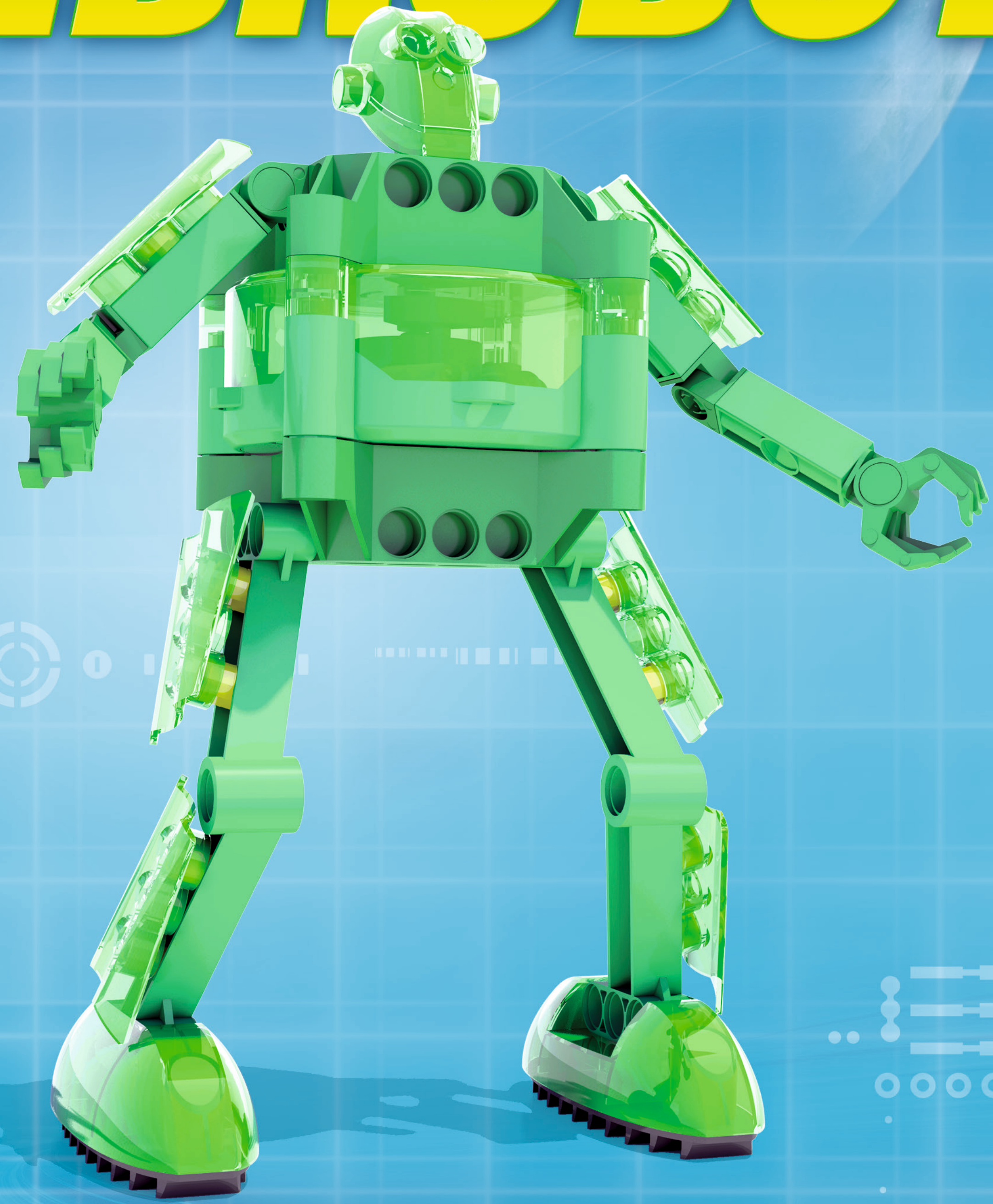
EXPERIMENT MANUAL

VIBROBOT



THAMES & KOSMOS

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Safety Information

When handling the vibrating motor, hold it securely so that it doesn't shake itself out of your hands! It's best to turn it off whenever you are handling it. Don't hold the switched-on vibrating motor for long periods of time. Regarding the underside of vibrating motor: Do not bring hair or fingers in contact with the rotating shaft.

NOTE! Not suitable for use by children under 3 years of age. There is a risk of choking if small parts are swallowed or inhaled. Store the experiment material, particularly the battery-powered vibrating motor, and assembled models out of the reach of small children.

NOTE! Only for use by children 8 years and older. Instructions are included for parents or other supervising adults. Please follow them! Save the packaging and instructions. They contain important information.

Safety for Experiments with Batteries

››› Never experiment with wall outlets or the household power supply. Never insert wires or other parts into wall outlets! Household voltage can be deadly.

››› For operation, you will need three AAA batteries (1.5-volt, type AAA/LR03) or three AAA rechargeable batteries (1.2-volt, min. 1100 mAh), which are not included in the kit due to their limited shelf life.

››› The supply terminals are not to be short-circuited. A short-circuit could lead to overheating of circuits and battery explosions.

››› Different types of batteries or new and used batteries are not to be mixed.

››› Do not mix old and new batteries.

››› Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.

››› Only install batteries in the correct polarity direction. Press them gently into the battery compartment.

››› Always close battery compartments with the lid.

››› Never recharge non-rechargeable batteries. They could explode!

››› Rechargeable batteries are only to be charged under adult supervision.

››› Rechargeable batteries are to be removed from the toy before being charged.

››› Exhausted batteries are to be removed from the toy.

››› Dispose of used batteries in accordance with environmental provisions.

››› Make absolutely sure that metallic objects such as coins or key chains are not left in contact with battery terminals.

››› Do not bend, warp, or otherwise deform batteries.

With all of the experiments that use batteries, have an adult check the experiment or model **before use** to make sure you have assembled it properly.
After you are done experimenting, remove the batteries from the battery compartments. Note the safety information accompanying the individual experiments!

Notes on disposal of electrical and electronic components

The electronic components of this product are recyclable. For the sake of the environment, do not throw them into the household trash at the end of their lifespan. They must be delivered to a collection location for electronic waste, as indicated by the following symbol:

Please contact your local authorities for the appropriate disposal location.

Dear Parents!

Before starting the experiments, read through the instruction manual together with your child and discuss the safety information. Check to make sure the models have been assembled correctly, and assist your child with the experiments.
We hope you and your child have a lot of fun with the experiments!

Kosmos Quality and Safety

More than one hundred years of expertise in publishing science experiment kits stand behind every product that bears the Kosmos name. Kosmos experiment kits are designed by an experienced team of specialists and tested with the utmost care during development and production. With regard to product safety, these experiment kits follow European and US safety standards, as well as our own refined proprietary safety guidelines. By working closely with our manufacturing partners and safety testing labs, we are able to control all stages of production. While the majority of our products are made in Germany, all of our products, regardless of origin, follow the same rigid quality standards.

1st Edition 2013

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An experiment to help you hit the ground running

Here's where unexpected forces are generated...
Check it out, and prepare to be surprised!

WANT TO LEARN MORE?
Then come along into the fascinating world of vibrating motors...

Are you strong enough for the vibrating motor?

YOU WILL NEED

- **Vibrating motor**
- *3 x AAA batteries (1.5-volt, type AAA/LR03) or 3 x AAA rechargeable batteries (1.2-volt, min. 1100 mAh)*

HERE'S HOW

1. Find the vibrating motor in the box and open the cover on the underside. That's how you get to the battery compartments.
2. Insert the batteries into the battery compartments as indicated on the inside.
3. Now place the cover back on.
4. Hold the vibrating motor very firmly and slide the switch on its underside in one direction or the other.
5. Next, return the switch to its original position and slide it in the opposite direction.

Are you strong enough for the vibrating motor?

WHAT'S HAPPENING?

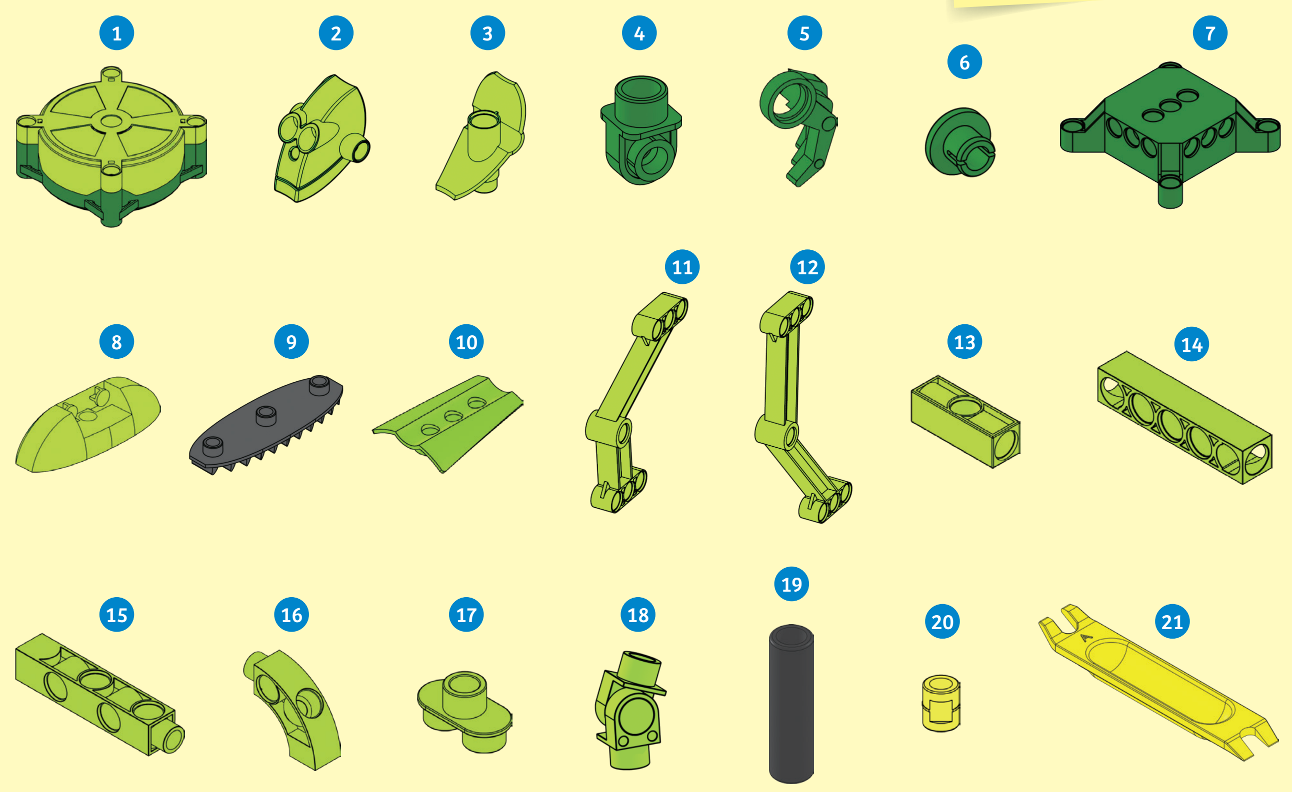
Look into the top of the vibrating motor. Do you see how the little arm inside starts to turn? It starts slowly, but gradually moves faster and faster. You don't just see it, you can actually feel it — it's so powerful that you have to hold the vibrating motor tightly to keep it from getting away. The vibration is caused by the movement of this arm, which is equipped with a weight and is mounted a little off-center. It's the rapid out-of-balance rotation that generates the force you feel.

