Lessons 1-2

Topic: Simple machines

Exploring simple machines

Lesson concepts

- Change to an object's motion is caused by unbalanced forces acting on the object
- Scientific discoveries have significantly changed people's understanding of the world
- Science and technology contribute to finding solutions to contemporary issues
- People use understanding and skills from science in their occupations
- A range of investigation types including experiments, can be collaboratively and individually conducted ensuring safety guidelines are followed
- Scientific understanding can be used to identify relationships and draw conclusions
- Ideas and findings can be communicated using scientific language and representations

Science start-up notes

In this series of lessons, students will be exploring simple machines. There is a wide variety of these machines: tin-openers, pliers, scissors, taps and door handles are examples of simple machines. The purpose of the start-up exercises is to start students thinking about familiar everyday machines.

Lesson notes

This series of lessons focuses on how simple machines help us to apply forces to complete tasks. Students need to concentrate on two aspects, the change in force direction and the change in the size of the force we need to use. A spoon levering up a tin lid has us push down to apply a force to push the lid up — a change of force direction. Get a longer spoon and do it again and you use less force to achieve the goal — the size of force applied is changed.

Some notes and links for simple machines

The inclined plane

Without an inclined plane it will take the same amount of force to lift an object as gravity exerts on the object. This is okay for smaller objects, but bigger ones can be moved upwards more easily on an inclined plane. It can help us lift objects over a greater distance using less force. Ramps, banks of earth, a staircase or escalator are all examples of inclined planes.

The lever

By doubling the length of a lever's arm, you halve the force required to move the load on the other arm. The fulcrum is a support or pivot for a lever. Moving the pivot point (fulcrum) changes the effort or the amount of force required to balance or move the load. You never get something for nothing; what you gain in reduced force, you lose in the extra distance you have to move the load. A claw hammer, seesaw, tin-opener or bottle opener are all examples of levers.

The screw and the wheel

Two simple machines (the lever and the inclined plane) are the basis of all other simple machines.

A winding (or twisted) inclined plane is a screw. A corkscrew, a car jack, a bench clamp, a screw and a bolt are all examples of the simple machine called a screw.

The wheel is actually a circular lever, where the axle of a wheel has taken the place of the fulcrum in a lever. The wheel allows you to apply a greater force to an axle at its centre. A doorknob, a steering wheel and a car wheel are all examples of wheels.

The pulley

The pulley is a wheel that moves freely around an axle. A pulley can change the direction of your pull. A pulley allows an object to be supported by more than one rope. By using less force you can move the object a greater distance when you pull more rope through the pulley.

Practical information

If you have internet access, the learning object listed below can be used to support student investigation of simple machines.

Website
Museum of Science and Industry: Simple machines game (needs Flash)

Lesson answers

1. a) Personal response required. For example: spoon to lever the lid off a tin; hammer to pull nails; bicycle to move you further, quickly and more easily; fan to move the air about; crow bar to open crates; scissors to cut paper and so on.
   b) Personal response required, reflecting current student understanding. Encourage students to focus on how machines can help them to complete actions more easily.
   c) Personal response required. Student response should be supported by appropriate reasons. 'Simple' here means 'using the least parts or steps'. A spoon is much simpler machine to open a lid than a more complicated can-opener.
   d) Personal response required. Student response should be supported by appropriate reasons. Complicated means more parts or steps involved in its functioning. A washing machine is fairly complicated having various moving parts, using electricity and having a computer chip inside to control the programs.

2. For example: corkscrew, posthole digger, soil corer, pineapple corer.

3. a) Personal response required. Students may have difficulty in identifying examples of some simple machines. They will have an opportunity to refer to **Sheet 1 - Simple Machines** to add to this list later in the lesson.

