Physics & Forces Guidebook

Are you curious about mechanical things, force, and motion? Then come along! Let's do the experiments in this kit together to learn all about them!

In this guidebook, you will see a lot of things that you already recognize. But there is so much left to discover about them! The pictures will guide us in doing our experiments and projects. And whenever you see a Try It box, you will see more ideas for other exciting experiments.

And now, let's begin!

little labs™

THAMES & KOSMOS

General Tips for Parents and Children

Caution! Individual parts of this kit are designed with sharp points, corners, or edges. There is a risk of injury. We reserve the right to make technical changes. Keep the experiment kit out of the reach of young children.

Dear Parents and Adults,

This experiment kit is designed for children ages 5 and up. For each experiment, first ask your child the question at the beginning of the experiment. Then present the various pictures to him or her as possible answers. In this way, your child can start to develop ideas about how to explain everyday experiences. Next, your child can follow the pictures to do the experiment mostly by him or herself, to test his or her ideas. That will let your child discover firsthand the answer to the question posed at the beginning. Finally, read your child the answer summary at the end of the experiment to confirm or correct his or her own conclusions.

Because the curiosity and powers of comprehension of children at this age are often more fully developed than their manual skills, your assistance will sometimes be needed. Support your little researchers when they need it. If an experiment doesn't work correctly, encourage your child to try it again.

✚ Please be sure to provide the children with extra materials not contained in the kit. These are designated with a red plus sign.

Spanish language instructions are available online at: www.thamesandkosmos.com/littlelabs

1st Edition, Franckh-Kosmos Verlags-GmbH & Co. KG, Stuttgart/2006

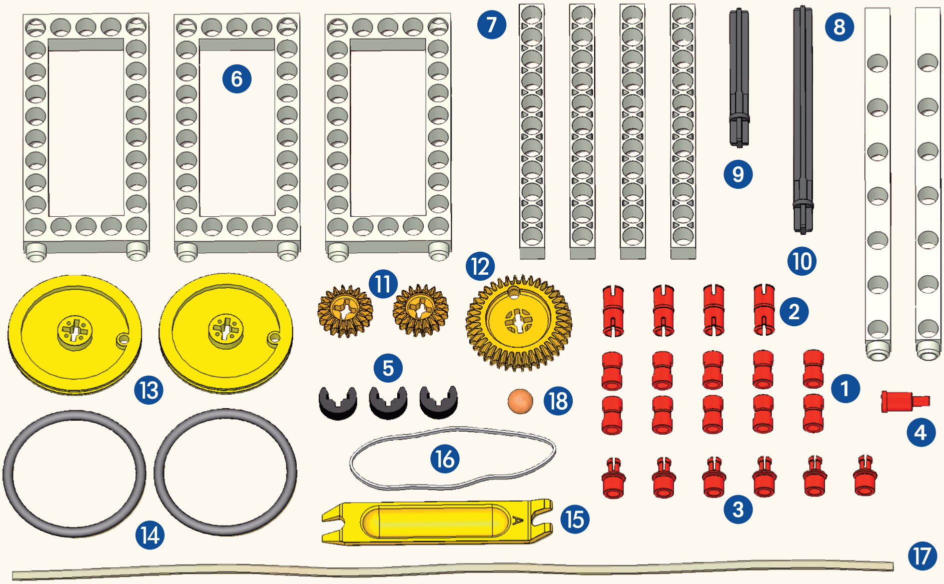
Printed in Taiwan

Project management: Annette Büchele. Layout and illustrations: komuniki – Michael Schlegel, Würzburg, Andrea Mangold, München

Translation: Lise and Jens Kure-Jensen
Editing, layout and production: Ted McGuire, Dan Freitas

Getting Started: What comes in your kit?

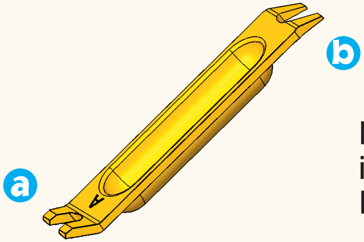
Kit contents:



1	Anchor pin	10	Long axle
2	Joint pin	11	Small gear wheel
3	Shaft plug	12	Medium gear wheel
4	Shaft pin	13	Large pulley wheel
5	Axle lock	14	Tire for large pulley
6	Short frame	15	Part separator tool
7	Short rod	16	Rubber band
8	Long rod	17	Long rubber band
9	Short axle	18	Wooden ball

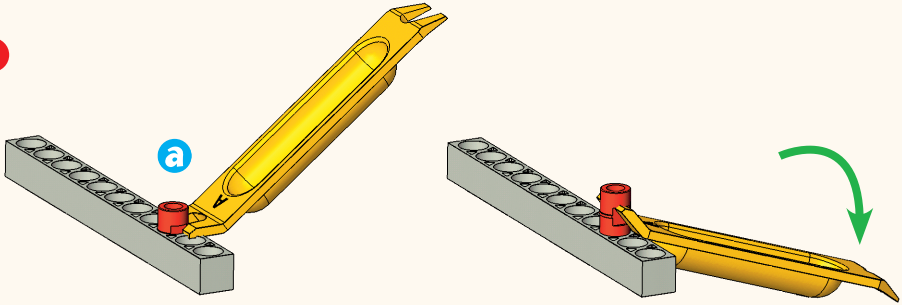
The names "short frame" and "medium gear wheel" come from previously issued kits and make identification of these parts easier.

Assembly Tips: How do you use these pieces?

