it might not be exactly 1,5 kΩ, but it will not be less than 1 425 Ω (1 500 – 5% of 1 500) or more than 1 575 Ω (1 500 + 5% of 1 500).

Brown
The first stripe indicates the first figure in the number.

Green
The second stripe indicates the second figure in the number.

Red
The third stripe indicates the number of noughts that follows the second figure in the number.

Gold
The fourth stripe indicates the tolerance.



Colour coding on a resistor.

The value of the resistor is 1 500 Ω or 1,5 kΩ. (k is short for kilo, which means thousand.)

ACTIVITY

Varying the resistance in an electric circuit

1. Use the 'How to' box opposite to work out the values of resistors with the following colour codes. Copy and complete these examples.

   a. Brown Black Orange Gold

   _____ _____ _____ _____ = _____

   b. Orange White Brown Gold

   _____ _____ _____ _____ = _____

   c. Blue Grey Black Gold

   _____ _____ _____ _____ = _____

   d. Orange White Yellow Gold

   _____ _____ _____ _____ = _____

   e. Brown Black Brown Gold

   _____ _____ _____ _____ = _____

   f. Grey Red Green Gold

   _____ _____ _____ _____ = _____

   g. Red Red Red Gold

   _____ _____ _____ _____ = _____

2. If you need resistors with the following values, which colour codes would you look for?

   a. 4 7 0 5%

   _____ _____ _____ _____ = _____

   b. 2 8 00 5%

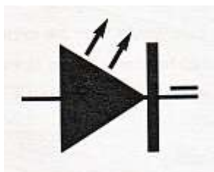
   _____ _____ _____ _____ = _____

NEW WORDS

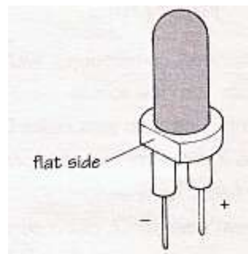
The letters **LED** stand for 'light emitting diode'. An LED is an electronic component that is designed to light up when even a very small current passes through it.
Emit means to give off, as a lamp gives off light or pig manure emits a strong smell.

Using an LED

Bulbs are used to light up darkness so that people can see what they are doing. Bulbs are designed to light up when an electric current passes through them. A lot of electric energy is needed to produce enough light, therefore a large electric current is needed. In fact, bulbs can only light up if the current that passes through them is large enough. That is also why a cell used to light a bulb runs out of energy so quickly. Lights are also sometimes needed to indicate whether an appliance is switched on or not. For example, there is a tiny green light on the screen of a computer to indicate when it is switched on. Some alarms have a tiny red light that either stays on or flickers. Lights such as these might stay on for a very long time. An LED (light-emitting diode) is very useful to use as an indicating light because LEDs use only a very small electric current and therefore do not use a lot of energy.



The symbol used in a circuit diagram to represent an LED.



A light-emitting diode (LED).

HOW TO CONNECT AN LED IN A CIRCUIT

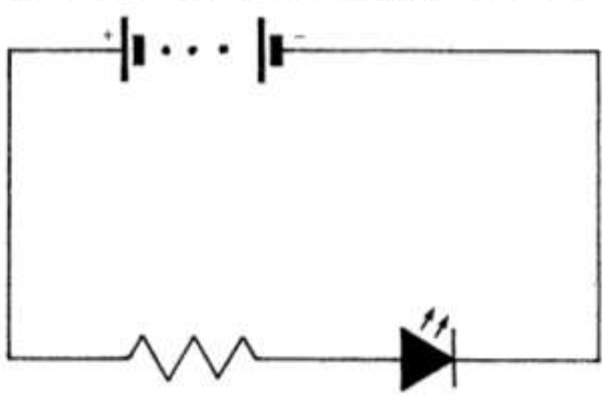
TAKE CARE

An LED will blow if the electric current that flows through it is too large. It can be used with a cell that supplies 1,5 V, but if you want to use it with a 9 V battery, you will have to use a 1 kΩ resistor to protect it. The resistor will limit the current passing through the LED in a circuit.

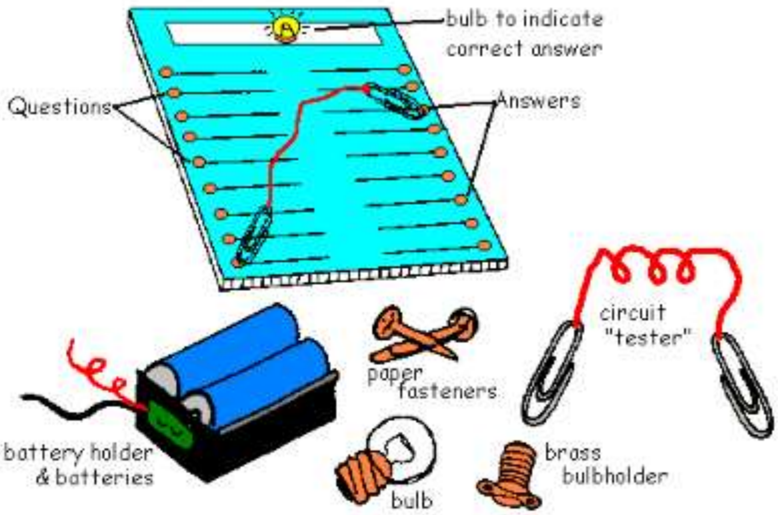
TAKE CARE

The electric current can pass through an LED from one direction only. The arrow in the circuit diagram symbol shows the direction in which the electric current will pass through the LED: an electric current coming from the positive terminal of the battery will pass through the LED from left to right, leaving through the flat side of the LED.

1. An LED has a flat side to indicate which way round it should be connected. The flat side must be facing the negative terminal of the cell or battery.
2. The circuit diagram below shows how to connect an LED in a circuit as well as on your temporary circuit board.



ELECTRICITY ASSIGNMENT



Design an electrical Quiz game. You may use any theme.

