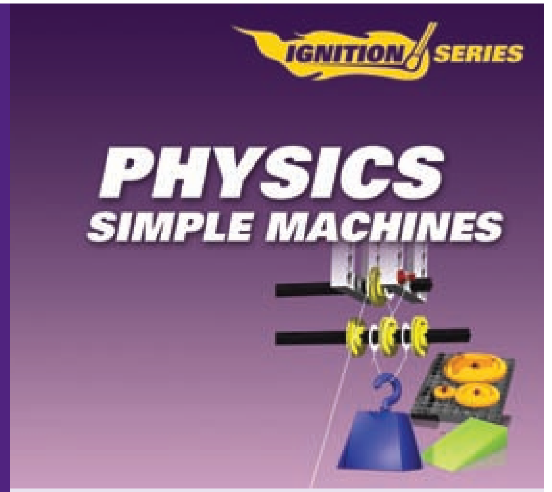

Thames & Kosmos®

Instructions

Warning! — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Only for use by children 8 years of age and older. Use only under careful supervision of adults who have familiarized themselves with the kit's written safety precautions.

A Note to Parents and Supervising Adults
Please stand by your child's side as they do the experiments in this kit, providing support and company to him or her as needed. Read through the instructions together before beginning the experiments, and follow them. Please be sure that no small pieces get into the hands of young children. Provide your child with any required household items that are not contained in the kit, and encourage your child to repeat an experiment if the initial results don't meet expectations.

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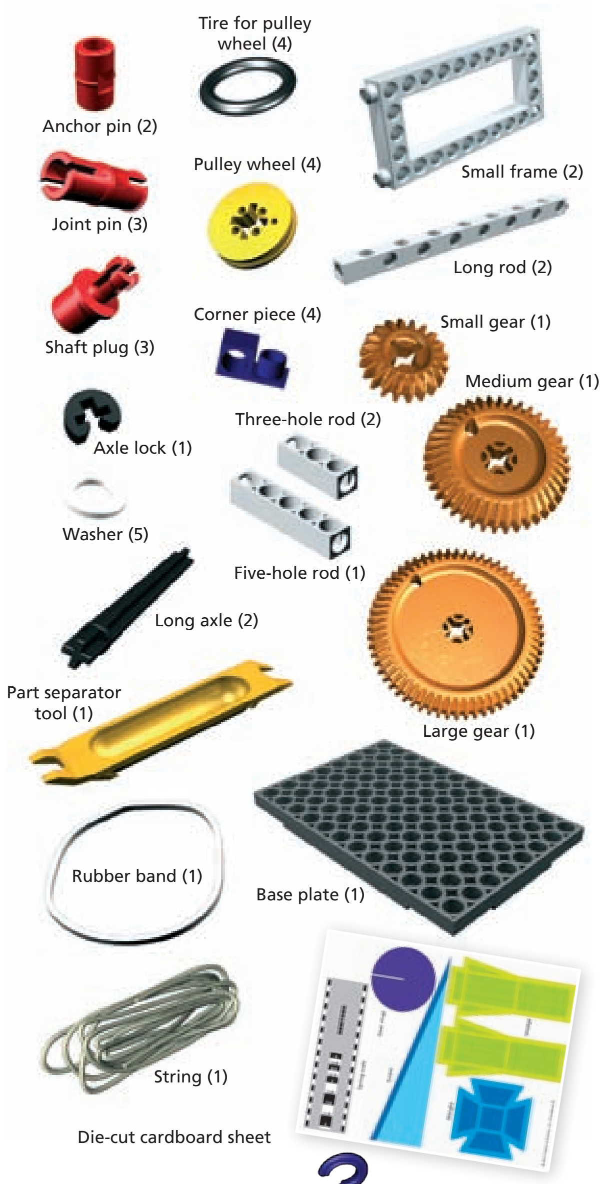


Water Bottle Weight
You will need to make a weight out of a water bottle. Have an adult poke two holes in the bottle cap and use it to tie on the cardboard lid and the hook with the string. Fill the bottle with about a half of a cup of water.

Introduction

Simple machines are devices that make physical work easier by changing the amount of force required to do work or changing the direction of the force required to do work. To understand this, we first need to understand what forces and work are.

For the purpose of this kit, you can think of a **force** as a push or a pull that causes an object to move, or change its speed if it is already moving. When you push on a door to open it, you are applying force to the door to move it open. Forces act on masses (objects with mass) in specific **directions**.

You may think of **work** as the chores your parents make you do or the assignments you do in school, but to a physicist, work is the amount of energy exerted when a force moves an object a certain **distance**. When you carry a box of toys up the stairs, you are doing work equal to the amount of force it takes to move that box the distance from the bottom of the stairs to the top.