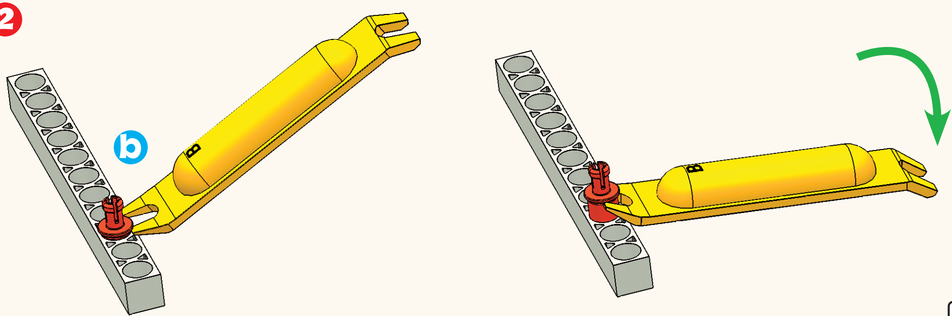


Here are some instructions for using the Part Separator Tool.

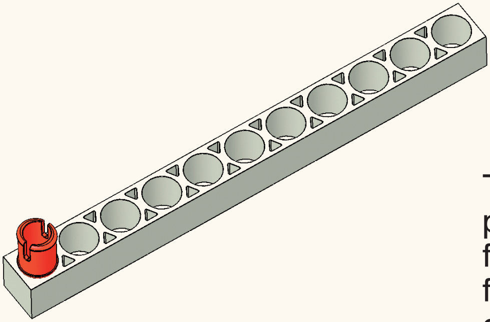
1



2

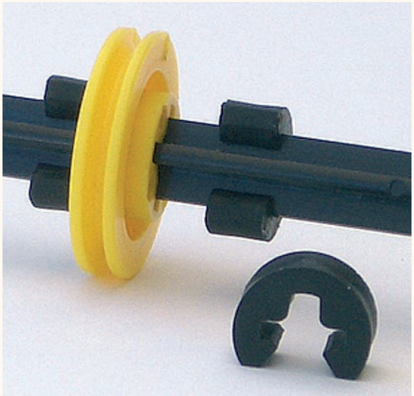


3



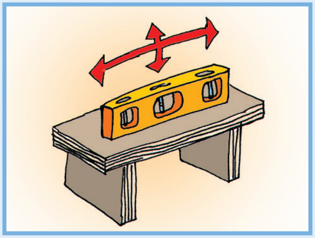
To remove a joint pin, pull it out with your fingers or push it out from the rear with the anchor pin lever.

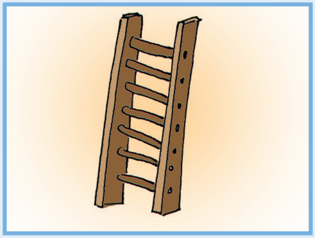
4

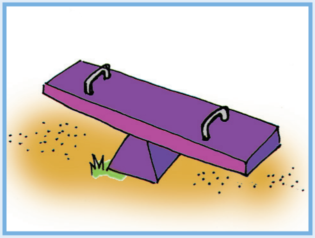


To make sure that the wheels do not slide off, axle lock clips are installed.

Experiment 1: What does a lever do?

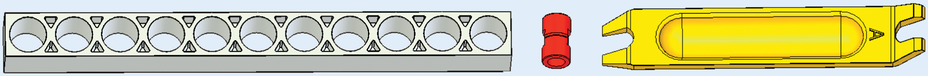


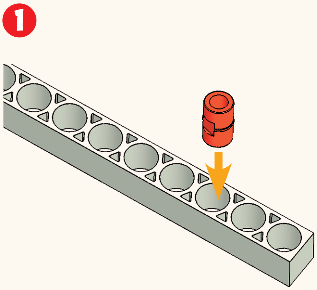


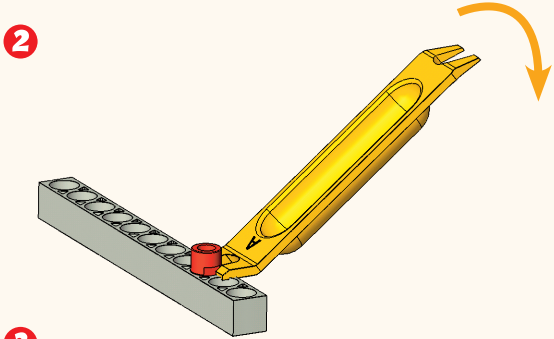


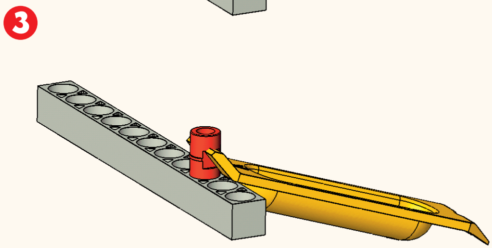
Or do you have other ideas?

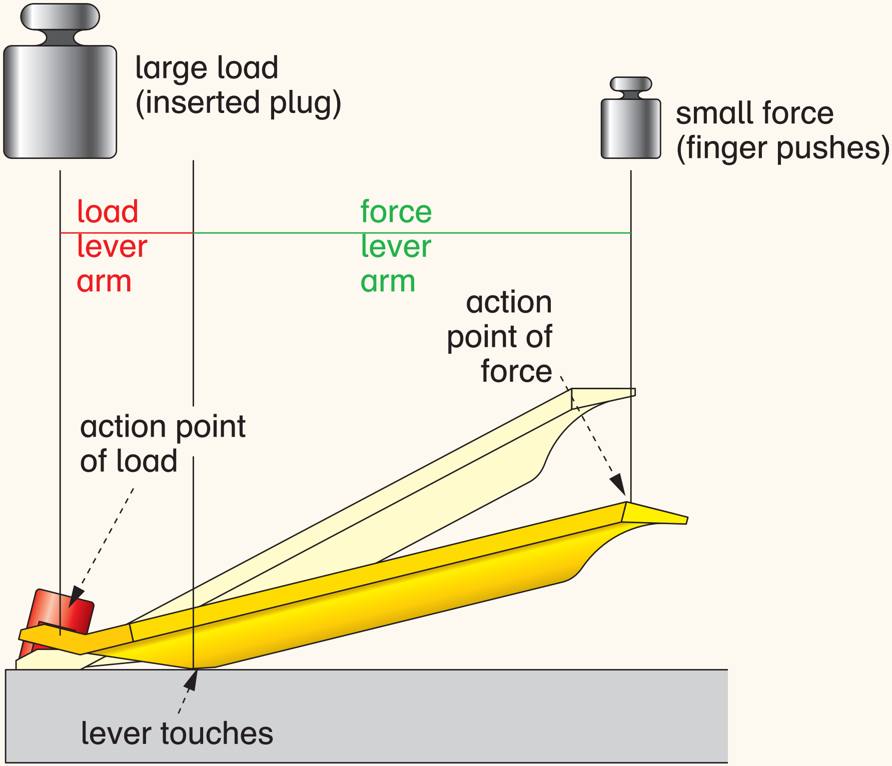
Figure it out like this:





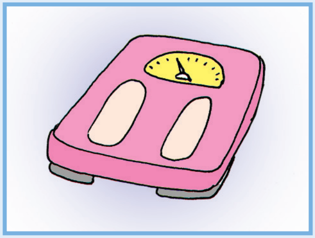


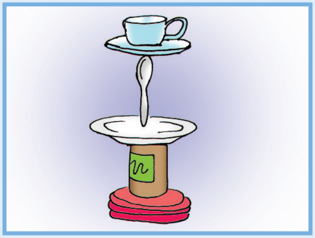




Answer:
You cannot pull the plug out with your fingers, but the part separator tool can help you do it. It is a lever. The part of the lever that lifts the plug is shorter than the part you push on with your finger. With the long lever, you can pull out the plug with a small force. Some door handles are also shaped as levers. Can you think of other levers?

Experiment 2: How does a balance scale work?

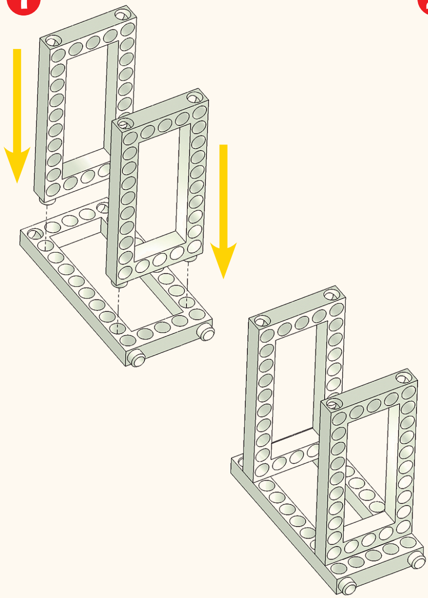




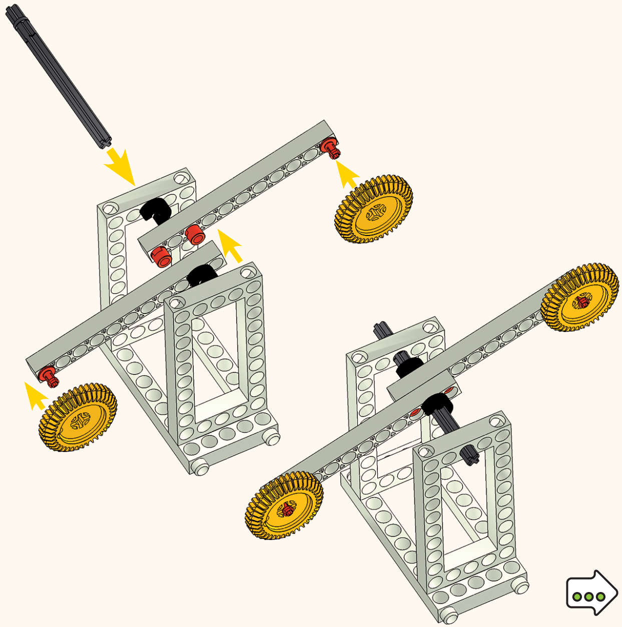
Or do you have other ideas?

Figure it out like this:

1



2



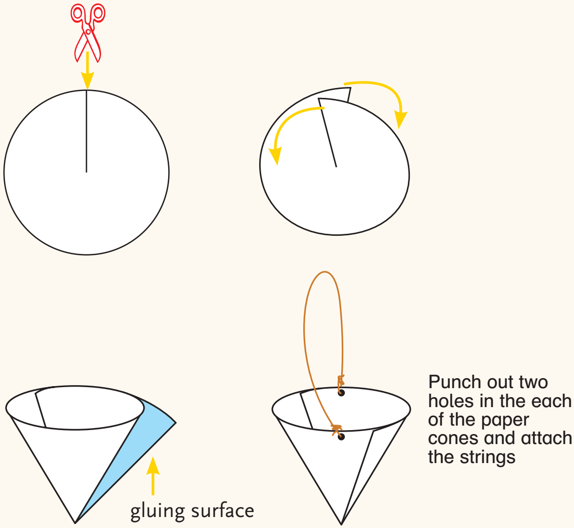
Answer:

Here you have two levers. They are connected in the middle, at the point of rotation, like two arms. If both sides are loaded with the same weight, the scale is in balance. If you remove one gear wheel, the other side will be heavier and move downward.
This way you can compare weights and also measure them if you know the numerical weight of one of them.

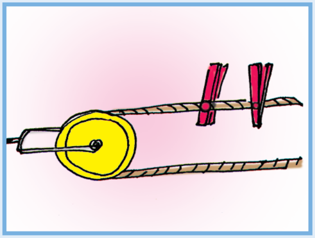
Tip: Try attaching more gear wheels on both sides using more shaft plugs. The closer to the point of rotation a weight is attached, the lighter it will seem to be.