The power source has to be one penlight battery (AA). You may use LED's, otherwise use a flashlight bulb (2,4V). Use split pins, paper clips and insulated electrical wire Your electrical connections must be neat. You must have at least 10 questions.
Size: A4 to A3.

<u>The following should be done in your exercise book:</u>

Investigating

Design brief (your assignment written in your own words) (5)
Specifications and constraints: Given and own (5)

Designing

5 possible ideas (neatly drawn) (5)
Final design: Neatly drawn (A4) Front and Back (10)
(layout of wires, battery and bulb)

Making

List of materials and tools used (5)
Final product (Use A4 to A3 size cardboard or polystyrene) (25)

Evaluating

Appearance. Does it work? Are you satisfied? Modifications? (5)

TOTAL: 60

- Demonstrates knowledge and understanding of how materials can be processed to change or improve their properties by adapting them to suit particular purposes:
  - to withstand forces (e.g. tension, compression, bending, torsion, shear);
  - to increase strength or life-span;
  - how specific properties suitable for packaging can be achieved.

CONSUMER

The role of the consumer in the economy

To be an effective producer, you must render the best service. The effective producer knows the need for a specific product and produces it according to demand.

The effective consumer uses the economic resources with descretion to ensure progress. If time, labour and rewources are used discreetly money can be earned and used to satisfy needs. Marketers usually only think about themselves. A variety of products are produced in big quantities while the variety of products increases daily. The consumer's need or products is created artificially, for example by using advertisements. Many products are of weak quality. If the consumer buys the weak product it is to the disadvantage of all consumers. Every time a product is bought, it is seen as a positive sign for the manufacturer and the manufacturer keeps producing the weak product. If a company renders bad service and consumers keep on using this bad service the company will keep on rendering bad service because the consumer doesn't have a problem with it. The consumer is supposed to have the last say in what is wanted concerning the availability and quality of products and service. There are several organisations which protect the rights of the consumers and which offer information that helps to make them better informed consumers, for example:

- The South African Co-ordinating Consumer Council (who sets the minimum standards for products)
- The South African National Consumer Union
- The South African Buro of Standards
- Toll free numbers on labels of products

Factors which influence consumer choice

Three types of factors influence the consumer's choice of products:

<u>Psychological influences</u>
Because of similarities in personality traits it is possible to segment people into similar consuming groups, which are likely to use the same type of products. For example: people concerned about their health will buy a health roll for lunch while people not concerned about their health will rather buy fried chips for lunch. Products have a symbolic value for the individual that becomes important for the consumer in making choices between products. For example: a group of grade 9 teenagers will rather buy an expensive Billabong jersey than an identical "no-name" jersey for less, from a chain store.

Social influences
The group with whom individuals associates influences the individual. Different social groups' needs are similar, for example: a group of grade 9 teenagers will rather go for pizza on a Friday night, than dine at a formal restaurant.

Economic influences
Different methods of packaging are used to attract consumer attention and tempt them to buy the product. When you look at the layout of a shop you will see that sweets and magazines are usually put near the checkout points so that consumers are tempted to buy these products while they wait their turn. Advertisements encourage people to buy products for a special price—even if they do not need it.

Activity

Consumers have certain rights. This means that they can demand good service and quality. Interview 5 consumers to determine what is important for them when they go shopping. Use the following tables to distinguise between the people and criteria.

Consumers interviewed		
Number	**Name of consumer**	**Career of consumer**
1		
2		
3		
4		
5		

Criteria when products are bought							
	Quality	**Price**	**Customer service**	**The right to complain**	**Safe products**	**Choice between products**	**The right to be informed about products**
1							
2							
3							
4							
5							

The need for standardisation

Standardisation is so much part of our lives that we often do not notice it exists. Very few aspects of our lives are unaffected by standardisation. For example we use the same time, called South African Standard Time, taken from the 30° East line of longitude, we use the same standardised measurements and currency.

What is the SABS?

The South African Bureau of Standards (SABS) is an organisation that was started in 1945. It develops national standards for products and services that are made and carried out in South Africa. The SABS publishes and distributes these standards and ensures that compulsory standards are met. Compulsory standards are there to protect the health and safety of the consumer. For example, there are standards to ensure that electrical goods that draw a lot of current are earthed.

A standard is a generic description for standards, specifications, codes of practice and standard testing methods. So far, about 4 000 standards have been developed and published by the SABS. A standard could specify the performance required to equipment. For example, measuring equipment such as petrol pumps must be set to measure petrol very accurately. A standard can also give a detailed description of a product's safety features. It could contain diagrams, symbols, codes, testing methods and definitions. Or it could contain details about qualifications of technical staff and specifications.

The SABS mark

You may have seen the SABS mark on products. The mark indicates that the product has passed the SABS standards test. The following marks are used by the SABS to inform the consumer about the different standards with which a product complies.

Specific properties
e.g. fireproof materials

Environmental friendliness
e.g. refrigerator coolant that does not contain CFCs

Packaging
e.g. safe packaging for dangerous goods such as acid

Approved performance
e.g. toaster, car parts

Safety
e.g. safety belts

There are two main groups of processing technology:

Construction technology

Making use of materials to build different structures like bridges, houses, shopping centers, towers, etc.

