Simple Machines

Curriculum Connections

History Curriculum:

There are natural links between the theme of Simple Machines and a number of strands in the history curriculum:

1) Continuity and Change over time
   - E.g. Strand Unit: Transport

   Idea: Study technological and scientific developments over long periods, from the use of simple machines to compound machines to computer-based technologies to make our lives easier

2) Local Studies
   - E.g. Strand Unit: Homes or Games and pastimes in the past

   Idea: Collecting and examining old artefacts and looking at their use of simple machines

3) Early people and ancient societies
   - E.g. Strand Unit: Stone Age peoples

   Idea: How work, technologies and weapons have evolved using simple machines

Science Curriculum:

The theme of Simple Machines lends itself greatly to skill development in science and also fits very naturally into the objectives of the Strand Unit: Forces and the Strand Unit: Science and the Environment.

1) Skill development
   a. Working scientifically
      i. Questioning
      ii. Observing
      iii. Predicting
      iv. Investigating and experimenting
      v. Estimating and measuring
      vi. Analysing
      vii. Recording and Communicating
      viii. Evaluating (5^{th}/6^{th} only)

   b. Designing and making
      i. Exploring
      ii. Planning
      iii. Making
      iv. Evaluating

2) Environmental Awareness and Care
   - Science and the Environment

- The child should be enabled to appreciate the application of science and technology in familiar contexts *e.g. in the work-place: conveyor belts and pulleys in a factory; pneumatic drill, cement mixer and crane on a building site*
- The child should be enabled to examine some ways that science and technology have contributed positively to the use of the Earth's resources *e.g. generating electricity*

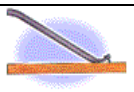
3) Energy and Forces
   - Forces
     - All objectives

See Science Teacher Gudelines Pgs 107-116 - *Approaches to learning about forces*

Suggested Activities:

3rd/4th Classses:

- Children are shown a visual (poster, picture from book or photograph) of a situation where many machines are operating-How does the presence of the machines effect the work being done? If this was 200 years ago what might have been used instead? (You may prefer to approach this in reverse-old to modern ways) Introduce the 6 Simple Machines. 6 Groups are given one simple machine card –definition and simple visual and are asked to come up with 10 home/school examples for where this simple machine is used? They fill out their grid and then trade one team member with a team that has a different simple machine-now they can fill in another column in their grid with the info this new member has brought them, and so on….

	Lever	Pulley	Wheel & Axle	Inclined Plane	Screw	Wedge
Definition						
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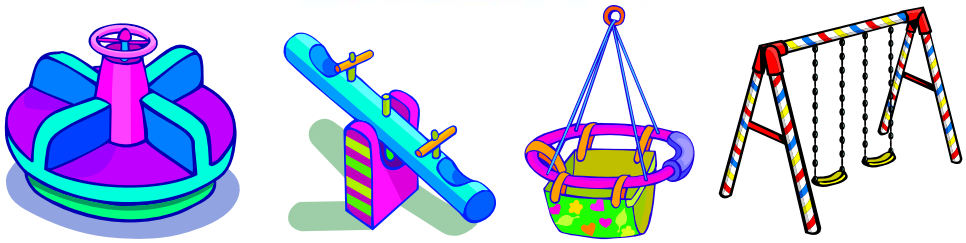
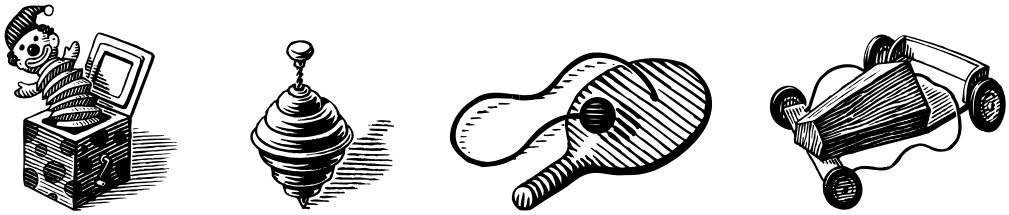
The children are told that they are going to be building a miniature playground for the 'Littleton people'. They will have to design different playground or fairground toys with moveable parts so that the Littletons can play. The class are asked to try to figure out how everything works in a typical playground. Perhaps there is a local playground that the children are familiar with, if not photos of playground toys or Clipart pictures might inspire them.



