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Lower Primary

TEACHER RESOURCE KIT

About engineering

This guide includes:

- Engineering: what is it?
- What are simple machines?
- Buildings and structures

ENGINEERS
AUSTRALIA

Engineering: what is it?

Have you ever walked down the street and been amazed by the houses and other buildings around you?

Have you ever wondered why a bridge does not collapse when a heavy truck drives across it?

Have you ever been curious about how your toilet works?

Have you ever thought about where your shampoo, medicines or food come from?

Did you know that the people who are part of engineering teams have something to do with the design and production of all these things *(and many more)*?

Members of engineering teams work together to make decisions about how to design things. They also work together to solve any problems that happen when things that you use every day are being designed, created, produced or built.

Engineering team

The different kinds of engineering

There are four main types of engineering:
Civil engineering, Chemical engineering, Electrical engineering and Mechanical engineering.

Civil engineering teams

How do you think your house stays standing? Who decides where to build roads and what kind of roads to build? Why do very tall buildings sometimes sway in the wind but do not fall down?

You need a Civil engineer to answer these questions.

Civil engineers do lots of different jobs such as:

- investigating how buildings, roads, bridges and railways can be designed and built
- studying the soil and rock where the buildings will be built
- looking at ways to save water and improve the health of our rivers
- creating comfortable and safe buildings for us to live and work in.

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Chemical engineering teams

Who makes medicines? Why do red jelly beans taste different from black jelly beans? How can we make washing-up detergent safe for the environment?

You need a Chemical engineer to answer these questions.

Chemical engineering teams help to research, design and create everyday things such as food, paper and detergents.

Chemical engineers do lots of different jobs such as:

Offshore Oil Rig

- researching, designing and creating everyday things such as food, paper and detergents
- researching and copying how animals' bodies work and how plants grow
- finding, removing and using oil and natural gas from the earth or from under the sea. They also turn petroleum into other products such as fuel, plastic, fabrics and dyes
- creating life-saving medicines
- turning raw materials into other products, such as sand into glass. They also combine various metals and non-metals together to make new products.

Electrical engineering teams

Where does electricity come from? How do telephones work? Who thinks of new power sources that do not harm the environment?

You need an Electrical engineer to answer these questions.

Electrical engineers do lots of different jobs such as:

- helping to produce electricity for use in our homes, communities and industries
- creating new and better computer hardware and software
- designing telephone systems and satellites that allow us to talk to people all around the world
- designing and creating important medical equipment such as pacemakers and artificial limbs.

Mechanical engineering teams

When you see or talk about machines, do you ever wonder how they were made or who made them? A Mechanical engineer can tell you.

Mechanical engineers do lots of different jobs such as:

- designing and creating aircraft, tractors, mountain bikes, light bulbs, doors, shoes and much more
- making sure that the machines we use every day are safe and work well
- working in areas such as robotics, manufacturing, transport and air conditioning.

The creation of so many of the things you use every day has probably involved a mechanical engineer in some way.

Now that you know all the different jobs that engineers do, think about how many engineering teams are at work in your local community and all around our country right now!

What are simple machines?

Here you will discover all sorts of interesting things about simple machines and how they work. There are some great diagrams as well!

A machine is something that makes it easier for us to do work, such as moving objects.

Simple machines are ones which have only one part to do the work. One example of a simple machine is a lever *(see Diagram 1)*.