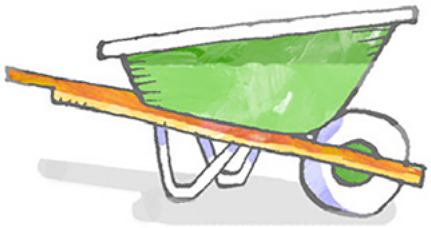
   b) Personal response required, based on student choice. Any diagrams drawn should be scientific line drawings, not free-body diagrams, to help explain where forces act and the directions of these forces.

4. a) Students can enter extra examples from **Sheet 1**, for example:

Simple machine	Everyday examples
lever	seesaw, pliers, the claw of a hammer, crowbar
wedge	axe, knife, door stop, nail
inclined plane	ramp, slide
wheel and axle	wheels on cars, rollerskates, door handle
screw	screw, nut and bolt, corkscrew, spiral stair case, car jack
pulley	pulleys used on sailboats, flag poles and cranes

   b) For example: Levers, pulleys, inclined planes and wedges change the direction of the force. The lever and pulley reverse the direction — to lift an object you push or pull downwards. The inclined plane and wedge push at an angle to the direction you wish something to move.

5. a)

Compound machine	Simple machines
wheelbarrow 	wheel and axle lever inclined plane
seesaw 	inclined plane lever
scissors 	wedge incline plane lever

worm gear and pinion 	wheel and axle screw inclined plane lever
crane 	lever pulley inclined plane
egg beater 	wheel and axle lever screw

b) Personal response required. Encourage students to apply their understanding of simple machines to analyse those they used in the boxes at the beginning of the lesson. There should be more precise answers about force directions and sizes now.

6. a) Personal response required. The answer will depend on what the student observes
   b) Personal response based on students ideas.
   c) They overcome friction by waiting until the Nile river flooded and the water helped them to slide the blocks across the wet sand. Ramp, inclined planes were the simple machines used according to the video.
   d) Personal response required.
   e) Personal response required.

Lesson 3

Topic: Simple machines

Investigating forces on simple machines

Lesson concepts

- Change to an object's motion is caused by forces acting on the object
- Earth's gravity pulls objects towards the centre of the Earth
- Investigation types including experiments, can be collaboratively conducted, ensuring
- Safety guidelines are followed
  Representations can be constructed and used to represent and analyse relationships
- Data from investigations can be summarised and scientific understanding can be used
- Identify relationships and draw conclusions
- Ideas and findings can be communicated using scientific language and representations

Lesson notes

We start with a quick review of levers and their parts then move to investigate two simple machines — a lever and a pulley.

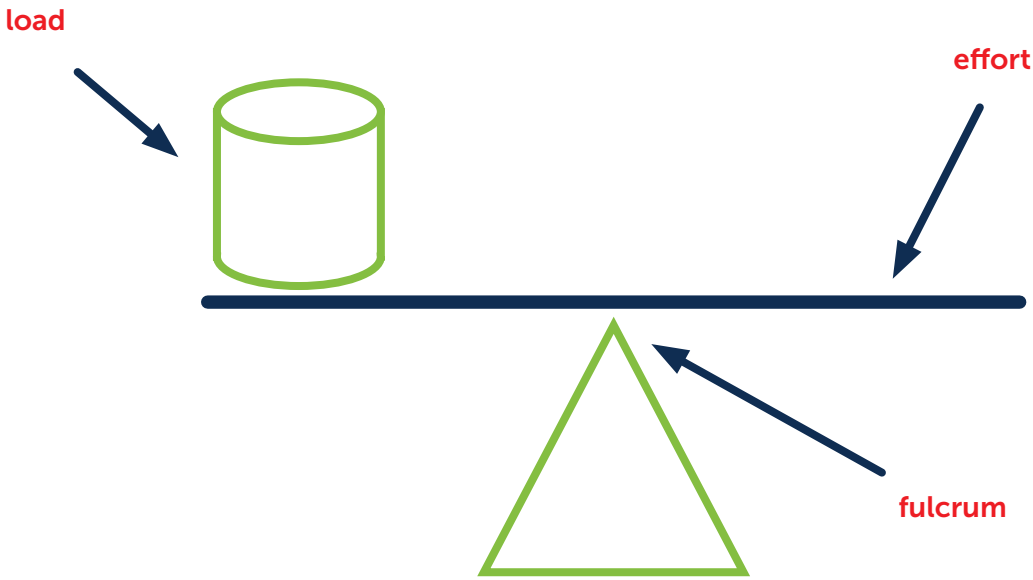
Students complete **Sheet 2** - Levers using simple items found at home, such as pencils or pens, rulers and coins. These tasks allow students to measure forces acting and positions of these forces.