Different groups will be asked to design different parts of the playground using a bag of materials that they are each given. (The materials included in the bag could be dry recyclables collected by the children, with some art materials provided also e.g. coloured card, string, elactic bands, sellotape, split pins, paper clips, etc.) They firstly have to decide on the design and figure out how they are going to use the materials they've been given. They will then get to try out their designs. They can also invent new playground toys for the Littletons if they have extra time. At the end the groups will present their toys to each other. The rest of the class can question each group about the simple machines and/or forces that feature in their design- i.e. the science of how the toy works and the materials (why?) they would use for each part if they were going to construct a full scale model for an outdoor playground.

5th/6th Classes:

- Children are given an old fashioned toy and asked to figure out how it works- what it is made of (Materials-why? Parts-why? Other toys that work in the same way?) NB -Pushes, pulls and twists as forces.



These are lovely Clipart pictures, if you have original toys to show-fantastic!

The concept of simple machines can be introduces in the same way as outlined for the 3rd/4th class groups. For 5th-6th however, you may wish to give them a good understanding of each simple machine and the use of the definition cards provided may be helpful. These cards could be used cut up as a game of bingo or snap. Giving each child the job of researching one of the simple machines on the internet or library prior to the lesson might also be something to consider.
The class are then told that they will have to design a toy themselves. In groups they are given an old –fashioned placard that advertises what this amazing toy can do; 1)…..2)……3)…..but doesn't picture the toy. This could be done orally instead where the teacher tells each group what their toy has to do. (Use the suggestions below). The group are asked then, using their new knowledge of simple machines and forces to design a toy that meets all of these objectives i.e. it can lift a 50g weight, can catapult a paperclip….

Design a toy that can:

- Raise and lower a marble from the surface, swing the marble onto a ramp and cause the marble to knock a set of dominoes
- Swing a lego man into a trolley and allow the trolley to transport him by conveyor belt where at the end of the belt he lands on a see saw that causes another lego man to catapult into the air
- Using at least 3 gears, 4 inclined planes (ramps), a toy car and cannon, put a robot doll in a bucket.
- Run continuously (non-stop) moving balls without you having to keep it going.
- Catch a ball with the magnet. You must have at least 10 parts that the ball must touch before it gets stuck to the magnet.
- Roll the car down a ramp (inclined plane), knock over a stack of blocks, set the Ferris wheel spinning.
- Knock over a stack of at least 20 blocks (or other toys) with only one cannon shot, 2 of the blocks must spring back up when hit
- Allow two players to play a 'fishing for magnetic materials' game
- Create a shoe box theatre where two characters move by the use of levers and pulleys
- A 'jack in the box' where a character pops up and raises its arms when you open the lid
- A car trap which features a suspended cage that can 'steal' a car when it descends to the end of a ramp

These are some suggestions, perhaps you can invent others.

After that they will be presented with a box of materials that can only be used for the design of their group toy. Now knowing what resources they can use they will have to adapt their design to allow them to complete their task. Each group can be provided with decorating materials that they can individualise their design with (time permitting-structure this so that there will be enough time left for glue/paint to dry.)
Children are then asked to finish, complete any labelled design drawings they want to use and then each group elects a scientist who will explain the science behind the toy their team designed.

Good materials to have collected in the fortnight before these lessons:

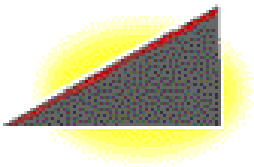
- dry recyclables, including kitchen rolls, boxes, containers, cereal boxes, card, paper, shoe boxes, straws, bottle tops, OJ cartons,
- elastic bands, paper clips, split pins, springs, string, Sellotape, Blu tack, glue sticks, match sticks, lollipop sticks, plasticine, spools, corks,.
- dominoes, marbles, Lego people, toy building blocks, toy cars, small magnets,…

Internet Reference: www.edheads.org
See this site for some lovely activities on Simple Machines, including downloadable worksheets

Simple Machines Definition Cards 1

Inclined Plane

A plane is a flat surface. For example, a smooth board is a plane. Now, if the plane is lying flat on the ground, it isn't likely to help you do work. However, when that plane is inclined, or slanted, it can help you move objects across distances. And, that's work! A common inclined plane is a ramp. Lifting a heavy box onto a loading dock is much easier if you slide the box up a ramp--a simple machine.



