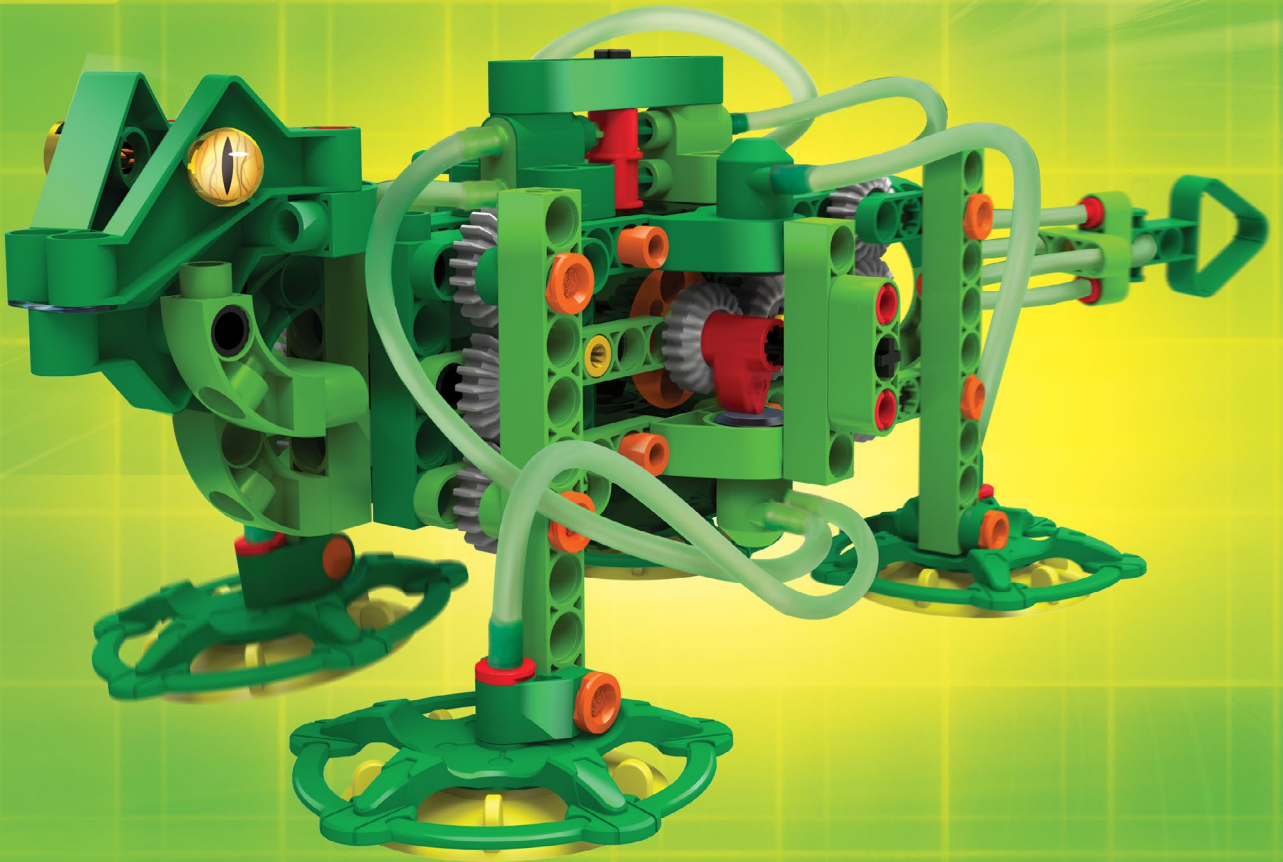


EXPERIMENT MANUAL

GECKKOBOT



THAMES & KOSMOS



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Thames & Kosmos UK Ltd, Goudhurst, Kent, TN17 2QZ, United Kingdom | 01580 212000 | www.thamesandkosmos.co.uk

Safety Information

The geckobot and other models in this kit have many moving parts. Please always be careful that fingers, hair, other body parts, or delicate objects are not harmed by or pinched between the moving parts (e.g., in the linkage of the suction gun). Handle the models carefully.

If children are playing with the geckobot model on a mirror or other glass surface that is affixed to a wall, the mirror or glass surface could fall off the wall when the model is pulled off the surface. Please make sure the model is used only on well-secured surfaces.

If the geckobot model climbs out of the reach of children, they might try to climb up to retrieve the model. Please make sure children do not injure themselves trying to retrieve the model.

For any toy that is used with a window, like the geckobot model, there is the potential risk that a child opens the window and falls out the window. Please supervise children around windows.

Children should be supervised by an adult at all times when playing with the geckobot model. We encourage parents and adults to set up a safe playing environment for the geckobot model.

Warning. Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled. Strangulation hazard — long tubes may become wrapped around the neck. Store the experiment material, particularly the battery-powered motor, and assembled models out of the reach of small children.

Warning! Only for use by children aged 8 years and older. Instructions for parents or other supervising adults are included and have to be observed. Keep the packaging and instructions as they contain important information.

Safety for Experiments with Batteries

>>> The wires are not to be inserted into socket-outlets. Never perform experiments using household current! The high voltage can be extremely dangerous or fatal!

>>> Two AAA batteries (1.5-volt/LR03) are required, which could not be included in the kit due to their limited shelf life.

>>> The supply terminals are not to be short-circuited. A short circuit can cause the wires to overheat and the batteries to explode.

>>> 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.

>>> Batteries are to be inserted with the correct polarity. Press them gently into the battery compartment. Follow the instructions on page 6. Always close the battery compartment with the lid after installing batteries.

>>> Non-rechargeable batteries are not to be recharged. 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, not in the household trash.

>>> Be sure not to bring batteries into contact with coins, keys, or other metal objects.

>>> Avoid deforming the batteries.

With all of the experiments that use batteries, have an adult check the experiment or model **before use** to make sure it is assembled properly. Always operate the motorized models under adult supervision.

Note the safety information accompanying the individual experiments or models.

After you are done experimenting, remove the batteries from the battery compartments.

Notes on Disposal of Electrical and Electronic Components

None of the electrical or electronic components in this kit should be disposed of in the regular household trash when you have finished using them. Instead, they must be delivered to a collection location for the recycling of electrical and electronic devices. The symbol on the product, instructions for use, or packaging will indicate this. The materials are reusable in accordance with their designation. By reusing or recycling used devices, you are making an important contribution to the protection of the environment. Please consult your local authorities for the appropriate disposal location.



Dear Parents and Adults,

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.

The geckobot requires a very smooth surface like a glass window or mirror. Please assist your child in finding a surface where he or she can play with the geckobot safely. To avoid accidents, do not let the geckobot walk out of reach.

We hope you and your child have a lot of fun with the experiments!

>>> TABLE OF CONTENTS

Safety Information Inside front cover

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MODELS

Geckobot 3

How to operate the geckobot 14

Industrial robot arm 16

Suction tow truck 18

Suction gun 20

Inch worm 22

Smartphone holder 23

Ellipsograph 24

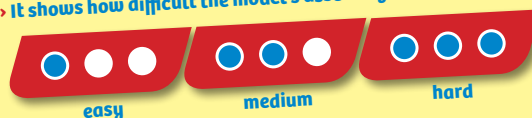
Publisher's Information Inside back cover



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:

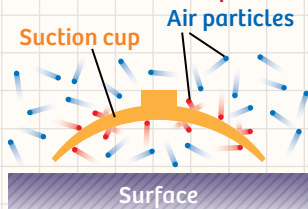


HOW DO SUCTION CUPS WORK?

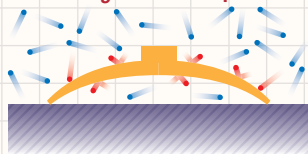
Suction cups are devices that use air pressure or water pressure to stick to hard, smooth surfaces where a partial vacuum can be created.

A suction cup has a cup-shaped surface made of a flexible material, like silicone, rubber, or plastic. When this cup is pressed against a hard surface, the air inside the cup, between the cup and the surface, gets pushed out. **Air particles** get pushed out, creating a void, or **vacuum**, inside the cup. The regular atmospheric air outside the cup remains the same, containing many more air particles per unit volume of space than inside the cup. All these air particles are constantly flying around through the air and hitting things. Each one makes a tiny impact. The sum of all these tiny impacts is **air pressure**.

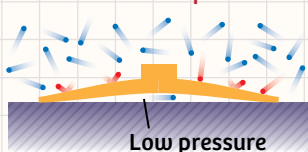
Unstuck suction cup:



Pressing suction cup down:



Stuck suction cup:



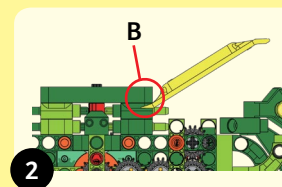
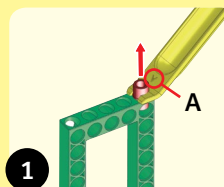
There are a lot more air particles per unit volume on the outside of the cup than on the inside, so the air pressure is a lot higher on the outside than on the inside. This difference in air pressure is what keeps the suction cup stuck to the surface.

Over time, the material of the suction cup returns to its original shape. The forces pulling the suction cup back into its original shape are ultimately stronger than the air pressure keeping the suction cup stuck to the surface. When the suction cup returns to its original shape, the low pressure inside the cup is released, so the suction cup will no longer stick to the surface.

TIP! The anchor pin lever

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

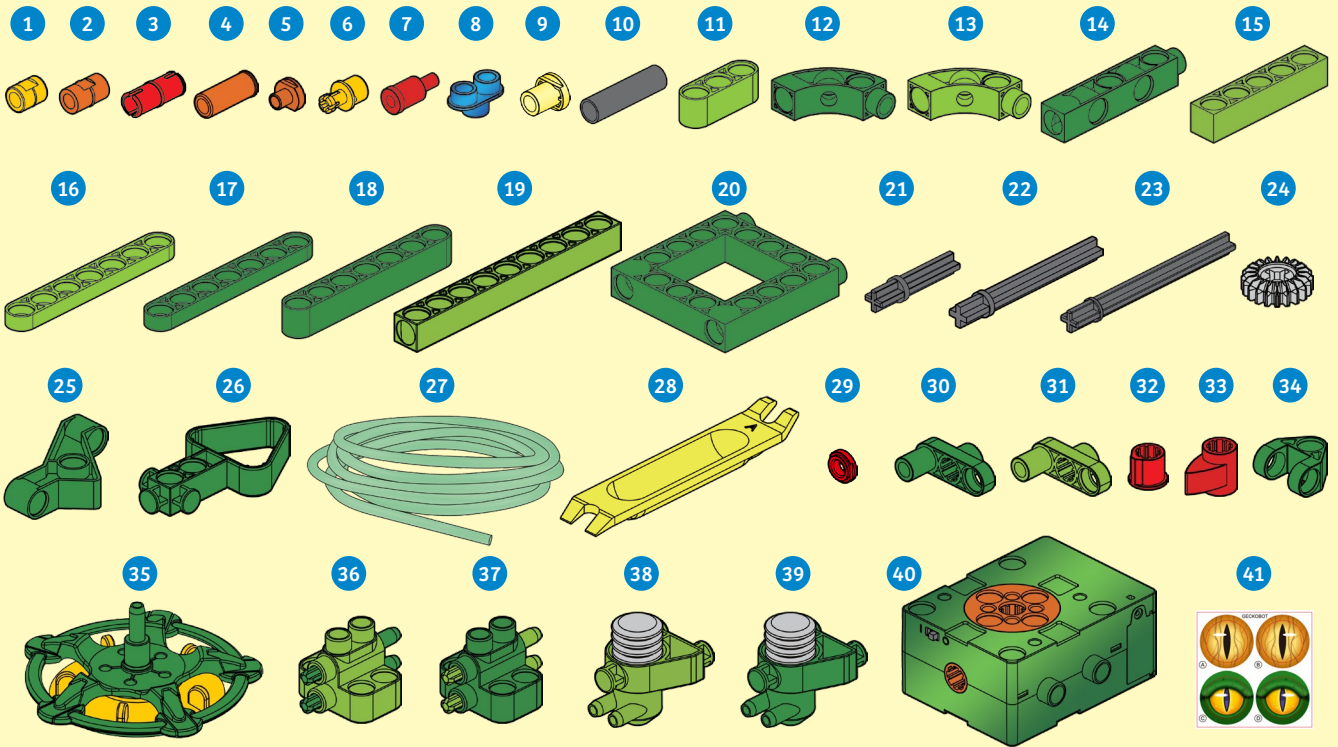
1. End A of the anchor pin lever makes it easy to remove anchor pins from the frames.
2. End B of the tool can be used for prying up and separating other parts.



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

US: techsupport@thamesandkosmos.com
 UK: techsupport@thamesandkosmos.co.uk

What's inside your experiment kit:



Checklist: Find – Inspect – Check off

✓	No.	Description	Qty.	Item No.	✓	No.	Description	Qty.	Item No.
<input type="radio"/>	1	Short anchor pin (yellow)	10	7344-W10-C2Y	<input type="radio"/>	22	Axle, 60 mm	4	7413-W10-M1D
<input type="radio"/>	2	Anchor pin (orange)	10	7061-W10-C10	<input type="radio"/>	23	Axle, 70 mm	4	7061-W10-Q1D
<input type="radio"/>	3	Joint pin	10	1156-W10-A1R	<input type="radio"/>	24	Small gear	18	7026-W10-D2S
<input type="radio"/>	4	Tube bolt	5	7404-W10-G10	<input type="radio"/>	25	Angled arm	3	7404-W10-B2G2
<input type="radio"/>	5	Tube bolt cap	12	7409-W10-F20	<input type="radio"/>	26	Triangular bracket	1	7388-W10-K1G
<input type="radio"/>	6	Shaft plug	4	7026-W10-H1Y	<input type="radio"/>	27	Tube, 200 cm	1	7409-W85-200
<input type="radio"/>	7	Shaft pin	6	7026-W10-J3R	<input type="radio"/>	28	Anchor pin lever	1	7061-W10-B1Y
<input type="radio"/>	8	Two-to-one converter	2	7061-W10-G1TB	<input type="radio"/>	29	Tube connector cap	4	7409-W10-F1R
<input type="radio"/>	9	Long button pin	2	7061-W10-E2TY	<input type="radio"/>	30	3-hole crank (dark green)	4	7409-W10-H1G
<input type="radio"/>	10	Tube, 30 mm	5	7400-W10-G1D	<input type="radio"/>	31	3-hole crank (light green)	4	7409-W10-H1G1
<input type="radio"/>	11	3-hole wide rounded rod	7	7404-W10-C1G2	<input type="radio"/>	32	Small cam (pear shape)	2	7409-W10-G1R
<input type="radio"/>	12	Curved rod (dark green)	5	7061-W10-V1G	<input type="radio"/>	33	Large cam (teardrop shape)	2	7409-W10-G2R
<input type="radio"/>	13	Curved rod (light green)	5	7061-W10-V1G3	<input type="radio"/>	34	3-hole 90-degree converter	4	7409-W10-I1G
<input type="radio"/>	14	5-hole dual rod C	4	7026-W10-S3G1	<input type="radio"/>	35	Suction cup pad	4	7409-W85-E
<input type="radio"/>	15	5-hole rod B	4	7413-W10-K2G2	<input type="radio"/>	36	Dual valve (light green)	1	7409-W85-D1G1
<input type="radio"/>	16	7-hole flat rounded rod (light green)	8	7404-W10-C3G2	<input type="radio"/>	37	Dual valve (dark green)	1	7409-W85-D1G
<input type="radio"/>	17	7-hole flat rounded rod (dark green)	4	7404-W10-C3G1	<input type="radio"/>	38	Pump (light green)	2	7409-W85-C1G1
<input type="radio"/>	18	7-hole wide rounded rod	1	7404-W10-C2G1	<input type="radio"/>	39	Pump (dark green)	2	7409-W85-C1G
<input type="radio"/>	19	9-hole rod	4	7407-W10-C1G	<input type="radio"/>	40	Motor box	1	7409-W85-A
<input type="radio"/>	20	Square frame	4	7026-W10-T2G	<input type="radio"/>	41	Geckobot eye stickers	1	R20#7409-US
<input type="radio"/>	21	Axle, 35 mm	1	7413-W10-O1D					

Centimeters

20

17

15

9

02

NOTE! Cutting the tube to length

You must cut the 200-cm tube into these lengths. The specific lengths needed for each model are indicated in the assembly instructions for each model. You will have 4 cm of tube left over after cutting. You can use the measuring guide on the left edge of this page. You can also write the lengths on the tubes with a pen so they are easier to tell apart.

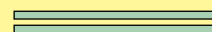
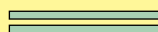
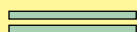
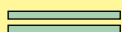
9 cm x 2

15 cm x 2

17 cm x 2

20 cm x 3

27 cm x 2



You will also need:

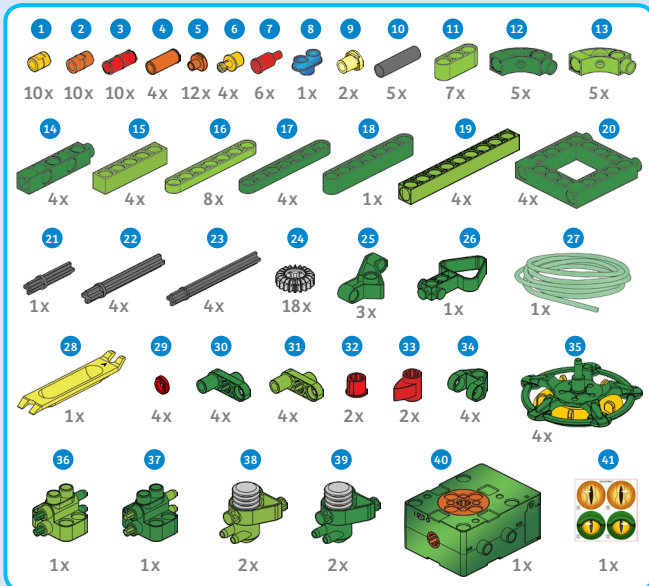
2 x AAA batteries (1.5-volt, type AAA/LR03), scissors, ruler or measuring tape, smooth flat climbing surface (such as glass, plastic, or smooth laminate), small Phillips-head screwdriver, a few sheets of paper, sheet of thin plastic (such as a binder cover), marker



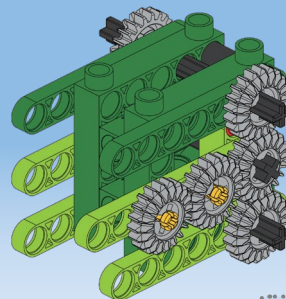
GECKOBOT

TIP!

After you build the geckobot model, make sure you read and follow all of the instructions for operating the geckobot on pages 14-15.



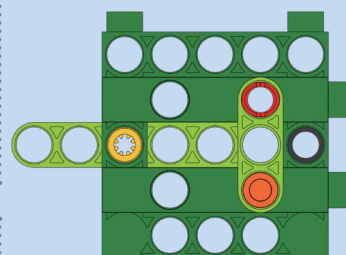
Body units: Steps 1 through 8



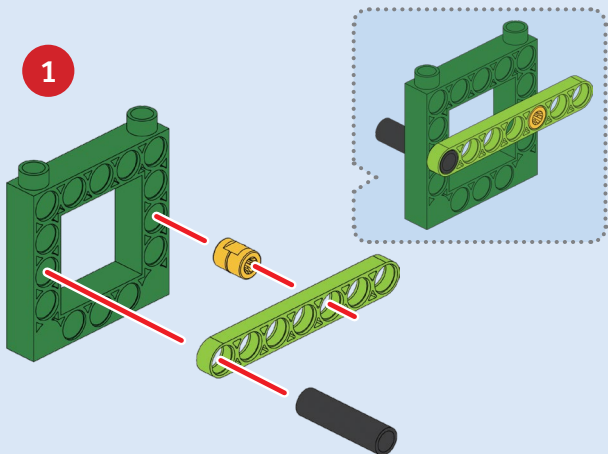
2x

Repeat steps 1 through 8 twice to build two copies of this body unit.