So, simple machines make work easier to do by allowing you to push or pull with less force or in a more convenient direction to move an object. But, any force that is saved by using a simple machine must be accounted for in terms of distance. This is an important rule to remember about simple machines. The amount to which a simple machine makes work easier is called its **mechanical advantage**. There are six classic types of simple machines:

Lever: A lever is a rigid bar that can be pivoted on a point, called the fulcrum. Applying force to one part of the lever will cause a load (weight) somewhere else on the lever to move.

Wheel and Axle: This is a wheel with a pole through its center called the axle. It is actually a type of lever that rotates around the fulcrum.

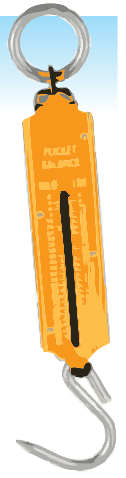
Pulley: A pulley is a wheel and axle with a groove in its circumference. A rope or chain is run through the groove. A weight attached to one end can be moved by pulling in the opposite direction on the other end.

Inclined Plane: This is a ramp where one end is higher than the other. Moving an object up the ramp requires less force than lifting the object vertically.

Screw: A screw is an inclined plane wrapped around a pole. It converts are turning force into a straight (linear) force along the length of the pole.

Wedge: A wedge is two inclined planes attached back to back. It converts a force acting on its end into two perpendicular forces acting out from the sides.

Measuring Forces



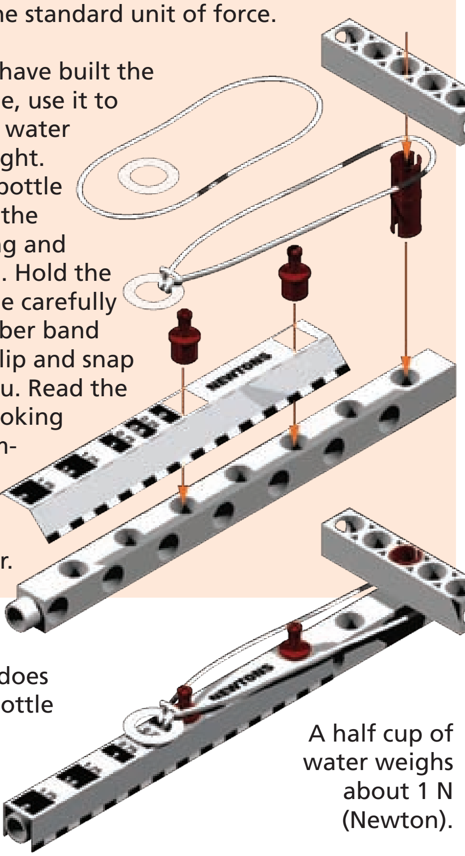
In order to be able to experiment with simple machines and see what they are doing, we need a way to measure forces. To do this, we will build a **spring scale**, which is a simple tool that uses a spring to measure forces. Most spring scales use metal coil springs, but we will build one using a rubber band which exhibits some of the same elastic properties as a metal spring.

The theory behind the way a spring scale works is that the amount of force it takes to stretch the spring is proportional to the distance the force stretches the spring. In other words, a large force will stretch the spring a lot and a small force will stretch the spring only a little. By measuring the distance a spring is stretched, we can approximate the force being exerted on the spring.

Build and Test the Spring Scale

Assemble the spring scale as shown. Use the force meter scale from the die-cut cardboard sheet. This spring scale measures forces in Newtons, which is the standard unit of force.

After you have built the spring scale, use it to weigh the water bottle weight. Hook the bottle weight to the washer ring and let it hang. Hold the spring scale carefully so the rubber band does not slip and snap back at you. Read the scale by looking at the number that shows through the washer.

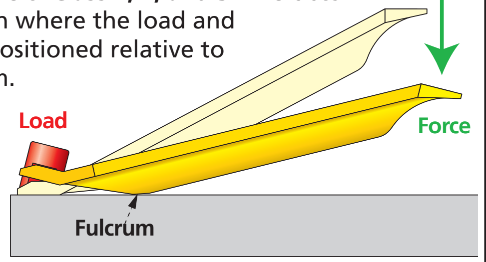


How much does the water bottle weight?

A half cup of water weighs about 1 N (Newton).

Levers

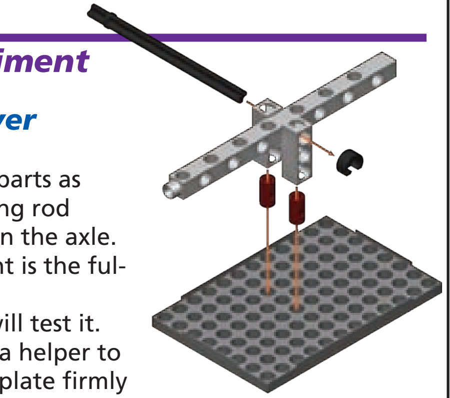
Levers are rigid bars that pivot on a point called the fulcrum. A weight (or load) at one point on the bar can be moved by applying a force to another point on the bar. If the distance from the fulcrum to the force (the **force arm**) is greater than the distance from the fulcrum to the load (the **load arm**), than a smaller force can move a larger load. This is how the lever makes work easier. There are three types of levers: **Class 1, 2, and 3**. The class depends on where the load and force are positioned relative to the fulcrum.