Wedge

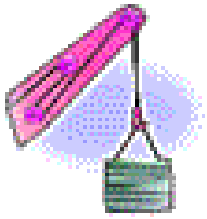
Instead of using the smooth side of the inclined plane, you can also use the pointed edges to do other kinds of work. For example, you can use the edge to push things apart. Then, the inclined plane is a wedge. So, a wedge is actually a kind of inclined plane. An axeblade is a wedge. Think of the edge of the blade. It's the edge of a smooth slanted surface. That's a wedge!

Wheel and Axle

The rotation of the lever against a point pries objects loose. That rotation motion can also do other kinds of work. Another kind of lever, the wheel and axle, moves objects across distances. The wheel, the round end, turns the axle, the cylindrical post, causing movement. On a wagon, for example, the bucket rests on top of the axle. As the wheel rotates the axle, the wagon moves. Now, place your pet dog in the bucket, and you can easily move him around the yard. On a truck, for example, the cargo hold rests on top of several axles. As the wheels rotate the axles, the truck moves.

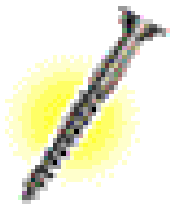
Pulley

Instead of an axle, the wheel could also rotate a rope or cord. This variation of the wheel and axle is the pulley. In a pulley, a cord wraps around a wheel. As the wheel rotates, the cord moves in either direction. Now, attach a hook to the cord, and you can use the wheel's rotation to raise and lower objects. On a flagpole, for example, a rope is attached to a pulley. On the rope, there are usually two hooks. The cord rotates around the pulley and lowers the hooks where you can attach the flag. Then, rotate the cord and the flag raises high on the pole.



Screw

Now, take an inclined plane and wrap it around a cylinder. Its sharp edge becomes another simple tool: the screw. Put a metal screw beside a ramp and it's kind of hard to see the similarities, but the screw is actually just another kind of inclined plane. Try this demonstration to help you visualize. How does the screw help you do work? Every turn of a metal screw helps you move a piece of metal through a wooden space. And, that's how we build things!



Lever

Try pulling a really stubborn weed out of the ground. You know a deep, persistent weed that seems to have taken over your flowerbed. Using just your bare hands, it might be difficult or even painful. With a tool, like a hand shovel, however, you should win the battle. Any tool that pries something loose is a lever. A lever is an arm that "pivots" (or turns) against a "fulcrum" (or point). Think of the claw end of a hammer that you use to pry nails loose. It's a lever. It's a curved arm that rests against a point on a surface. As you rotate the curved arm, it pries the nail loose from the surface. And that's hard work!

Compound Machines

If two or more simple machines work together as one, they form a compound machine. Most of the machines we use today are compound machines, created by combining several simple machines.

Simple Machine

A machine is a tool used to make work easier. Simple machines are simple tools used to make work easier.
In science, **work** is defined as a force acting on an object to move it across a distance. Pushing, pulling, and lifting are common forms of work. Furniture movers do work when they move boxes. Gardeners do work when they pull weeds. Children do work when they go up and down on a see-saw. Machines make their work easier. The furniture movers use a ramp to slide boxes into a truck. The gardeners use a hand shovel to help break through the weeds. The children use a see-saw to go up and down. The ramp, the shovel, and the see-saw are simple machines.

Simple Machines Definition Cards 2

Gears:

Two toothed wheels fit together either directly or through a chain or belt so one wheel will turn the other. Some gears may have a screw or a toothed shaft in place of one of the wheels. A gear may also be a combination of toothed wheels that produces a certain speed (such as a bicycle's top gear which makes the bike go fast, and the low gear for slow speed.)