›› KIT CONTENTS

GOOD TO KNOW! If you are missing any parts, please contact Thames & Kosmos customer service.

Any materials not included in the kit are indicated in *italic script* under the "You will need" heading.

The parts in your kit:



Checklist: Find – Inspect – Check off

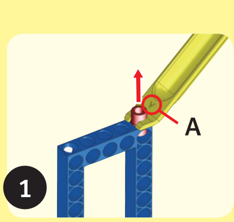
✔	No.	Description	Count	Item-No.
❍	1	Vibrating motor	1	714 194
❍	2	Head	1	714 201
❍	3	Neck	1	714 202
❍	4	Wrist	2	714 327
❍	5	Hand	4	714 203
❍	6	Rivet	4	714 328
❍	7	Body	2	714 200
❍	8	Foot	2	714 198
❍	9	Non-slip sole	2	714 199
❍	10	Armor panels	6	714 197
❍	11	Right leg	1	714 196

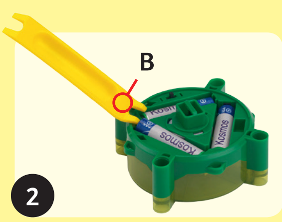
✔	No.	Description	Count	Item No.
❍	12	Left leg	1	714 195
❍	13	3-hole dual rod	8	714 186
❍	14	5-hole rod	1	714 187
❍	15	5-hole dual rod	4	714 188
❍	16	Curved rod	1	714 189
❍	17	Two-to-one converter	2	714 190
❍	18	Hinge	12	714 191
❍	19	Tube, 30 mm	2	714 287
❍	20	Anchor pin	22	714 193
❍	21	Anchor pin lever	1	702 590

The anchor pin lever

In the box, you will find a little tool — the yellow anchor pin lever.

1. End A of the anchor pin lever makes it easy to remove anchor pins from the frames.
2. End B of the tool is used for removing batteries from the battery compartments.

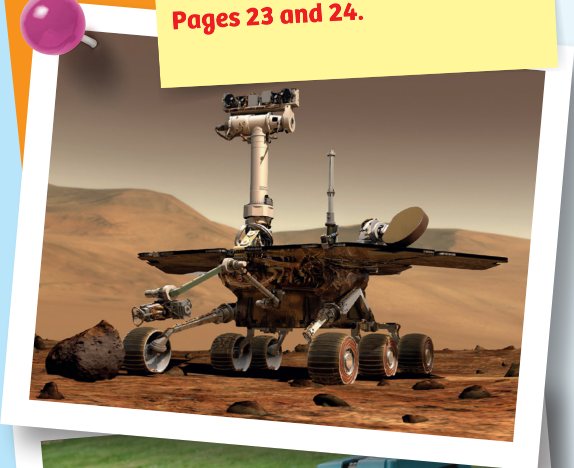




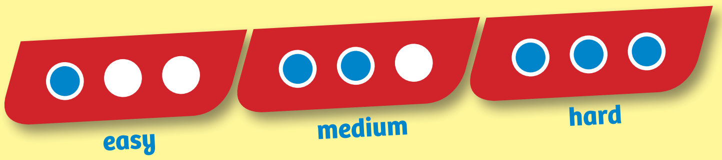
You will also need:
3 x AAA batteries (1.5-volt, type AAA/LR03) or 3 x AAA rechargeable batteries (1.2-volt, min. 1100 mAh), box of opaque watercolor (gouache) paints, paintbrush, paper, water, paper towels, old clothes, clean empty yogurt container, one or two felt-tip pens, small rocks in a bag

››› TABLE OF CONTENTS

TIP!
You will find supplemental information here: "Check It Out" Pages 23 and 24.



TIP!
At the top of each model assembly page, you will find a red bar:
››› It shows how difficult the model's assembly will be:

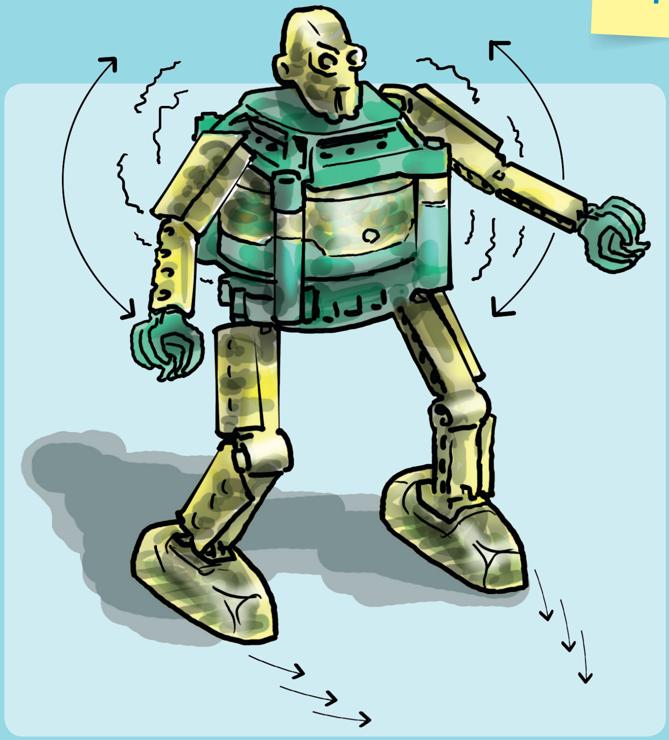


Vibration Technology

Vibro – what? In this case, "vibro" is an abbreviation of the word "vibration." Your vibrating motor works with vibration technology. It has a swing arm attached to the shaft of its motor, so the arm rotates as the motor shaft turns. The fact that the arm is mounted off-balance makes the whole device vibrate. A lot of things operate with vibration technology: your cell phone, fitness machines, and paving compactors used in street construction.

EXPERIMENT 1

TIP!
Your robot will move best on a large, smooth surface.



What makes your robot walk?

YOU WILL NEED

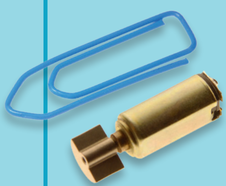
› **The assembled vibrobot**
› *3 x AAA batteries or 3 x AAA rechargeable batteries*

HERE'S HOW

1. Start by following the assembly instructions for your vibrobot. You will find the instructions on the following pages.
2. Remove the vibrobot's legs and open the cover on the underside of the vibrating motor. That's how you reach the battery compartments.
3. Insert the batteries in the direction indicated in the compartments. Then replace the cover and reattach the legs.
4. Remove the soles from the bottoms of the vibrobot's feet. Slide the switch on the underside of the vibrating motor in one direction or the other.
5. Does the vibrobot start walking right away? What happens when you slide the switch in the other direction?
6. Now you can try different experiments. Switch off the vibrating motor and mount the soles on the vibrobot's feet. Start with the grips on the soles tilted to the rear.
7. Switch on the vibrating motor. In what direction does the robot walk? Turn the soles around. What happens now?
8. By changing the positions of the two arms, can you get the robot to walk forward? Try it with one arm straight up and the other arm straight out in front, for example.

DID YOU KNOW?

Inside your cell phone, there's a tiny motor that is smaller than a paper clip. It, too, spins an unbalanced weight. That's what makes the cell phone vibrate when set to vibration mode.

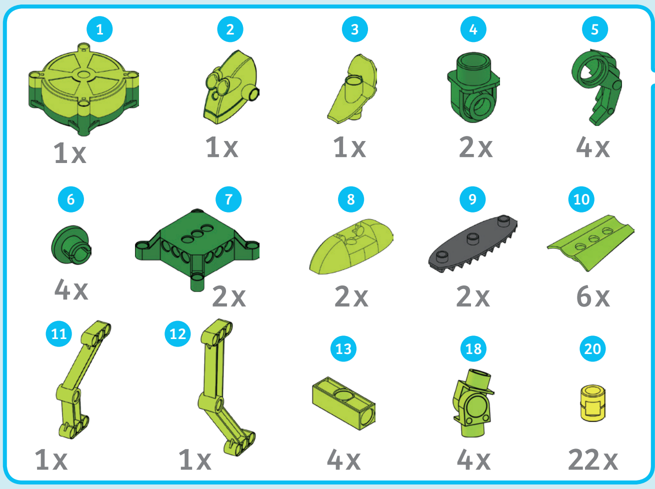


TIP!
Run some more experiments: Turn just one of the soles around or change the position of the arms.

WHAT'S HAPPENING?

The vibrations from the motor are passed along to the entire robot — all the way down to his feet. Depending on the direction that the arm swings, the robot will turn to the right or the left. The direction of the sole's treads or the direction in which the arms point will also determine the direction of movement — forwards, backwards, or in a circle.

VIBROBOT



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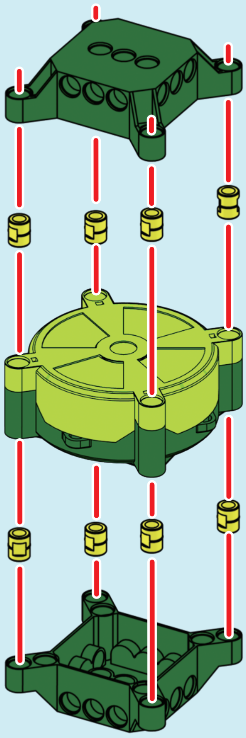

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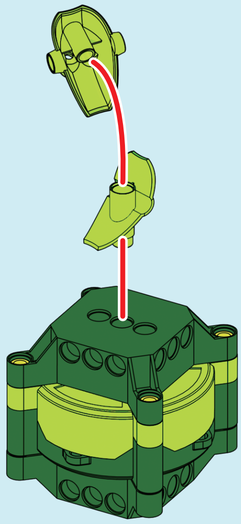

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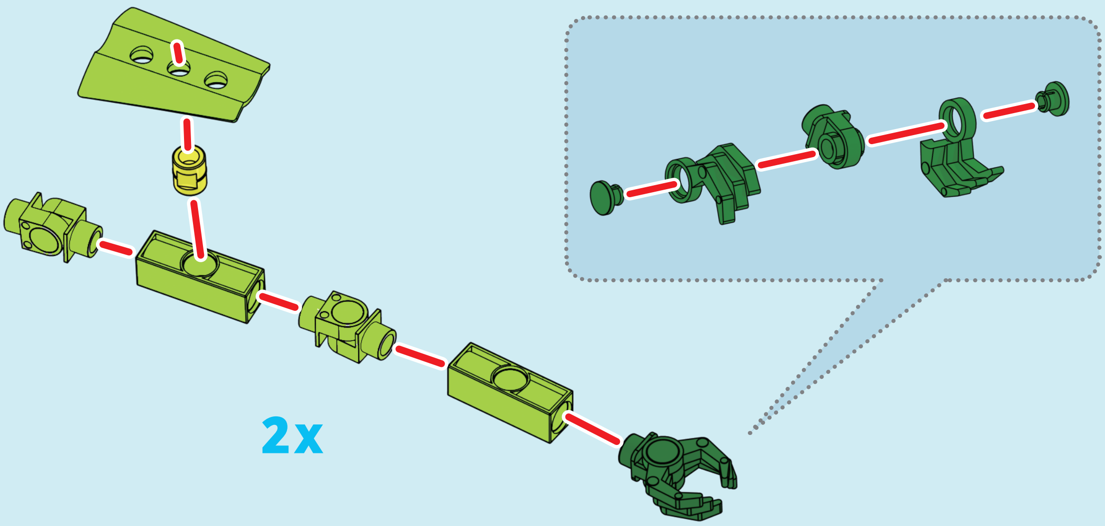