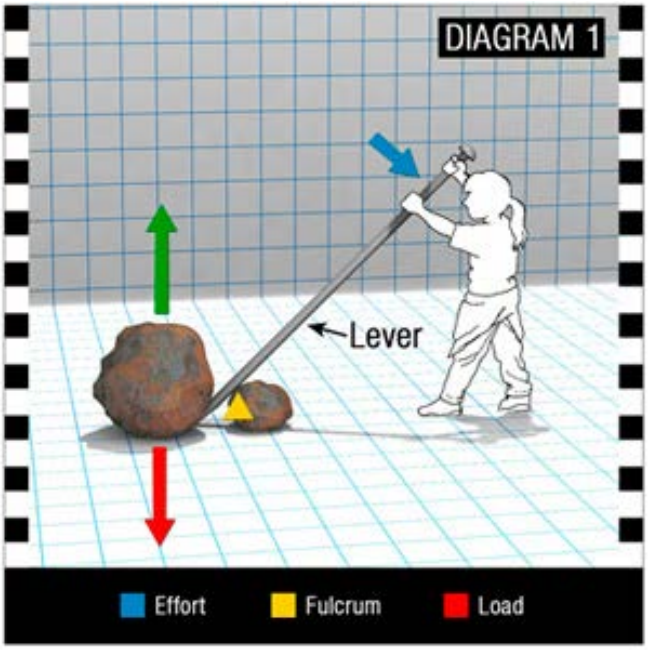
More complicated machines *(sometimes called 'compound machines')* have two or more simple machines working together to do the same work. A wheelbarrow is one example of a compound machine because it has levers *(the handles)* and a wheel *(see Diagram 2)*.

Types of simple machines

There are a number of different types of simple machines. These include:

- Inclined planes 
- Levers 
- Pulleys 
- Wheels and axles 
- Wedges 
- Screws 
- Gears 

Compound machines are made up of a combination of these simple machines.



Inclined planes

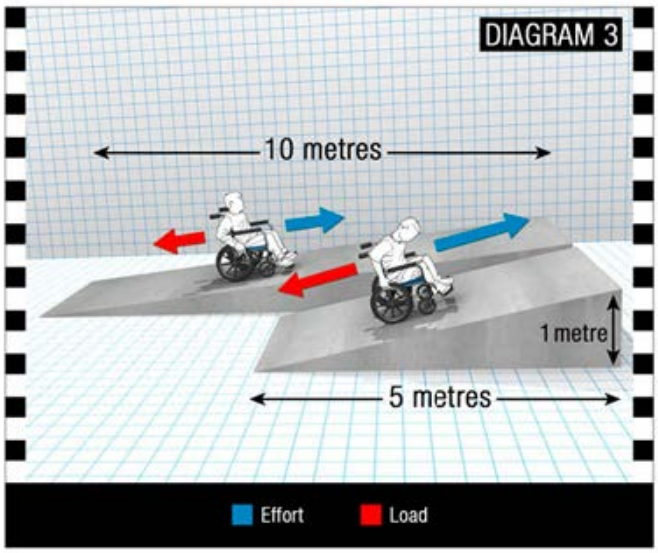
An inclined plane is a flat surface that is at an angle to the load. This type of 'machine' has no parts that move.

An example of an inclined plane is a ramp for wheelchairs *(see Diagram 3)*. The inclined plane of the ramp makes it easier for the person in the wheelchair to move up into a building.

Some other examples of inclined planes include:

- roads built up hills or mountains
- ramps in parking stations
- staircases for people to walk up and down.

You will agree that it is easier to walk up a ramp or a staircase than to climb to the same height up a ladder.