Examples: Clock, Automobile, Drill

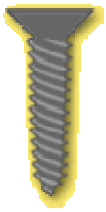
Inclined plane:

A sloping surface, such as a ramp. An inclined plane can be used to alter the effort and distance involved in doing work, such as lifting loads. The trade-off is that an object must be moved a longer distance than if it was lifted straight up, but less force is needed.

Examples: Staircase, Ramp, Bottom of a Bath Tub

Screw:

An inclined plane wrapped around a shaft or cylinder. This inclined plane allows the screw to move itself or to move an object or material surrounding it when rotated.

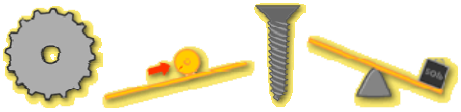


Examples: Bolt, Spiral Staircase

Simple Machine:

A machine with few or no moving parts. Simple machines make work easier.

Examples: Screw, Wheel and Axle, Wedge, Pulley, Inclined Plane, Lever



Lever:

A straight rod or board that pivots on a point known as a fulcrum. The fulcrum can be moved depending on the weight of the object to be lifted or the force you wish to exert. Pushing down on one end of a lever results in the upward motion of the opposite end of the fulcrum.

Examples: Door on Hinges, Seesaw, Hammer, Bottle Opener

Pulley:

A wheel that usually has a groove around the outside edge. This groove is for a rope or belt to move around the pulley. Pulling down on the rope can lift an object attached to the rope. Work is made easier because pulling down on the rope is made easier due to gravity.

Examples: Flag Pole, Crane, Mini-Blinds

Wedge:

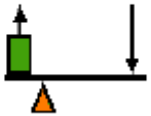
Two inclined planes joined back to back. Wedges are used to split things.

Examples: Axe, Zipper, Knife

Wheel and Axle:

A wheel and axle has a larger wheel (or wheels) connected by a smaller cylinder (axle) and is fastened to the wheel so that they turn together. When the axle is turned, the wheel moves a greater distance than the axle, but less force is needed to move it. The axle moves a shorter distance, but it takes greater force to move it.

Examples: Door Knob, Wagon, Toy Car

	Lever 	Pulley 	Wheel & Axle  Gears 	Inclined Plane 	Screw 	Wedge 
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Additional Teacher Information

- Introduction to Simple Machines
  a. **Why use Simple Machines**?
  ..make our work easier by enabling us to use less mechanical effort to move an object.
  There are often a number of simple machines used together in complex machines
  What is work?
  Work is simply the *application of a force over a distance*, with one catch - the distance only counts if it is in the direction of the force you apply.

In science, **work** is defined as a force acting on an object to move it across a distance.

  b. What are the **6 Simple Machines**?
  Picture of each-the wedge, the ramp, the screw, the lever, the wheel & axel, and the pulley
  c. They can be grouped into two families:
    - **Inclined Plane** Family- Wedge, Ramp, Screw
    - **Lever Family**- Lever, Pulley, Wheel & Axel
- **Picture of machines at work**……how they make life easier…..types of machines
  - Construction site/ Office/ School
- **History** -How did Stone Age people move things?
  -How did the Normans protect their castles?

a) A Ramp:

A ramp (inclined plane), helps us to move heavy objects more easily, but we have to move them further to complete the task. We use less force; however, we have to apply the force over a greater distance. Friction is one problem encountered in using a ramp to move heavy objects.
We use stairs or ramps to walk up and down. If an incline is very steep, steps are cut into the incline to make it easier for us. Ramps are used in moving vans, for wheelchair access and on loading docks.

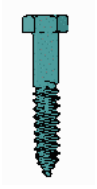
What is friction?

Friction is the resistance produced by rubbing two objects together. To overcome friction, the surface of a ramp should be as smooth as possible. Alternatively, rollers, wheels or lubricant can be used.