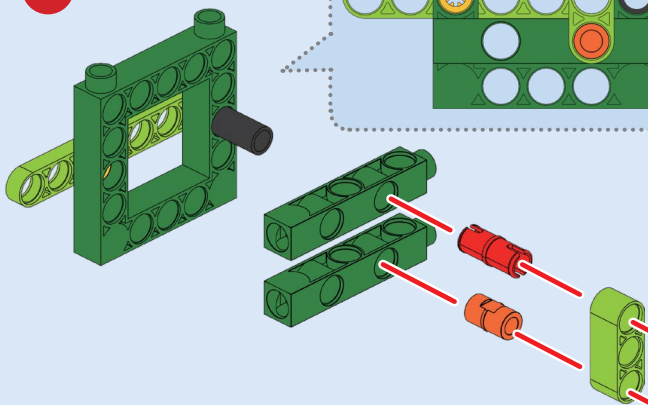
Side view



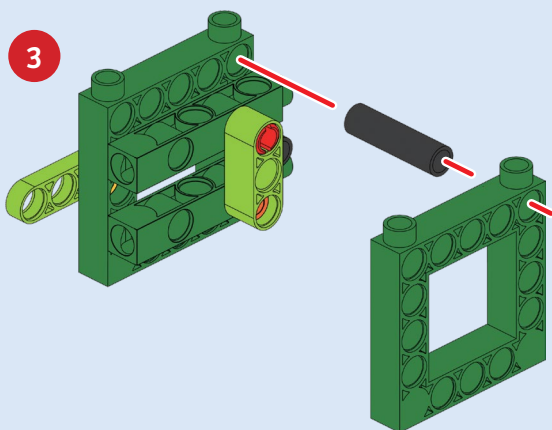
1



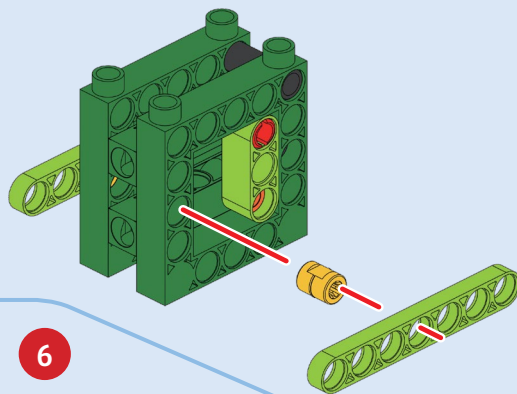
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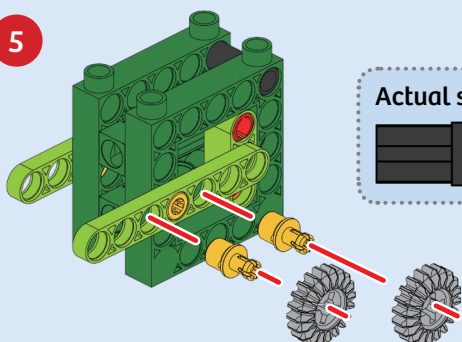
3



4

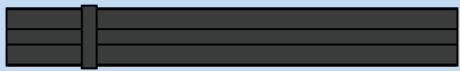


5

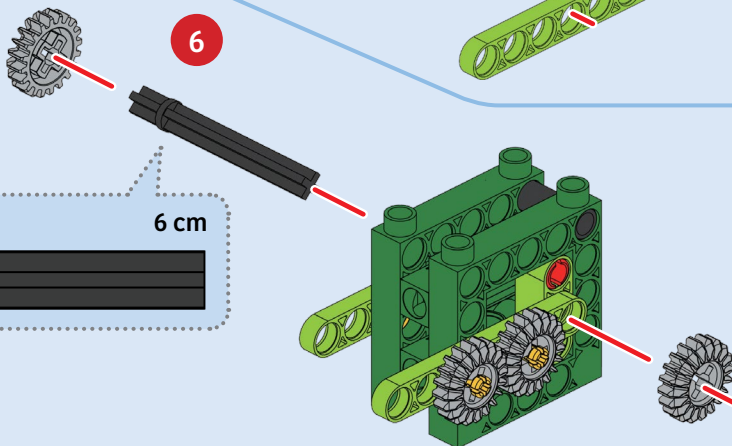


Actual size

6 cm



6

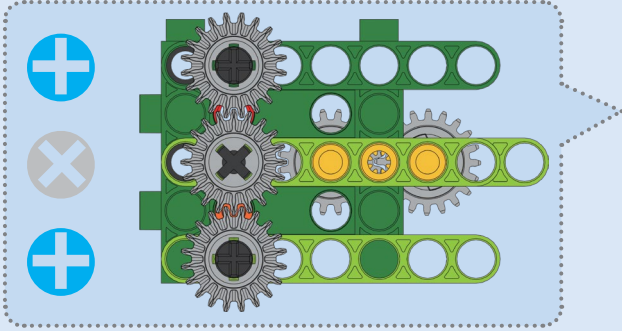




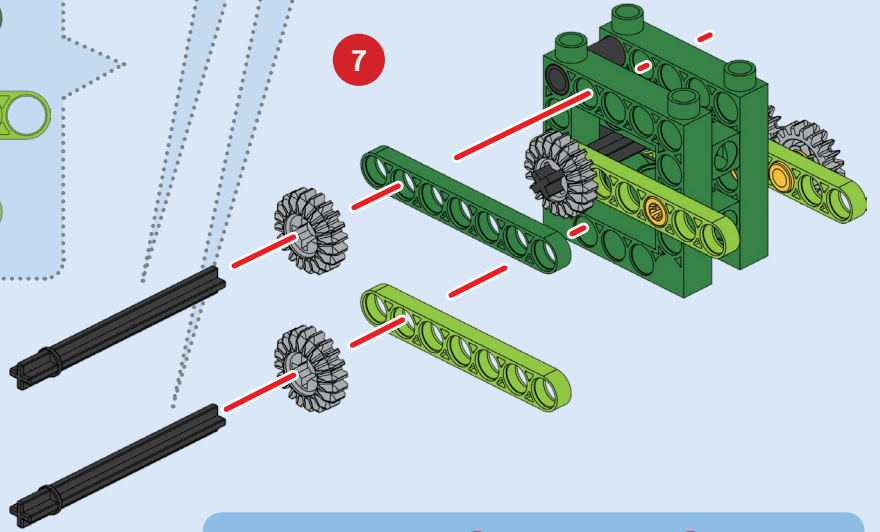
GECKOBOT

Actual size

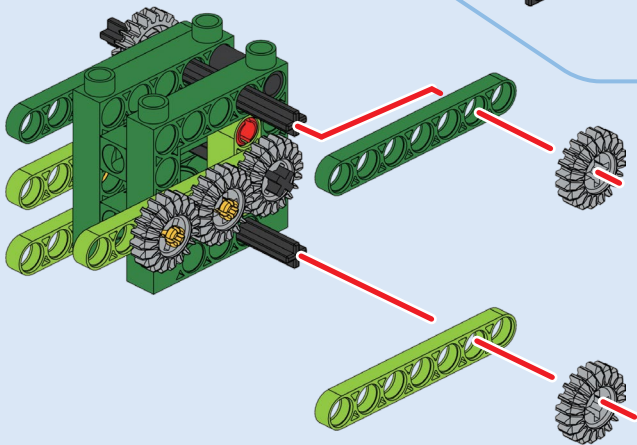
7 cm



7



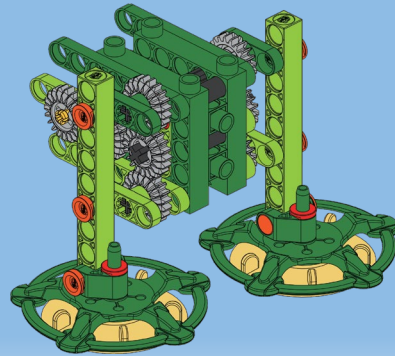
8



Legs: Steps 9 through 15

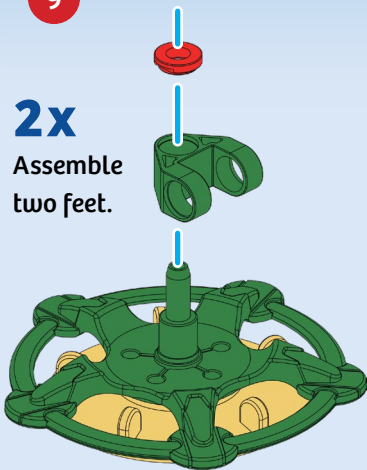
2x

Repeat steps 9 through 15 twice to attach two legs to each body unit.

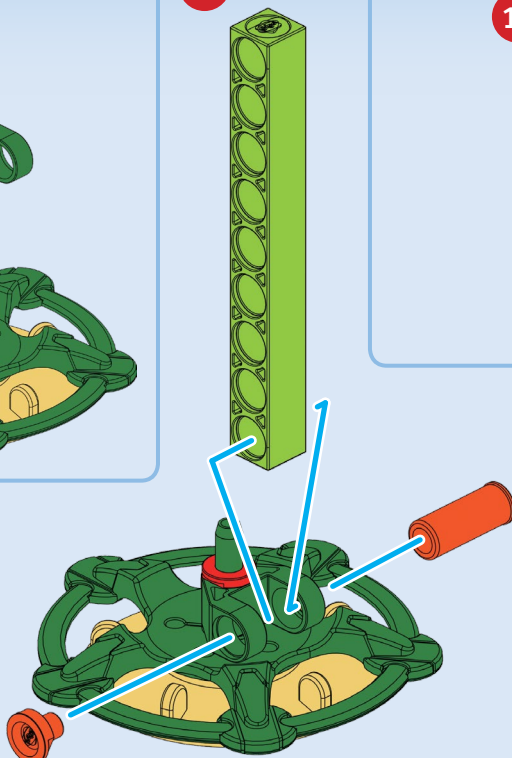


9

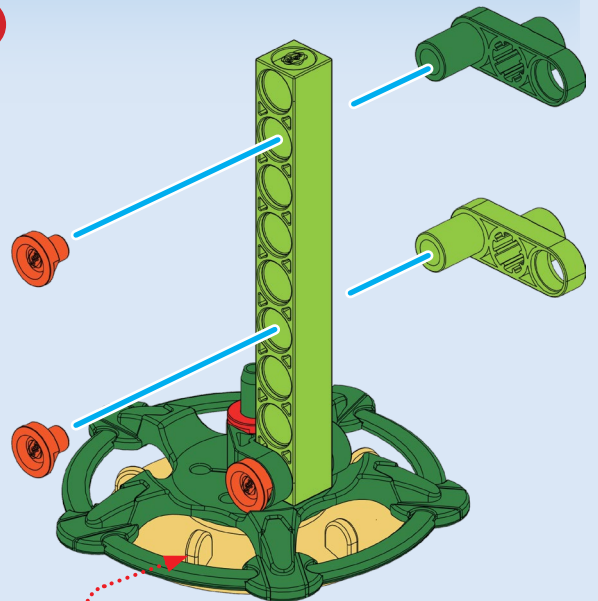
2x
Assemble two feet.



10

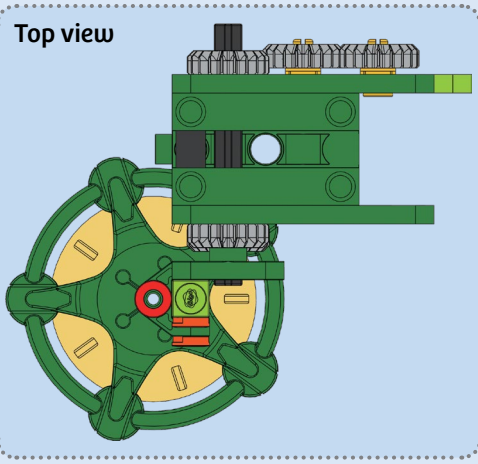


11

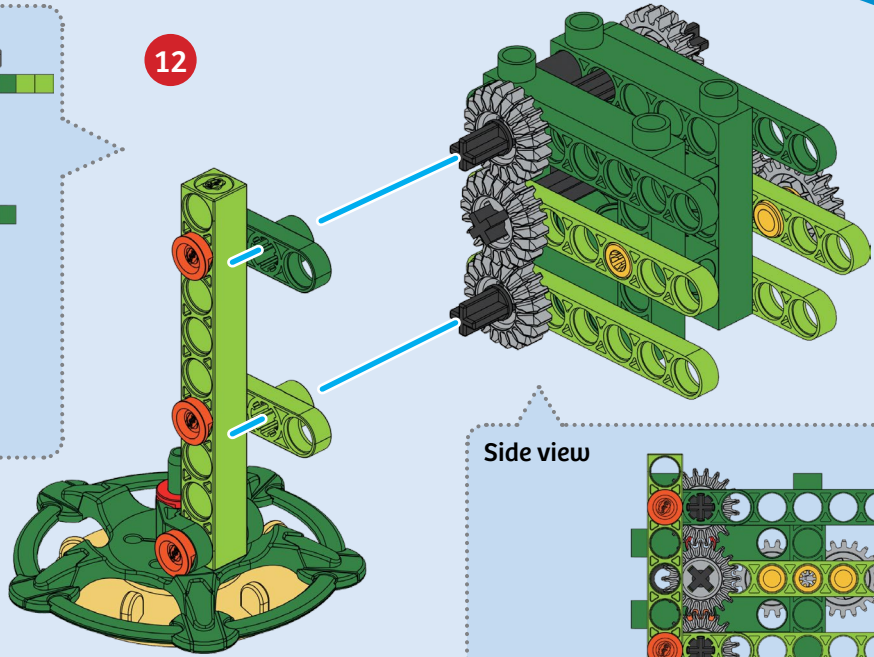


TIP! When one of the suction cups is stuck to a surface and you want to release it, pull one of the small yellow tabs on the suction cup, rather than trying to pull the whole model.

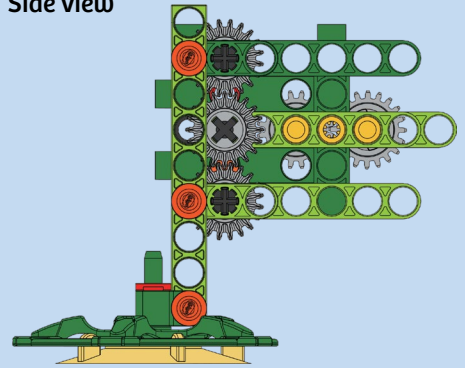
Top view



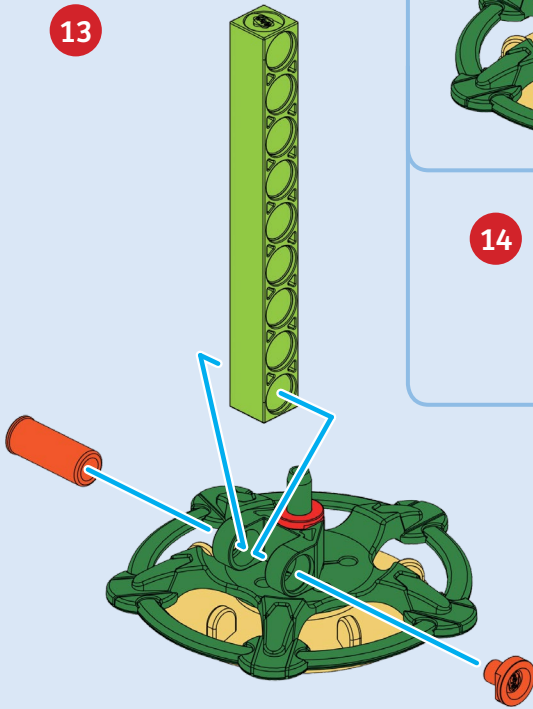
12



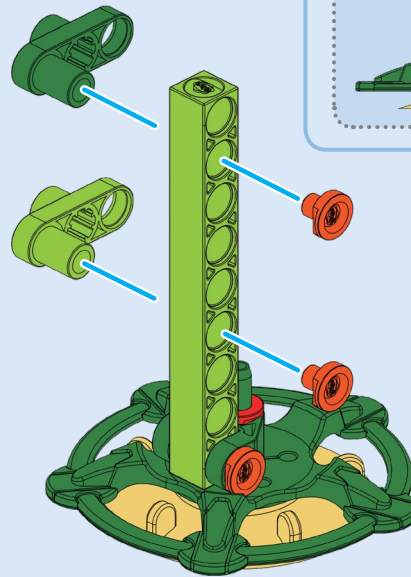
Side view



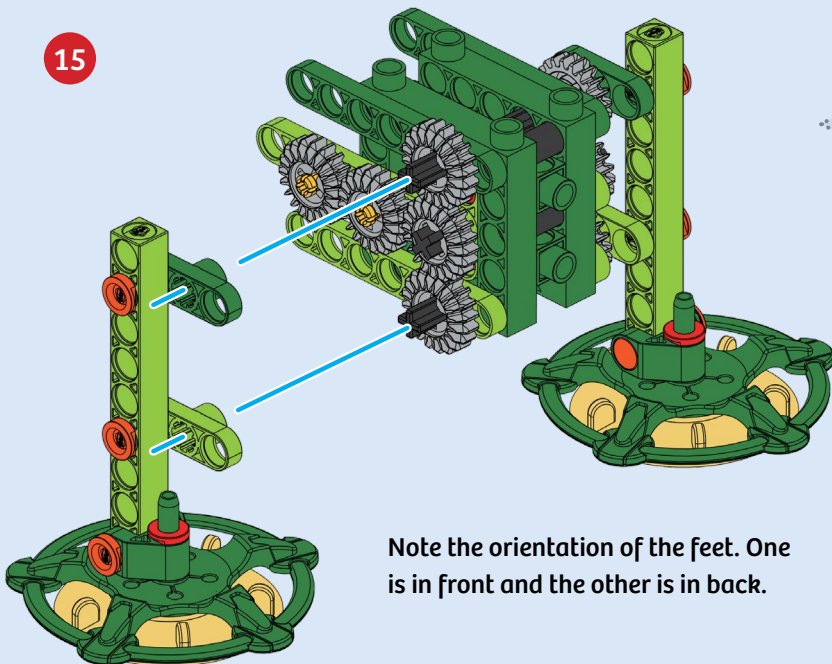
13



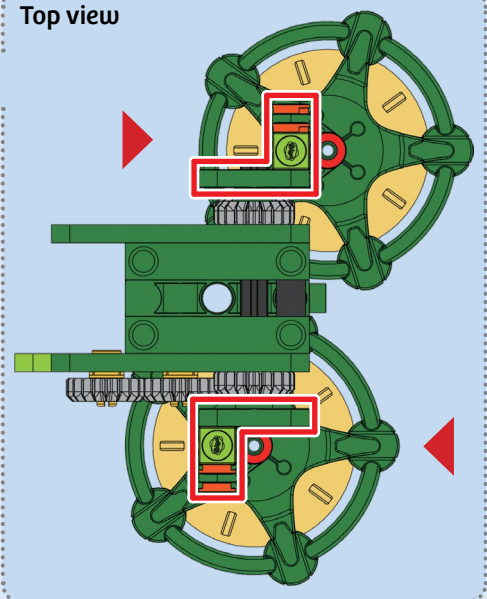
14



15



Top view



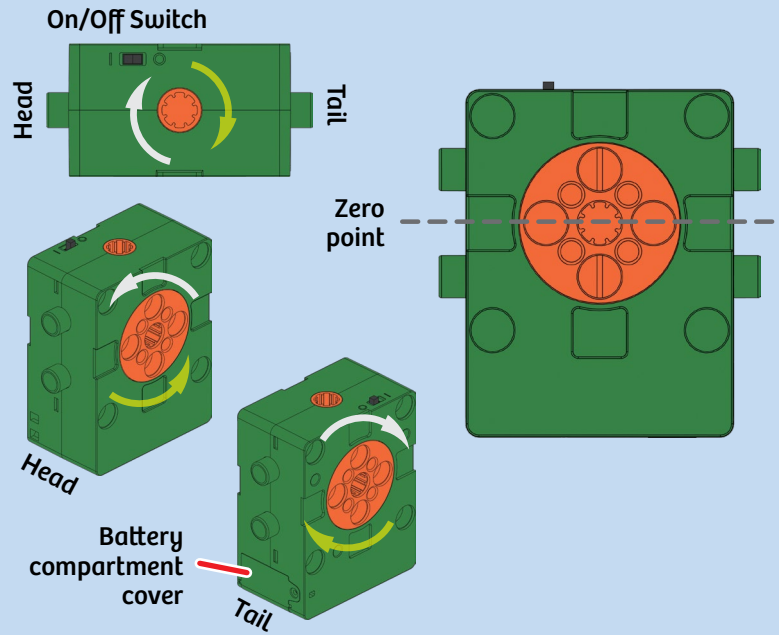
Note the orientation of the feet. One is in front and the other is in back.

Motor unit

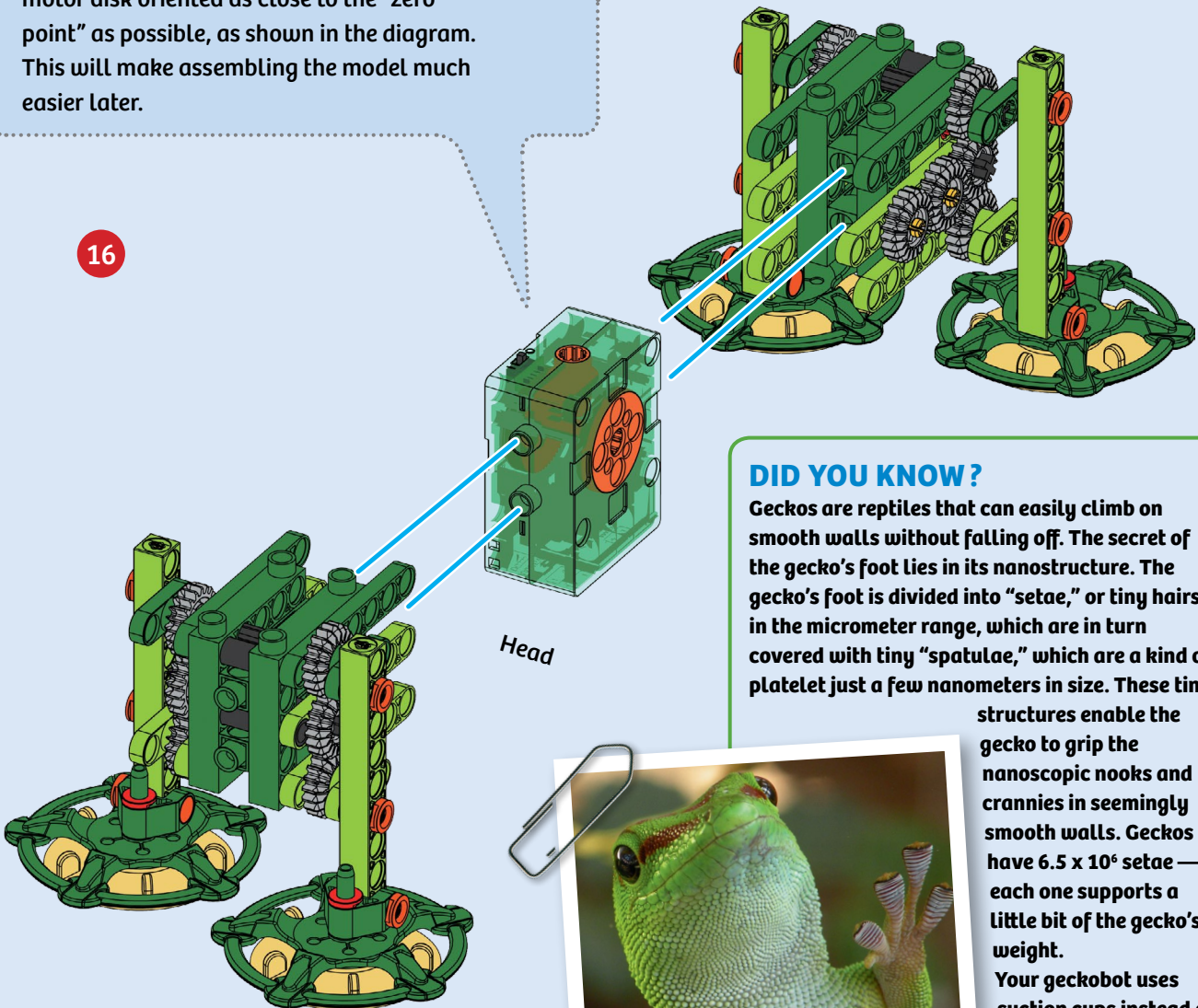
The geckobot's walking direction is dictated by the motor. It is important to install the motor unit in the correct orientation in the model. The battery compartment cover should be facing the tail of the geckobot. The power switch is closer to the head.