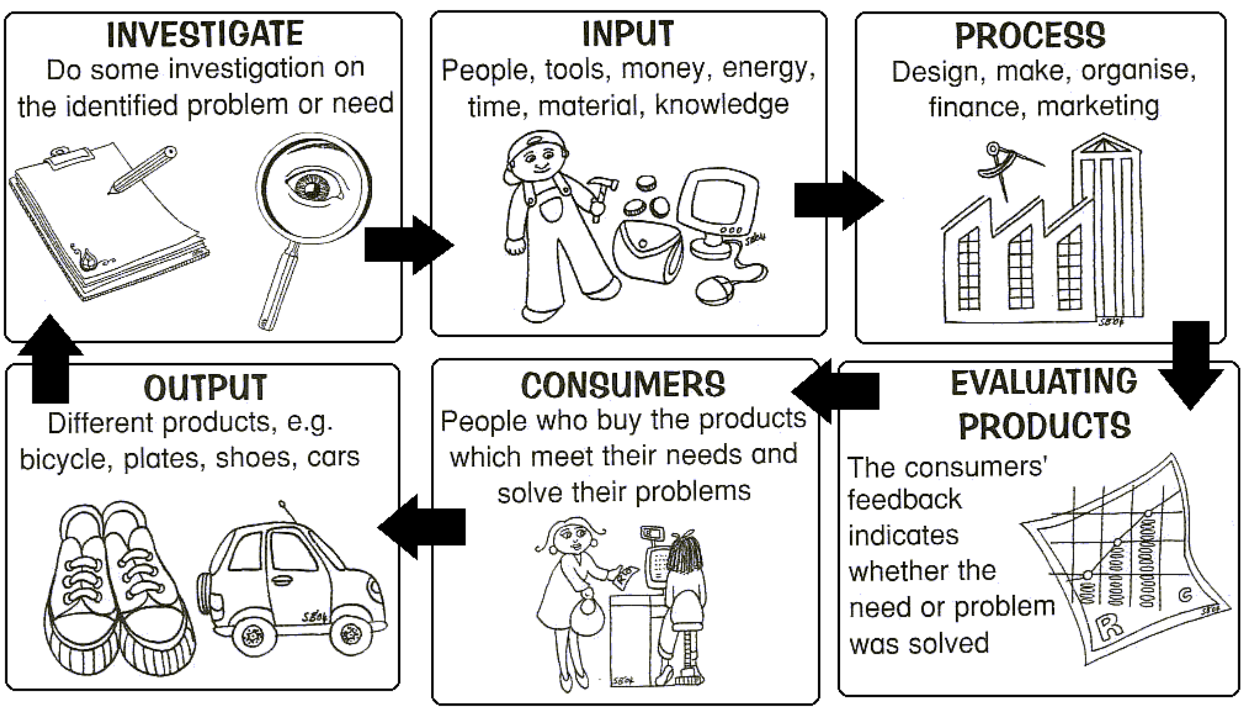
Manufacturing technology

Making use of materials to make different products in factories, e.g. electrical appliances, food, cars, clothing, furniture, etc.

So……

Processing is about using tools and machines to change raw **materials** into useful products. We can illustrate this with the following simple flow diagram:

Now let's take a closer look at the **technological process**:



Materials

Materials can be natural or manufactured.

Raw materials are materials which we find in their natural state, such as materials that we get from plants, animals and the earth. Examples include fibers from the flax plant that are used to make linen and cotton, which is a processed, natural material that is made from the seeds of cotton heads. We also get raw materials from animals, such as silk that is produced by silk worms. From the coats of animals such as sheep and goats, we get fibres to make wool. Wool is a processed, natural material.

Processed natural materials can be made from minerals. A mineral is a non-living thing that comes from the earth. Iron ore is a rock that contains iron. Before we can use the iron, we have to find ways to separate the iron from the ore. Natural processed materials from minerals include iron, salt, diamonds, granite, marble and copper.

People make **synthetic** or artificial materials. These are materials that are not found in nature. People use special chemical processes to make artificial materials. People use coal and oil to make nylon, polyester and acrylic. They use crude oil to make petroleum that we use as fuel in our cars. We use many synthetic materials, for example perspex for CD covers and vinyl for floor coverings and the dashboards of vehicles.

Apply your knowledge

Look around you and list 7 objects in the first column and then decide what they are made of and whether they are natural or synthetic.

Object	Plastic	Wood	Metal	Fabric	Glass	Natural	Synthetic

Properties of materials describe the way materials feel when we touch them, their appearance when we look at them and the way they smell. We can describe the materials with specific words, such as "shiny", "fluffy", "dry", "cool" and "sour". But properties also describe the way materials behave when we use them. We call these working properties. Here are some words that we use to describe the working properties of materials:

- **strong** - it does not break when very big forces are applied to it.
- **tough** - it does not crack or break easily and it is very hard.
- **hard** - it cannot be scratched or dented easily.
- **brittle** - it breaks easily if you hit it or bend it.
- **stiff** - it does not stretch or bend.
- **flexible** - it bends easily and goes back to its original shape.
- **elastic** - it stretches and goes back to its old shape.
- **plastic** - it changes shape when you press or squash it; it will stay in the new shape and will not go back to its old shape.

Testing the working properties of materials will help us to decide if a material will be able to do the job for which we require it.

Try this:

Material	Apply a force				
	Stretch or deform	Press or squash	Bend or stretch	Hit or drop	Scratch, dent or cut
	It is elastic?	Is it plastic?	Is it stiff or flexible?	Is it brittle or tough?	Is it hard or soft?
Chalk					
Copper wire					
Foil					
Prestik/clay					
Plastic bag					
Paper					
Stone					
Wood					
Glass					

Improving materials

Materials can be **improved** through:

- chemical conditioning
- coating
- mechanical conditioning.

Materials can be **processed** in three ways:

- shaping (material is removed)
- forming (all of the material is used) or,
- conditioning (the internal properties of the materials are changed).

Sometimes a combination of processing techniques is used. Materials are also processed with temperature treatment, coating, mixing, combining, extracting, dehydrating, and so on.

Chemical conditioning

A **chemical reaction** takes place when materials are chemically conditioned. For example, when you add lemon juice to fresh milk, something happens chemically and the milk curdles and turns sour.
Chemical conditioning can also be used to enhance flavours. When you stir a teaspoon of sugar into a glass of water, you make the water taste sweeter. When the sugar and the water mix, a **reaction** takes place and the taste of the water is changed. The sugar dissolves in the water.

Coating

Another way in which materials are conditioned is by **coating** them. There are different reasons for coating, including protection (rust proofed burglar bars), increased value (gold-plated jewellery), improved feel (velvet coating in gift boxes feels soft to the touch), and safety (non-slip flooring). Coatings are usually applied onto the surface of objects, although sometimes the coating soaks through.