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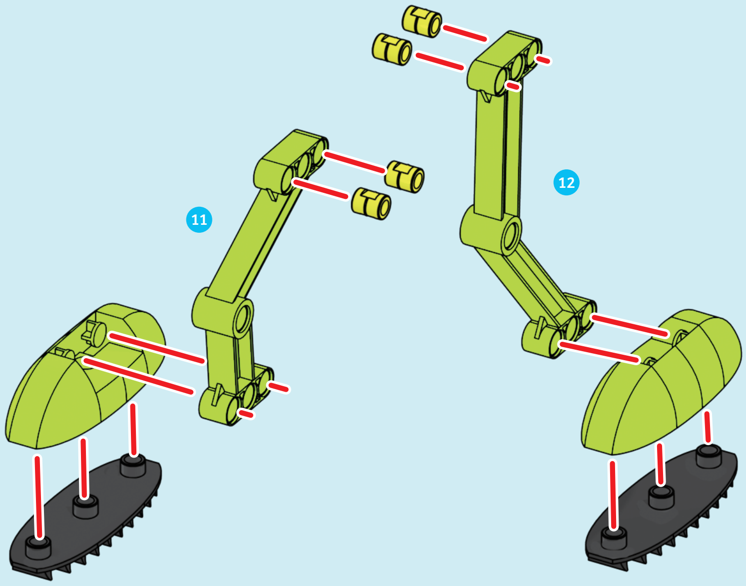

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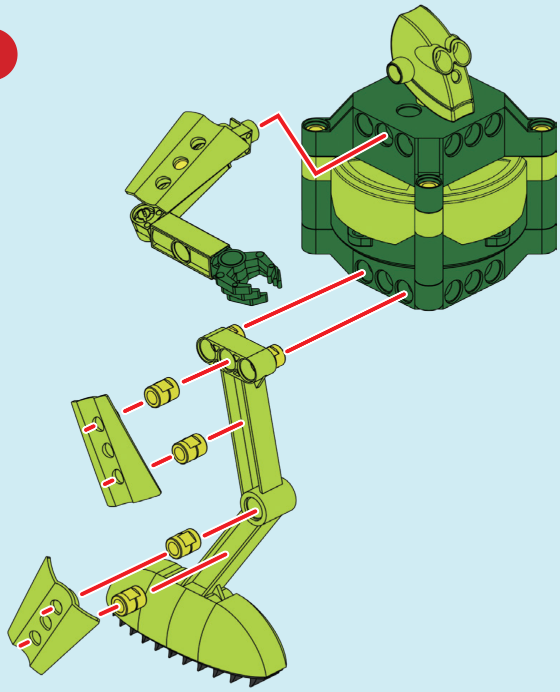

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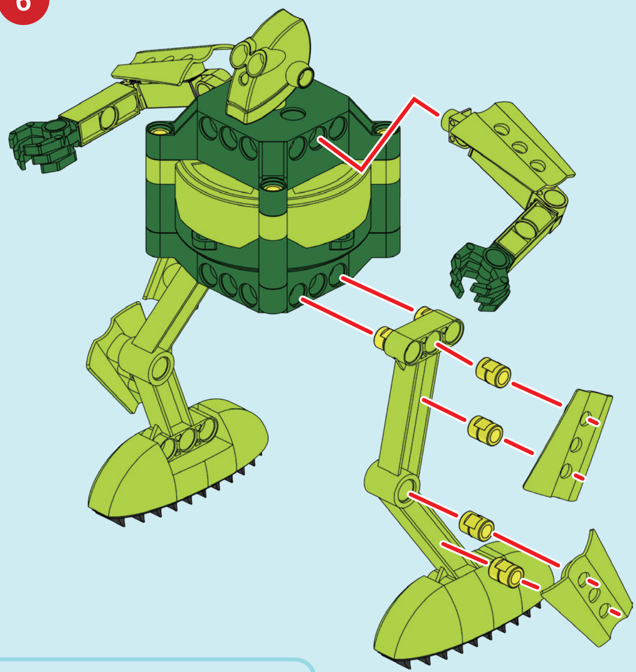

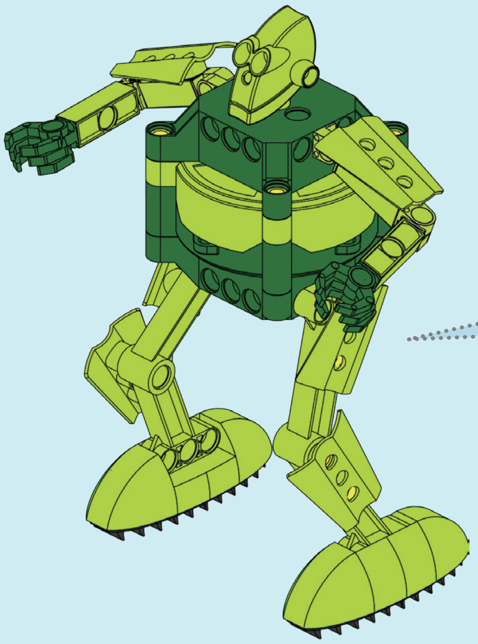

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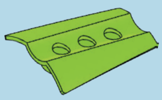
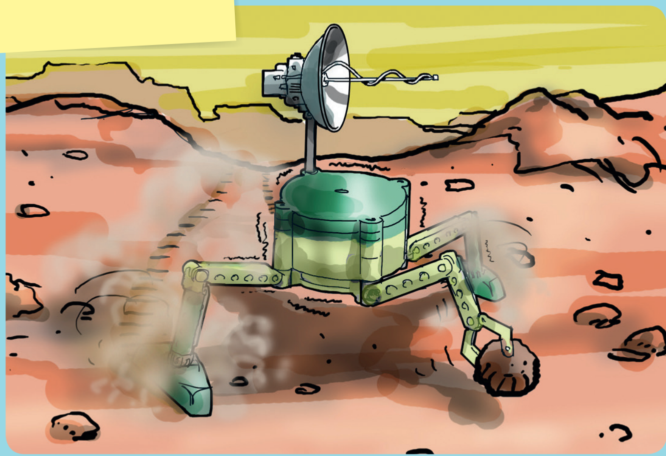


Make sure you insert the anchor pins attached to the armor panels into the correct holes, and that you insert them securely, or they might fall off from all of the vibrating action.

EXPERIMENT 2

Taking off for Mars

TIP!
Your rover will run best on a large, smooth surface.



YOU WILL NEED

› **The assembled Mars rover**
› *3 x AAA batteries or 3 x AAA rechargeable batteries*

HERE'S HOW

1. Start by assembling your Mars rover. You will find the instructions on the following pages.
2. Remove the vehicle's legs and open the cover on the underside of the vibrating motor.
3. Insert the batteries in the direction indicated in the compartments. Then replace the cover and reattach the legs.
4. Slide the switch on the underside of the vibrating motor in one direction or the other. In which direction does the rover walk? Again, you can try experimenting with the direction of the switch and try turning the soles around.
5. The rover's gripping hand mimics the robotic arms on the real Martian rovers. Can you manage to place an object from your room in its hand? Then let the rover carry it along.

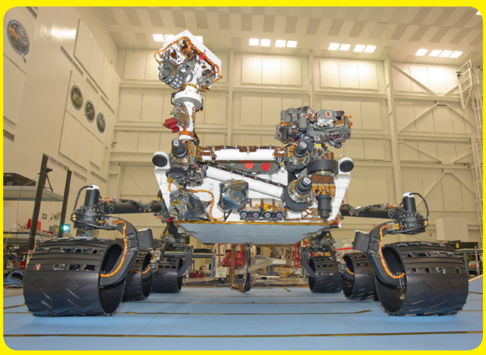
WHAT'S HAPPENING?

A robot that can drive is called a "rover." When a rover is moving across the Martian surface, it is very important that it be able to pick up things that are lying on the ground. That's the only way that it can study the planet's rocks.

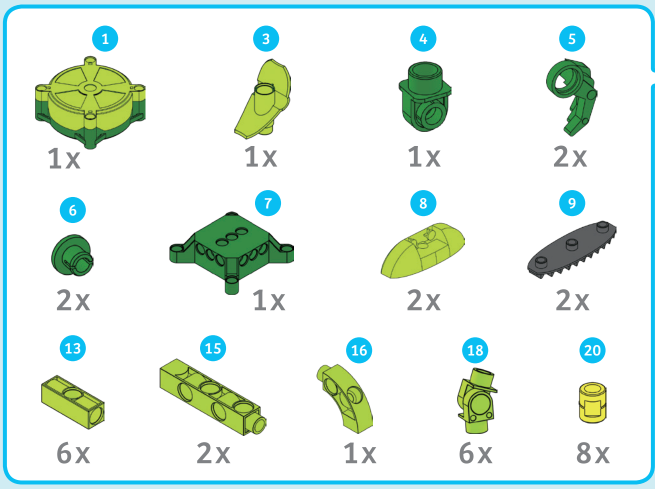
To do that, rovers have other instruments on board as well, such as microscopes, drills, and brushes. Then, with the help of its antennas, it sends the analysis results back to Earth.

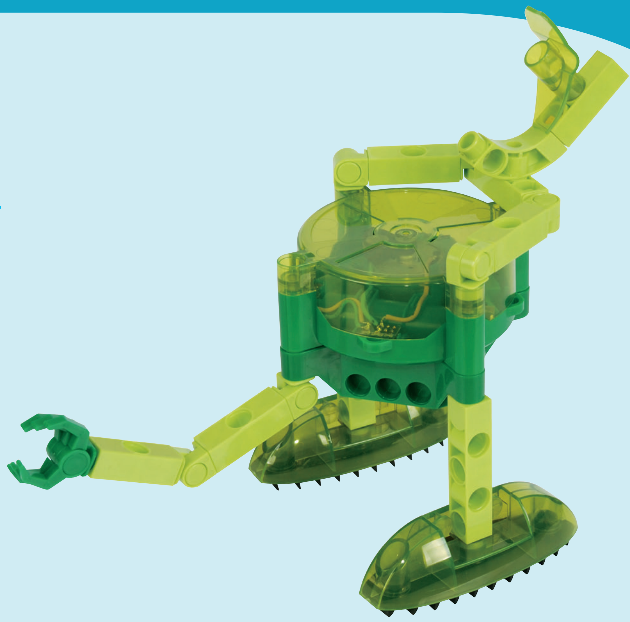
KEYWORD: MARS ROVER

Mars rovers like this one have already been sent four times to explore the planet Mars. To develop this kind of rover, engineers start by using a computer to create a drawing showing how it should look. Then, they construct a model. When the actual rover is finally complete, it often looks completely different from the sketch that they started with, because they constantly change and improve it in the course of development.