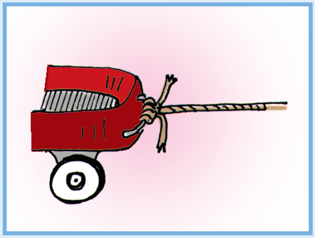
Continue to experiment:

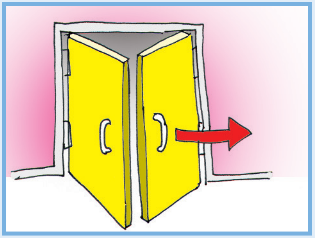
To compare the weight of other items (such as coins or marbles), you will need two weighing pans that you can attach to the shaft plugs. All you need for this are two circular pieces of paper, two pieces of string, some glue, and scissors.



Experiment 3: What does a pulley do and where can you find pulleys?

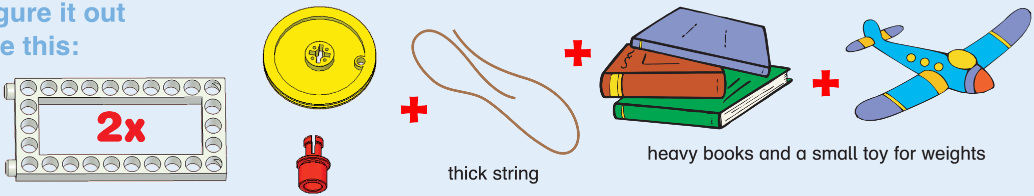






Or do you have other ideas?

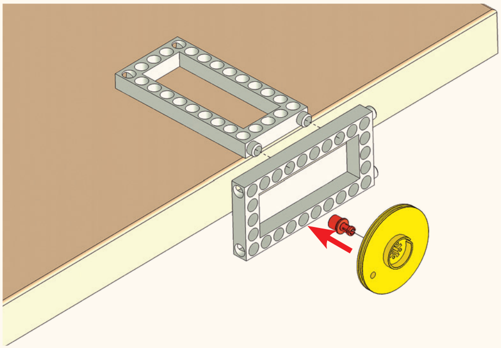
Figure it out like this:



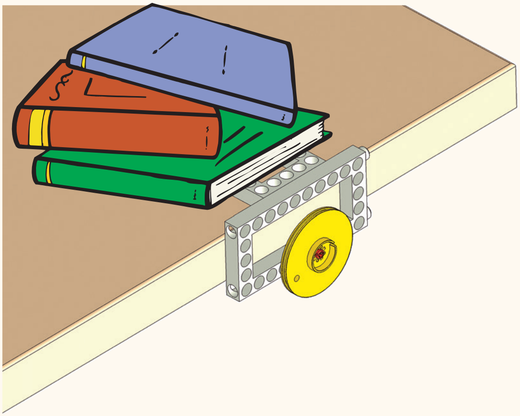
thick string

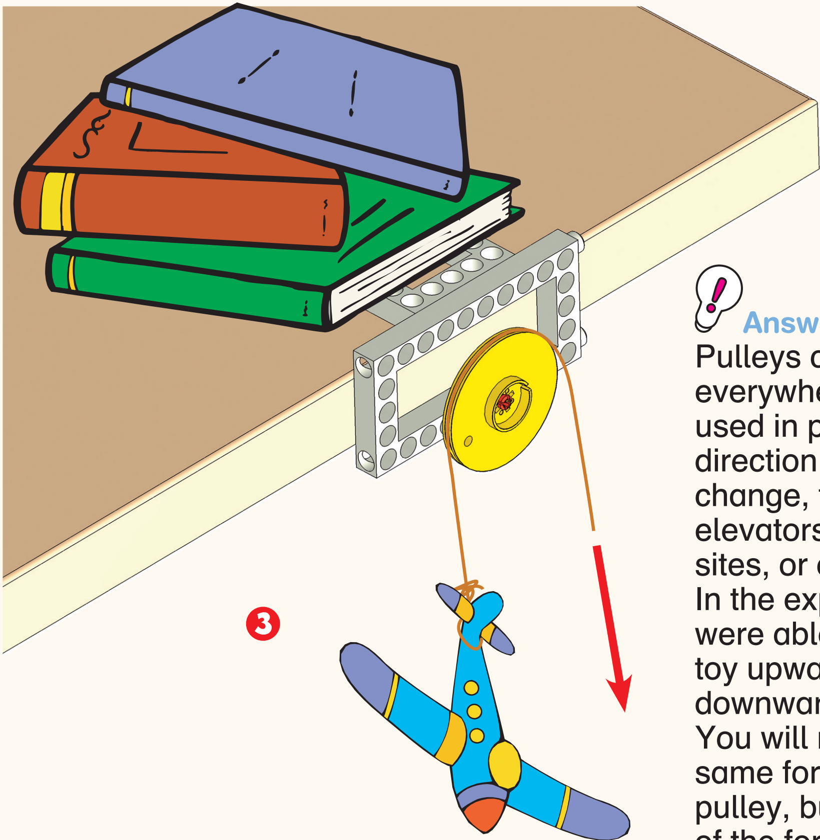
heavy books and a small toy for weights

1



2

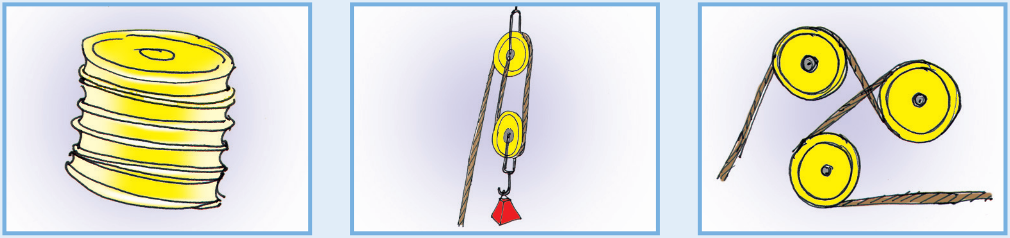




Answer:

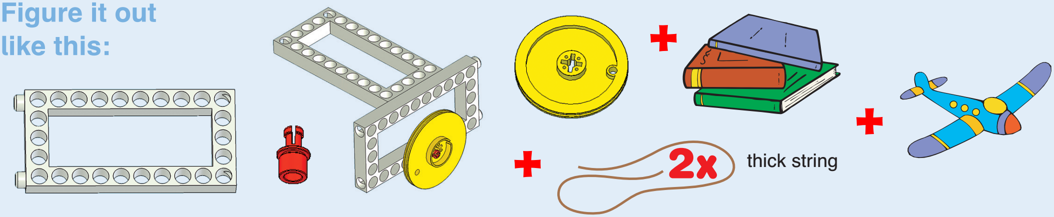
Pulleys can be found everywhere. They are used in places where the direction of a force must change, for example on elevators, construction sites, or onboard sailboats. In the experiment, you were able to move your toy upwards by pulling downwards on the string. You will need exactly the same force as without a pulley, but the direction of the force is changed. This is how a construction worker standing on the ground can easily get materials to his coworker above.

Experiment 4: How can pulleys be put together to make lifting easier?

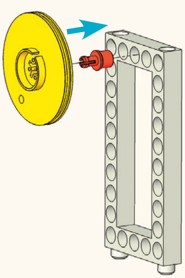


Or do you have other ideas?

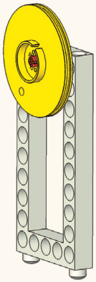
Figure it out like this:



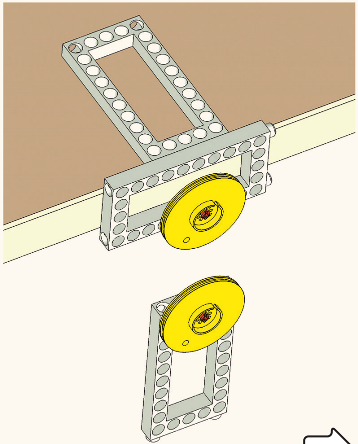
1

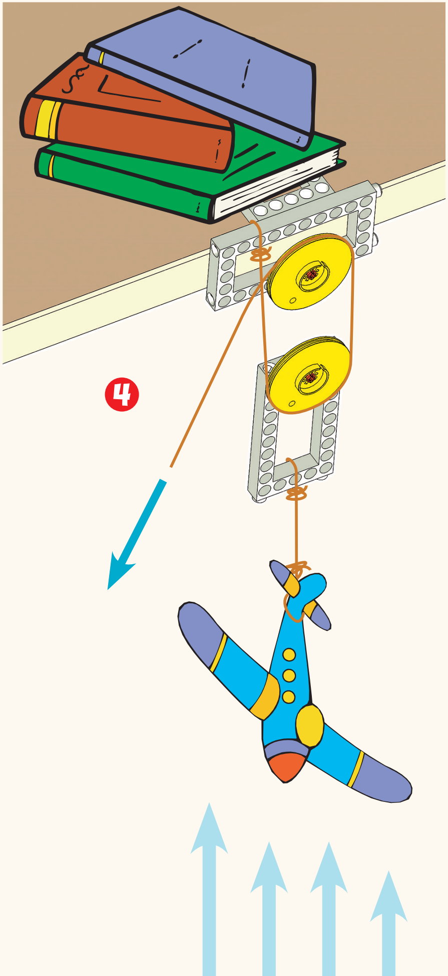


2



3





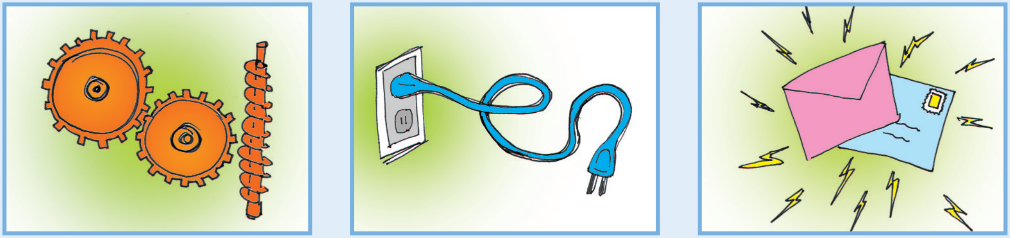
Answer:

Two or more pulleys can be put together into a device called a block and tackle. The simplest version has a fixed pulley, like the one from the previous experiment, and a moving pulley attached to the load. When lifting the load, you will notice that you are changing the direction of the force. You are pulling down instead of up. And when pulling, you can feel that you need far less force than the weight of the load.

The load, your toy, hangs from two sections of the string: one to the left and one to the right of the pulleys. This cuts the force you need to hoist it up in half. But, you will have to pull more string to raise the load the same distance as with the single fixed pulley.

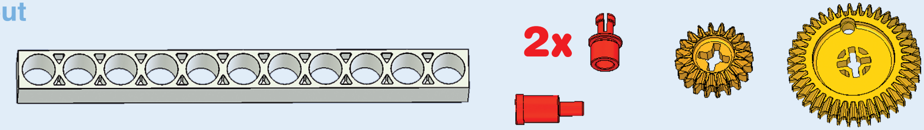
The block and tackle was most commonly used on sailing ships to help seamen hoist and secure heavy sails. It is also useful in hoisting up parts at construction sites. Archimedes is said to have invented the block and tackle over 2,200 years ago!