Waterproofing materials

A material that already has many uses can be enhanced by being made waterproof or water resistant. This can be done easily by coating the material with accessible (easy to get) materials such as varnish, nail polish, silicone, and so on.

Fire resistant

Fires cause enormous damage. There are many fire-retardant materials in industry. An easy way to process wood to make it fire retardant is to mix river or sea sand with wood glue and then coat the wood with the mixture. Note that this is not fire proof, but it can delay the burning process.

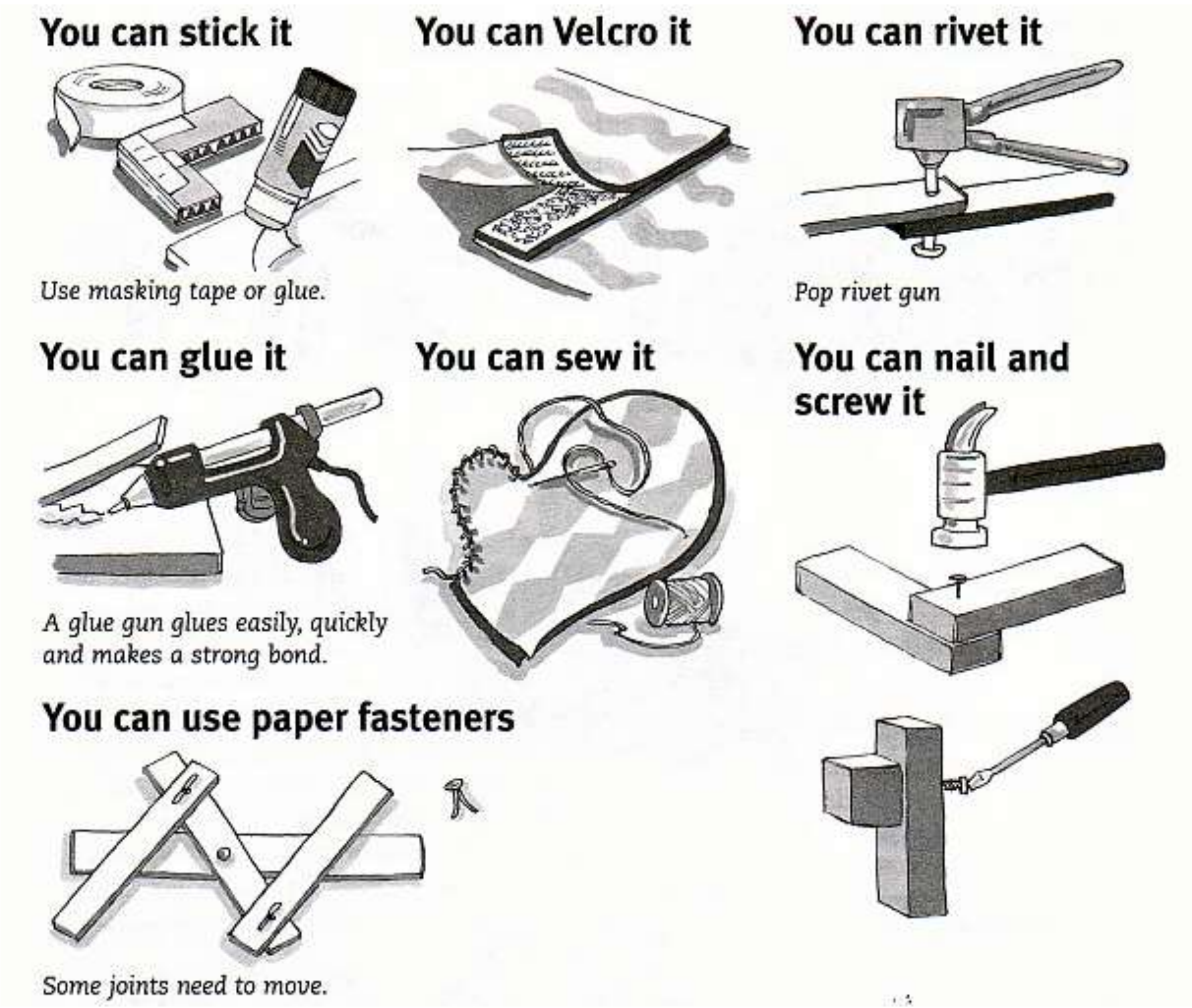
Magnetizing

When a piece of steel is magnetized, the molecules (which are usually arranged in a random way) are lined up in a particular direction. Certain steels can be magnetized, as you can see in the illustration. This is an example of a material that has been processed by conditioning: its internal structure has been altered.

Hardening

Have you heard of toughened glass? Regular glass is fragile and it breaks easily. Glass can be hardened and tempered: the glass is heated to a particular temperature, which is near to its melting point (when it becomes soft). Depending on the type of glass, the temperature at which it starts to become soft ranges from 500°C-1 650°C. Once the glass has been brought to this temperature, it is cooled rapidly with a blast of cold air, or it may be immersed in water. This controlled heating and cooling makes the glass tougher.

Joining Techniques



PLASTIC

Types of plastics

All plastics are formed and shaped by heating them. Plastics that can be reheated and made into different shapes are called thermoplastics - for example, polythene carrier bags. Plastics that can only be heated and shaped once are called thermosets - for example, melamine plates.
Thermoplastics have different properties to thermosets. By changing the chemical composition, manufacturers can make different thermoplastics and thermosets. Each type of plastic has certain characteristics that make it suitable for making different plastic products. These are called the working characteristics.

Activity:

Refer to the following table about plastics, and discuss reasons for the following:
1. Urea formaldehyde is suitable for making electrical light fittings.
2. Polystyrene is used for food packaging.
3. Polypropylene is used to make syringes.
4. PVC rather than polythene is used to make window frames.
5. Nylon is suitable for making bearings.
6. Polystyrene is unsuitable for making milk crates.