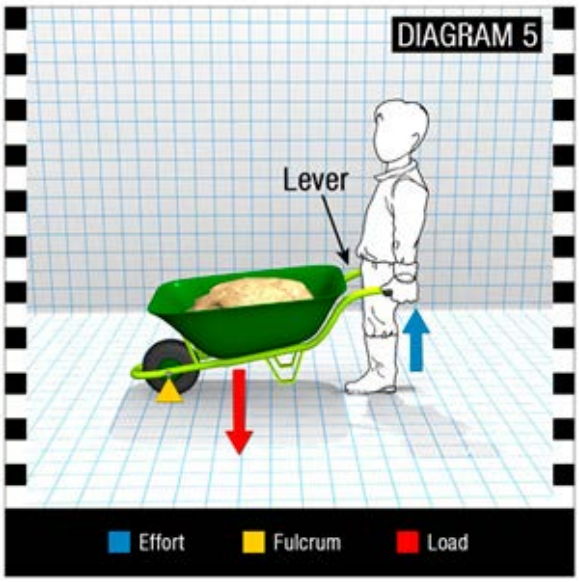


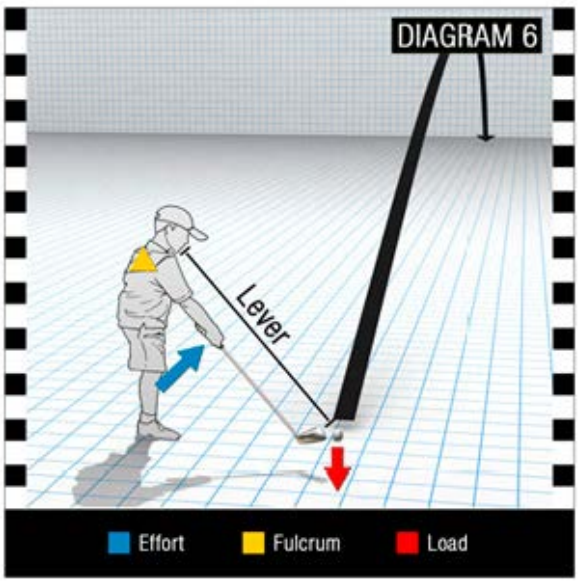
Levers

A lever is a bar that turns around a fixed point. The bar must be rigid or firm. It cannot be floppy. This balancing point is called the fulcrum. A lever uses a force *(or effort)* to make the load move.

Some examples of levers include:

- using a screwdriver to open a can of paint *(see Diagram 4)*
- using a bottle opener to open a drink
- playing on a see saw
- lifting a load in a wheelbarrow *(see Diagram 5)*
- swinging a golf club *(see Diagram 6)*
- a stapler.

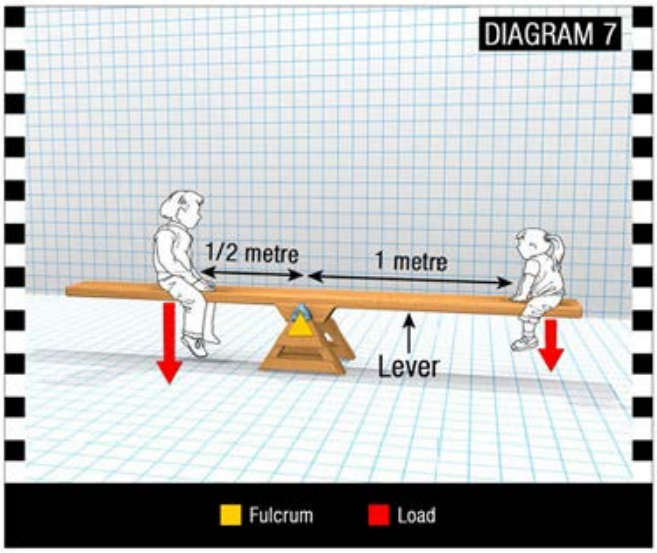




Levers in balance

A see-saw is actually a lever with a fulcrum *(balancing point)* in the middle *(see Diagram 7)*. Think about a see-saw with two people sitting at different distances from the fulcrum. If one person is twice as heavy as the other, the lighter person must sit twice as far away from the fulcrum as the heavier person for the see-saw to be balanced.

Once balanced, it requires very little force for each person to push the seesaw up and down with their legs.



Wheels and axles

A wheel and axle is a simple machine that is made up of a smaller cylinder *(the axle)* joined to a larger cylinder *(the wheel)*. A wheel and axle can make it a lot easier to move a load. Think about when you go shopping and use a trolley. If you took the wheels off the trolley it would be much harder to push!

Some examples of wheels and axles include:

- rolling pins
- egg beaters
- door knobs
- Ferris wheels
- bicycle wheels.

Pulleys

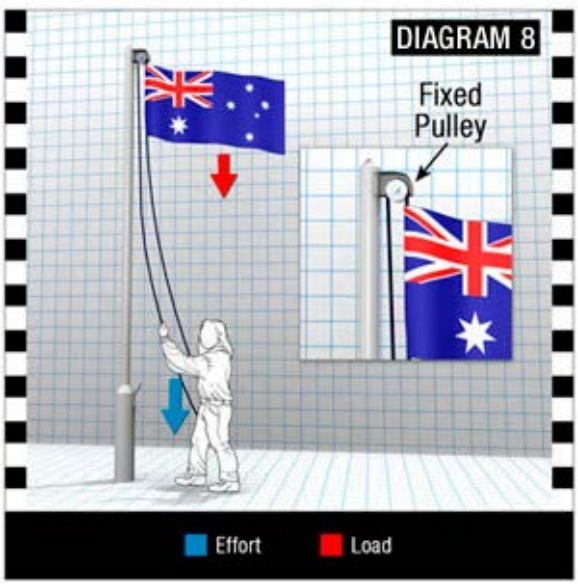
A pulley is made from a rope *(or a belt or chain)* that passes around a wheel.