Experiment 5: How can you transmit power from one place to another?

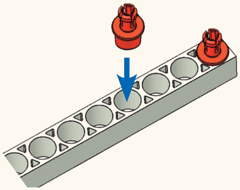


Or do you have other ideas?

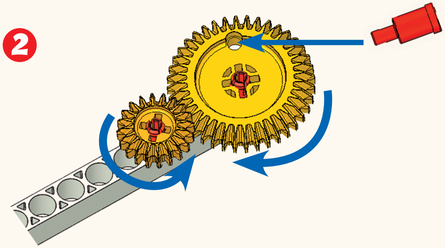
Figure it out like this:



1



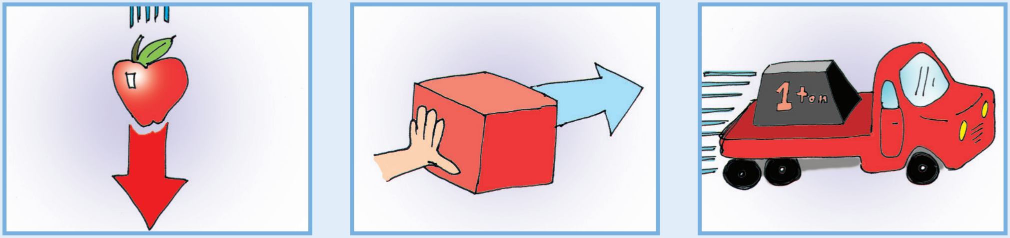
2



Answer:

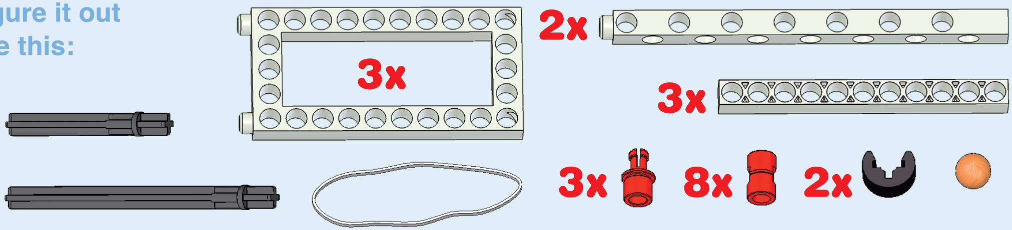
Build a power transmission! This transmission uses gears. With this, you can transmit a force from one gear to the other and either make it larger or smaller. The small gear has 20 teeth, whereas the larger has 40 teeth, which is twice as many. When you turn the large wheel once with the help of the peg (like a crank), the small wheel turns twice. The score is 2:1 for the small wheel. This is called the gear ratio. Turn the small wheel several times and count the revolutions of the larger gear wheel! Other possible ways of transmitting power are: with chains (like on a bicycle), and with a belt or rubber band like in the rubber motor that you can build later.

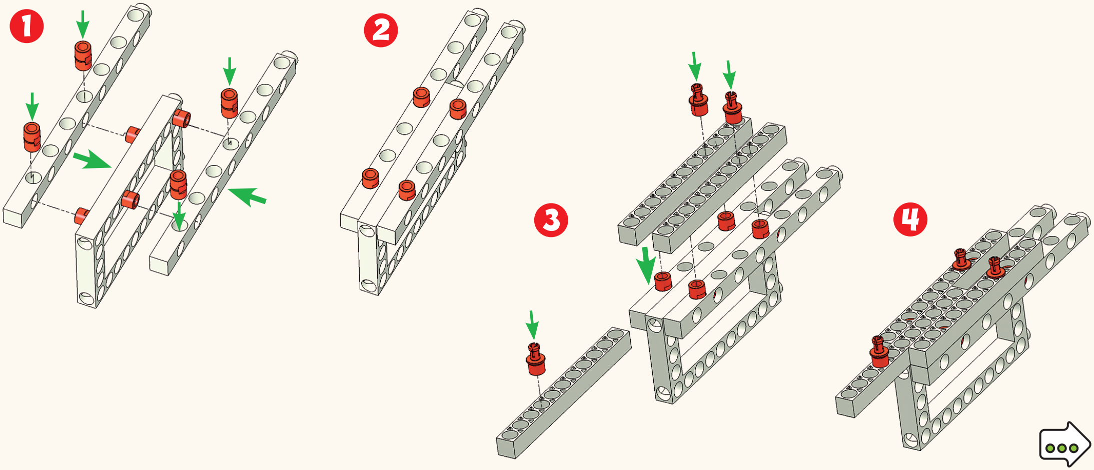
Experiment 6: How does force relate to motion?



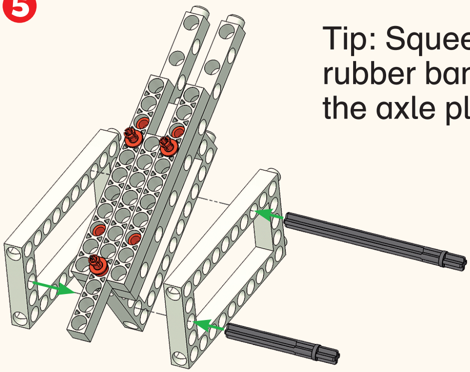
Or do you have other ideas?