MARS ROVER





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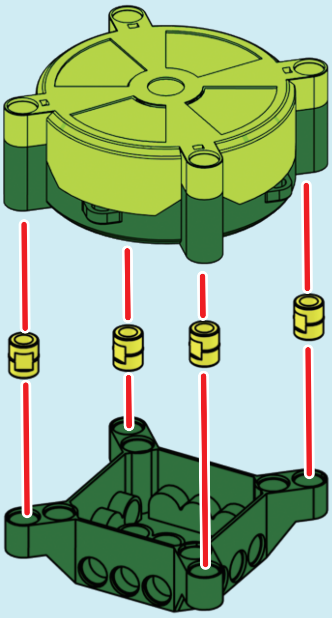

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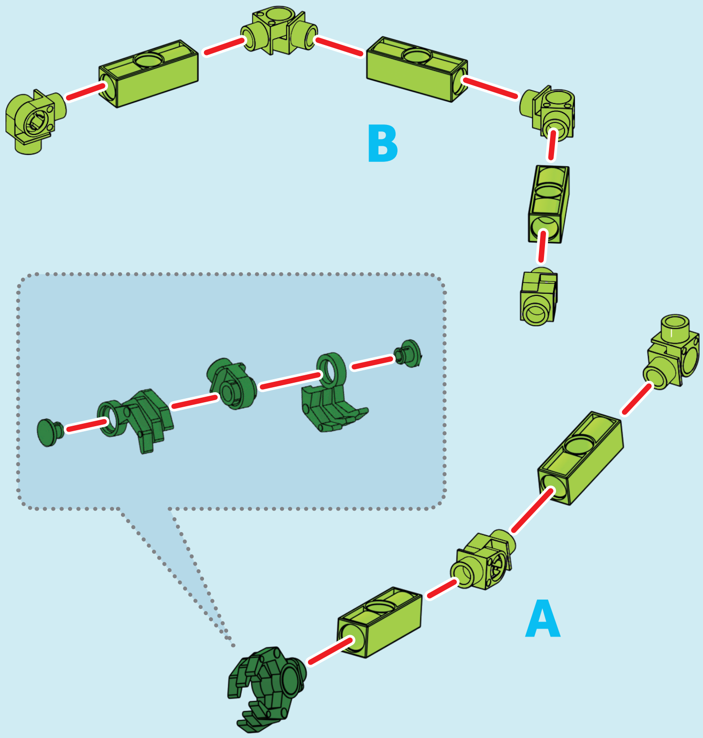

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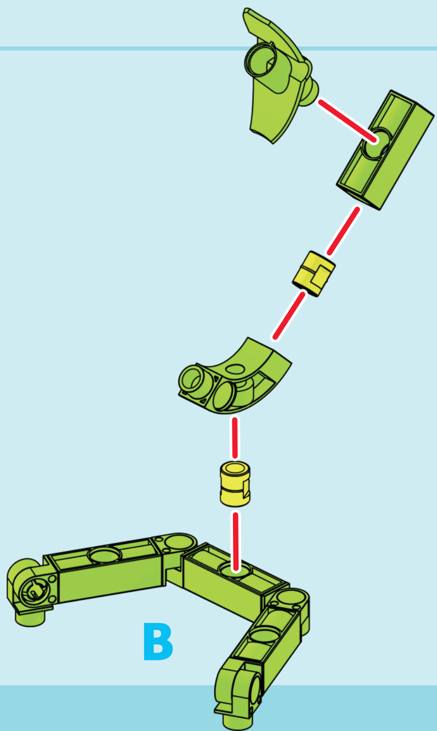

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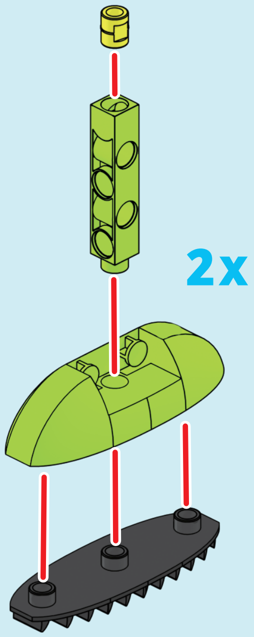

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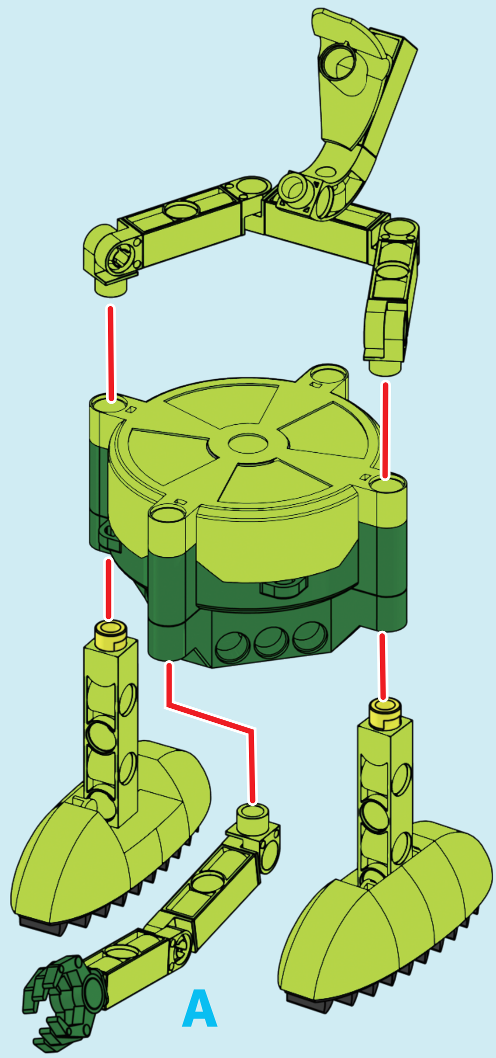
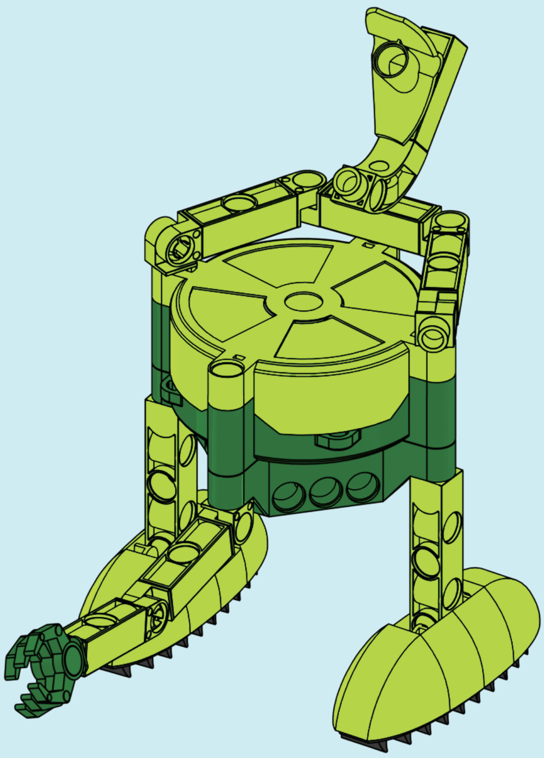




Done!

EXPERIMENT 3

TIP! Your beetle will crawl best on a large, smooth surface.

Beetling along

YOU WILL NEED

› **The assembled vibro-beetle**
› *3 x AAA batteries or 3 x AAA rechargeable batteries*

HERE'S HOW

1. Start by following the assembly instructions for your vibro-beetle. You will find the instructions on the following pages.
2. Remove the beetle's legs and open the cover on the underside of the vibrating motor. Insert the batteries in the direction indicated in the compartments. Then replace the cover and reattach the legs.
3. Slide the switch on the underside of the vibrating motor in one direction or the other. Bend the legs so that they are pointed the same way on both sides and so they touch the ground. Does the beetle start crawling off right away?
4. Watch how the beetle moves across the ground. Next, try changing the position of the legs. Bend all three legs on one side upward. Does the beetle move differently now?

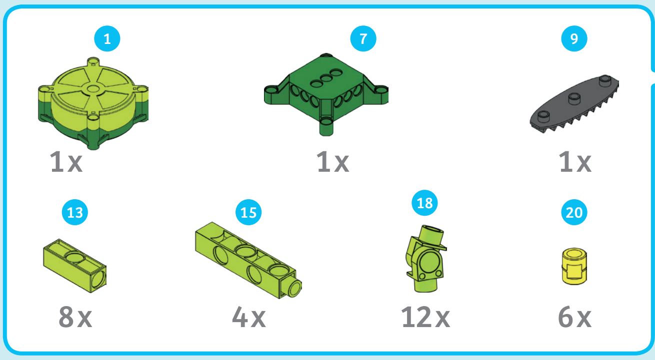
KEYWORDS: FORCE AND LEVER ARM

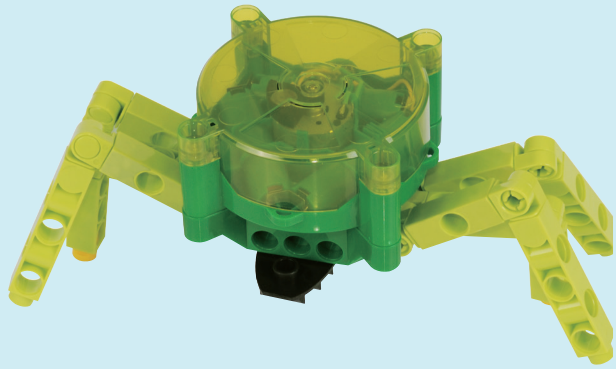
Picture a see-saw with a person on either end. If the two people are the same weight and the pivot point (or fulcrum) is in the middle, then the see-saw is balanced. If one person is heavier, he or she must slide in toward the fulcrum, so the weight balances out. The force that a load exerts on a lever is equal to the weight of the load times its distance from the fulcrum, otherwise known as the lever arm.

WHAT'S HAPPENING?

If the beetle's legs are pointed in the same direction on both the right and left sides, the insect's center of gravity will lie precisely in the center (in other words, right in the middle of the vibrating motor). If you bend the legs in a different direction on just one side, the center of gravity shifts to another location. Any object will have a center of gravity, which is the location where its weight is equal on all sides.