How to install and remove the batteries: Install the batteries by removing the cover, inserting the batteries in the correct polarity direction as indicated by the markings on the motor unit, and closing the cover again. You will need a small Phillips-head screwdriver to remove and replace the screw holding the cover in place.

Turn on the power and try to get the orange motor disk oriented as close to the "zero point" as possible, as shown in the diagram. This will make assembling the model much easier later.



16

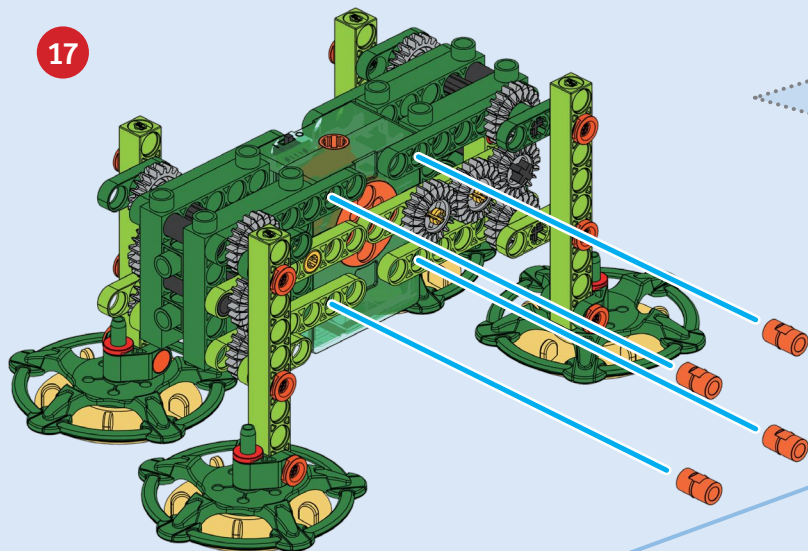


DID YOU KNOW?

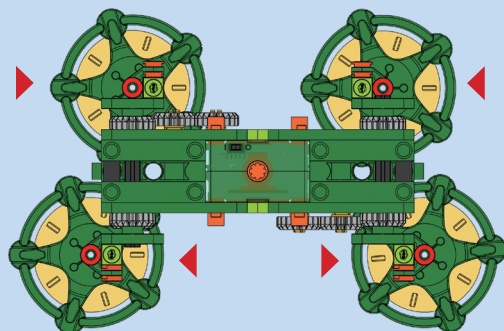
Geckos are reptiles that can easily climb on smooth walls without falling off. The secret of the gecko's foot lies in its nanostructure. The gecko's foot is divided into "setae," or tiny hairs in the micrometer range, which are in turn covered with tiny "spatulae," which are a kind of platelet just a few nanometers in size. These tiny structures enable the gecko to grip the nanoscopic nooks and crannies in seemingly smooth walls. Geckos have 6.5×10^6 setae — each one supports a little bit of the gecko's weight. Your geckobot uses suction cups instead of setae to hold itself up.



17

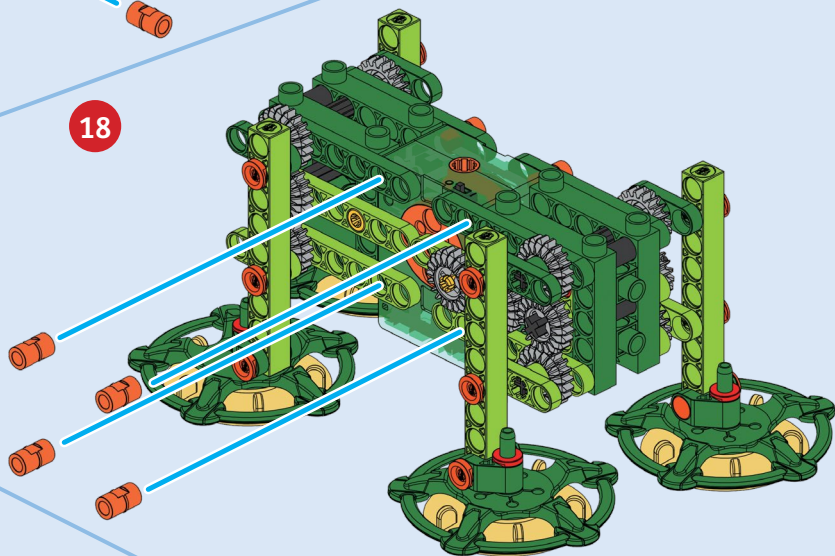


Top view

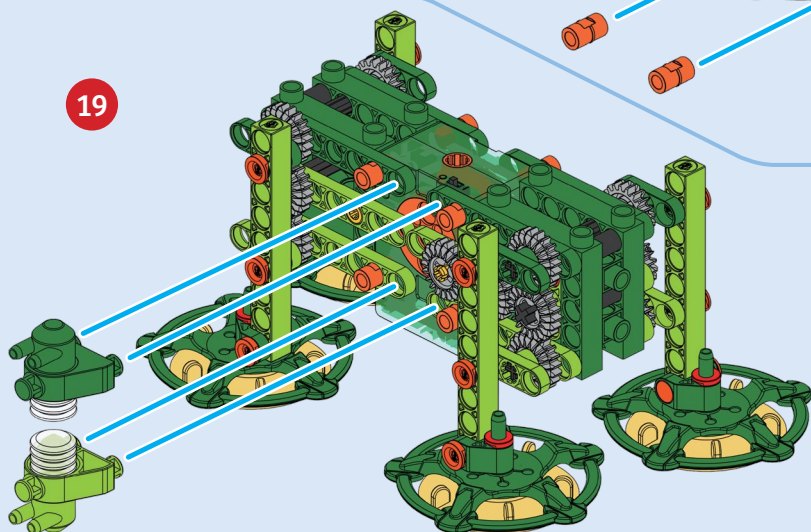


TIP! At this point, you should make sure that the geckobot's legs can rotate through a complete rotation. Make sure that the axles that attach the legs to the body are not sticking out too far and blocking the rotation of the legs.

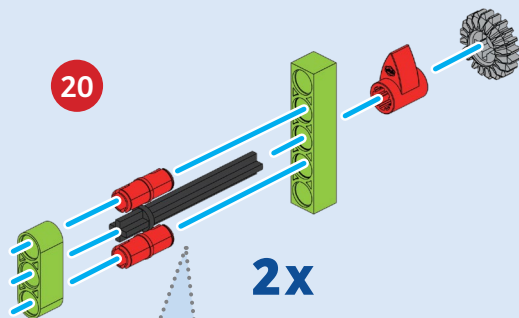
18



19

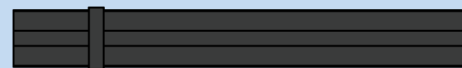


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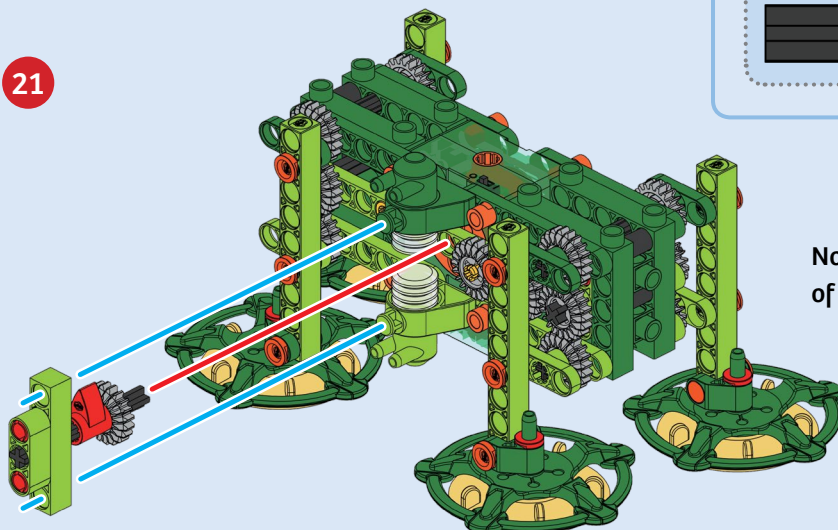


Actual size

6 cm



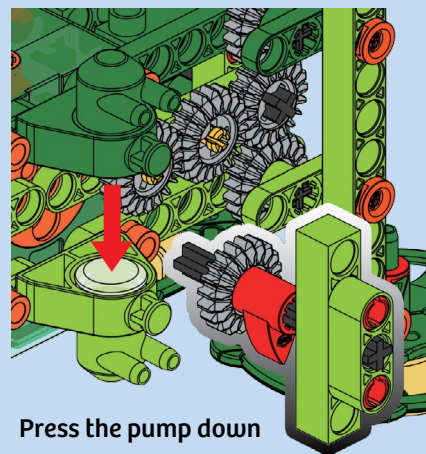
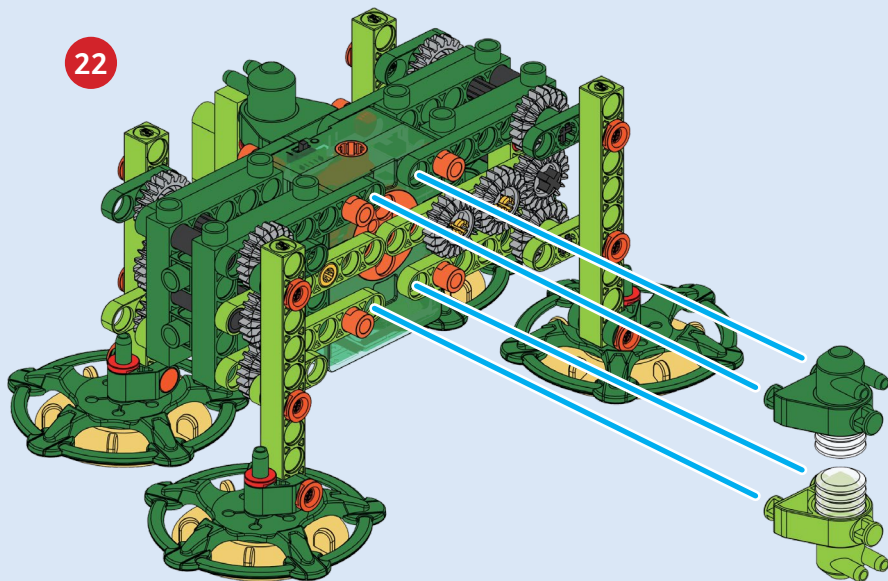
21



Note the orientation of the feet.

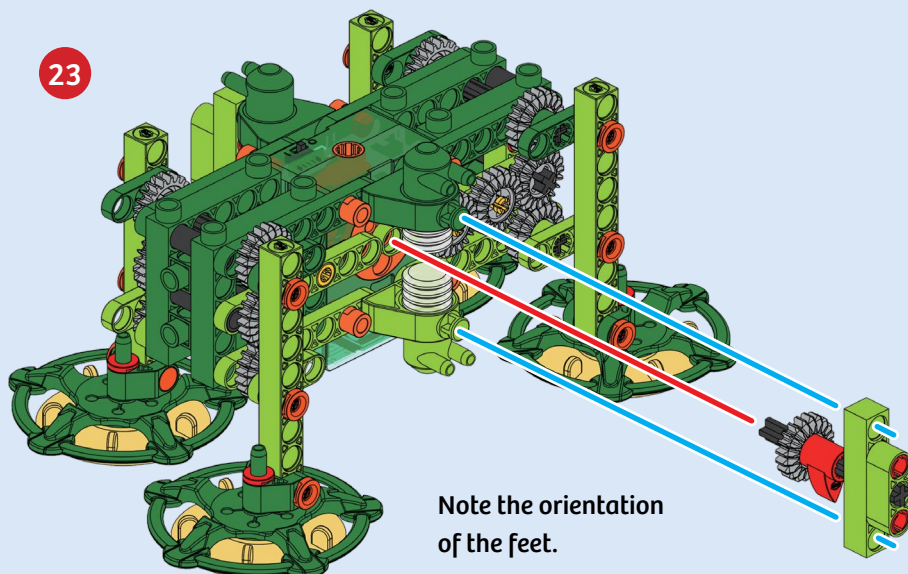


22



Press the pump down before assembling.

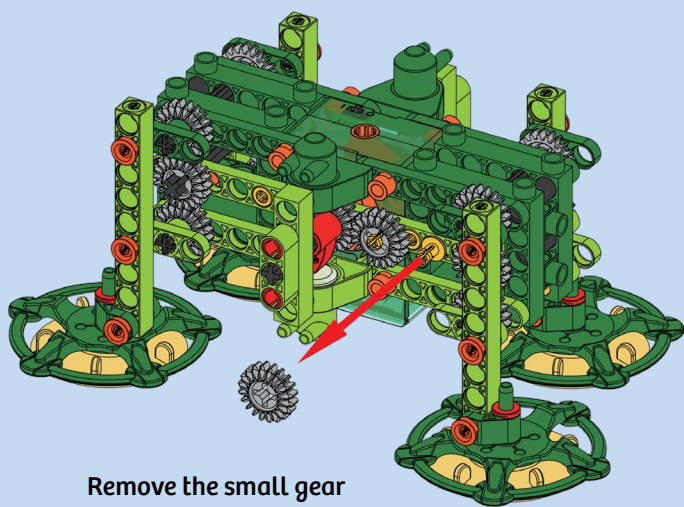
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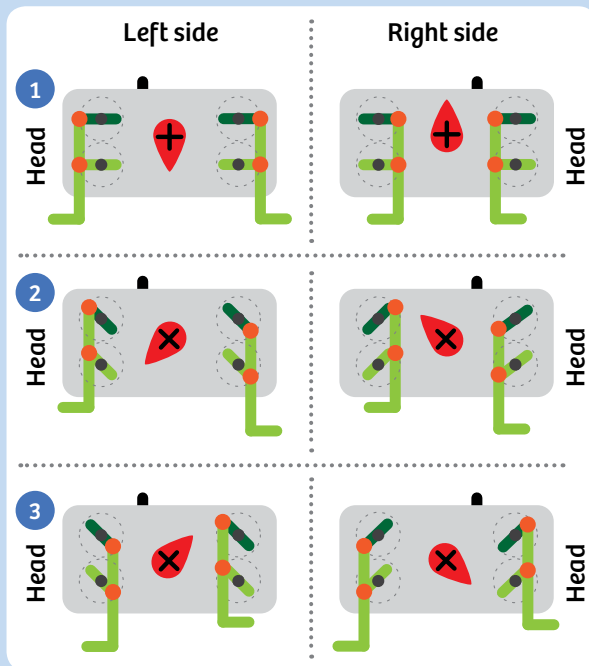
Note the orientation of the feet.

24 Aligning the legs for smooth walking

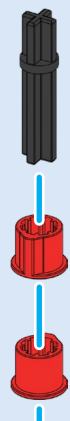
Follow the diagram below to correctly orient the legs with each other and the red cams on each side. The legs and cams have to be aligned or else the geckobot will not walk or stick to the surfaces. To adjust the legs, remove the small gear, turn the legs into place, and replace the small gear to lock them in place.



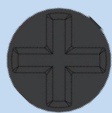
Remove the small gear to easily rotate the legs.



25



Small cam shaft

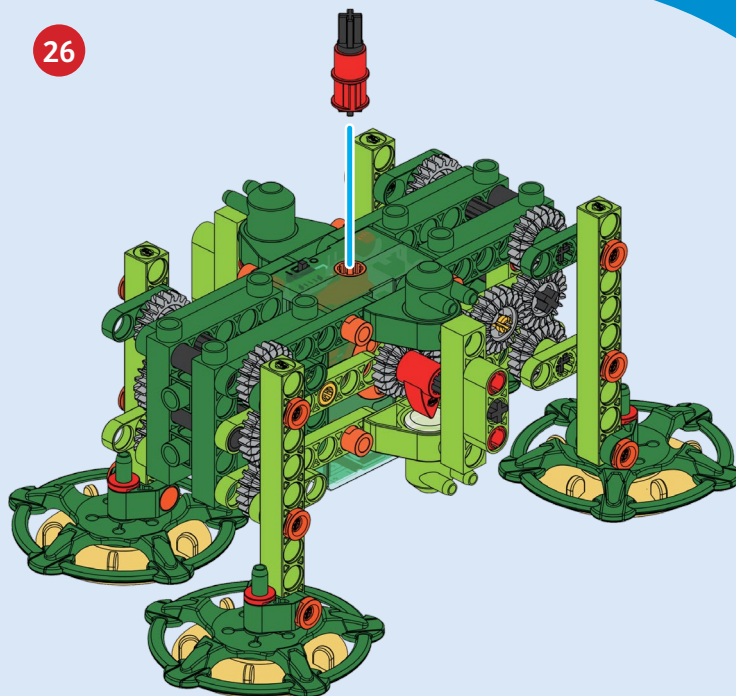


Small cams

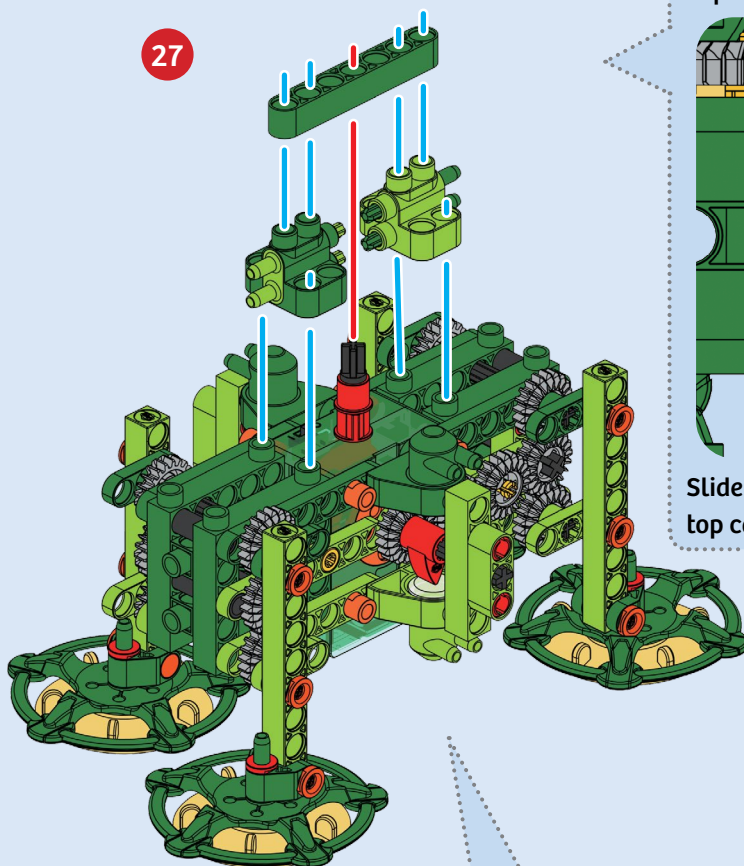
These small cams control when the pressure is released in the suction cups. When the tip presses on the valve and opens it, the suction cups lose their pressure.

These two tips must be placed on the axle so that one tip is rotated 180 degrees from the other.

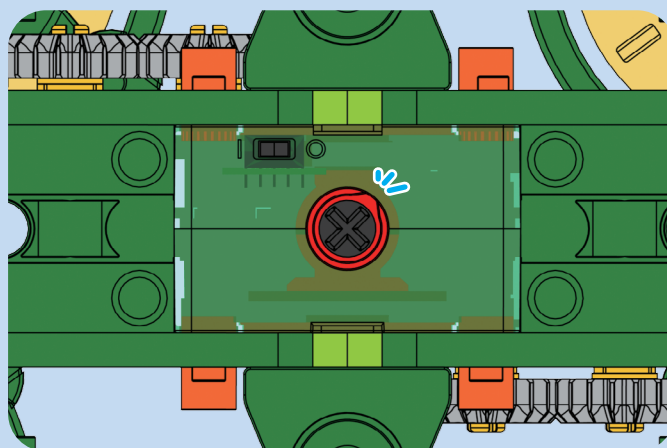
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27

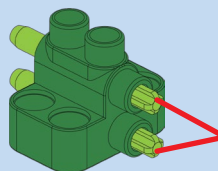


Top view



Slide the small cam assembly into the motor box so that the top cam tip points to the back right.

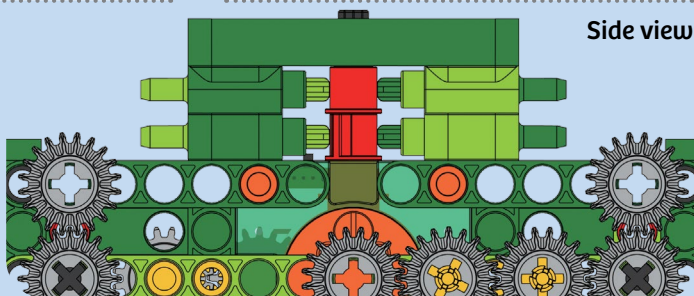
Dual valve



When the pressure relief button is not pressed in, the valve is closed. When the geckobot lifts its foot, the button must be pushed in to release the pressure at the suction cup. Each of the two dual valves has two sets of release buttons and tube connectors.