The part separator tool is actually a class 1 lever, as this illustration shows.

01 Experiment

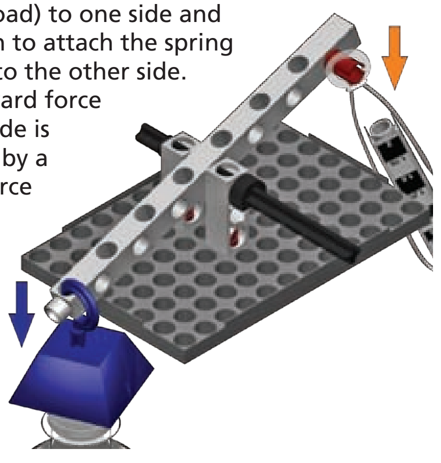
Class 1 Lever

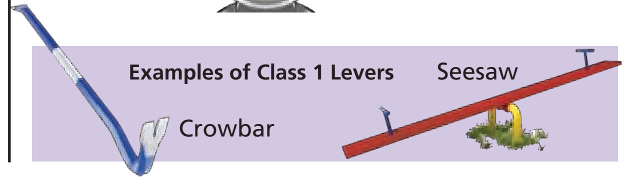


Assemble the parts as shown. The long rod should pivot on the axle. This pivot point is the fulcrum.

Now we will test it. You will need a helper to hold the base plate firmly in place. Hook the water bottle weight (the load) to one side and use a joint pin to attach the spring scale washer to the other side.

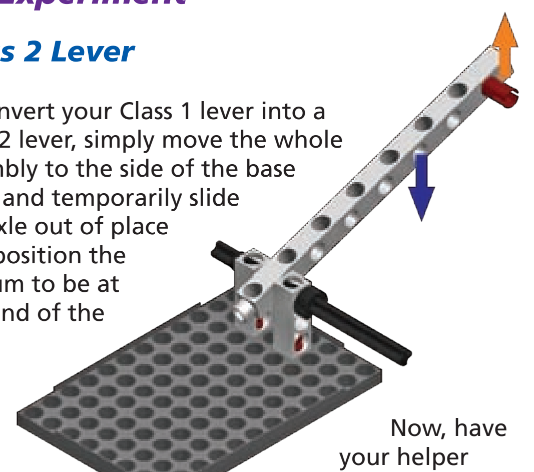
A downward force on the load side is counteracted by a downward force on the other side. How much force does it take to lift the water bottle weight?





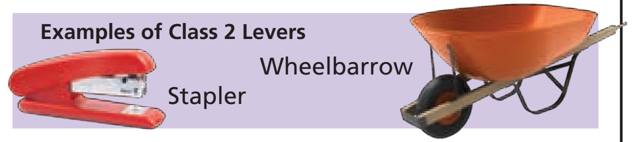
02 Experiment

Class 2 Lever



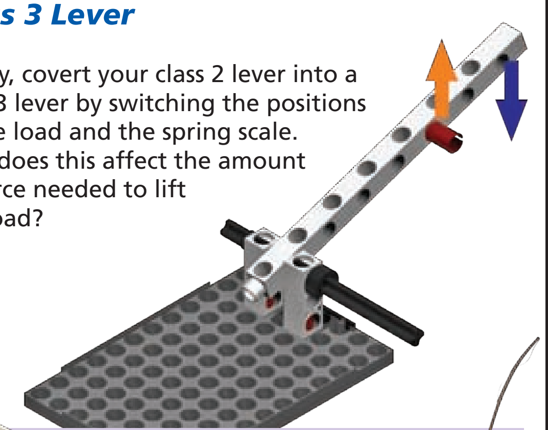
To convert your Class 1 lever into a Class 2 lever, simply move the whole assembly to the side of the base plate and temporarily slide the axle out of place to reposition the fulcrum to be at one end of the lever.

Now, have your helper hold the base plate firmly in place. Affix the bottle weight to the spot where the blue arrow is and hook the spring scale on the joint pin. Now, a downward load is countered by an upward force. How much force does it take to lift the bottle now? If you move the load to a hole closer to the fulcrum, how does it change the force required to lift it?



03 Experiment

Class 3 Lever



Finally, covert your class 2 lever into a class 3 lever by switching the positions of the load and the spring scale. How does this affect the amount of force needed to lift the load?