Plastic and group	**Properties and working characteristics**	**Products**
Low density polythene (thermaplastic)	Common plastic, tough, flexible, soft, good chemical resistance electrical insulator, waxy attracts dust, range of colours.	Washing-up liquid bottles, toys, plastic bogs, electrical cables.
High density polythene (thermoplastic)	Stiff, hard, resistant to chemicals, can be sterilised, waxy feel.	Milk crates, buckets, bowls, bins, pipes.
Polypropylene (thermoplastic)	Very light, hard, floats, chemical and impact resistant, can be sterilised, easily joined, flexible.	Medical equipment, syringes, ropes, nets, kitchen utensils, crates, chairs.
Polystyrene (thermoplastic)	Light, hard, stiff, colourless, brittle, low resistance to impact, water resistant, safe with food.	Disposable plates, food containers, appliance casings, model toy kits.
Expanded polystyrene (thermoplastic)	Very light, floats, good heat and sound insulation, crumbles easily, little mechanical strength.	Insulation baords, surf boards, flotation rings, packaging.
Polyvinyl chloride (PVC) (thermoplastic)	Stiff, hard, tough, light, good chemical resistance, electrical insulator, range of colours, fades in sunlight unless stabilised.	Pipes, guttering, roof sheets, window frames, shoe soles.
Plasticised PVC (thermoplastic)	Soft, flexible, electrical insulator.	Hose-pipes, table cloths, floor covering, wire insulation.
Polyamide (nylon) (thermaplastic)	Hard, tough, withstands wear, creates very little friction, self-lubricating, resistant to extremes of temperature, good chemical resistance, easy to work.	Gears, bearings, curtain rails, clothing, stockings, combs.
Urea formaldehyde (thermoset)	Stiff, tough, brittle, white or light coloured, electrical insulator, heat resistant, easily moulded.	Electrical light fittings such as switches, wood adhesives, door knobs.
Melamine (thermoset)	Stiff, hard, strong, scratch resistant, heat resistant, stain resistant, range of colours, odourless.	Kitchen worktops, plates, cups and cutlery, buttons.

Polyester resin (thermoset)	Stiff, hard, brittle, high strength, bonds well, heat and chemical resistance, electrical insulator, resists ultraviolet light.	Boats, car bodies, chair shells, baths, motorcycle luggage boxes.

Investigating polystyrene

'Poly' means many, so polystyrene is made of styrene.

What is polystyrene made of?

The products shown above look different and have different working characteristics, but they are all made from the same basic chemical compound. Remember from Natural Sciences that a compound consists of different elements bonded together? You may remember that all plastics are made from oil. The oil is chemically separated into different compounds. One of these products is styyene. All types of polystyrene are made from styrene by a process called polymerising. During this process many molecules of styrene are chemically joined to form polystyrene.

The styrene molecules are dissolved in water, chemicals are added and the mixture is stirred. This causes the styrene molecules to join to form polystyrene. Lots of polystyrene molecules then clump together to form tiny crystal beads that look like fine grains of sugar. The polystyrene beads are raw materials for conventional polystyrene.

To make expanded polystyrene, pentane gas is added under pressure when the beads are being formed. This process is called foaming. The foamed beads contain pentane gas in their centres, which causes them to swell. All polystyrene foam beads are imported into South Africa as there is no factory that makes these locally. The foam beads are processed to make a variety of products that you can read about in the next case study.

Manufacturing of expanded polystyrene products

1. Polystyrene foam beads are imported from the Far East.
2. Beads are heated with steam for three minutes. The pentane gas inside the beads expands and the beads 'foam up' like popcorn as their volume increases many times.
3. After steaming, beads are left for about four hours to allow the internal pressure of the beads to drop until it is equal to the atmospheric pressure pushing in from the outside.
4. The cooled beads are fed into a mould. Steam is pumped in for about 90 seconds. The heat softens the outer skin of the beads, causing them to stick together and form a block in the shape of the mould.
5. The outside of the block cools in about 15 minutes, but the blocks are left overnight to allow the insides to cool.
6. The polystyrene is cut to size.

Uses of expanded polystyrene

You saw that expanded polystyrene has certain properties, including:

- it is light in weight
- it is a good sound and heat insulator
- it has little mechanical strength

These properties give expanded polystyrene certain working characteristics that make it a very suitable material for manufacturing a variety of products. We shall focus on the insulating properties of expanded polystyrene.

Cold storage

Storing fruit and vegetables at low temperatures can delay their ripening. Also different fruits and vegetables store best at certain temperatures. Once the fruit is taken out of cold storage it ripens quickly. Frozen products such as fish and chicken have to be stored at temperatures below -5°C. In cold storage units the walls are lined with thick layers of expanded polystyrene. The thicker the layer, the longer the stored products will remain at the required temperature.

Roof insulation

Laminated roof sheets which consist of a sheet of expanded polystyrene bonded to metal foil and fibre-cement. The fibre-cement gives the sheet strength and the shiny metal foil reflects heat. These sheets are installed between the roof and the ceiling of a house. They can also be installed between the bricks in double-brick walls. The sheets prevent the temperature inside the house from getting too high or too low. Insulated roof sheets are now being used in the construction of small, low-cost homes.

Activity

1. Identify the properties of expanded polystyrene that are utilised in the manufacture of cold storage units and roof sheets.
2. Explain why the walls of the cold storage units connot be made entirely of expanded polystyrene.
3. Suggest reasons why the roof sheets need to be strengthened with fibre cement. (Hint: installation.)

How does expanded polystyrene, insulate?

An insulator slows down the transfer of heat from one body to another. Insulators are all poor conductors of heat. Air is a good example of an insulator. This is why a padded jacket keeps you warm. It is the air trapped in the padding that slows down the transfer of heat from your body to the cold air outside. You will remember that expanded polystyrene contains air in every expanded bead. In fact expanded polystyrene is 98% air! So a sheet of expanded polystyrene is a good way of trapping large quantities of air.
Heat is transferred from one body to another until both bodies are the same temperature. This is why hot things cool down and cold things warm up to 'room temperature'. If there is a layer of air between the two bodies, the transfer of heat is

slowed down. This is how an insulator works. Do the following experiment to investigate the effectiveness of an insulator.