Note the direction of the small cams and valve buttons. The valves need to face inward, toward the cams.

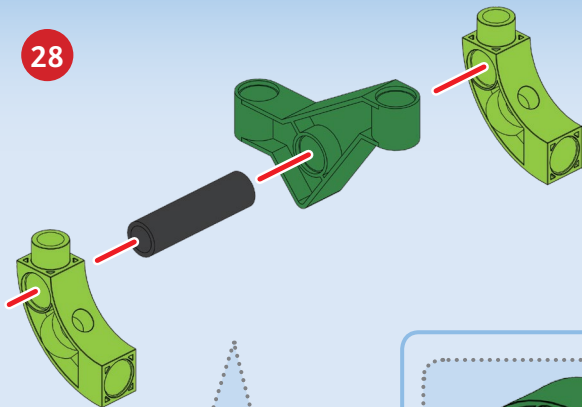
Side view



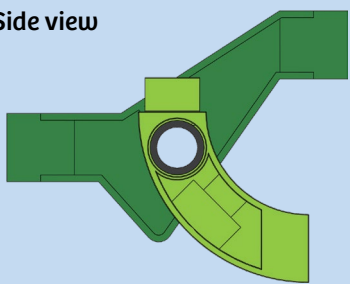


Head: Steps 28 through 33

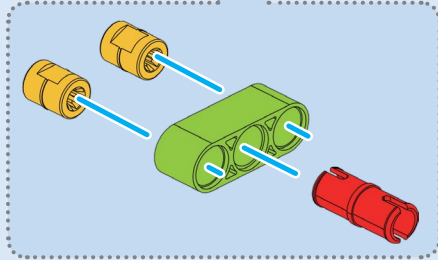
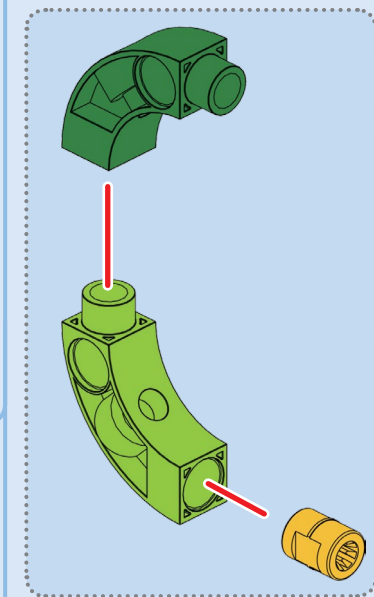
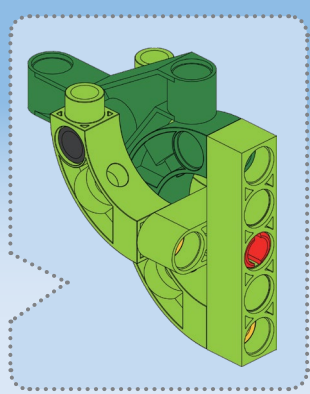
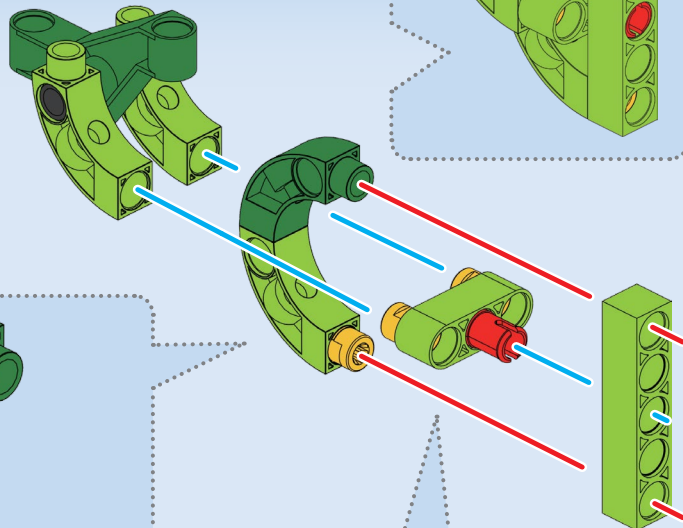
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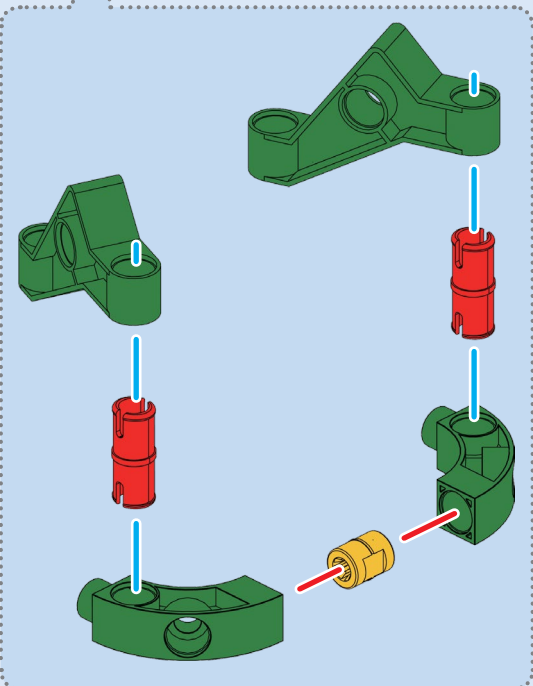
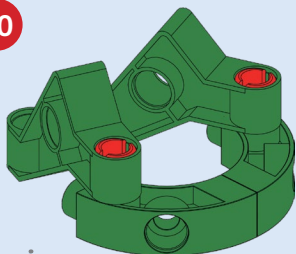
Side view



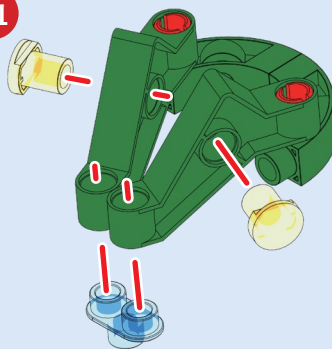
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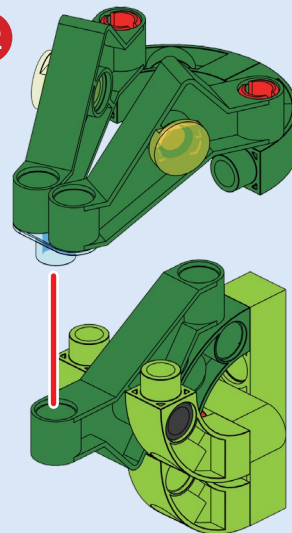
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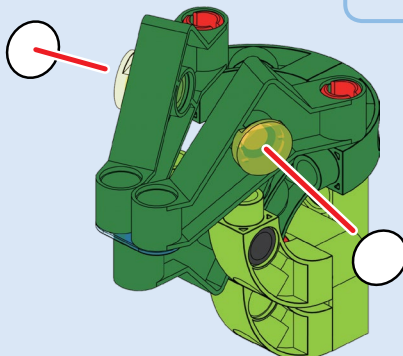
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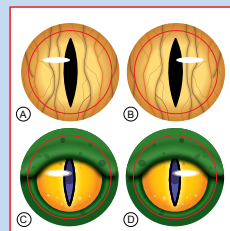
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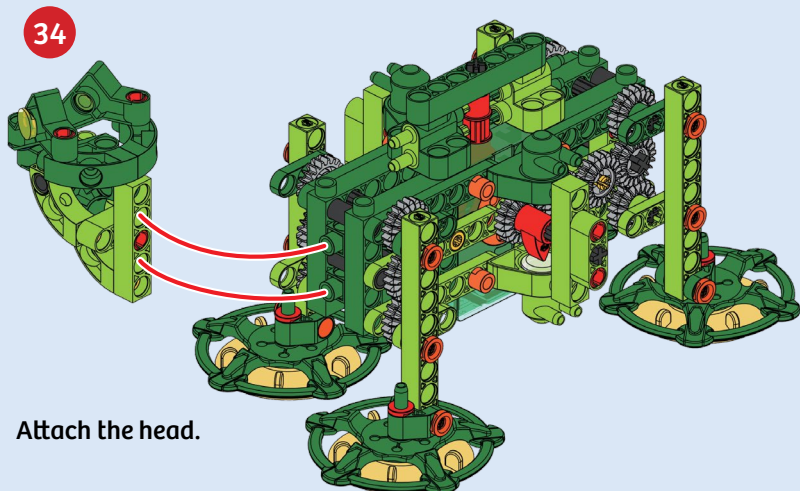


33



Choose a pair of eye stickers.

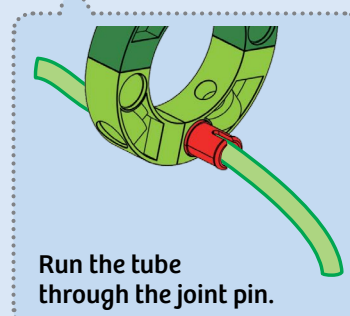
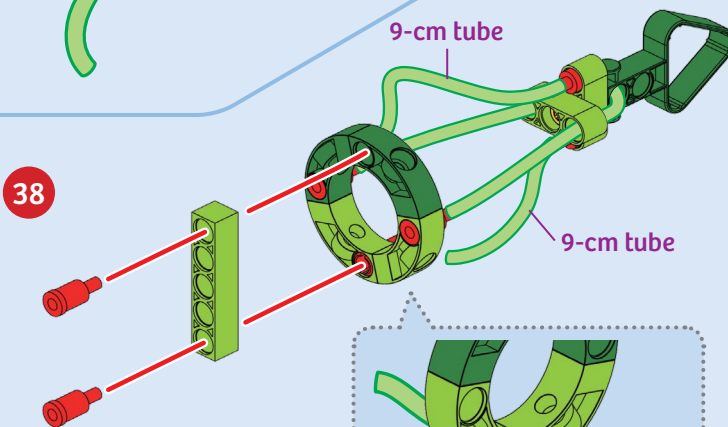
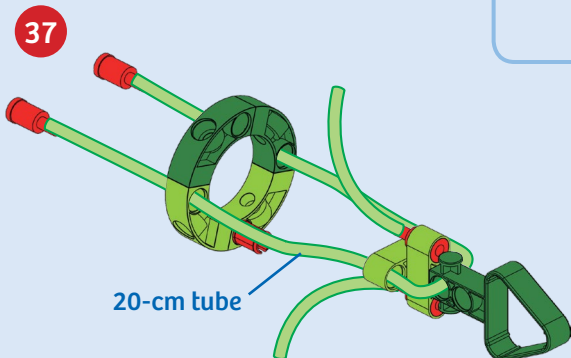
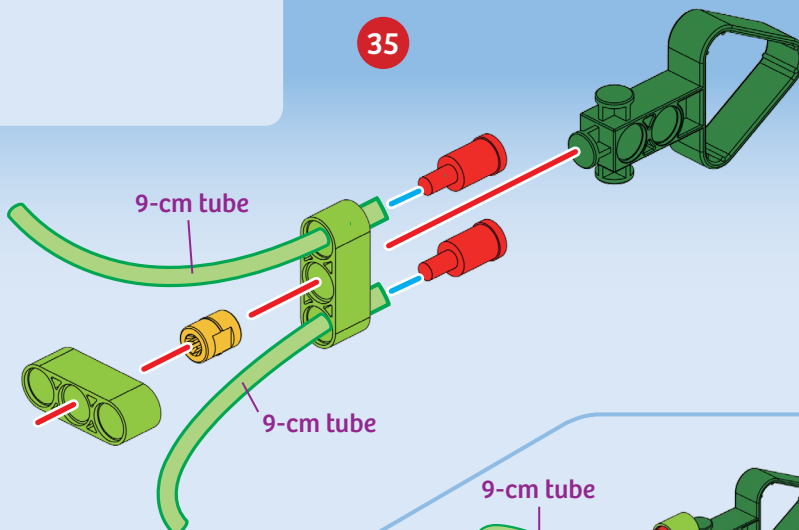
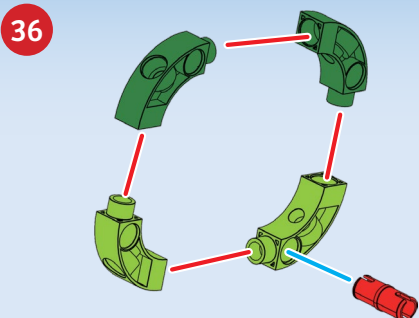




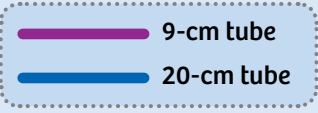
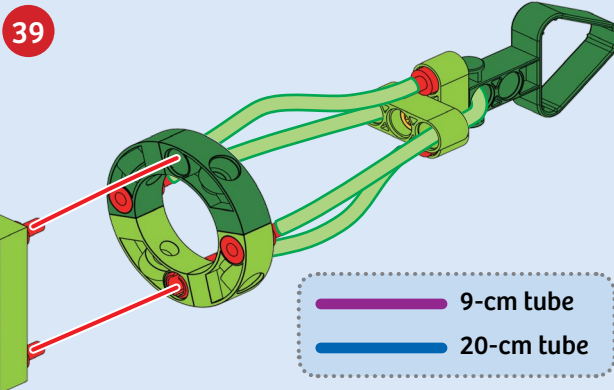
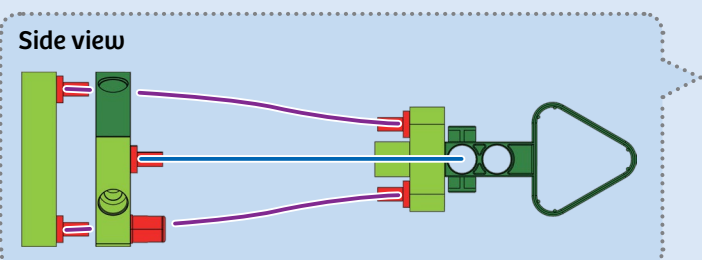
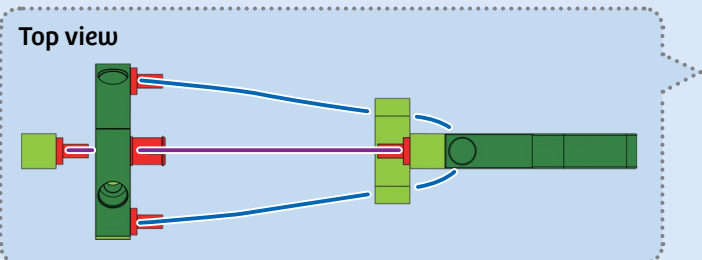
Attach the head.

Tail: Steps 35 through 39

You must cut the tube into segments of the indicated lengths. Use a ruler or measuring tape and scissors.

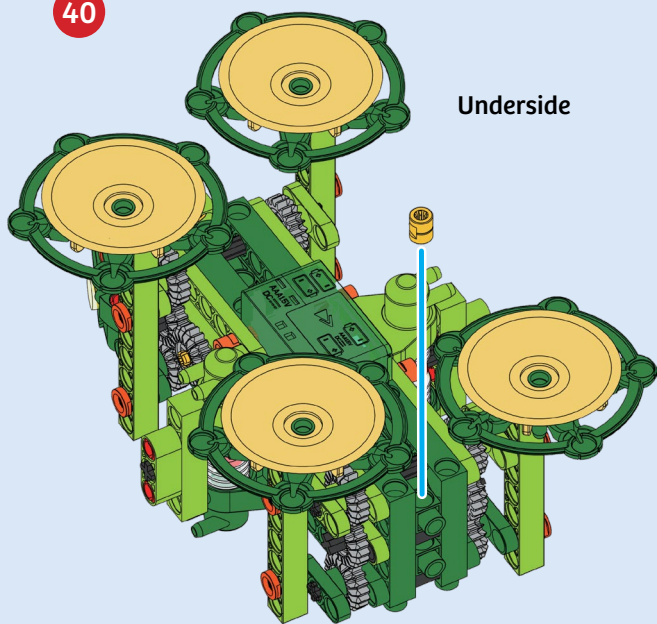


Run the tube through the joint pin.



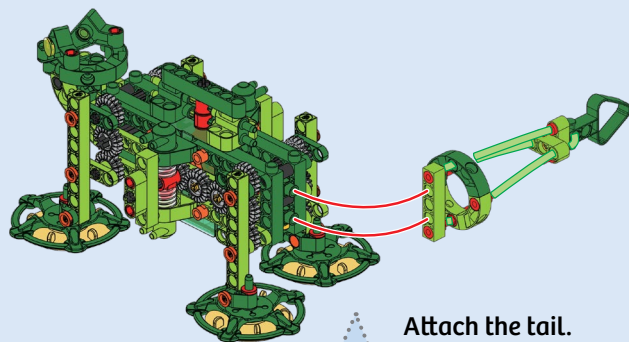


40

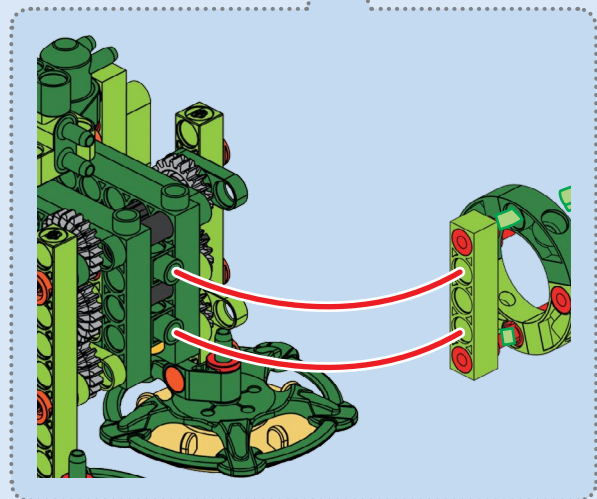


Underside

41

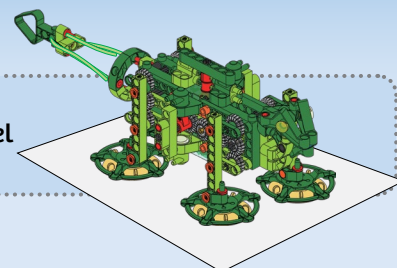


Attach the tail.

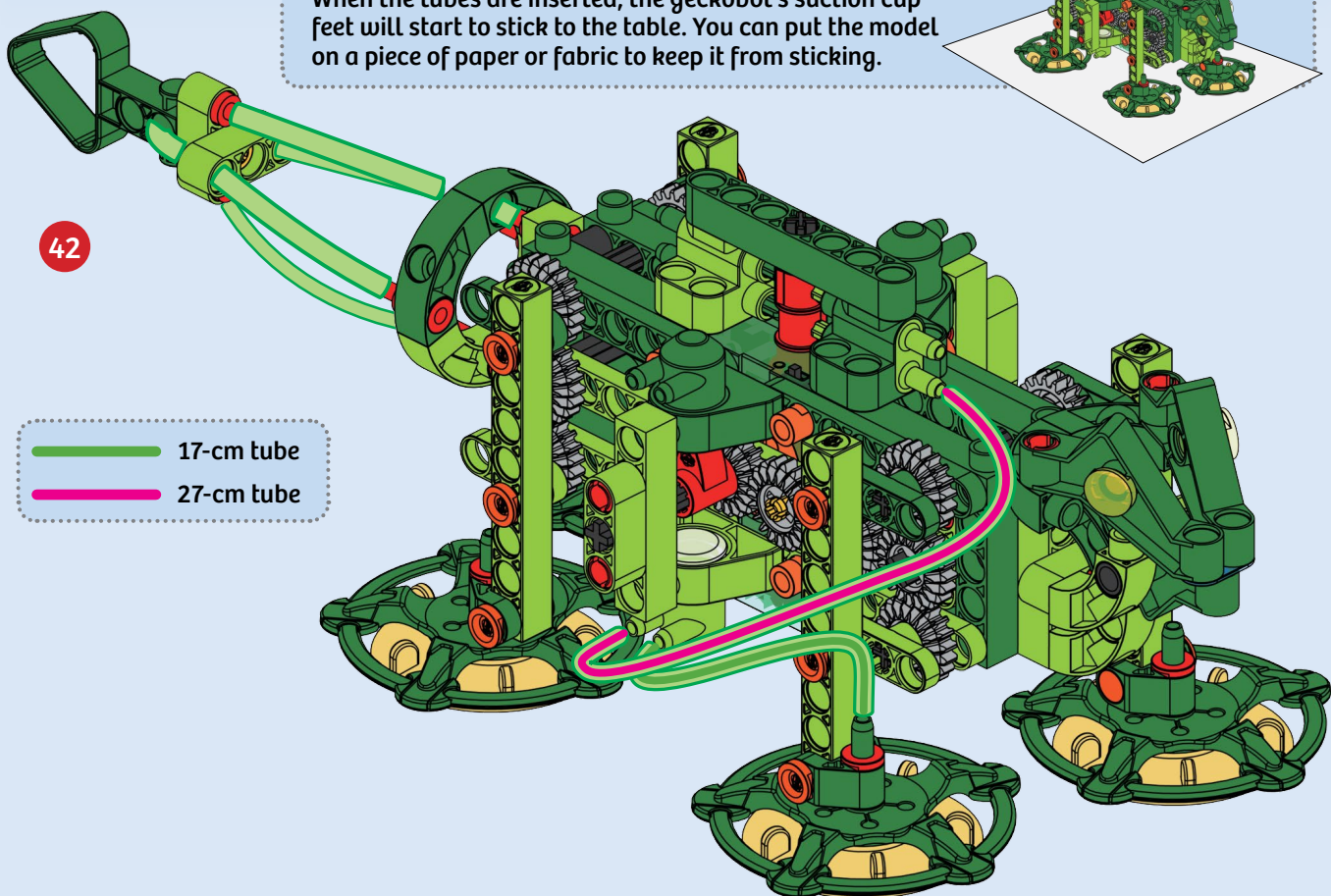


Connecting the tubes: Steps 42 through 45

When the tubes are inserted, the geckobot's suction cup feet will start to stick to the table. You can put the model on a piece of paper or fabric to keep it from sticking.