VIBRO-BEETLE





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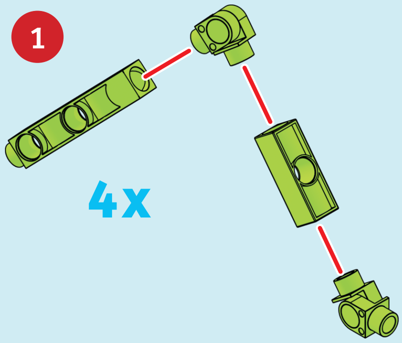

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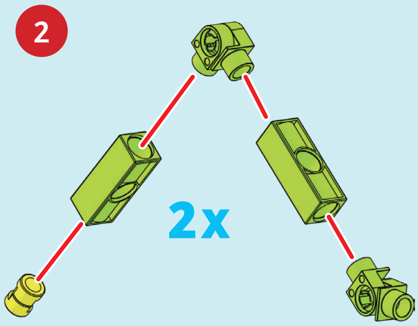

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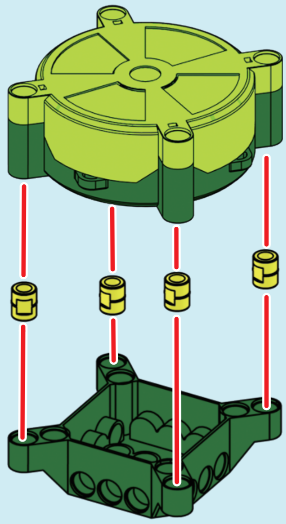

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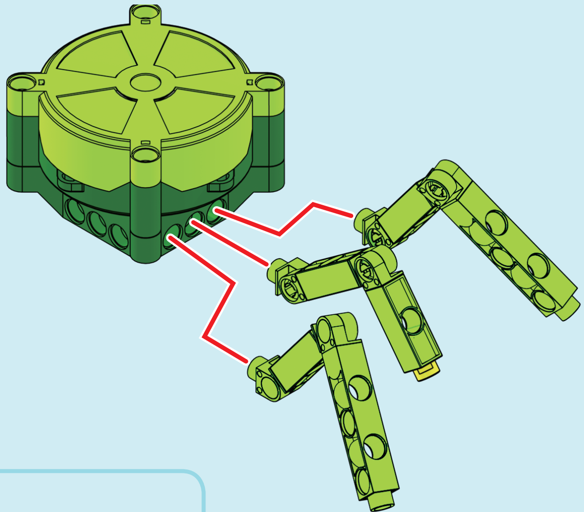

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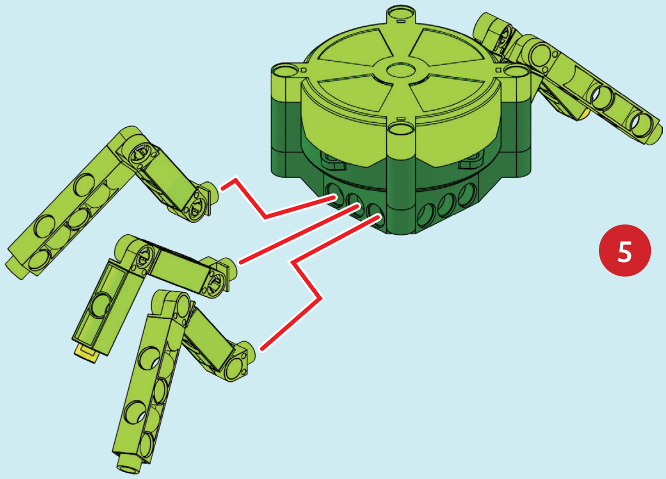

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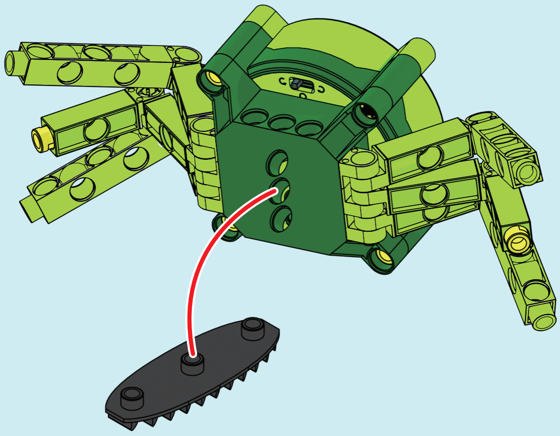

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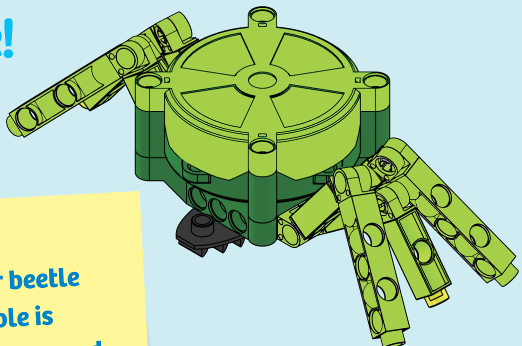
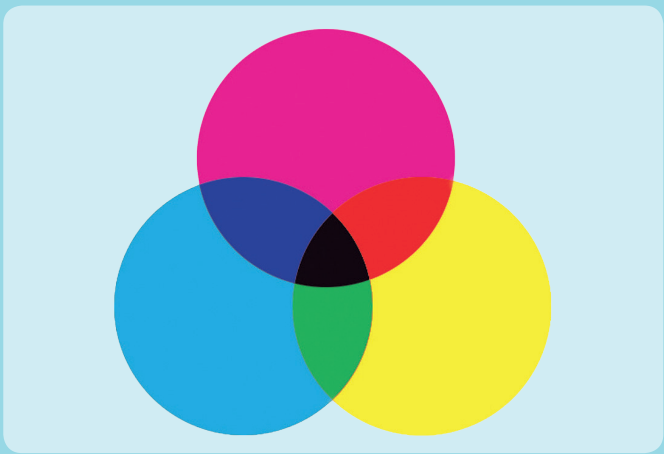


TIP!
Press down on your beetle until its non-skid sole is resting firmly on the ground.

EXPERIMENT 4



Here's where things get colorful ...

YOU WILL NEED

› *Box of opaque (gouache) paints*
› *Brush*
› *Paper*
› *Water*
› *Paper towels*
› *Old clothes*
› *Clean, empty yogurt container*

DID YOU KNOW?

These primary colors are also used in printing. The color model used here is also known as the CMYK model, with the letter standing for the various colors, as follows:
C = cyan (bluish-green)
M = magenta (reddish-pink)
Y = yellow
The K stands for "key," and is used to refer to the black portion.
Take a look at the pictures below to see some of the many ways that colors are used.

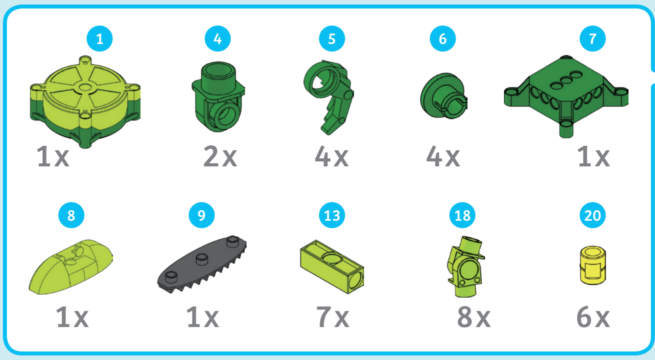
HERE'S HOW

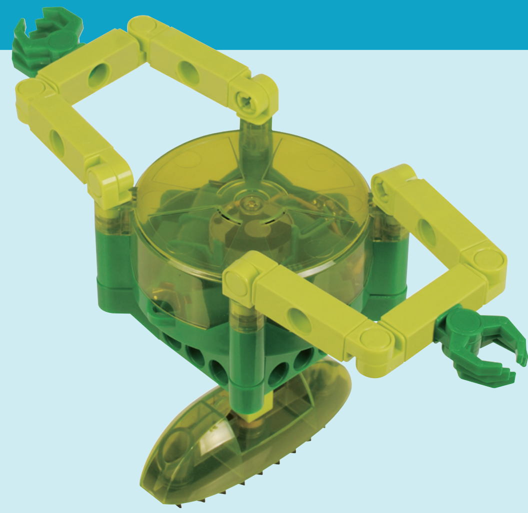
1. For this experiment, it would be best to find a place that can handle a little abuse, and wear old clothes.
2. Find the color yellow in your box of paints, and use your brush to paint a yellow circle on the sheet of paper. You will want to paint the subsequent colors while the paints are still wet.
3. Wash out the brush and dip it in the blue paint. Paint a blue circle next to the yellow one, but make sure it overlaps the yellow one a little. Look at the color that is created where the two circles overlap each other.
4. Again, wash the brush out well, take the red color, and paint a red circle overlapping both the yellow and the blue one. What new colors do you see in the areas where the circles overlap?
5. Now, let's go! Assemble your own painting robot. You will find the instructions on the following pages.

WHAT'S HAPPENING?

You probably know what it's like when you have to mix different paint colors because the one you wanted wasn't in the paint box. You just did the same thing here. The basic colors you started with in this case are called primary colors. Just these three are enough to mix together all the other colors of the rainbow.

PAINTING ROBOT





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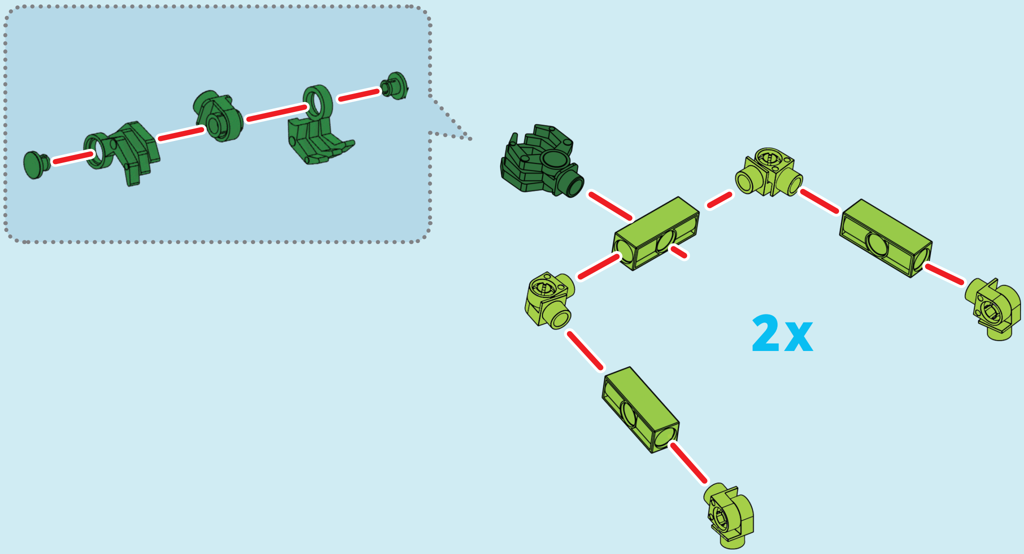

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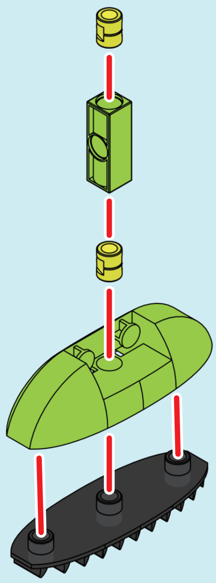

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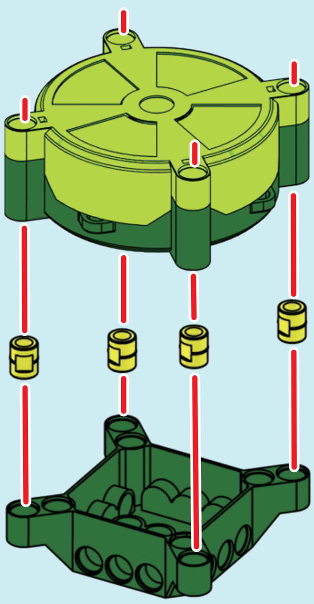