Activity

You will need two thermometers, a polystyrene cup, and a glass or a china cup.

Minutes	Container 1 °C	Container 2° C
0		
5		
10		
15		
20		

1. Fill each cup with 200 ml hot water from a kettle.
2. Place a thermometer in each cup and measure the
3. temperature of the water. Record the results.
4. Measure the temperature every five minutes for a
5. period of 20 minutes. Record the results in a graph.
6. In which cup did the temperature of the water
7. decrease faster? Use your knowledge of insulation to explain why.

How to cut polystyrene

You will need a piece of wire about 30 cm long and two pieces of wood to use as handles, and a flame heat source.

1. Join each end of the wire to a piece of wood.
2. Heat the wire in a flame.
3. Cut the polystyrene with the hot wire.
4. If you want to cut shapes out of the polystyrene, make the shape out of the wire before heating in the flame.

PLANTS

Fabrics are made from different fibres. Fabrics are made by weaving or knitting threads, either by hand or by machine. The threads in a fabric are called yarn. Yarn is made up of many even smaller threads called fibres. Fibres are twisted together to form yarn. This twisting process is called spinning.
Some fibres come from plants. The stems, leaves and seeds of plants are made up of hundreds or thousands of fibres. Cotton, hessian and coir are all fibres that come from plants. We also get fibres from some animals. All these plant and animal fibres are called **natural fibres.** Fibres can also be made from **minerals** such as coal and oil. People have even invented ways of making fibres from **chemicals.** We call these fibres made from minerals and chemicals synthetic fibres.

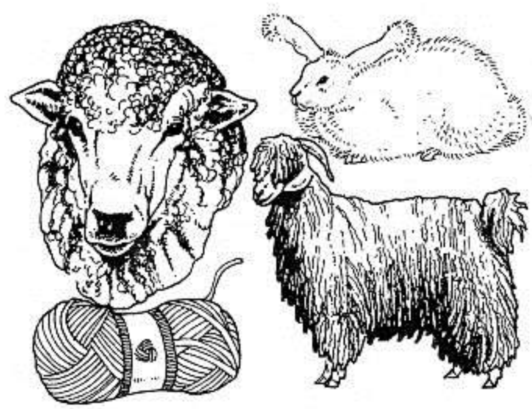


FIGURE 8(A)
We get wool fibres from animals such as sheep, goats and rabbits.

FIGURE 8(B)
Cotton fibres are made from the seed pods of cotton plants. The fluffy seed pods are called bolls.

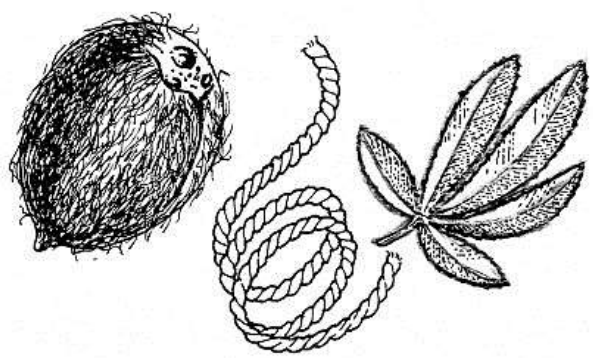


FIGURE 8(C)
Hessian fibres come from hemp plants and are used to make rope, sackcloth and other hard-wearing cloth. Coir fibres from the coconut are also tough and strong.

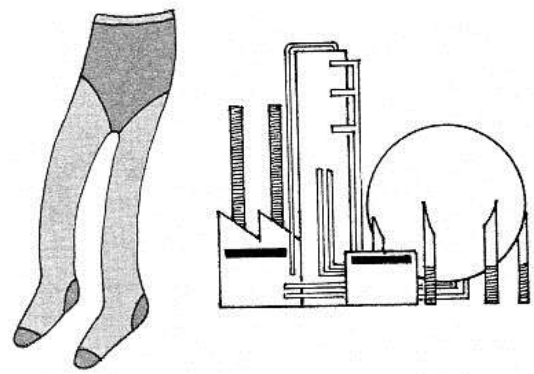
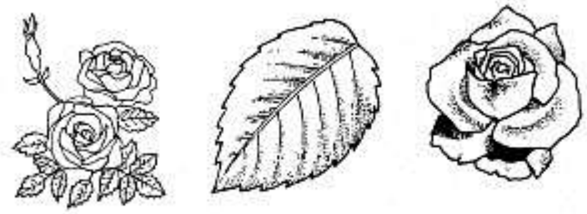


FIGURE 8(D)
Acrylic fibres are made from oil and chemicals. Acrylic yarn is lightweight and dries quickly. It can be used on its own to make fabrics but it is often combined with natural fibres.

Where does the fragrance of plants come from?

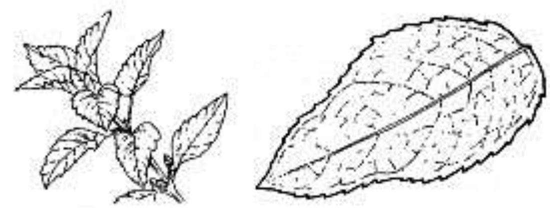
Special cells which produce fragrant oils, called **essential oils,** grow between the other tissue cells in plants. We can extract essential oils from different parts of a plant, such as the leaves, flowers, fruit, seeds, stems, bark and roots. In some plants the essential oils have a strong fragrance. When plant cells are damaged, squeezed or bruised, for example by squashing them between your fingers, tiny droplets of essential oil evaporate into the air so that you smell them.
Very large quantities of plant material are often needed to produce essential oils. For example, 3,5 million hand-picked jasmine flowers produce 1 kg of essential jasmine oils. Essential oils have very strong fragrances because they contain concentrated chemicals. Only a few drops of essential oil are needed to produce fragrant products.