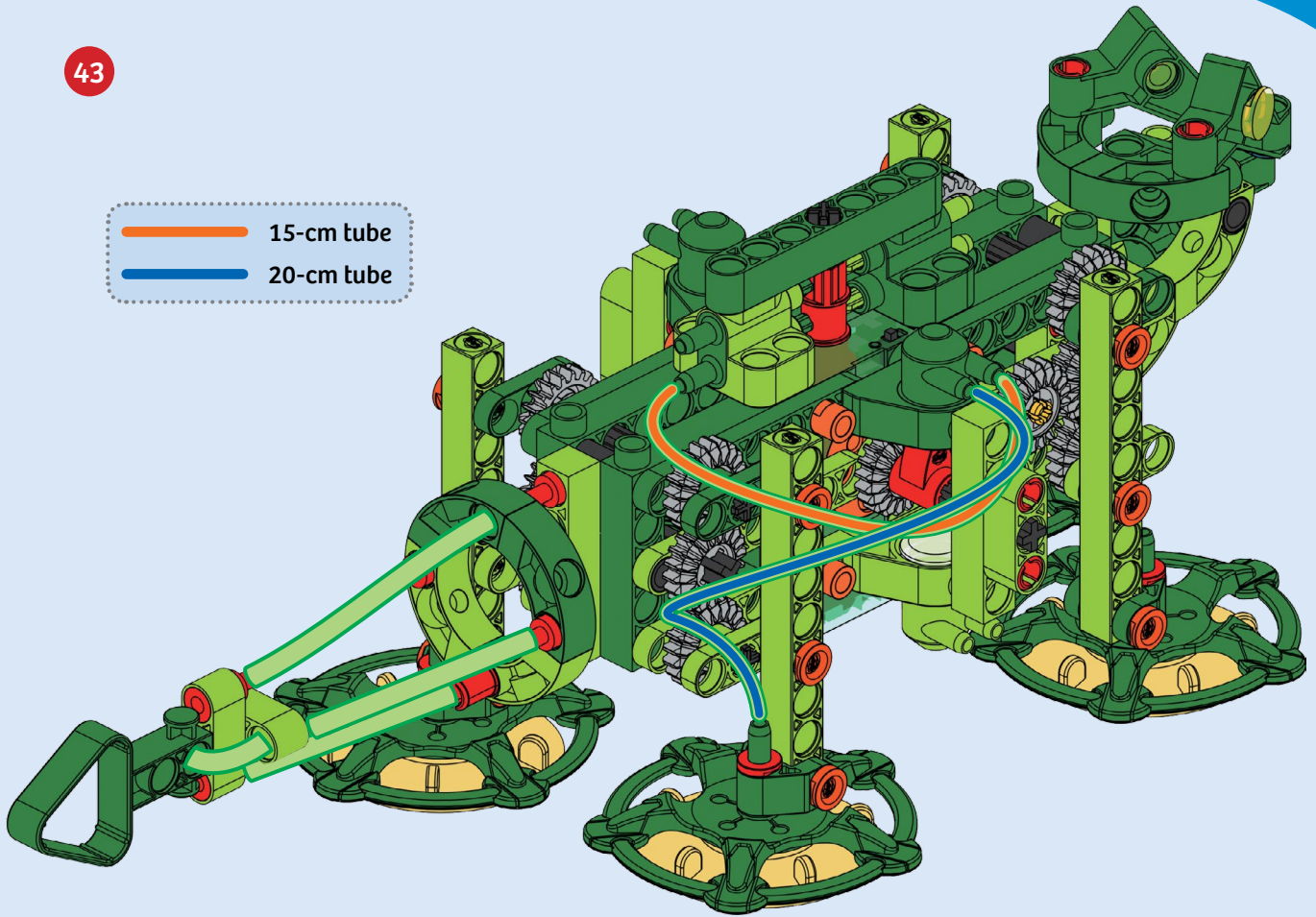
42



- 17-cm tube
- 27-cm tube

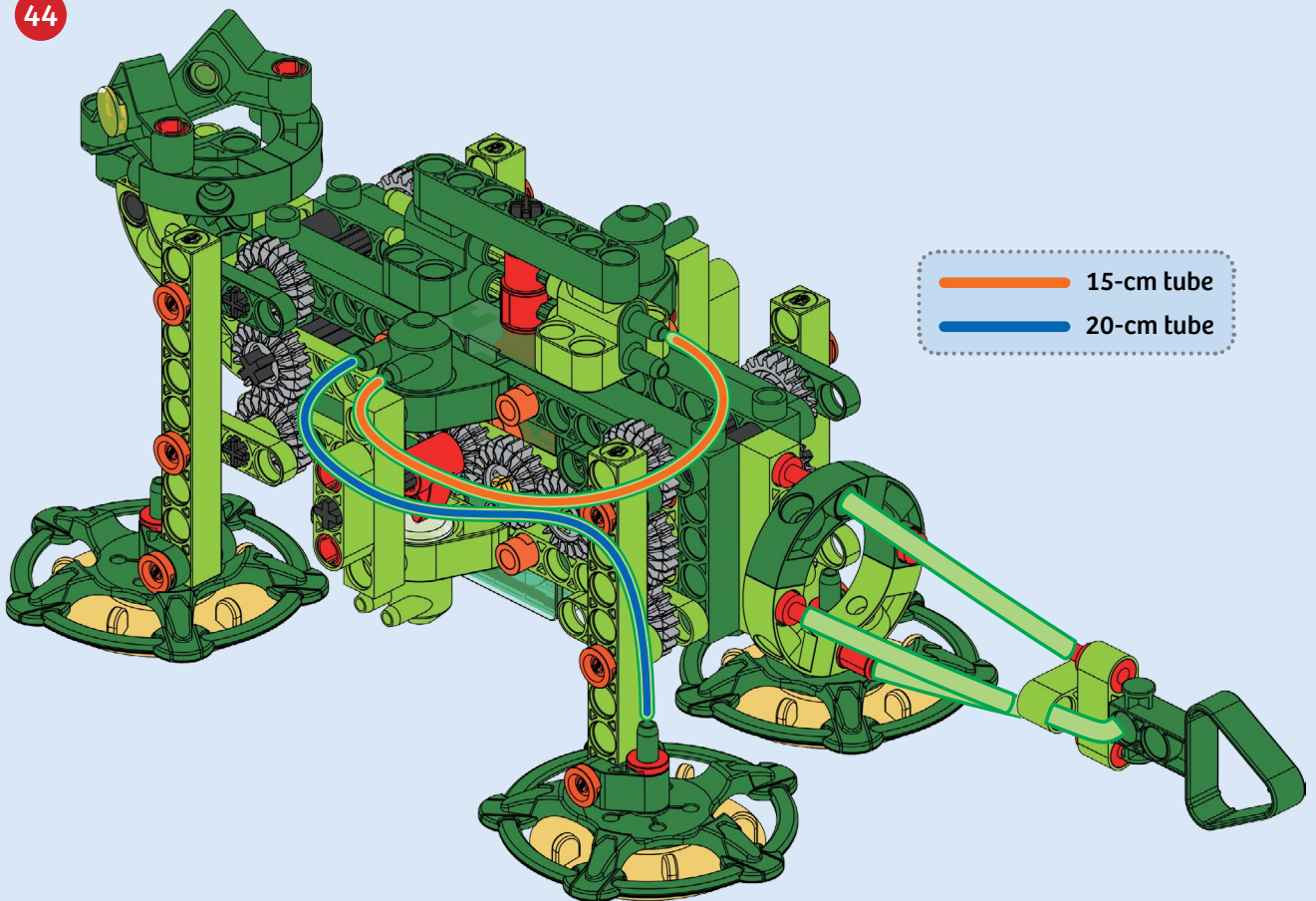
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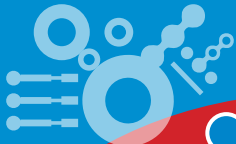
- 15-cm tube
- 20-cm tube



44

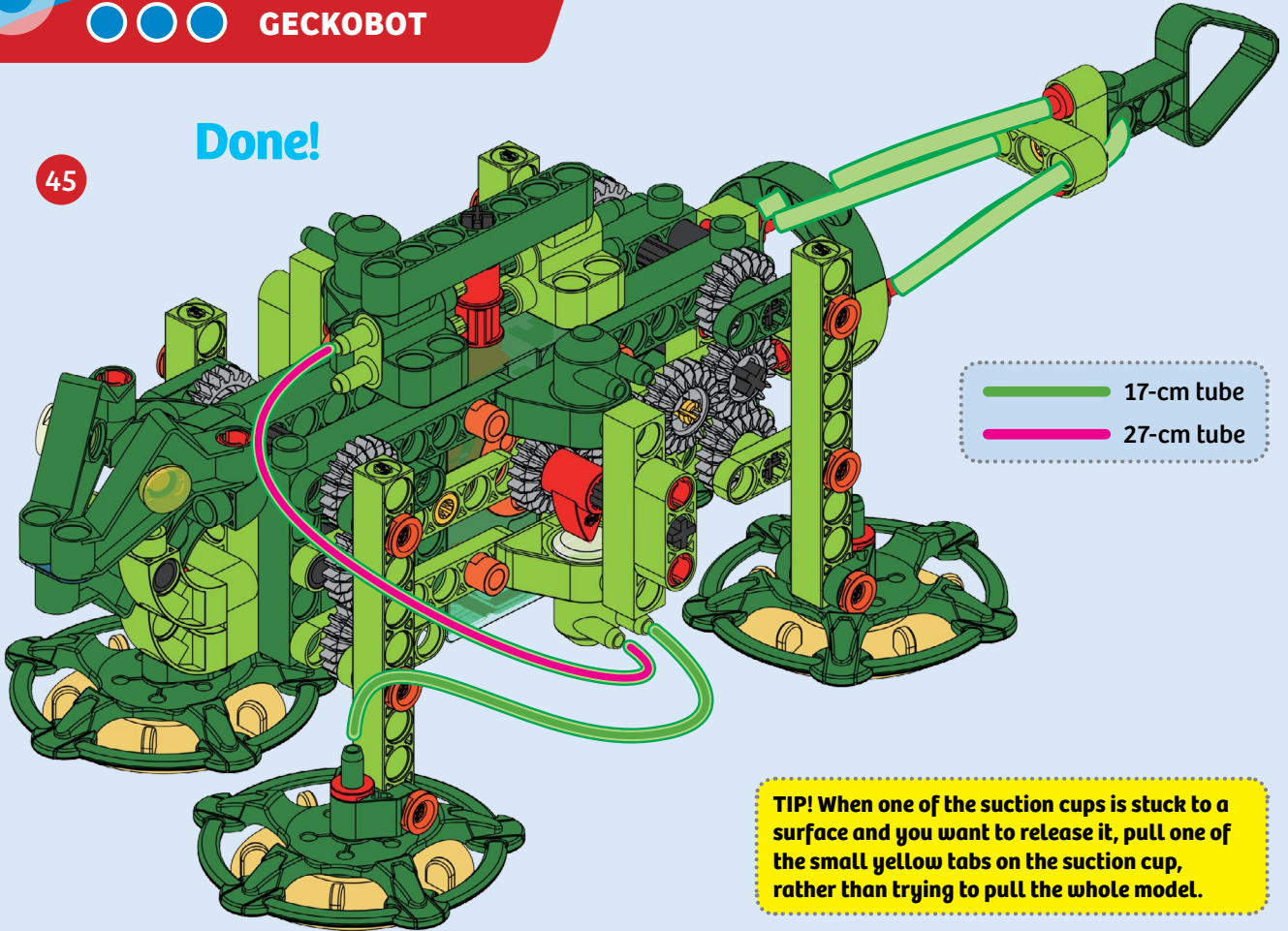
- 15-cm tube
- 20-cm tube





45

Done!

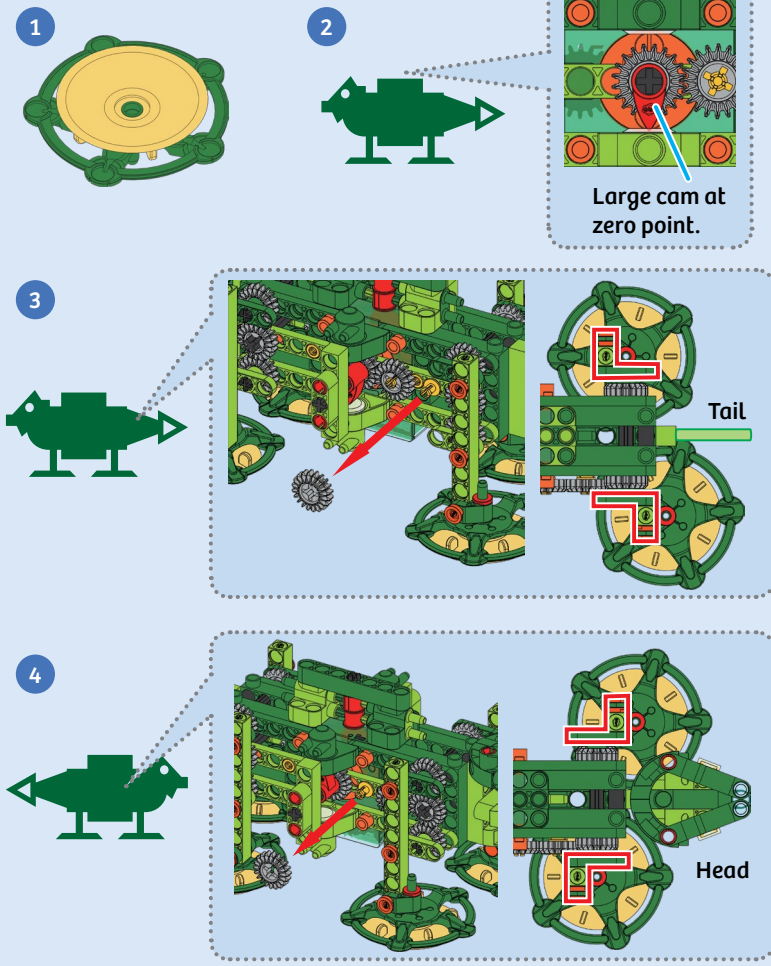


17-cm tube
27-cm tube

TIP! When one of the suction cups is stuck to a surface and you want to release it, pull one of the small yellow tabs on the suction cup, rather than trying to pull the whole model.

How to operate the geckobot

- 1 Make sure the suction cups are clean. If the suction cups have dust on them, they will lose pressure. Clean them by wiping them with a wet towel. Using a dab of lotion to clean the suction cups will make them stick to smooth vertical surfaces better.
- 2 Make sure the large cams are at the zero points. Turn on the motor and try to stop it so that the large cams stop at the zero points. The cams on the two sides are rotated 180 degrees apart. At the zero point, the cam on the left side faces downward and the cam on the right side faces upward.
- 3 Make sure the left rear foot is as far back as it goes and flat on the table. If you need to, remove the small gear and adjust the rear feet. The feet need to be 180 degrees apart, forward and backward. Then reattach the small gear.
- 4 Make sure the right front foot is as far back as it goes and flat on the table. If you need to, adjust the front feet by removing the small gear as described in step 3.



2
Large cam at zero point.

3
Tail

4
Head

Be careful with the model! Handle your geckobot model delicately. Pick it up by the body — not the tubes, legs, tail, or head.

5 If necessary, adjust the small cams. Use the anchor pin lever tool to remove the 7-hole round rod on the top of the model. Then adjust the top small cam shaft to the correct position, as shown here and described on page 9.

6 Test the geckobot by turning it on and letting it walk on a flat tabletop first.

- A. If the model walks smoothly on the table, well done! Now, test its ability to climb on a smooth vertical surface as described below.
- B. If the model sticks to the table and doesn't walk, the timing of the suction release is probably not synced up properly. Rotate the position of the small cam shaft clockwise in 45 degree increments until the model can walk smoothly on the table.

7 Now test out the geckobot on a smooth vertical surface!

The vertical climbing surface must be very smooth. Glass windows, glass mirrors, smooth plastic, smooth metal, and some glossy wood or laminate surfaces will work. Ask your parents where you are allowed to play with the geckobot. The climbing surface must be stable and secure.

Stick the geckobot to the surface. Make sure at least two of the suction cups stick to the surface. It's best to keep your hand on the model or ready to catch the model if it falls. Also, it's a good idea to have something soft on the floor underneath the model in case it falls. Turn the model on.

- A. If the model walks smoothly on the vertical surface, well done! Play around with it and try it on different surfaces.
- B. If the model sticks to the surface and doesn't walk, the timing of the suction release is probably too slow. Rotate the position of the small cam shaft clockwise in 45 degree increments until the model can walk smoothly up the surface.
- C. If the model slides down the surface or falls off, the timing of the suction release is probably too fast. Rotate the position of the small cam shaft counterclockwise in 45 degree increments until the model can walk smoothly up the surface.
- D. If you try many times to adjust the small cam and the geckobot still does not climb up the surface, try step 8.

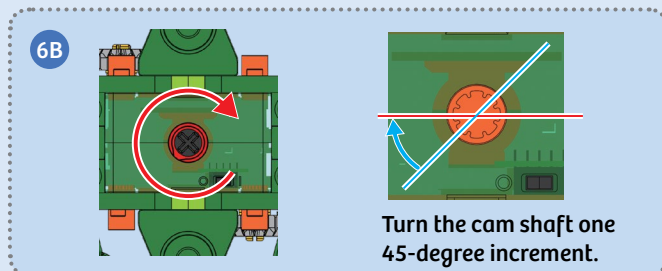
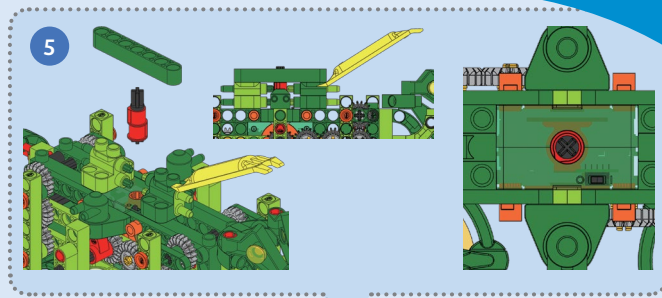
8 In some situations, the geckobot needs some minor adjustments to its pace. First, try turning the small cam shaft from "Slide" to "Stick," and then back to "Slide" again (one 45-degree increment).

Now focus on the right front foot. As you did in step 24, remove the small gear while holding the legs in place so they don't rotate around uncontrollably. Then carefully turn the right front leg so the two gears attached to the leg turn one-tooth increment clockwise. Reattach the small gear to lock the legs in place again. Try the model again.

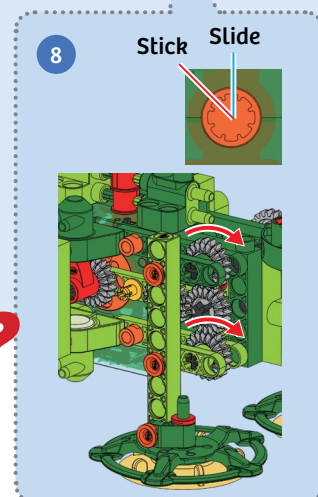
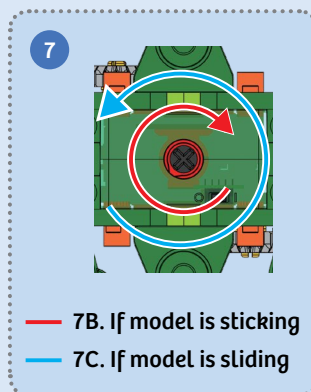
The geckobot has many moving parts and functional mechanisms. It is common for it to take some adjustments before it works properly. Don't get discouraged! Getting it to work is part of the learning process.

Danger! When using the geckobot on a window, there is the potential risk that a child opens the window and falls out the window. Please supervise children around windows.

Be careful not to let your geckobot climb out of reach!



Turn the cam shaft one 45-degree increment.



WHAT'S HAPPENING?

Inside the geckobot, the battery powered motor drives a gear system with three outputs: The motor shafts on the left and right sides turn both the large cams and gear trains connected to the legs. The third motor output turns the small cam shaft on the top, which operates the suction release valves. The gear trains move the legs in a synchronized manner, causing the legs to move back and forth and up and down — so two of the feet are touching the wall while the other two feet are lifted off of the wall, in an alternating motion.

At the start of the cycle, the two suction cups touching the wall are held in place by a vacuum. The suction release valves on the top of the model are closed, which maintains the vacuum.