Figure it out like this:



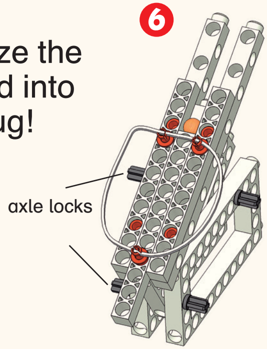


5

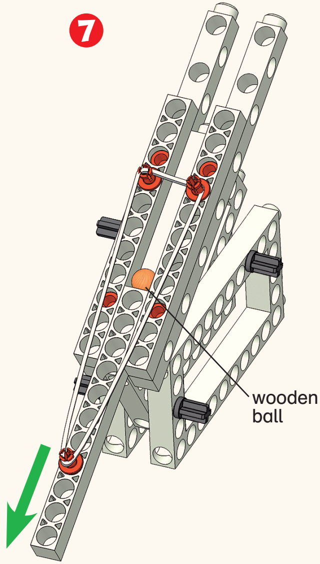


Tip: Squeeze the rubber band into the axle plug!

6



7



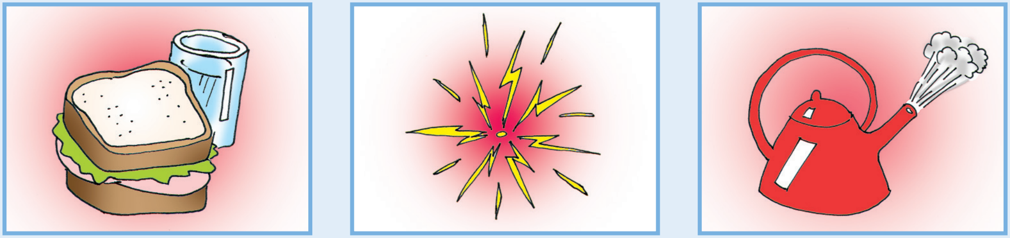
Tip: Build yourself a target goal or measure which of your friends can shoot the farthest. Also, try out different angles of elevation!

Answer:

You built a catapult, which uses force to propel the wooden ball. Without force, there is no acceleration, or change in speed. The catapult uses a stretched rubber band to supply the force to the ball. This force gives the ball an acceleration, which means that it flies away in a high trajectory. Nevertheless, gravity forces the ball back to the ground. Gravity is the attraction of the Earth that keeps us on the ground — without which we would float off into space.

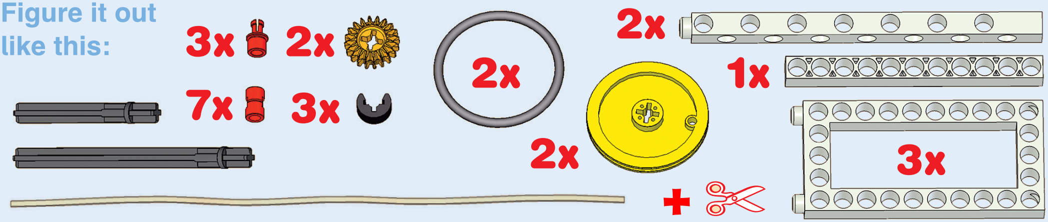
Force is measured in Newton (N) in the metric system and in pounds (lb) in US conventional system. From the point of launch to the return point, the ball flies in a curve. If you wish to change this curve, change the firing angle of the catapult and watch what happens.

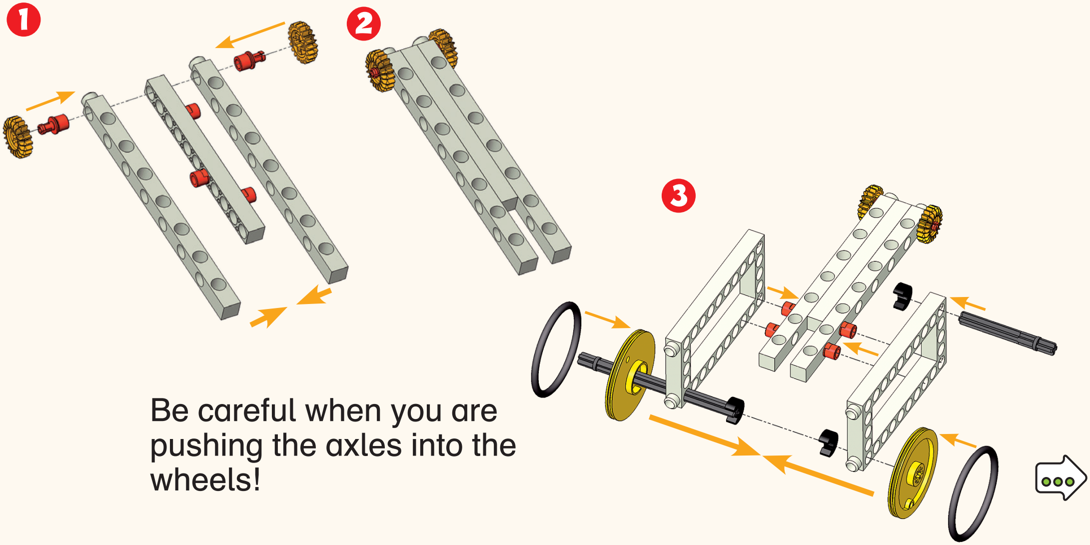
Experiment 7: What is energy?



Or do you have other ideas?

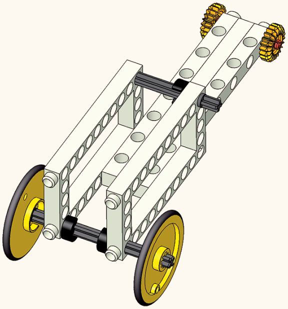
Figure it out like this:



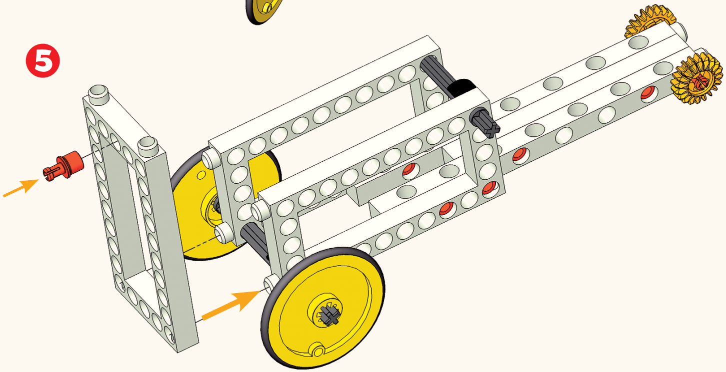


Be careful when you are pushing the axles into the wheels!