Lavender fragrance is soothing and relaxing. Lavender oil is good for massaging muscular aches. Lavender water rubbed into the skin helps to speed up the growth of new skin cells and is helpful for people with acne because lavender is a mild antiseptic. It also repels insects.

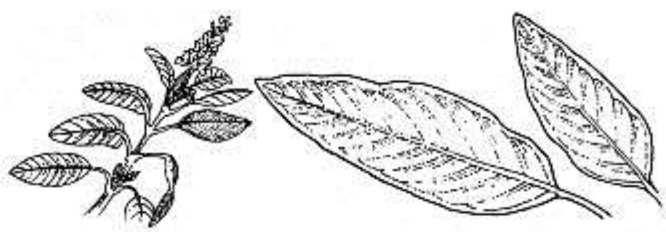


Roses have been grown for hundreds of years for their beauty as well as for their fragrance. Rose petal tea with honey helps to relieve stress and can also help people to sleep.

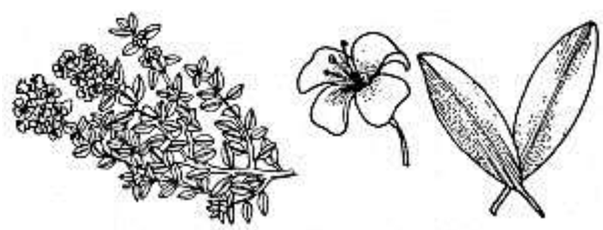
Rosemary is often used in skin creams, bath oils, soaps and hair-care products. It can be used to treat aching muscles, is a mild antiseptic and repels insects. Rosemary is astringent, which means it helps to dry out oily skin and make it more healthy. Rosemary water helps the hair to stay shiny, especially dark hair. Rosemary also reduces dandruff and hair loss.



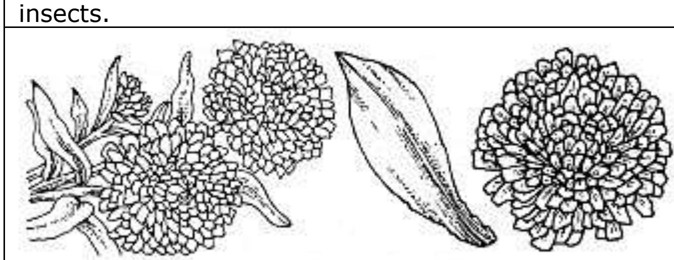
Peppermint is used in cosmetics such as massage creams, face packs, perfumes, toothpastes and mouthwashes. It stimulates, heals and disinfects the skin, and has a cooling effect and pleasant taste which make the mouth and gums feel fresh and clean. Peppermint helps to relieve pain. It repels insects such as ants and mosquitoes.



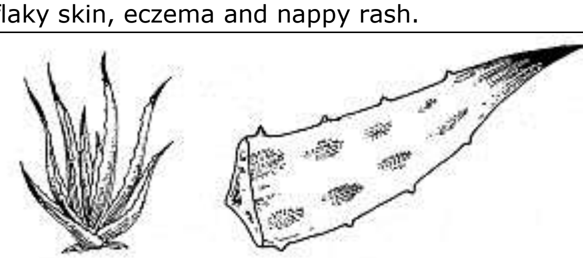
Sage stimulates hair growth, darkens hair slightly and helps to clear dandruff. Sage contains a natural antibiotic so it will help to heal spots. Used as an underarm wash it is an excellent deodorant. Sage is used in bath oils because it stimulates blood circulation. It is also used in shampoos, soaps, deodorants and mouthwashes. It repels household insects.



Thyme has antiseptic and antibiotic qualities. It helps to clear invisible fungi and bacteria which may cause skin problems. It is often used in aftershave lotions, underarm deodorants, mouthwashes, and shampoo or soap for greasy hair and skin. Thyme is a stimulant for skin cells and a nerve tonic. It helps to improve rough, flaky skin, eczema and nappy rash.



Calendula has been used for hundreds of years to treat oily skin and hair. Calendula water helps to make hair bright and shiny, especially reddish hair. Infusions or oils made with Calendula flowers have a soothing effect on the skin and help to heal sore or rough skin. Calendula is often included in skin fresheners. soaps, shampoos and face creams.



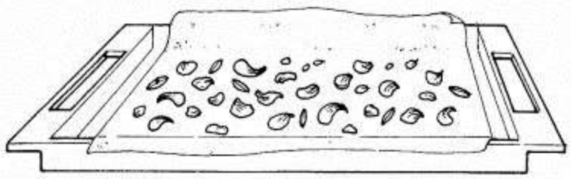
Plants in the aloe family have been used for thousands of years to cure skin infections and heal wounds. The South African aloe, with the Latin name *Aloe arborescens,* was used to heal wounds after the nuclear bomb was dropped on Hiroshima in the Second World War. Aloe is now used in many skin creams and other cosmetics.

HOW TO DRY FRAGRANT PLANTS

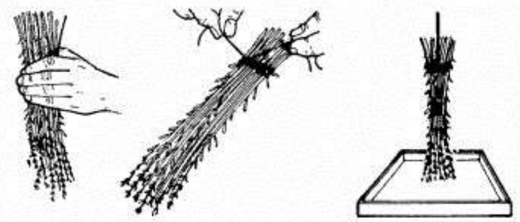
You will need:

- leaves or flowers of one or more fragrant plants
- a tray or shallow cardboard box
- brown paper or clean newsprint (not printed newspaper)
- string
- a dark airtight container
- a few old magazines

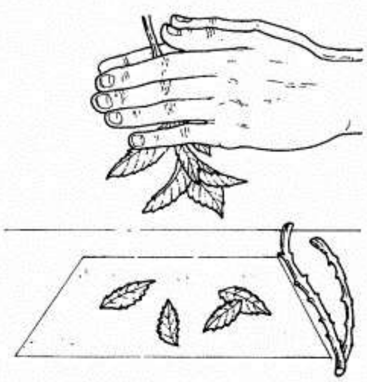
1. Carefully pull flowers apart and remove the petals. Remove any dirt and insects. Line the tray with paper. Spread the petals out on the paper and leave them to dry for 5–7 days, or longer if they still feel moist.