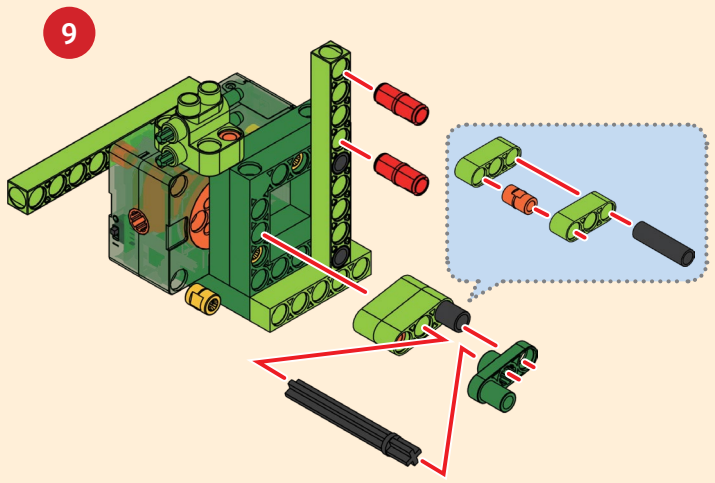
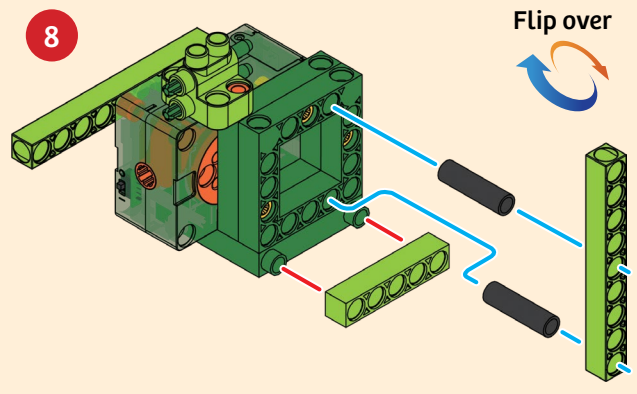
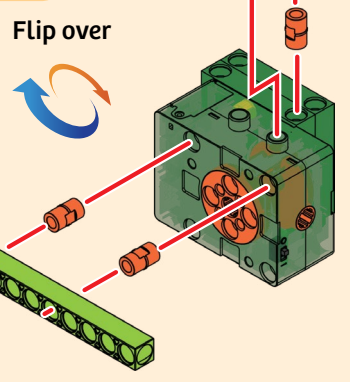
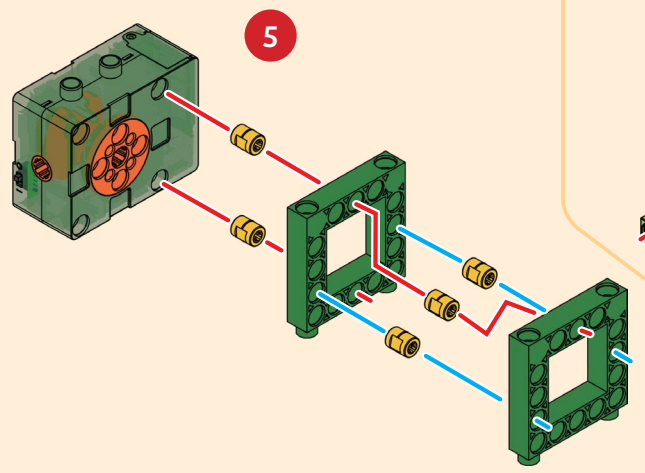
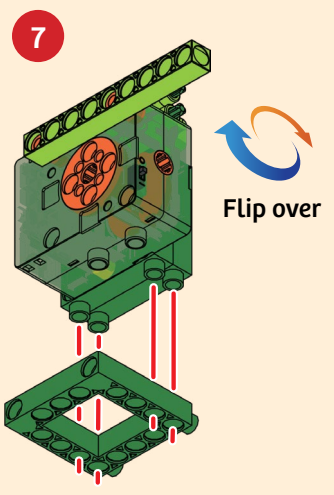
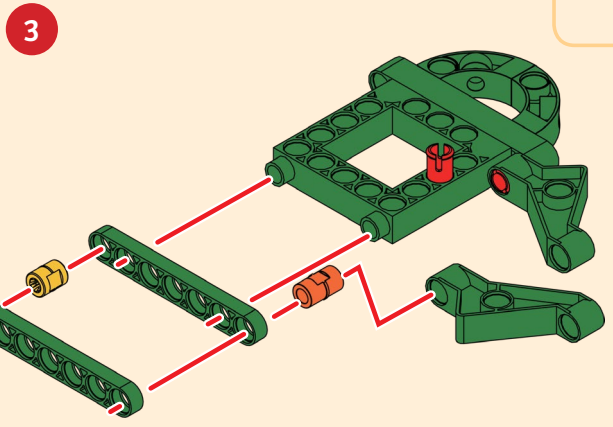
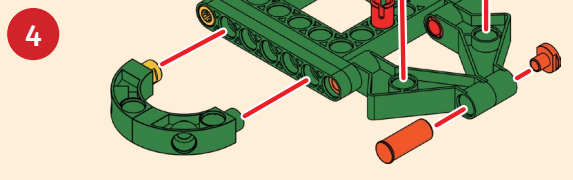
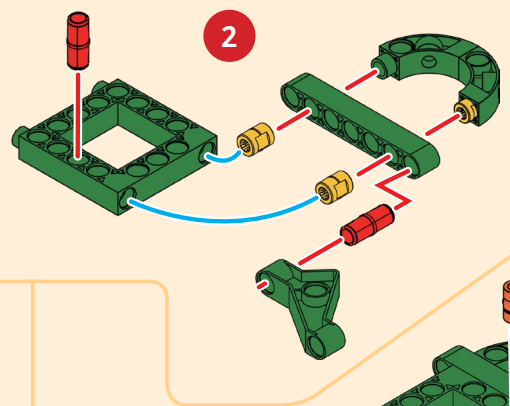
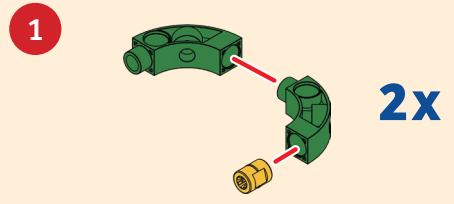
Next, the two lifted feet turn and press down onto the wall surface. At this very moment, the large cams compress the accordion pump to blow a puff of air from the pump through the tube to the two feet stuck to the wall, which are at this same moment lifting off of the wall. The puff of air releases the vacuum in these suction cups and lets them release from the wall.

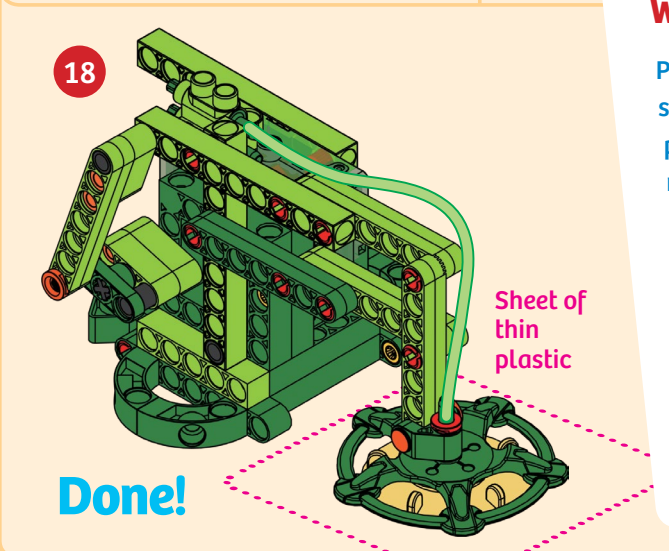
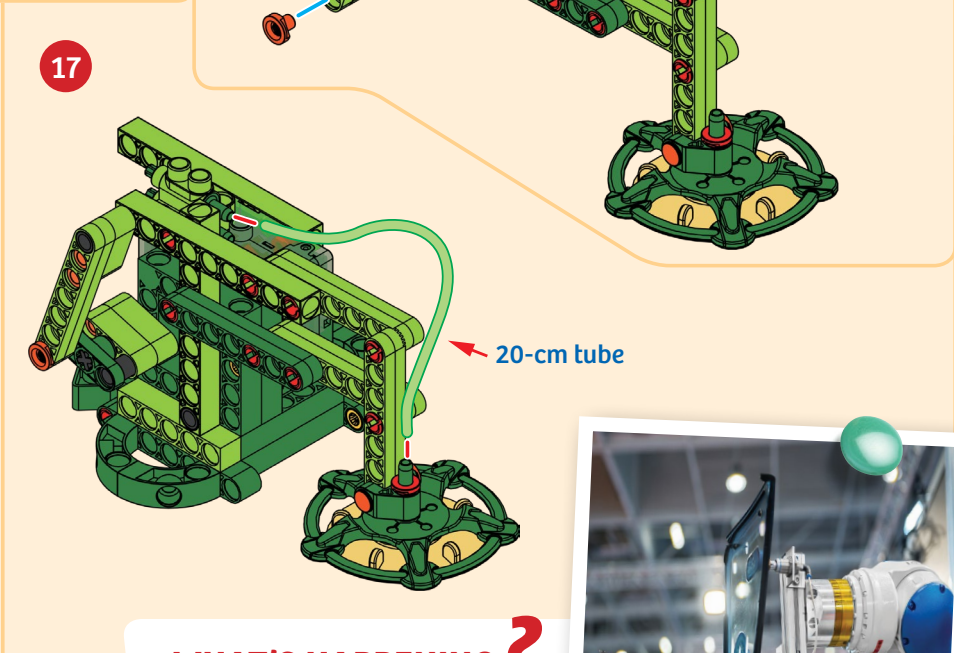
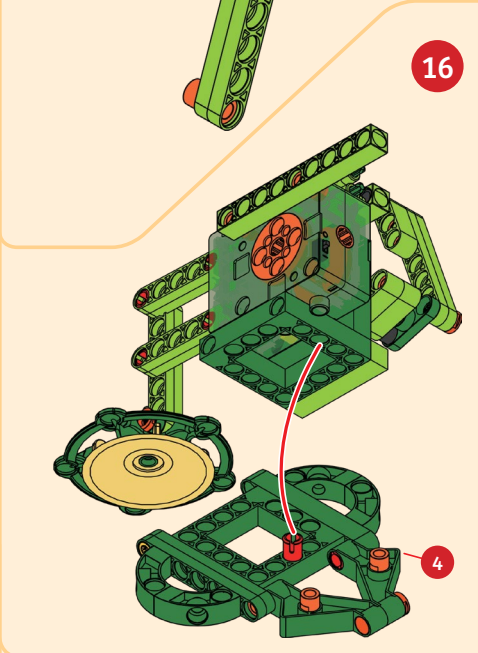
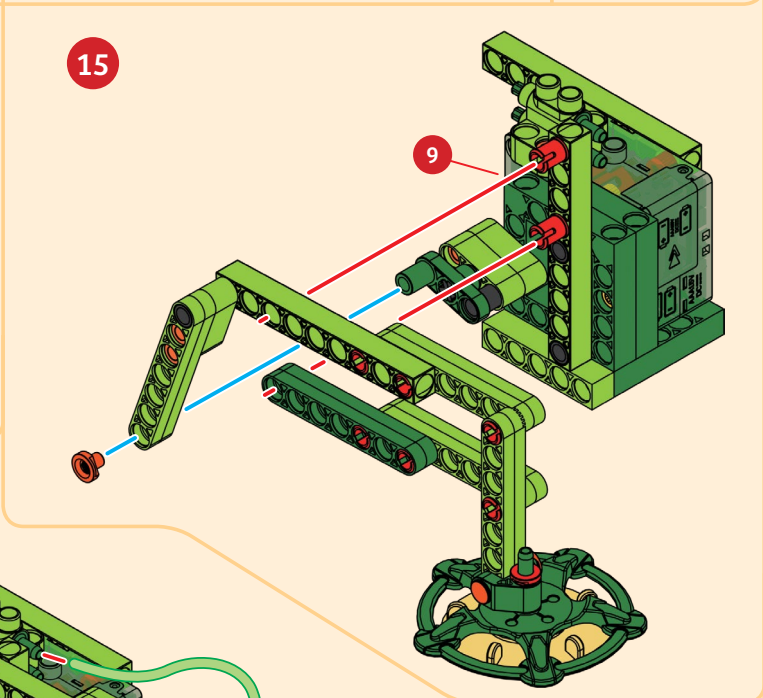
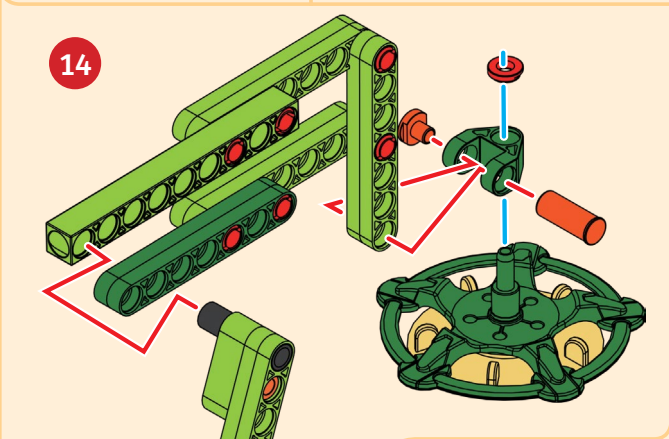
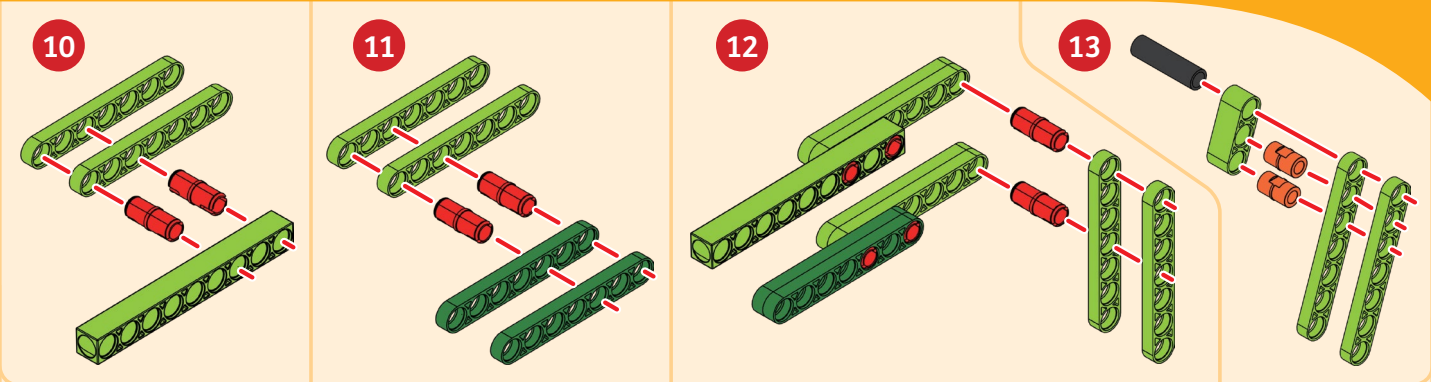
As the large cams rotate, they alternate between creating air pressure and a vacuum every half rotation. The moment when the condition in the tube changes from vacuum to pressure is when the small cam on the top quickly opens and closes the valves connected to tubes that distribute the air flow.

In summary, the air pumps are creating a cushion of air that allows the suction cups to lose their grip at the exact moment when the other two suction cups are pressing onto the wall and starting to grip the wall.

INDUSTRIAL ROBOT ARM

- | | | | | | | | | | | |
|-----|----|-----|----|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 10 | 11 | 12 | 15 | 16 | 17 |
| 10x | 9x | 10x | 2x | 3x | 4x | 3x | 4x | 1x | 8x | 4x |
| 18 | 19 | 20 | 22 | 25 | 27 | | | | | |
| 1x | 3x | 4x | 1x | 2x | 1x | | | | | |
| 28 | 29 | 30 | 34 | 35 | 36 | 40 | | | | |
| 1x | 1x | 1x | 1x | 1x | 1x | 1x | | | | |





Done!

WHAT'S HAPPENING?

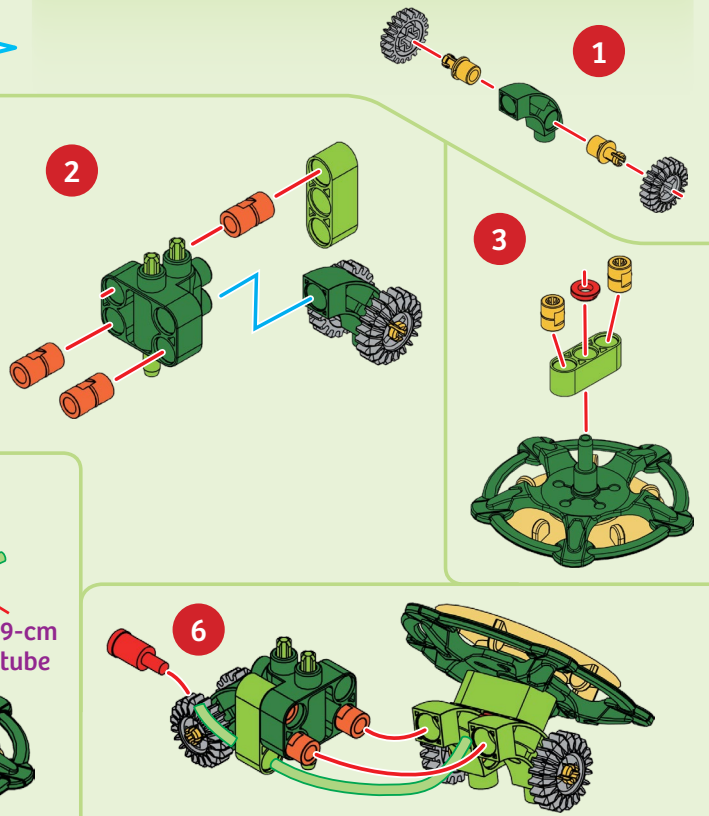
Position the suction cup over a sheet of thin plastic. Turn the power on with the switch. The motor turns the mechanical linkage that forms the arm of the model. The arm drops downward and the suction cup engages the sheet of plastic. The arm then rises up again, bringing the sheet of plastic with it. You can swivel the arm to move the sheet of plastic into place. You can release the suction pressure to drop the plastic into place by pressing the suction release valve button. Robotic arms like this are used in factories to place windshields onto cars during production.