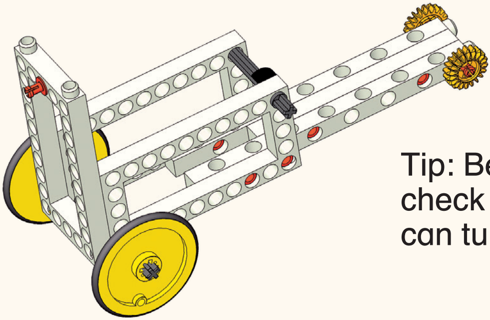
4



5

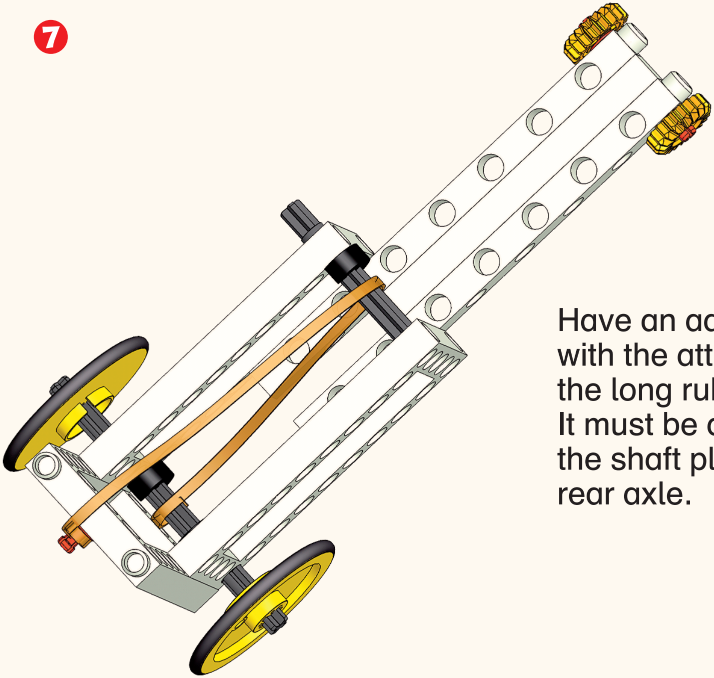


6



Tip: Before starting, check that the wheels can turn freely!

7



Have an adult help you with the attachment of the long rubber band! It must be attached at the shaft plug and at the rear axle.

Answer:

Energy is the ability of a thing to do work, such as move from one place to another. There are many types of energy. We can use this racecar to learn about two types: potential energy and kinetic energy.

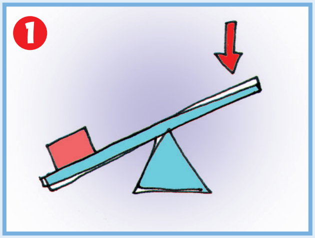
Pull your car backwards while pressing it firmly to the floor. This will wind the rubber band around the axle. Through your work of pulling the car backwards, energy is stored in the rubber band. This stored energy is called potential energy.

When you let the car go, it races away and the energy is changed from potential energy into movement energy (or kinetic energy).

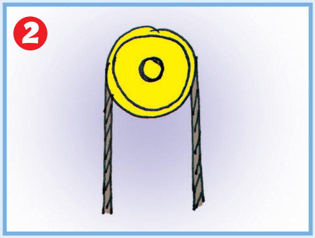
What are simple machines?

Answer:

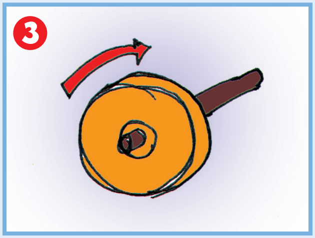
Simple Machines are devices that just need a single force to do work. They are used to make work easier, because they can reduce the amount of force needed to do the work, such as move an object. There are six simple machines:



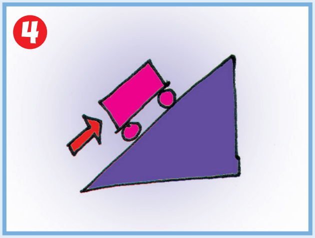
Lever: a bar that rests on a turning point that can be used to decrease the amount of force needed to move a load.
Experiment 1.
Examples: seesaw, crowbar, doorknob



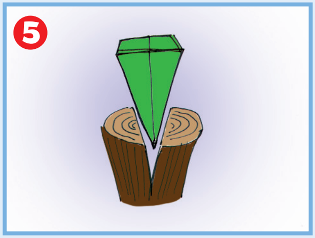
Pulley: a wheel with a groove in it that holds a cable. It can reverse the direction of a force, and when used in combination with other pulleys, can decrease the amount of force needed to move a load.
Experiments 3 and 4.
Examples: clothesline, block and tackle, hoist



Wheel and Axle: a lever that turns in circles around a point, which can decrease the amount of force needed to move a load.
Experiments 5 and 7.
Examples: wheels on a car, gears on a bike



Inclined Plane: a surface set at an angle that can be used to decrease the force it takes to move a load by increasing the distance that load must travel.
Examples: ramp, knife blade, propeller



Wedge: two inclined planes put back to back that can be used to split objects.
Examples: axes, wedges, nails

Screw: an inclined plane wrapped around a cylinder. It can convert a force going in a circle into a force going in a straight line.
Examples: wood screws, worm gears