Fixed pulleys

Take a look at a flagpole. That is an example of a fixed pulley *(see Diagram 8)*. Because of the pulley at the top, the person raising the flag can stand on the ground and hoist the flag by pulling down on the rope. Imagine how much harder it would be without a pulley – how would we get the flag to the top of the pole?

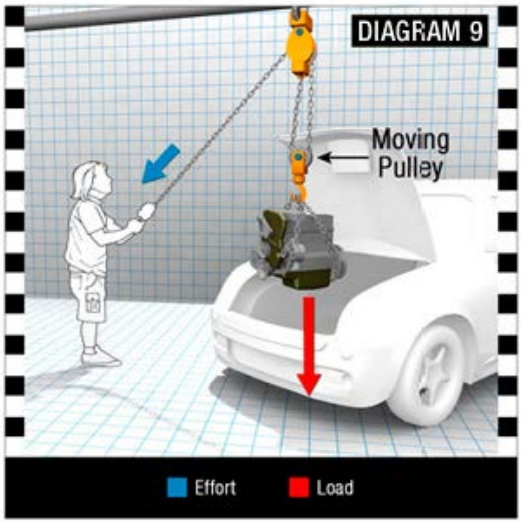
Other examples of fixed pulleys include:

- the pulley at the top of a yacht mast. The deckhand can raise the sail up the mast by pulling down on the rope.
- the pulley at the end of the boom of a crane. The crane works by pulling upwards to lift the load.



Moving pulleys

Diagram 9 shows one moving pulley attached to the engine *(the load)*, and one fixed pulley attached to the support above. This type of pulley system is called a 'block and tackle', where 'block' refers to the pulleys and 'tackle' is the chain that the person is pulling to lift the engine.



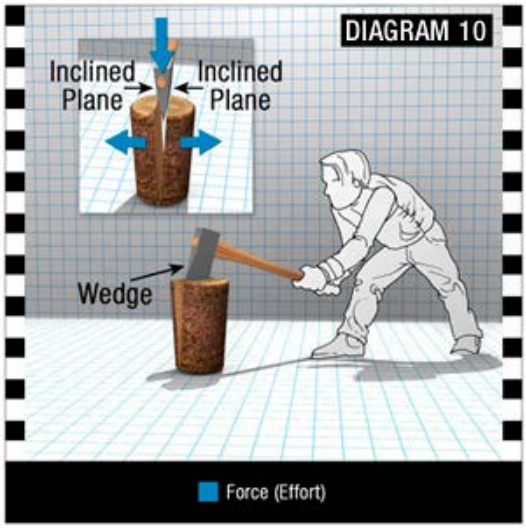
Wedges

A good example of a wedge is an axe. Did you know that the head of an axe is just two inclined planes that do all the work?

In Diagram 10 you can see an axe being used to split a piece of wood.

Other examples of wedges include:

- a knife blade
- a chisel used in woodworking
- the point at the end of a nail
- a doorstop that is wedged under a door to prevent it from moving.

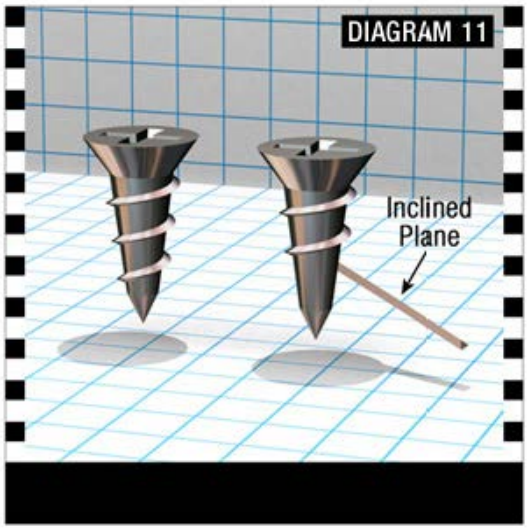


Screws

A screw is really an inclined plane that is coiled around a shaft *(see Diagram 11)*.