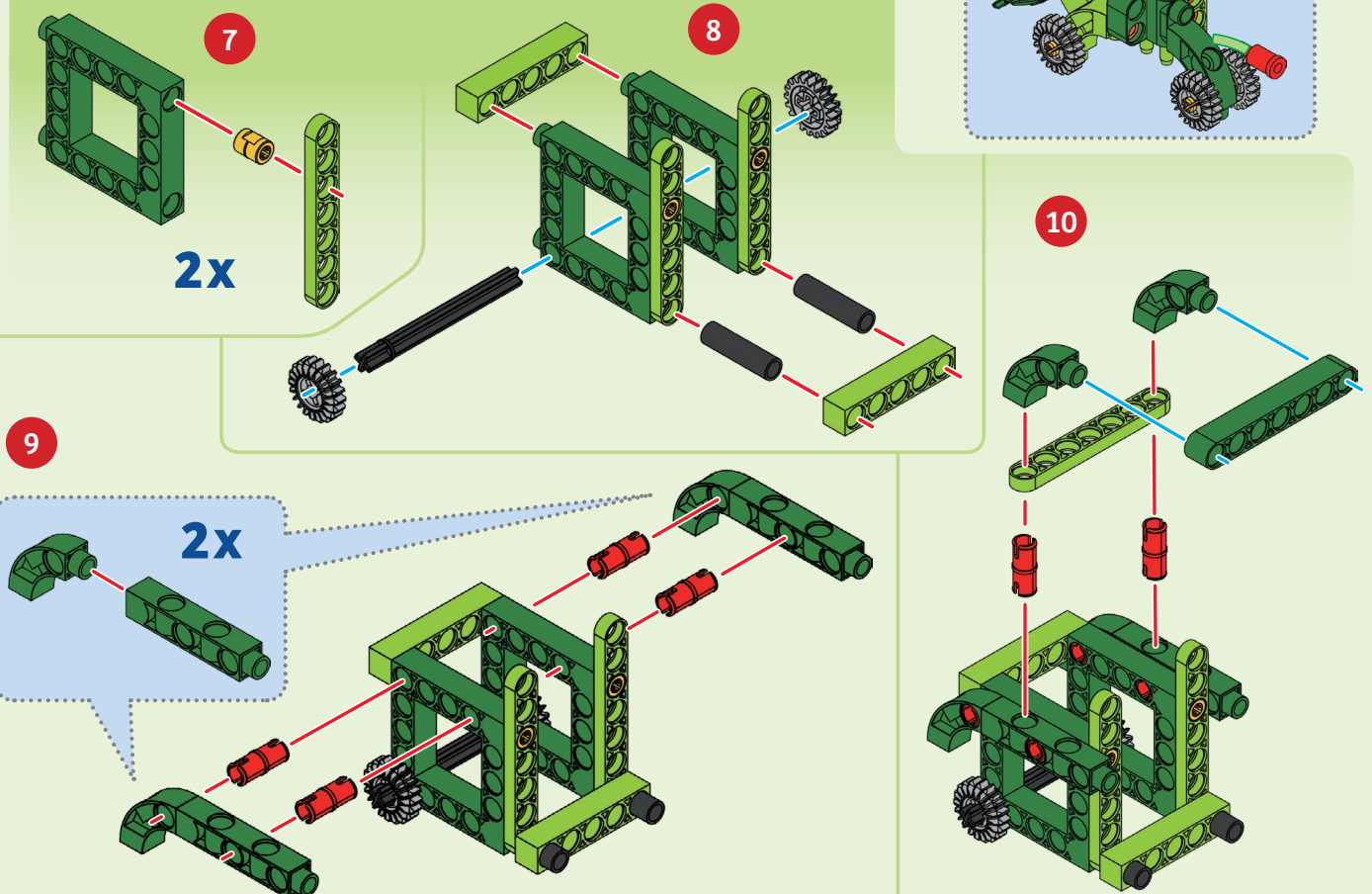
SUCTION TOW TRUCK

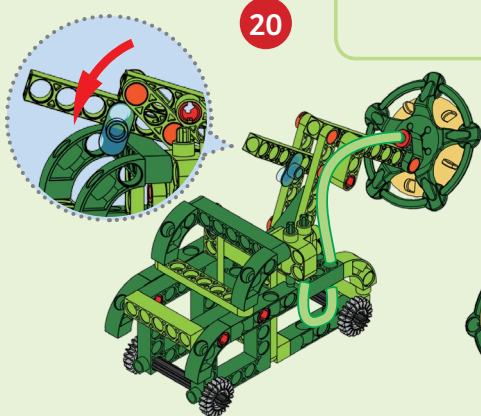
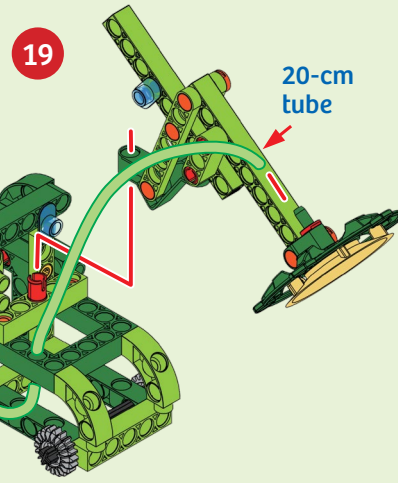
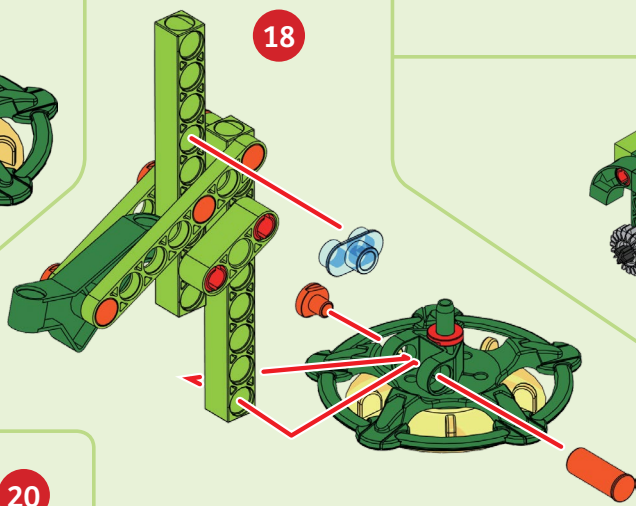
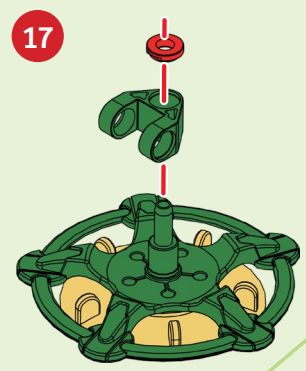
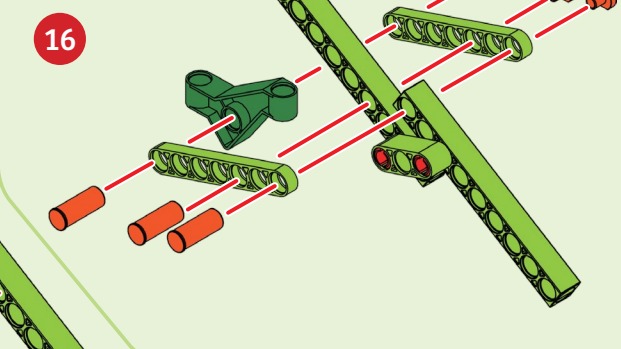
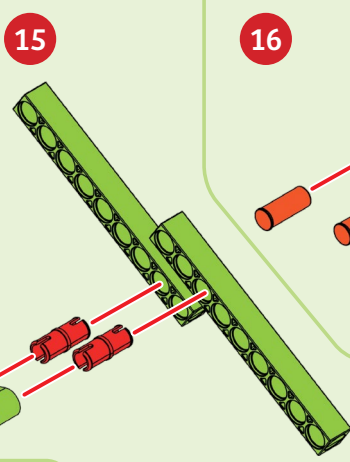
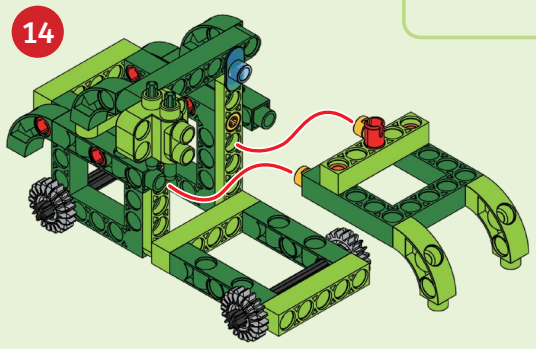
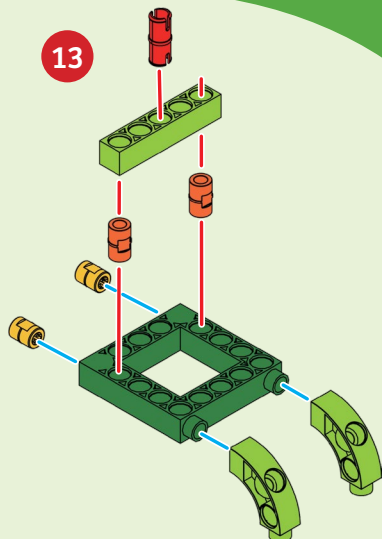
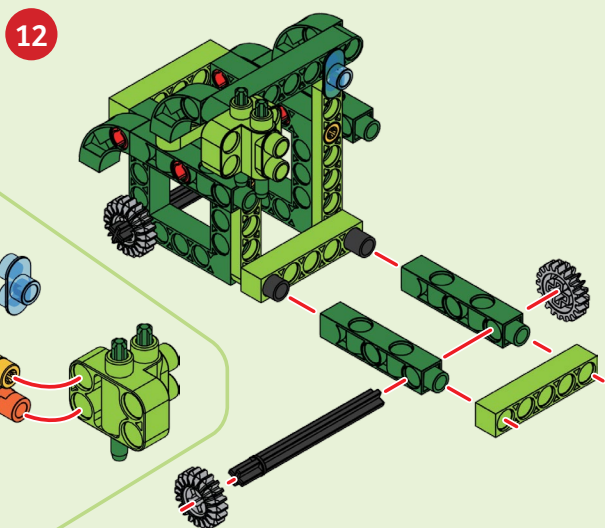
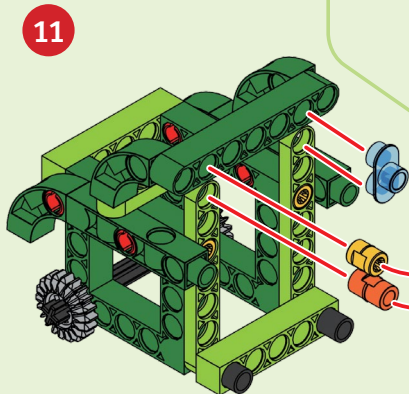
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|----|----|----|----|----|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 | 13 |
| 7x | 6x | 9x | 4x | 4x | 4x | 1x | 2x | 2x | 3x | 5x | 4x |
| 14 | 15 | 16 | 18 | 19 | 20 | | | | | | |
| 4x | 4x | 5x | 1x | 2x | 3x | | | | | | |
| 23 | 24 | 25 | 27 | 28 | 29 | | | | | | |
| 2x | 8x | 1x | 1x | 1x | 2x | | | | | | |
| 34 | 35 | 36 | 37 | | | | | | | | |
| 1x | 2x | 1x | 1x | | | | | | | | |

Car: Steps 1 through 6



Tow Truck: Steps 7 through 20





Done!

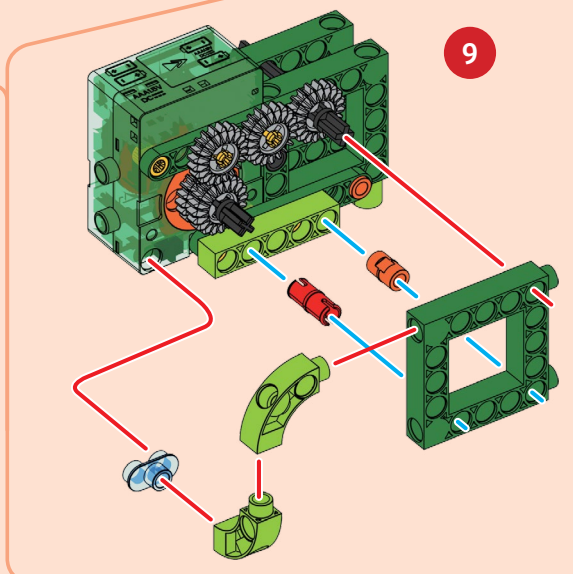
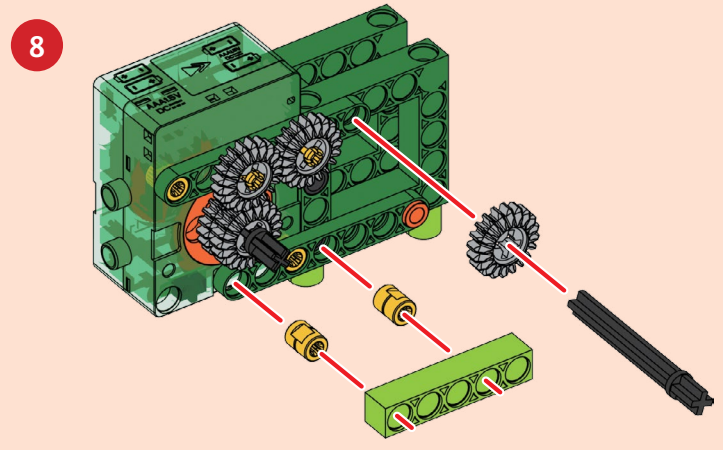
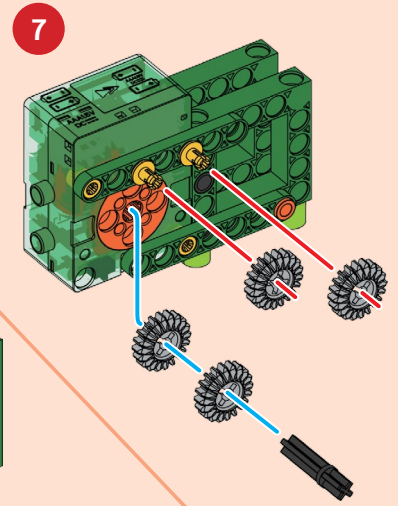
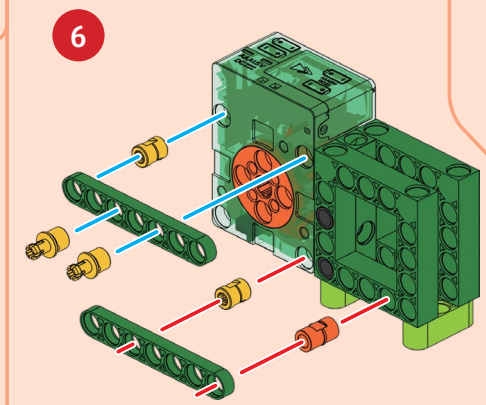
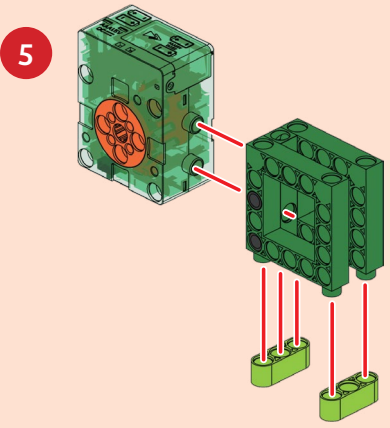
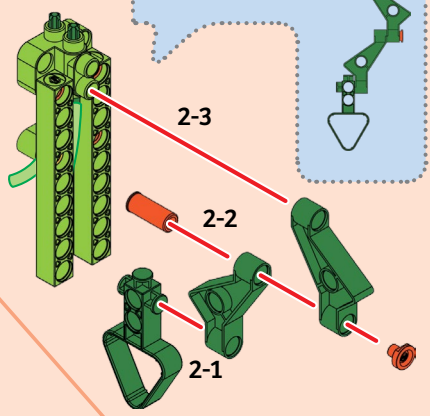
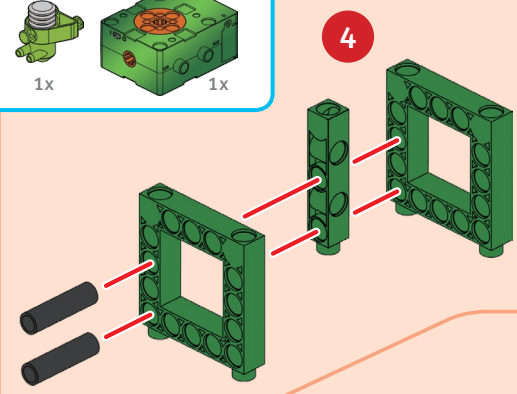
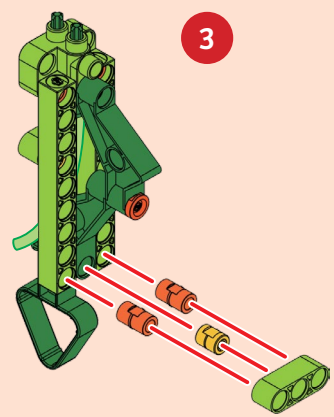
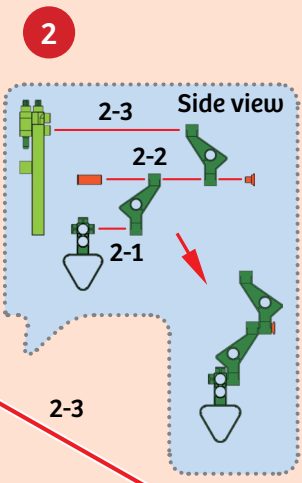
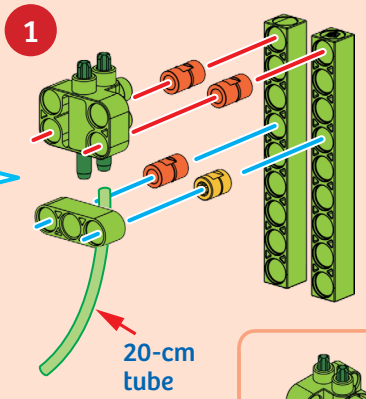
WHAT'S HAPPENING ?

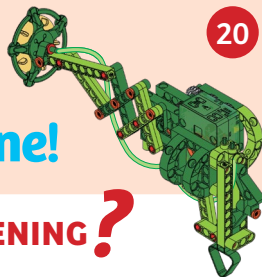
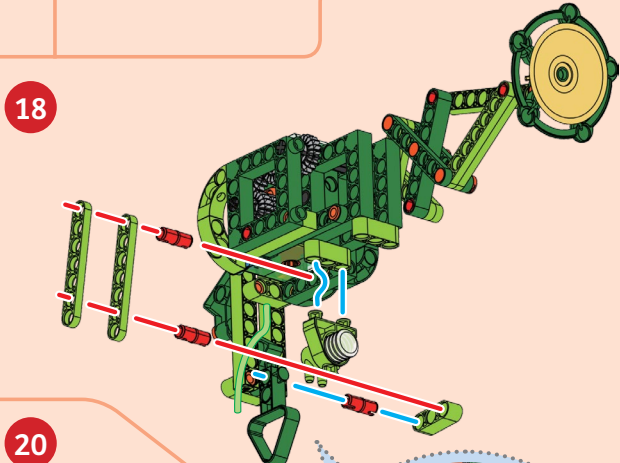
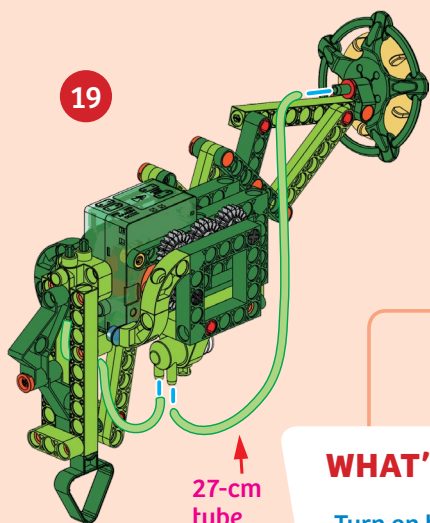
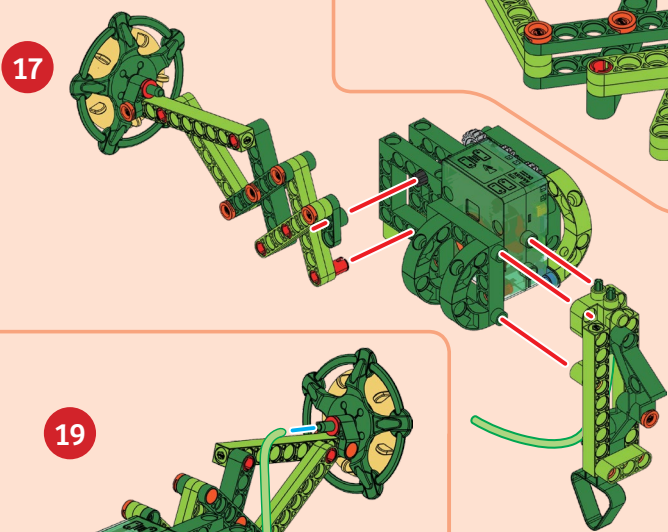
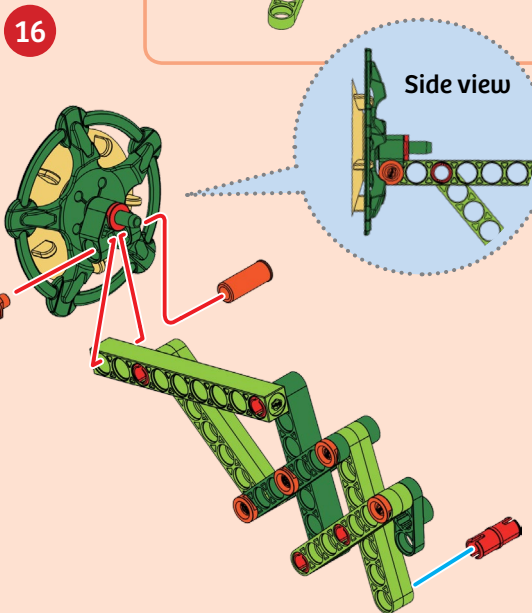
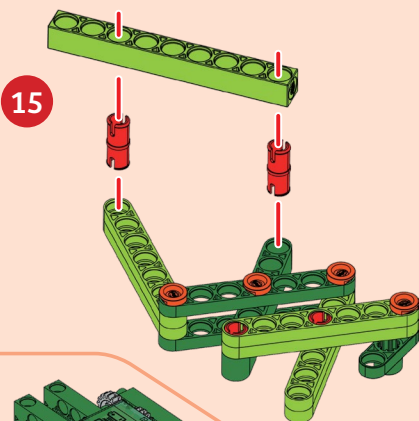
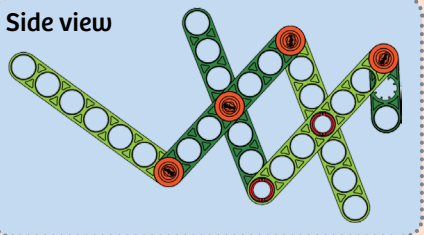
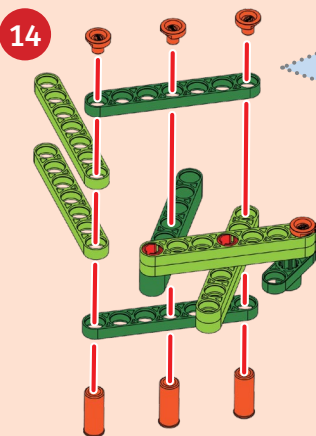
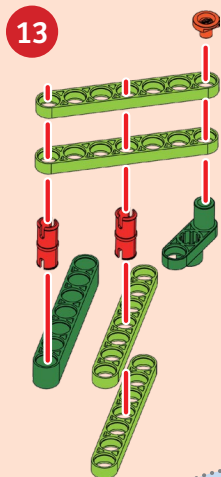
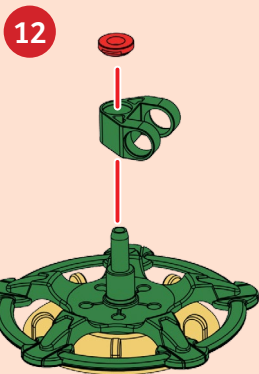
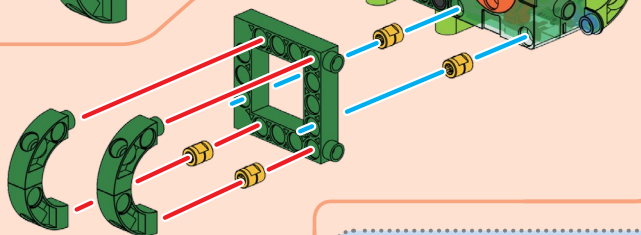
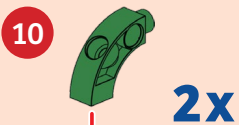
Back the tow truck up and extend its arm to attach its suction cup to the car's suction cup, squeezing the air out. The low air pressure in between the two suction cups keeps the models attached together until you release the pressure by pressing the button on the suction release valve.



SUCTION GUN

- 1 10x 2 7x 3 9x 4 5x 5 6x 6 2x 8 1x 10 2x 11 5x 12 4x 13 2x 14 1x
- 15 1x 16 8x 17 4x 18 1x 19 3x 20 4x 21 1x
- 22 1x 24 5x 25 2x 26 1x 27 1x 28 1x 29 1x
- 30 1x 34 1x 35 1x 36 1x 38 1x 40 1x

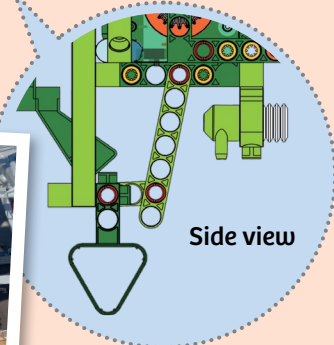




Done!