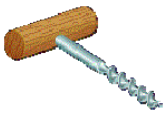
b) A Wedge:

A wedge consists of two back-to-back inclined planes. A wedge looks like an inclined plane but it works differently. It can either hold things together, as in a doorstop or nail, or it can split things apart, as in an axe or chisel. Other wedges include the cutting edge of scissors, knives and screwdrivers.

c) A Screw:



A screw is an inclined plane wound about a nail. The ridges are called the thread of a screw. These threads cut a groove in the wood as you turn the screw, making it hold very tightly. To remove a screw you have to turn in the opposite direction with a screwdriver. It is very difficult to remove a screw by pulling it straight out. The distance between the threads depends on the slope of the inclined plane - the steeper the slope, the wider the thread. Screws with less distance between the threads are easier to turn.
As with any inclined plane used as a simple machine, the force required is less but the distance travelled is greater.



d) A Lever:

The lever is a bar that turns on a point called a fulcrum.

The secret of the lever is the increased distance over which the force moves, i.e., the arm length of the lever, which is determined by the position of the fulcrum (pivot). It is the same principle as the inclined plane - **the greater the distance over which the force must be applied, the smaller the force required to do the work (lift the load).**

Our arm is in fact a lever. How hard it would be to use the arm if it didn't bend at the elbow! The elbow acts as a fulcrum and the muscles between the elbow and shoulder provide the force (hence the lower arm becomes the lever). Imagine that you have a cast on your arm so you can't move your elbow. Now try lifting a bag of flour. Which is easier, with or without the cast?

A shovel, wheelbarrow, hockey stick, wooden bat and tweezers are also levers.

e) A Wheel & Axel

A wheel and axle is a lever that is able to rotate through a complete circle (3600). The circle turned by the wheel is much larger than the circle turned by the axle. The increased distance over which the force is applied as the wheel turns results in a more powerful force on the axle, which moves a shorter distance. For example - the steering wheel, screwdriver, tap handle and wrench.

We use the wheel and axle in gears. **Gears** have teeth around the outer rim. When the teeth of two gears fit together and one gear turns, it will cause the other gear to turn, but in the opposite direction. When the gears are the same size and they have the same number of teeth, they both turn at the same speed. If one gear is larger than the other, however, the smaller gear will turn faster. We use gears to regulate speed and direction of motion in complex machines and to increase/decrease the force applied.

Machines that use gears include clocks, bicycles, cars, eggbeaters and other small household appliances.

A **crank** is the handle of a machine that is connected at right angles to an axle. It is used to transmit motion.

On a bicycle, the pedal attached to the gears is a crank. Cranks are used for turning, for example, the spinning wheel, eggbeater, peppermill etc.

f) A Pulley

Pulleys are wheels with grooves around the rim. The pulley turns as a string moves over the wheel and a load is raised as the string is pulled. This is a **fixed pulley** which doesn't change position. A fixed pulley makes work easier by changing the direction of the applied force. With a fixed pulley, the force required to lift the load remains the **same** as lifting it by hand, but realize how much easier it is to raise a flag or sail from the ground, as opposed to climbing up the pole or mast. If a force needs to be applied around a corner, a pulley allows us to overcome friction.

With a **moveable pulley**, both the load and the pulley move; the load moves in the **same** direction as the applied force. Moveable pulleys allow you to use less force to raise an object than if you

used only your hands. The amount of force required depends on the number of supporting ropes. The greater the number of pulleys and supporting ropes, the smaller the force required.

Sailing ships use pulleys to lift the heavy sails up the mast. A six pulley system meant that a sailor weighing 80 kilograms can lift a sail 6 times the weight of the sailor (480 Kg). Lifting cargo onto the ship was heavy work made increasingly lighter by the use of pulleys.

Simple Machines Word search

A N G E C N A T S I S E R I E R I C
R I M P U L A E D F G H U J N N B V
I N C L I N E D P L A N E O P Z A F
W O E D A N L Q U N N N F C E R O O
L Y L O A D E U L D I S T A N C E O
F R I C T I O N Z H D I U S C A D T
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L I E L O V V E I I C K W K R W S W
S A F O R C E W C H T H R O O M A H
E Z I N C R M H I O L Q E R S T H E

Find these words related to simple machines in the word search puzzle above. Words may be found backwards, forwards, upward, downward, or diagonal.

SIMPLE MACHINE	SCREW	ENERGY	FULCRUM	FORCE
INCLINED PLANE	WHEEL	DISTANCE	LOAD	WORK
FRICTION	LEVER	PULLEY	WEDGE	