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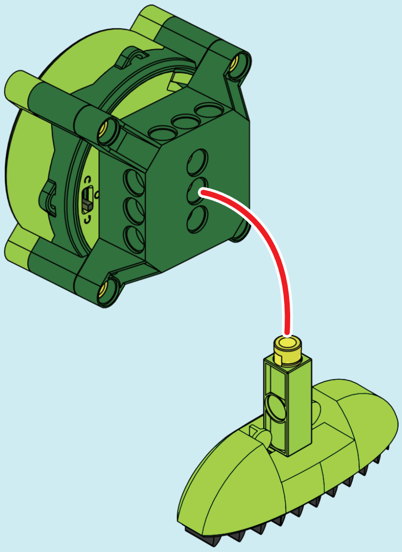

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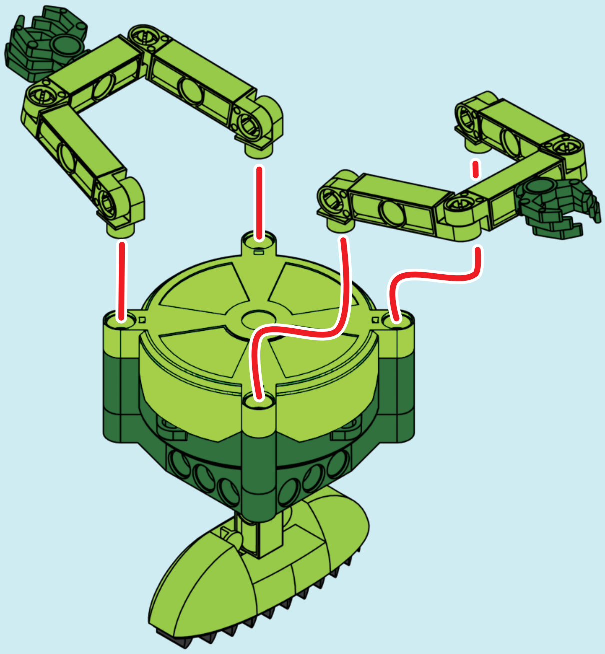
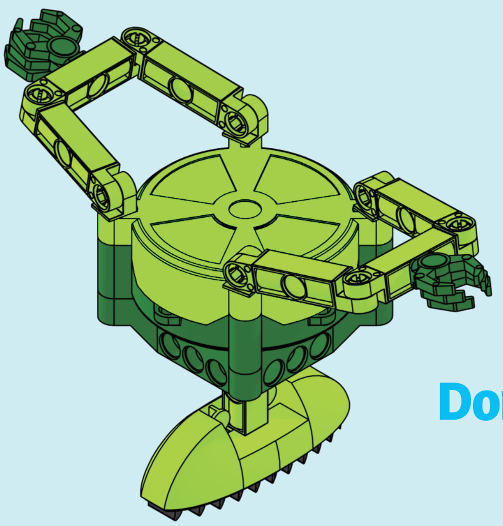




TIP!
Insert the batteries in the robot and switch it on. Then set the robot on a large sheet of paper and place one or two colored pencils or felt-tip pens in his hand. You will soon have lots of fun abstract images.

TIP!
Your robot will operate best on a smooth surface that can take a little abuse.

Done!

EXPERIMENT 5

How does a plate compactor work?

YOU WILL NEED

› **The assembled plate compactor**
› *3 x AAA batteries or 3 x AAA rechargeable batteries*
› *Different surfaces (hard and soft)*

HERE'S HOW

1. Start by following the assembly instructions for your plate compactor. You will find the instructions on the following pages.
2. Open the cover on the vibrating motor. That's how you get to the battery compartments.
3. Insert the batteries into their compartments as indicated. Then replace the cover.
4. Push the vibrating motor switch in one direction or the other.
5. Set the plate compactor on a hard surface, such as a tabletop, while holding tight to the handle. What happens to the plate compactor?
6. Now try testing the plate compactor on a soft surface. Try the mattress on your bed, for example. How does the plate compactor behave now?

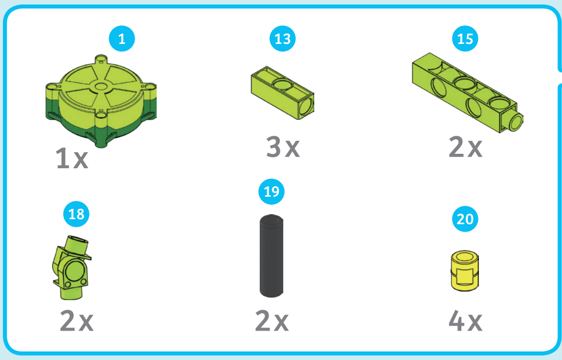
KEYWORD: ROADWORK IN PROGRESS

Caution, construction zone! You have probably seen plate compactors in use by street construction crews in the process of laying paving stones or building roads. Plate compactors briefly rise off the ground and then come crashing down again, compressing the earth or tar beneath them or making the paving stones stay firmly in place. Sometimes, the workers will first hammer the stones into position by hand.

WHAT'S HAPPENING?

If you let the plate compactor do its work on a hard surface, it really jumps up and down. The ground offers firm resistance, which throws back the force of the compactor. If, on the other hand, the surface is soft, it absorbs the force of the blows and gives way. So the plate compactor works best on a hard surface.

PLATE COMPACTOR



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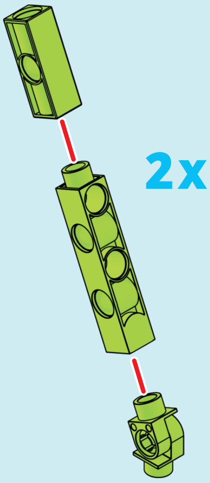

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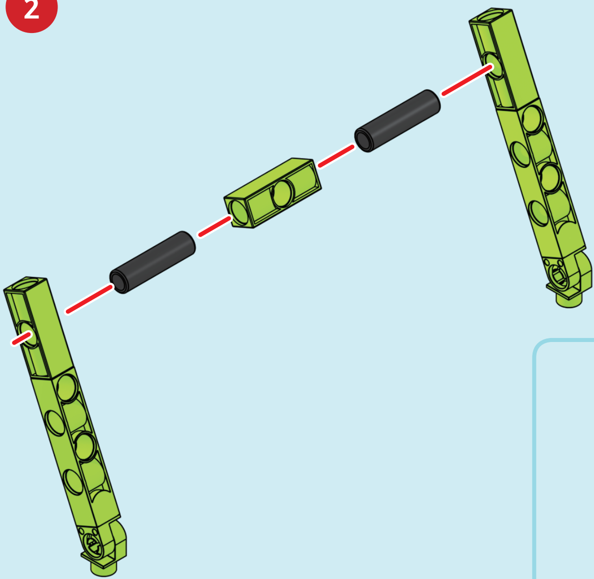

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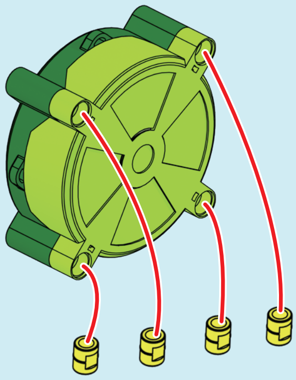

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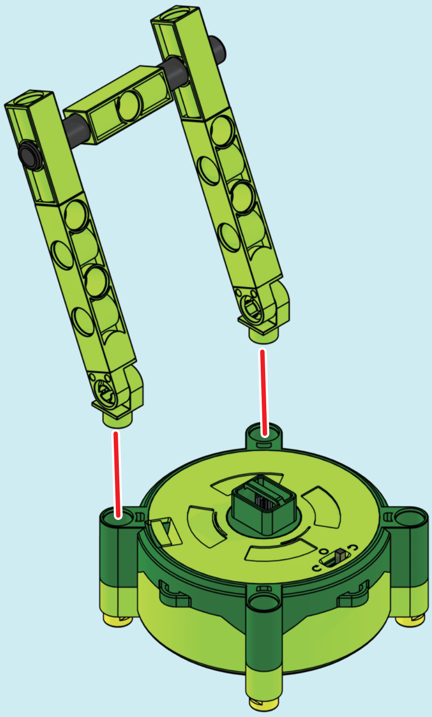
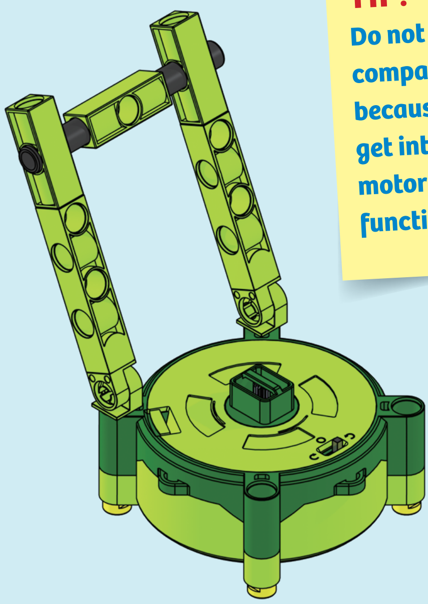




TIP!
Do not use the plate compactor outside, because sand or dirt could get into the vibrating motor and impair its function.

Done!

EXPERIMENT 6

What do shaking and exercise have in common?

TIP!
Your exercise machine will work best on a large, smooth surface.

YOU WILL NEED

› **The assembled exercise machine**
› **A few anchor pins and whatever bars you like**
› *3 x AAA batteries or 3 x AAA rechargeable batteries*
› *A few small stones in a bag*

HERE'S HOW

1. Build your own exercise machine! You will find the instructions on the following page.
2. Open the cover on the vibrating motor. That's how you get to the battery compartments.
3. Insert the batteries as indicated inside the compartments and replace the cover.
4. Stick the bars together however you like, mount them on the vibrating motor, and switch on the vibrating motor. What happens to the bars?
5. Now place the bag with the pebbles on the motor. What happens to it?

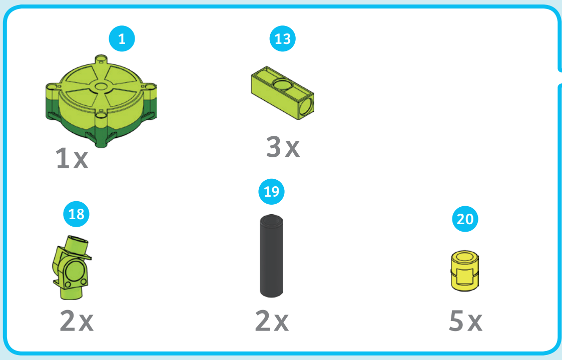
WHAT'S HAPPENING?

In this experiment, you will clearly see how the vibrations move upward from the motor and become transferred to whatever objects are on top of it. The heavier the objects, the less they vibrate. Just be careful not to let them fall off the motor platform.

KEYWORD: VIBRATION TRAINER

Can you really get into shape just by shaking? Of course! A lot of exercise gyms have vibration trainers. Simply get on, hold tight, and off you go! You can select how much you want the machine to vibrate, based on your weight and training goals. The vibrations are conveyed to the muscles in your body and work to strengthen them. That's how you can turn a vibrating motor into an exercise machine.