WHAT'S HAPPENING?

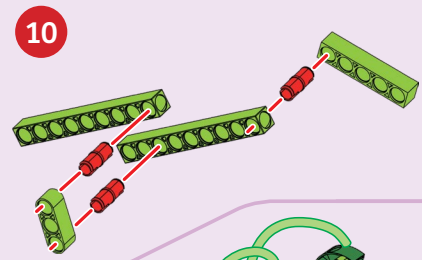
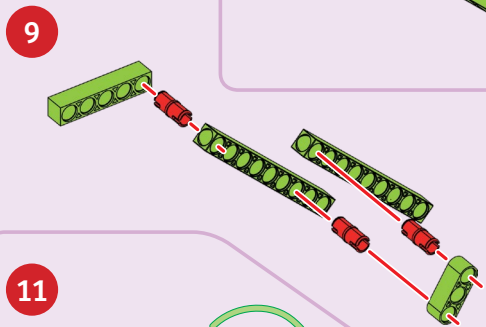
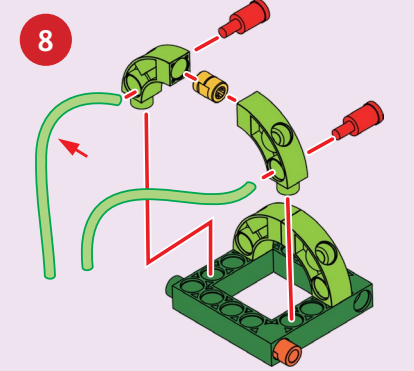
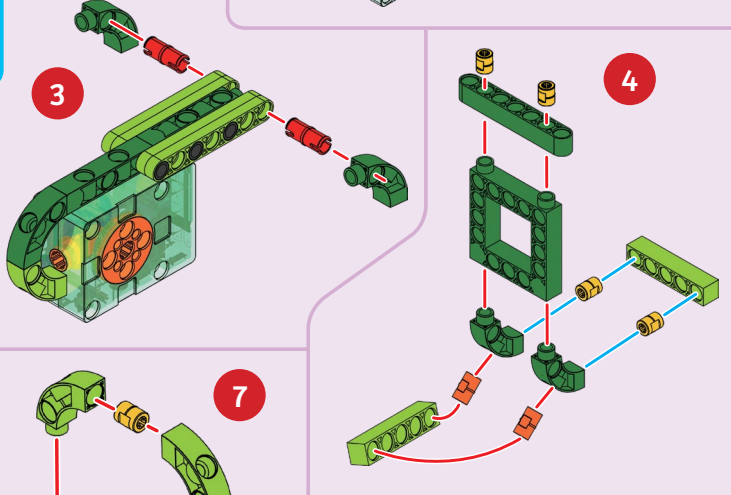
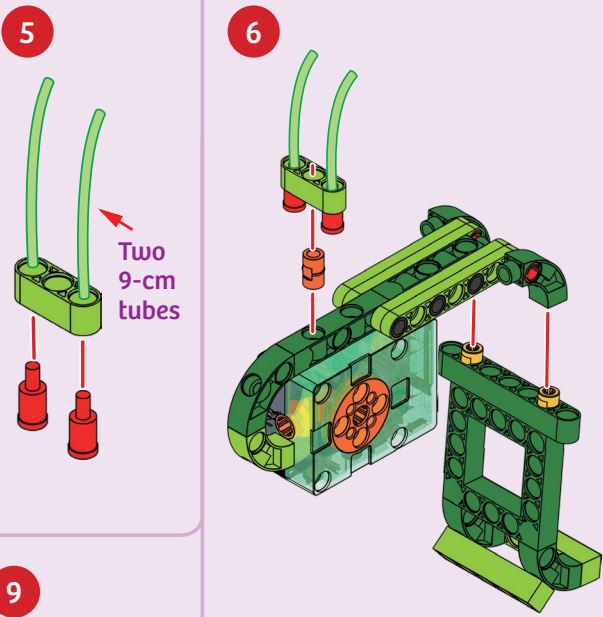
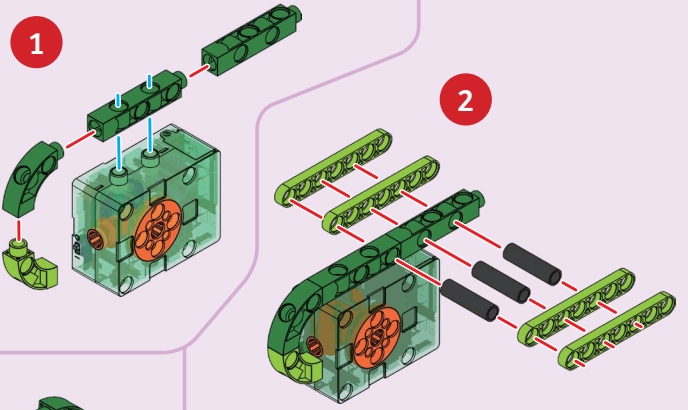
Turn on the power. The arm consists of a linkage that expands and contracts as the motor turns. Aim the gun at a flat sheet of plastic and try to pick it up with the suction cup.





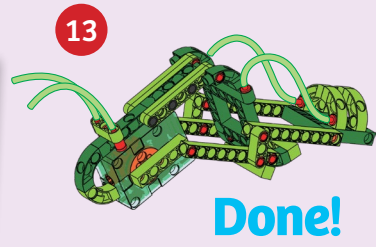
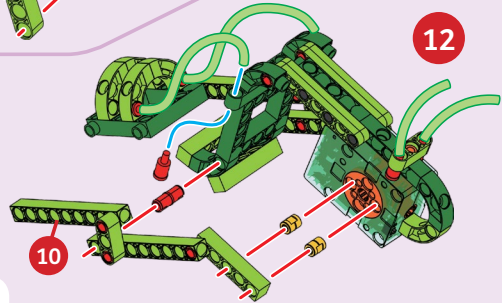
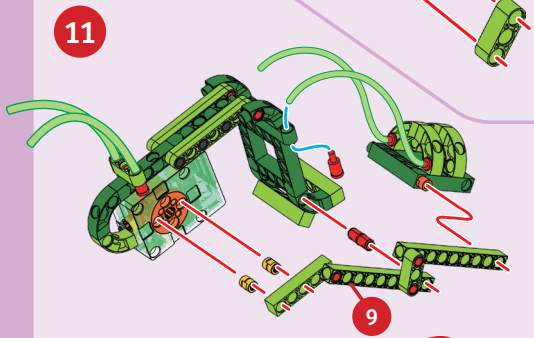
INCH WORM

- 1 10x 2 4x 3 10x 7 6x 10 3x 11 3x 12 5x 13 5x 14 2x 15 4x
- 16 4x 18 1x 19 4x 20 2x
- 27 1x 28 1x 40 1x



How to replace the batteries

- 1
- 2



WHAT'S HAPPENING?

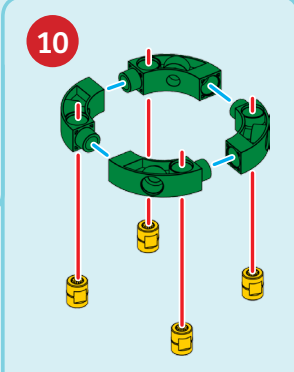
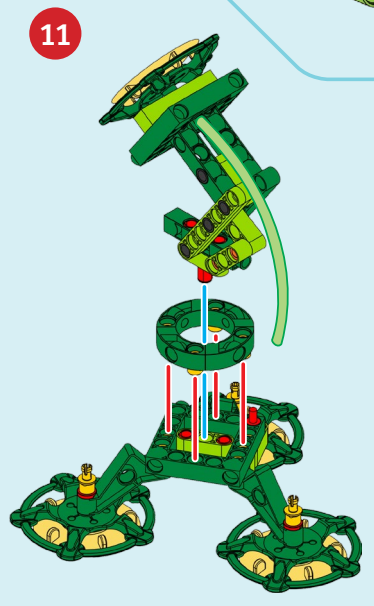
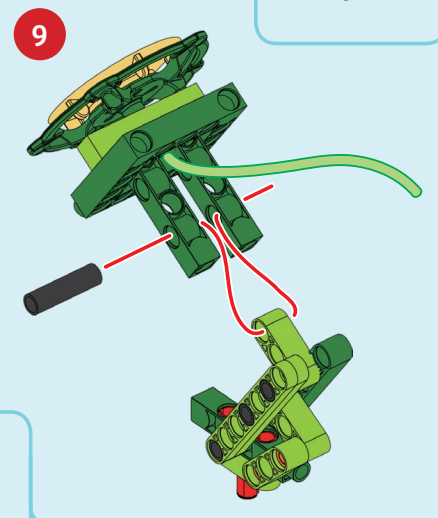
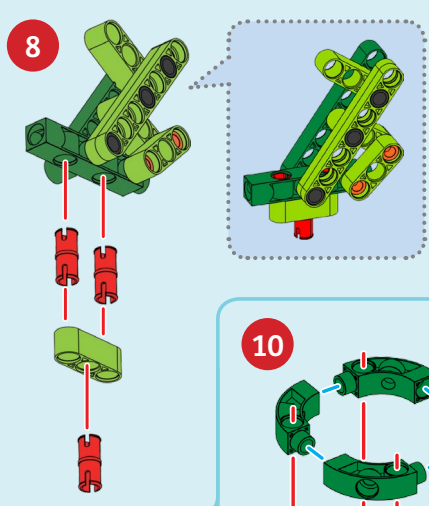
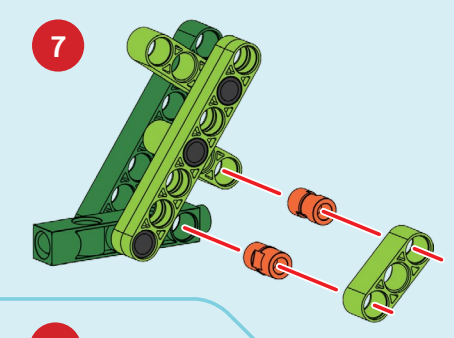
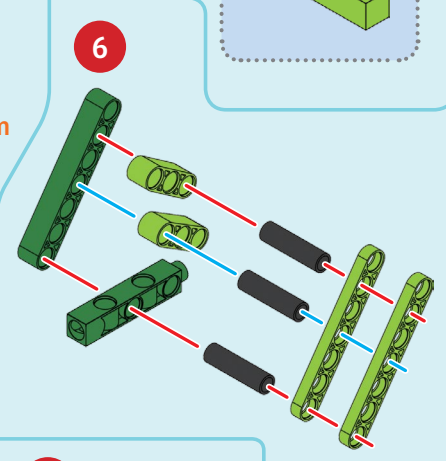
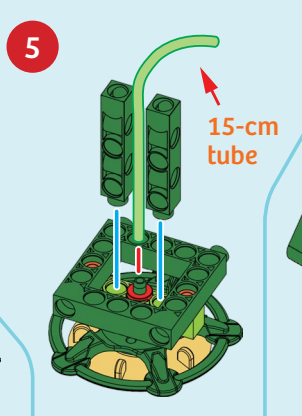
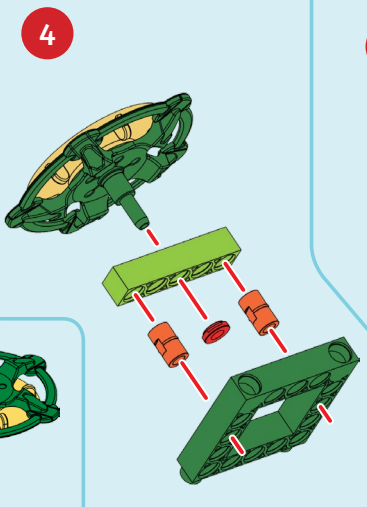
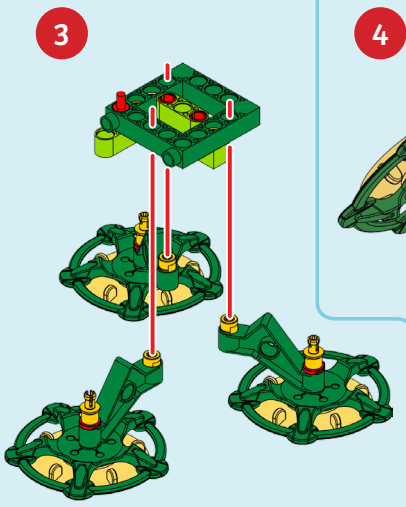
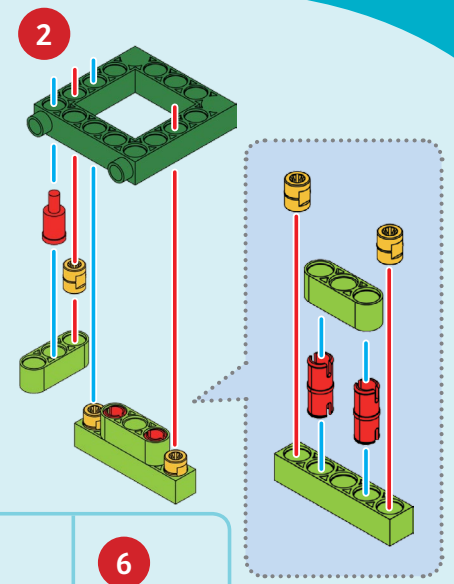
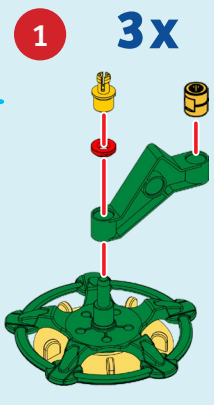
Turn on the motor and the inch worm inches along the table. The linkage turns the rotating motion from the motor into the back-and-forth motion of the inch worm's body, which pulls the model forward.





SMARTPHONE HOLDER

- 1 10x
- 2 4x
- 3 5x
- 6 3x
- 7 1x
- 10 4x
- 11 6x
- 12 4x
- 14 3x
- 15 2x
- 16 2x
- 18 1x
- 20 2x
- 25 3x
- 27 1x
- 28 1x
- 29 4x
- 35 4x

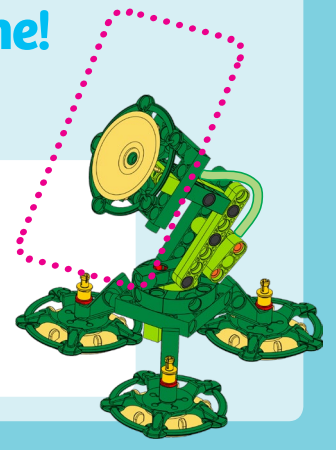


13 Stick a smartphone onto the suction cup.



Done!

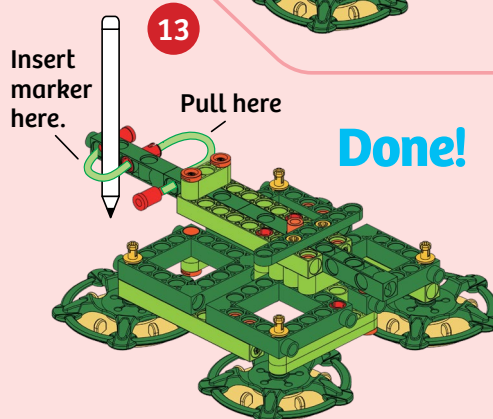
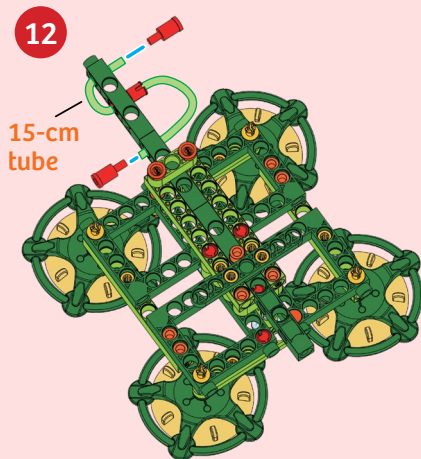
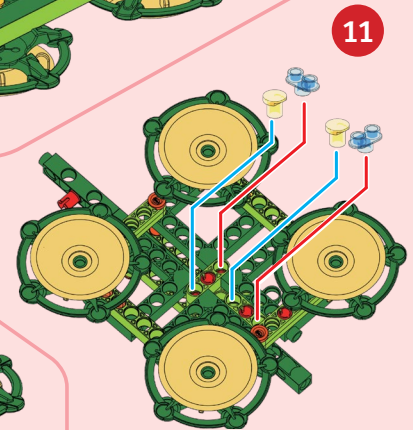
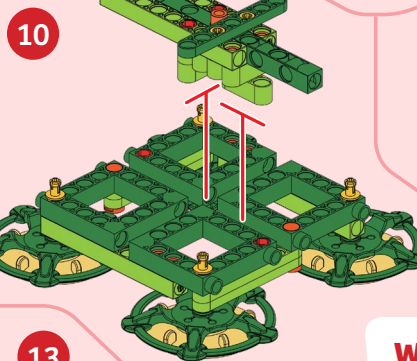
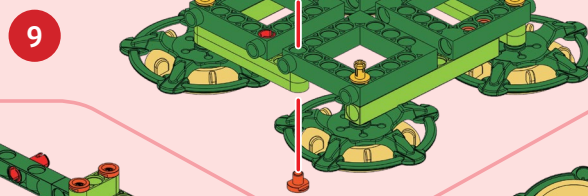
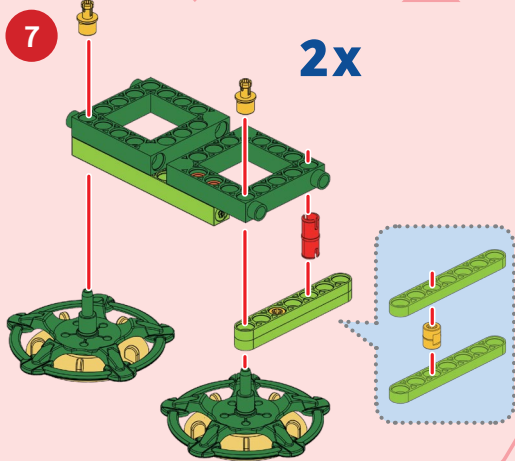
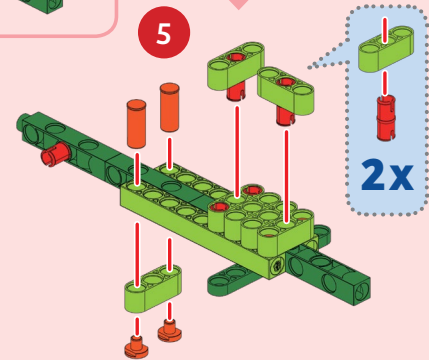
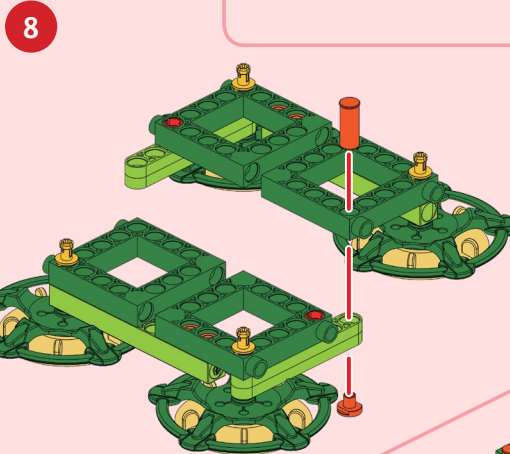
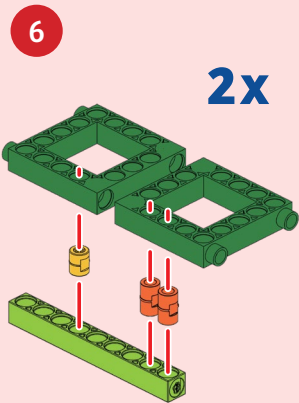
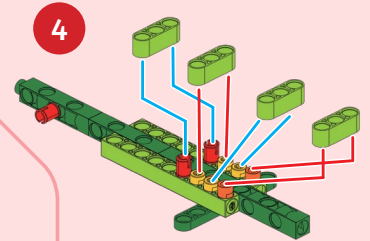
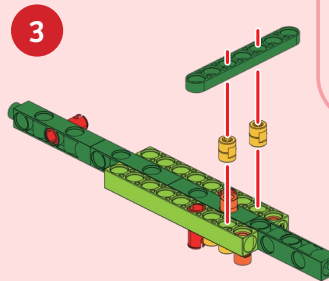
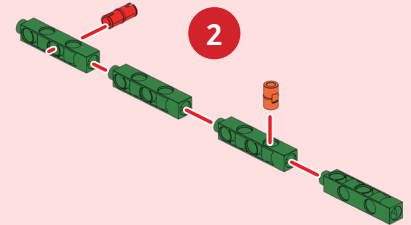
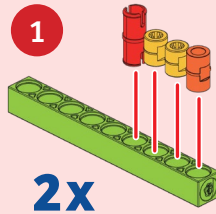
WHAT'S HAPPENING ?
 One suction cup is used to attach your smartphone to the holder. The other three suction cups secure the holder to the table.





ELLIPSOGRAPH

- | | | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|
| 1
10x | 2
7x | 3
7x | 4
4x | 5
4x | 6
4x | 7
2x | 8
2x | 9
2x | 11
7x |
| 14
4x | 16
4x | 17
1x | 19
4x | 20
4x | 28
1x | 27
1x | 35
4x | | |



WHAT'S HAPPENING ?

You can use the ellipsograph to draw a perfect ellipse on a piece of paper. The arm motion is constrained along two perpendicular tracks, causing the tip of the arm where the marker is attached to always follow an elliptical path. The suction cups hold the ellipsograph in place.



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