Some examples of screws include:

- wood screws
- the screw in a car jack
- the screw on the lid of a jar
- the blades of a fan
- the blades of an aeroplane propeller.



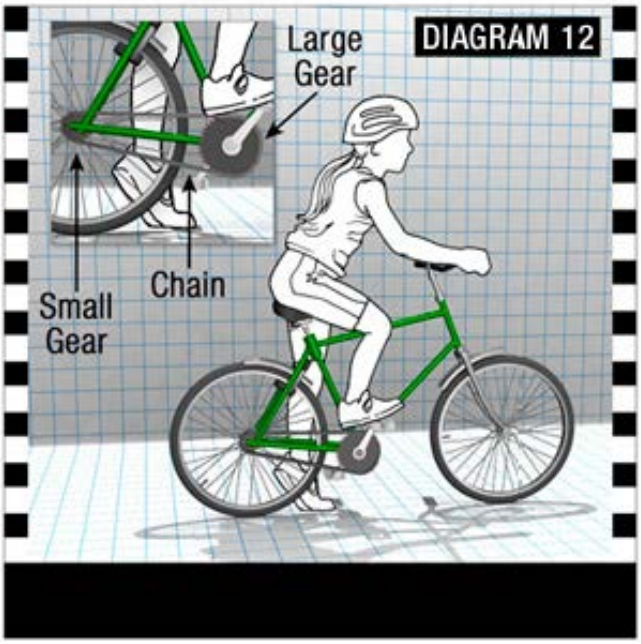
Gears

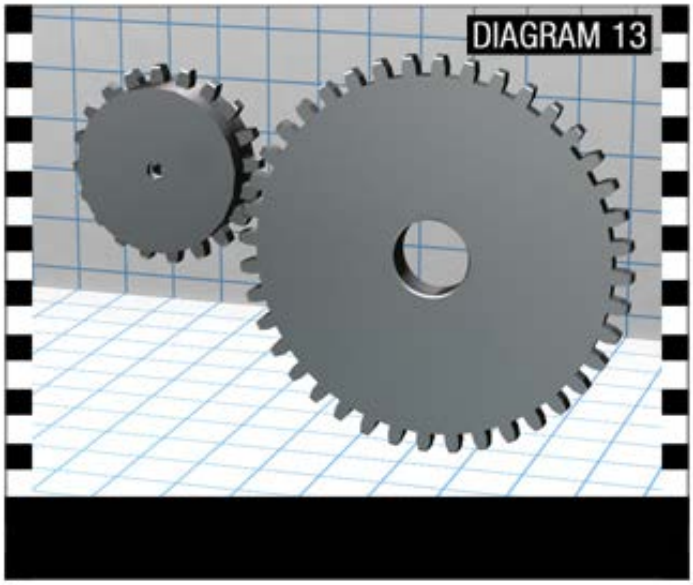
Gears are wheels that have 'teeth'. The teeth fit together so that when one gear turns it also turns the other gear. Sometimes the gears fit right together, and sometimes they work together through a chain or a belt *(see Diagram 12)*.

In Diagram 13, the big gear has 40 teeth, and the small one has 20 teeth. This means that as they turn the small gear will make more full rotations than the big gear.

Some examples of the use of gears include:

- mechanical clocks
- car gearbox and drive systems
- electric drills
- CD and DVD players.





Buildings and structures

Sydney Harbour Bridge at night

Look around you - you can see houses, tall buildings, bridges, roads and footpaths everywhere. Who made the buildings, bridges and dams? Who do you think built your house? Why are some houses in other parts of the world built differently? Civil engineers can answer all these questions.

Civil engineering teams solve problems to do with building and construction. They may have helped to design and construct your house, as well as other buildings and structures in your neighbourhood.