We finish with the concept of mechanical advantage — a measure of how well machines help us. The mechanical advantage is a comparison of the load to the effort. If effort is less than load we have an advantage because we do not need as much force acting to move the load.

Science prior knowledge answers

1.

Action	Simple machine
Open a paint tin lid that is stuck shut.	lever
Load a motorbike onto the back of a trailer.	inclined plane
Attach something to the bottom of a guinea pig cage so that it can easily be moved around the backyard lawn.	wheel and axle
Raise a sail on a yacht.	pulley
Attach two pieces of wood together.	screw
Split a block of wood in half.	wedge



3. Sheet 2 — Levers

Question 1 When you apply force on the crowbar you are using much less force than you would if you were to move the rock yourself.

Therefore, the crowbar has a force advantage because you use less force.

Question 2 Levers

Write a generalisation about the position of the pivot, load and effort.

Note: The student's answer should include explanation of:

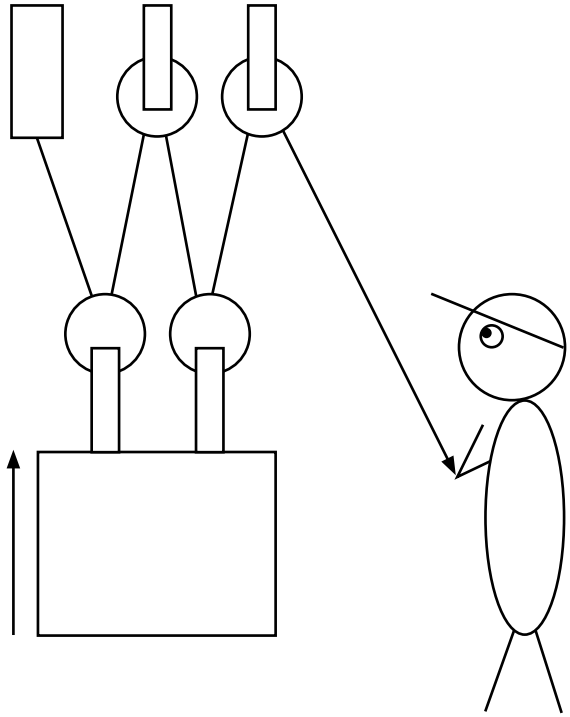
- the relationship between load position, fulcrum and effort in levers
- the relationship between effort position, fulcrum and load in levers
- the relationship between the number of pulleys and effort required to move a load.

4. Sheet 3 – Pulleys

1. The work need to lift the load is equal to the distance the rope is pulled multiplied by the force
2. Table might change as questions selected at random but this is the pattern of answers

Number of pulleys	Crate mass (kg)	Force applied by workers (N)	Distance rope is pulled (m)	Work done (force x distance)
1	40	4 x 100 = 400	1	400
2	40	2 x 100 = 200	2	400
4	40	1 x 100 = 100	4	400
1	40	4 x 100 = 400	1	400
4	40	1 x 100 = 100	4	400
2	40	2 x 100 = 200	2	400

3.



With 4 pulleys, there will be 4 times as much rope pulled as the object will be lifted. For example, if the object is lifted 1m, then 4m of rope needs to be pulled.

4. Write a concluding statement that relates pulleys to force.

   By adding more pulleys, you don't need to use as much force to lift an object. Also, by adding more pulleys, one person can lift more mass.