EXERCISE MACHINE



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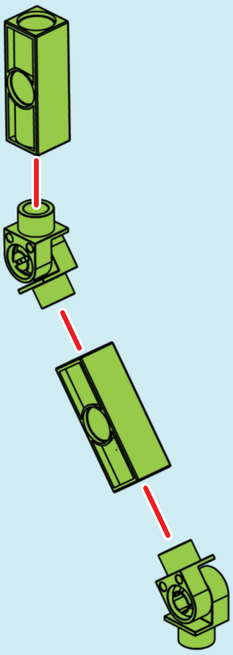

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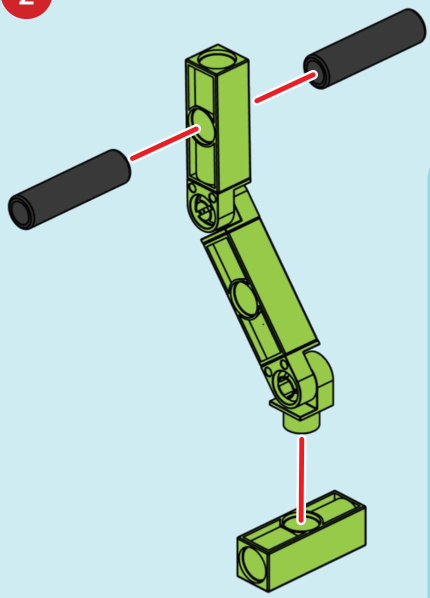

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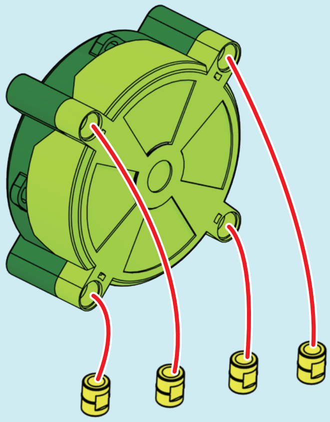

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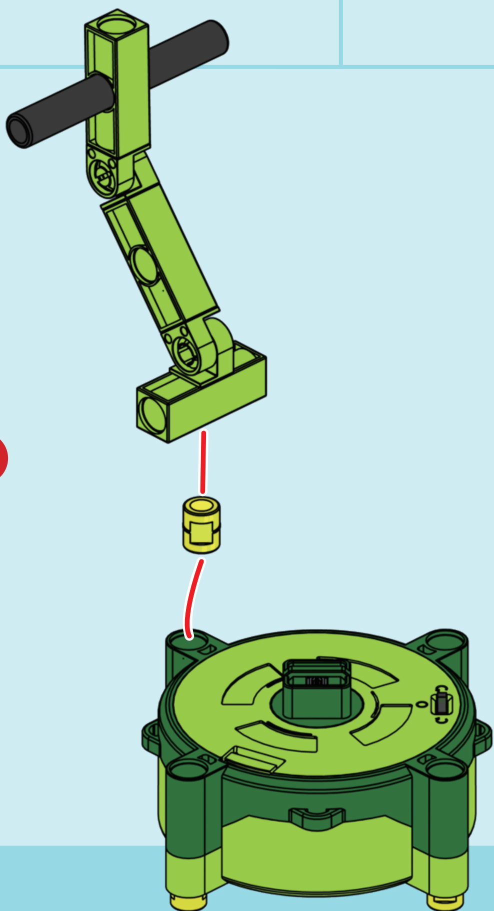
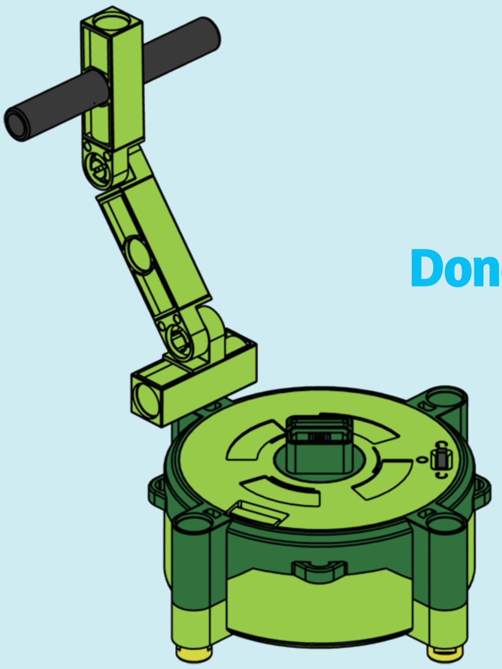




Done!

EXPERIMENT 7

Time to start ice skating!

TIP!
Your ice skater will glide best on a large, smooth surface.

YOU WILL NEED

› **The assembled ice skater**
› *3 x AAA batteries or 3 x AAA rechargeable batteries*

HERE'S HOW

1. Start by assembling the ice skater. You will find instructions on the following pages.
2. Remove the side section of the ice skater and open the cover on the underside of the vibrating motor.
3. Insert the batteries as indicated inside the compartments. Then replace the cover and reattach the side section.
4. Do you think your ice skater can skate even though the vibrating motor is oriented vertically?
5. Try it! Slide the switch on the side of the vibrating motor in one direction or the other. Does your ice skater skate away?
6. In what direction does he skate? What happens if you slide the switch in the other direction?

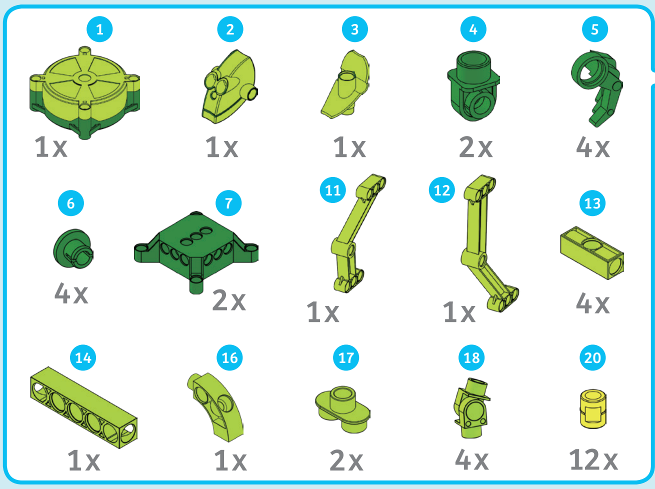
WHAT'S HAPPENING?

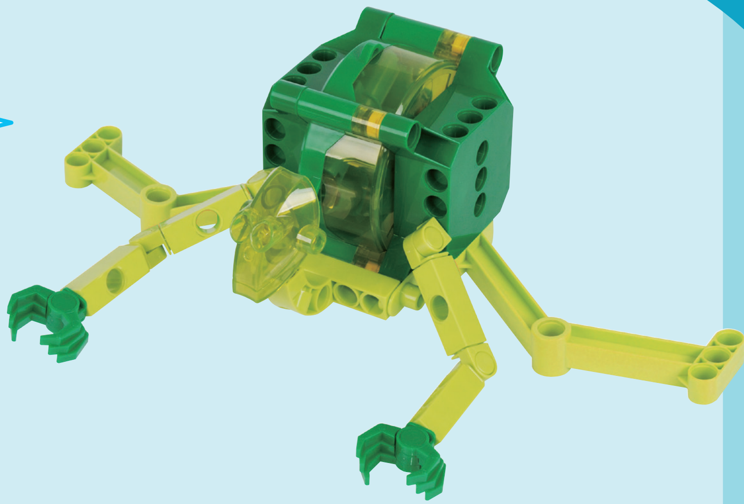
Even when the vibrating motor is installed vertically, the vibrations spread to all the components and the ice skater moves. On a smooth surface, your model will move like a real ice skater. And you can even make him move right or left by switching the direction that the swing arm turns.

DID YOU KNOW?

The first ice skating blades that people tried strapping under their feet were made out of animal bones! These days, metal blades are more popular. The invention of ice skating had nothing to do with having fun or playing a sport. It was simply conceived as a way to get around. Since then, lots of sports have been invented that use ice skates: ice hockey, figure skating, and speed skating, for example. Some countries even hold ice-skating marathons! In Sweden, this race is known as "Vikingarännet" ("The Viking Run"), and it covers over 80 km from Uppsala to Stockholm.

ICE SKATER





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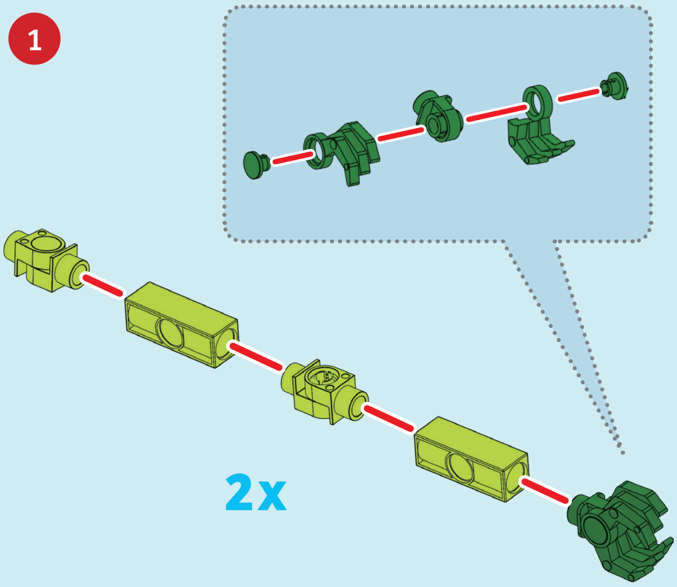

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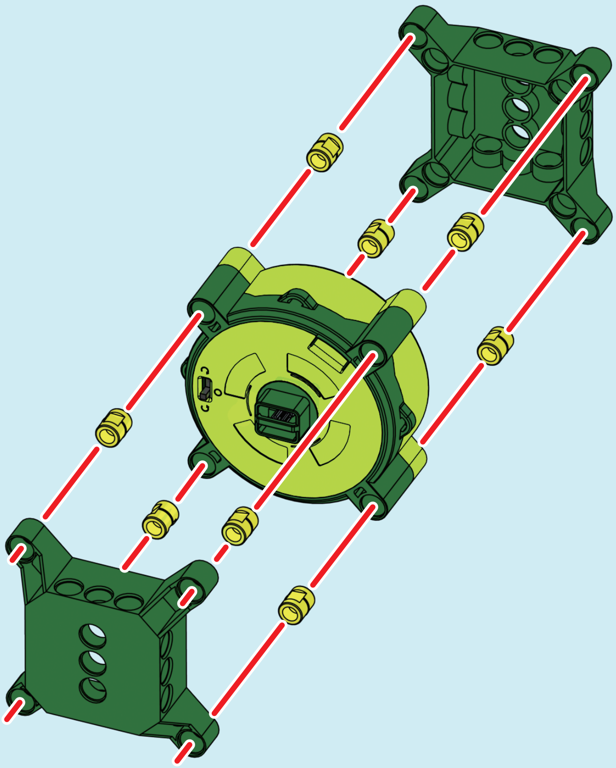