There are many different types of engineering teams and they all have different jobs:

- **Structural engineering teams** think of how to make buildings and other structures stronger so they will be safe and last for a long time. They also think of ways to make houses more environmentally friendly.
- **Geotechnical engineering teams** test the ground that houses or other structures are going to be built on and study the rocks and soil to see whether they will be able to support buildings.
- **Transport engineering teams** plan, design and build motorways, railways and any type of road or path. They also decide where traffic lights will be installed. Can you imagine travelling in a large city with no traffic lights?!
- **Hydraulic engineering teams** work on anything to do with water. They plan how to get water to your house and how to direct grey *(used)* water away from your house. Next time you flush a toilet, be grateful for hydraulic engineers!
- **Local Government engineering teams** work on improving the environment and the way we live in our local area.
- **Building services engineering teams** make sure that your house is comfortable and safe. Think of these engineers when you turn on a light or your air conditioning.

House construction

Building houses

Now let us look at some of the engineers who probably helped to build the home you live in.

Many different types of engineers worked together to build your house, furnish it and make it comfortable.

- **Structural engineering teams** design your house so that it will be safe and last a long time. They make sure that the walls are strong enough to stop your roof collapsing, and that the floor is strong enough to support the weight of you, your family and your furniture. Do you have stairs in your house? Stairs also need to be carefully planned, and structural engineering teams make sure that they are safe and easy to use.
- **Civil engineering teams** make sure that your house can be reached by road and is connected to places such as schools, parks and shopping centres.
- **Electrical engineering teams** are involved in the design and function of all the appliances you have in your house. These include TVs, DVD players, game consoles, washing machines, dishwashers, toasters, stereos and much more.

- **Mechanical engineering teams** design the moving parts, such as motors, that are in most of your appliances. They also investigate ways to reduce the amount of power and water that appliances use.
- **Manufacturing engineering teams** plan and manage the production of all the various machines, appliances and gadgets you have in your home.
- **Chemical engineering teams** work out how to manufacture some of the foods we eat and investigate ways to keep it fresh. They also create many of the chemicals used to make cleaning products.
- **Hydraulic engineering teams** are responsible for making sure that water comes into our house - and can go out too. Think of these engineers when you pull a plug or flush a toilet.

Amazing structures

There are millions and millions of buildings and structures in the world, but some are really amazing. They might have been built thousands of years ago, be much larger than all the other buildings around them, or have been built with nothing more than muscle power and basic tools.

Skyscrapers

Skyscrapers are amazing because of their incredible height. They are very tricky to design and build. Before building a skyscraper engineers must think about:

- how the building will support its own weight and the weight of people and furniture inside it
- how to protect it from wind, fire and earthquakes
- which materials will be used to build it
- how people will move around inside the building *(stairs, escalators, lifts)*.

The tallest skyscraper in the world is the Burj Khalifa tower in Dubai. It is 828m tall. Wow! Would you believe that the top of the building has even been designed so that it sways in the wind?

Australia's tallest building is the Q1 building on the Gold Coast. It is 322.5m tall.

Some other famous skyscrapers include the Eiffel Tower in Paris, the Space Needle in Seattle and the Empire State Building in New York.

Q1 building, Gold Coast. Australia's tallest building

Pyramids

The pyramids of Egypt are amazing for many reasons. No one is sure exactly how they were built, but there were no complex machines *(such as cranes, diggers, jackhammers etc.)* thousands of years ago, so the work would have been done mainly by human and animal power. Archaeologists working around the sites of the great pyramids have found examples of chisels, hammers, ramps, ropes and many other simple machines that people would have used to build the pyramids.

Perhaps the most famous pyramid is the Great Pyramid of Giza. It is about 4,000 years old, took 20 years to build *(using only simple machines)* and is 138.8m tall.

Great Pyramid of Giza

Dams/reservoirs

Dams *(also called reservoirs)* hold water that can be used for drinking, agriculture, mining, and manufacturing.

Building a dam is a difficult thing to do and needs the special knowledge and skills of Civil, Mechanical and Electrical engineering teams. To build a dam or reservoir a wall must be built across a river to stop the water flowing naturally down it. The water collects in a valley or gorge and can be used when it is needed.

Dams are amazing because the walls that hold back the water need to be incredibly strong. Engineers must think about what materials they will need to build a wall that is safe and will not collapse.

Cotter Dam