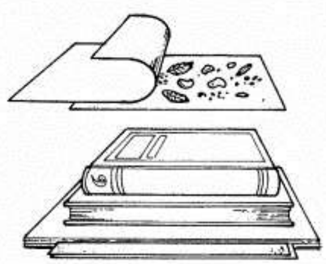
2. To dry other parts of plants, such as stems and leaves, tie them in small bundles and hang them up over trays. This method is ideal for lavender and rosemary.



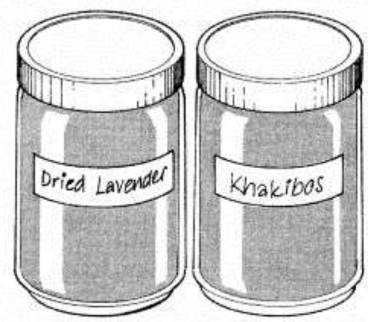
3. To dry leaves separately, begin drying as for (2) but rub the leaves off the stems when they are crisply dry. Throw away the stems.



4. To keep leaves, petals or small whole flowers such as jasmine in good shape while they are drying, lay them neatly between two sheets of unprinted paper in between the pages of an old magazine. Place several heavy books on top of the magazine and leave for a few weeks until dry.



5. When plant material is dry, store it in a dry airtight container with the lid tightly on. Keep in a cool place away from sunlight. Brown glass jars or plastic containers are best.



Using dried plant material

Dried plant material can be used in various ways for a long time after it has been picked. Before the development of modern mattresses, dried fragrant plants such as lavender were used to stuff mattresses. The Khoi people dug shallow holes the size of a bed in the ground. They filled these holes with fragrant plants and then covered them with animal skins to use as beds.

For hundred of years cushions of sweet-smelling plants have been used to calm nerves, relieve headaches and encourage sleep. Small cloth bags containing dried fragrant materials can be put in cupboards to give a pleasant smell and to repel insects such as fleas and moths from clothes.

Pot pourri is made from fragrant plant material. Spices, essential oils, **preservatives** and fixatives are added to blend all the fragrances together and to prevent the essential oils from evaporating too quickly. You can experiment with various plants, spices and essential oils in pot pourri, but always remember to add fixative.

Pressed dried flowers and leaves can be used to create greetings cards and labels. Stick themcarefully onto card. Cover them with contact plastic or varnish to protect them if you like.

New words:

A **preservative** is something that is added to prevent materials from going bad.

A **fixative** is something that is added to help keep the colour or fragrance in material - to fix its qualities.

HOW TO MAKE POT POURRI

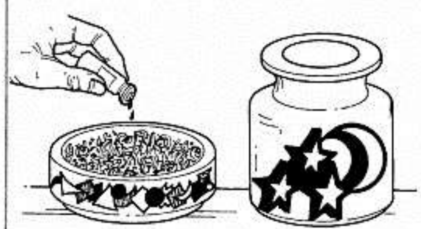
You will need:

- a total of 8 cups of dried plant material: fragrant flowers such as lavender, jasmine, rose, wild honeysuckle, and fragrant leaves such as lavender, rosemary, mint, orange-tree, lemon verbena
- 15 ml each of the following preservatives: cloves, coarse sea salt, cinnamon
- 45 ml orrisroot (as fixative)
- 10 drops of essential oil
- airtight containers such as screw-top jars
- a large bowl

1. Put the dried plant material in a bowl. Sprinkle on all the other ingredients and mix all the material thoroughly.

2. Put material into airtight containers and leave it for two months, turning the containers every day or two. Add a few drops more of essential oil to containers if necessary.

3. Fill decorative containers with pot pourri. It should keep its fragrance for about two years. You can add a few drops of extra essential oil from time to time.

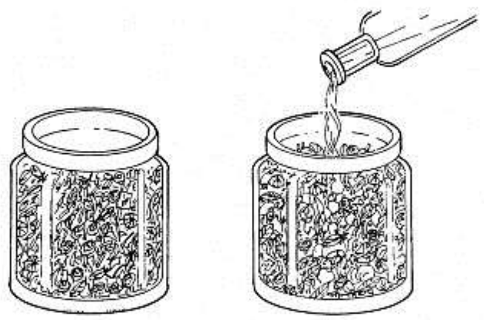


HOW TO MAKE FRAGRANT OIL OR VINEGAR

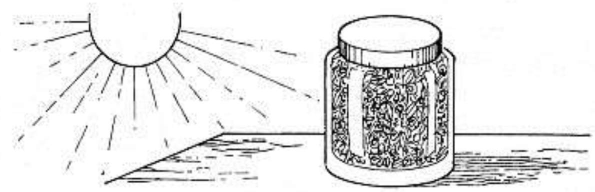
You will need:

- at least 250 ml natural oil (see table on page 136)
- at least 250 ml white grape or apple cider vinegar
- enough dried fragrant plant material to fill a jar
- jar with lid
- muslin bag
- large jug
- storage jar or bottle

1. Pack the jar tightly with plant material. Then cover it completely with oil or vinegar.



2. Put the lid on. For fragrant oil: leave the jar in a warm place for three weeks, but away from direct sunlight. For fragrant vinegar: leave the plant material and vinegar mixture in a warm place in the sun for three weeks.



3. During these three weeks, replace the plant material at least three times, but use the same oil or vinegar each time. To do this, put the muslin bag over the jar and empty the contents of the jar into the bag. Squeeze the oil or vinegar through the bag into a jug. Pack the jar with fresh plant material and cover it with the fragrant oil or vinegar from the jug. Use a little new oil or vinegar to completely fill the jar if necessary.

4. After three weeks, strain the oil or vinegar through the muslin bag once more. Then pour into small jars or bottles. Infused oils and vinegars remain good quality for up to a year if kept in a cool, dark place.