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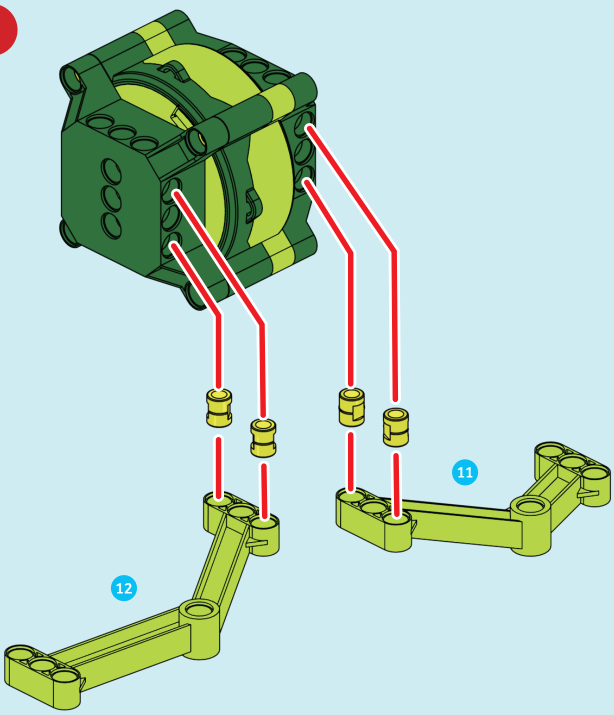

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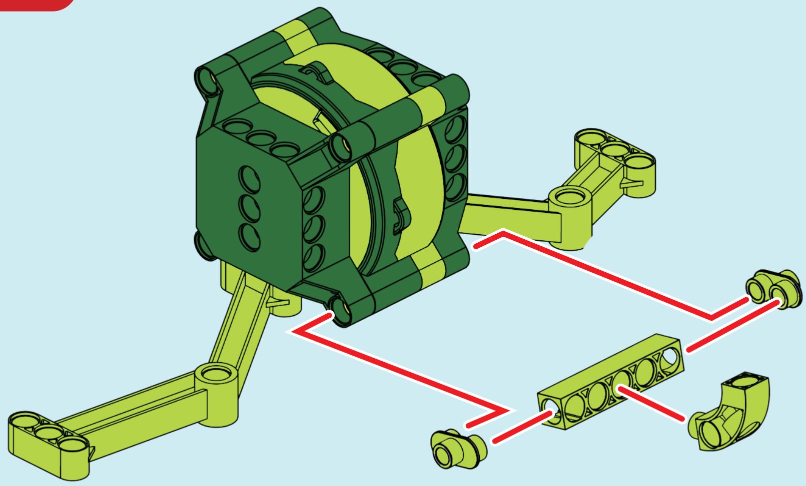

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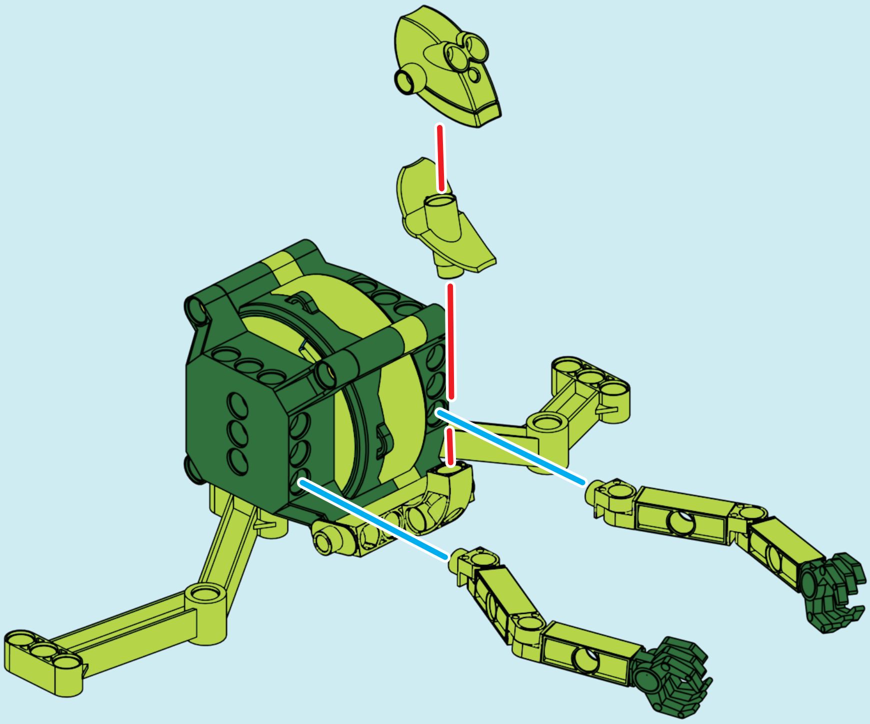

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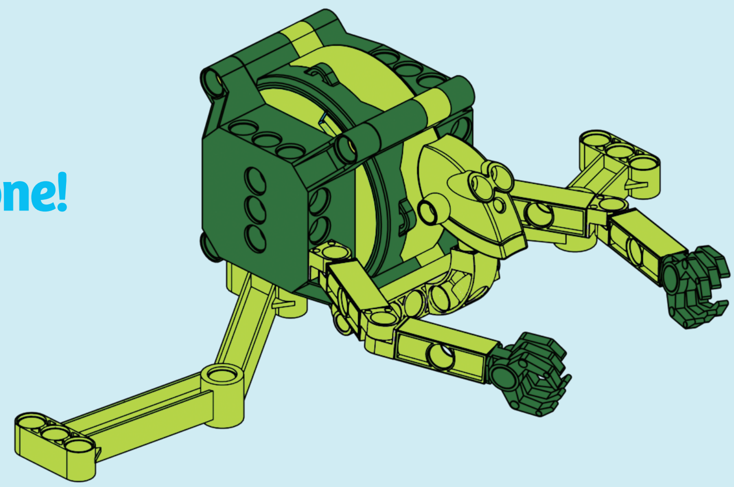
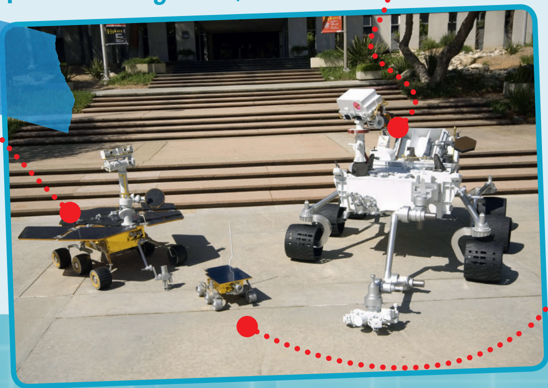


CHECK IT OUT

Mars Rovers ...

... come in large and small sizes. They often have fun names that are meant to express the spirit of human exploration. On the left, you see "Spirit," "Sojourner" is in the middle, and "Curiosity" is on the right. "Spirit" spent 6 years exploring Mars! "Curiosity" is the newcomer: It only landed on the Martian surface on August 6, 2012.



DID YOU KNOW?

What looks like a construction site is actually a plate compactor race. This contest is held every year in Eddelak, Germany. With a plate compactor in tow, each participant has to travel along a 100-meter course — across hills, barriers, high-speed straightaways, sand, and gravel. The winner gets to call himself champ!

SMALL, BUT POWERFUL!

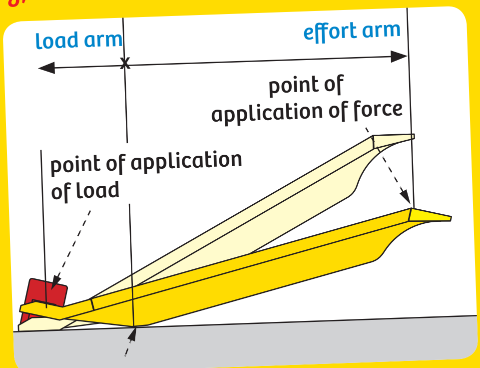
Plate compactors also come in small sizes. The little ones are called vibratory rammers, and are used to pack the ground in areas where there is not much space.

Your arms and legs are levers too.

LEVERAGE

You will find levers all over the place, some hidden and some in plain sight, in everyday life: door handles, the pedals of your bicycle, a pair of pliers, to name a few. Your arms and legs are levers too, of course.

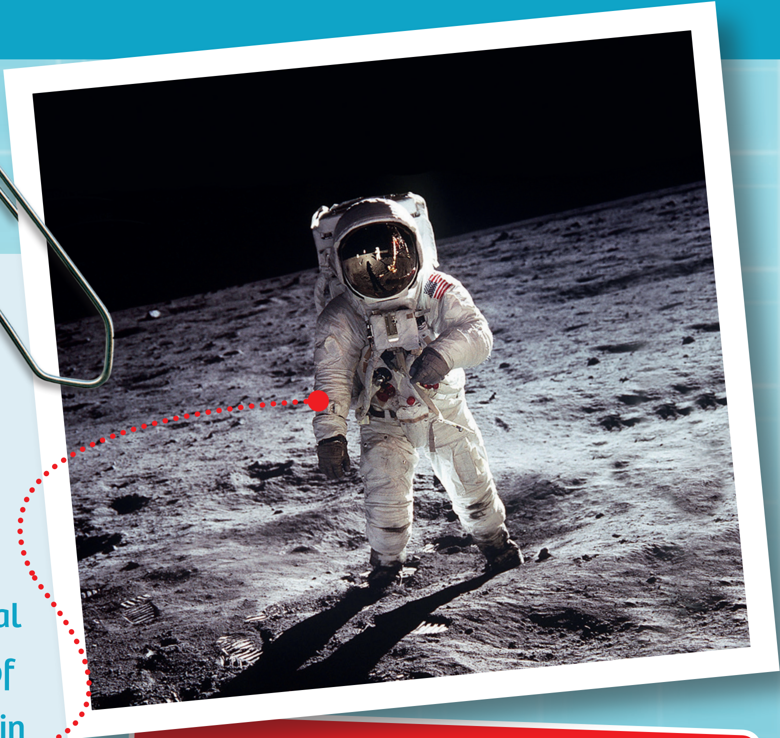
A lever is a rigid body that can be rotated around an axis. It can be any shape. Usually, it will be shaped like a rod. You can use a lever to amplify force. The end of the lever on which the force acts is called the effort arm, while the end used to lift a load is called the load arm.



CHECK IT OUT

Shaking in space?

Plate compactors are even used for physical training by astronauts in space! This kind of training will become even more important in the future, as astronauts take longer and longer trips into space. A trip to Mars and back can last more than 2 years. During that time, the astronauts will be subjected to zero gravity and their muscles won't be bearing any weight. That means that their muscles will atrophy, or break down, without training.



WHY DO YOU GLIDE ON ICE?

When you go ice skating, you move the skates' blades across the ice. The friction creates heat. The ice beneath the blades melts and forms a thin film of water. Due to the film of water, the friction between blade and ice is very low, so you can glide along effortlessly, as if you were light as a feather.

WONDERFULLY DIZZY...

Have you ever watched a figure skater spin in place? This "figure" is called a pirouette. Often, an arm or leg is extended out at the start of the spin, and then pulled in tight to the body. That makes the mass shift closer to the axis of rotation, which runs vertically through the middle of the figure skater's body.

In terms of physics, you would say that the body is no longer so "inert." That makes the speed of rotation increase and the figure skater spin faster and faster.