EXPERIMENT MANUAL

Bionic Robotic Arm



Scan this QR code for a full assembly video.

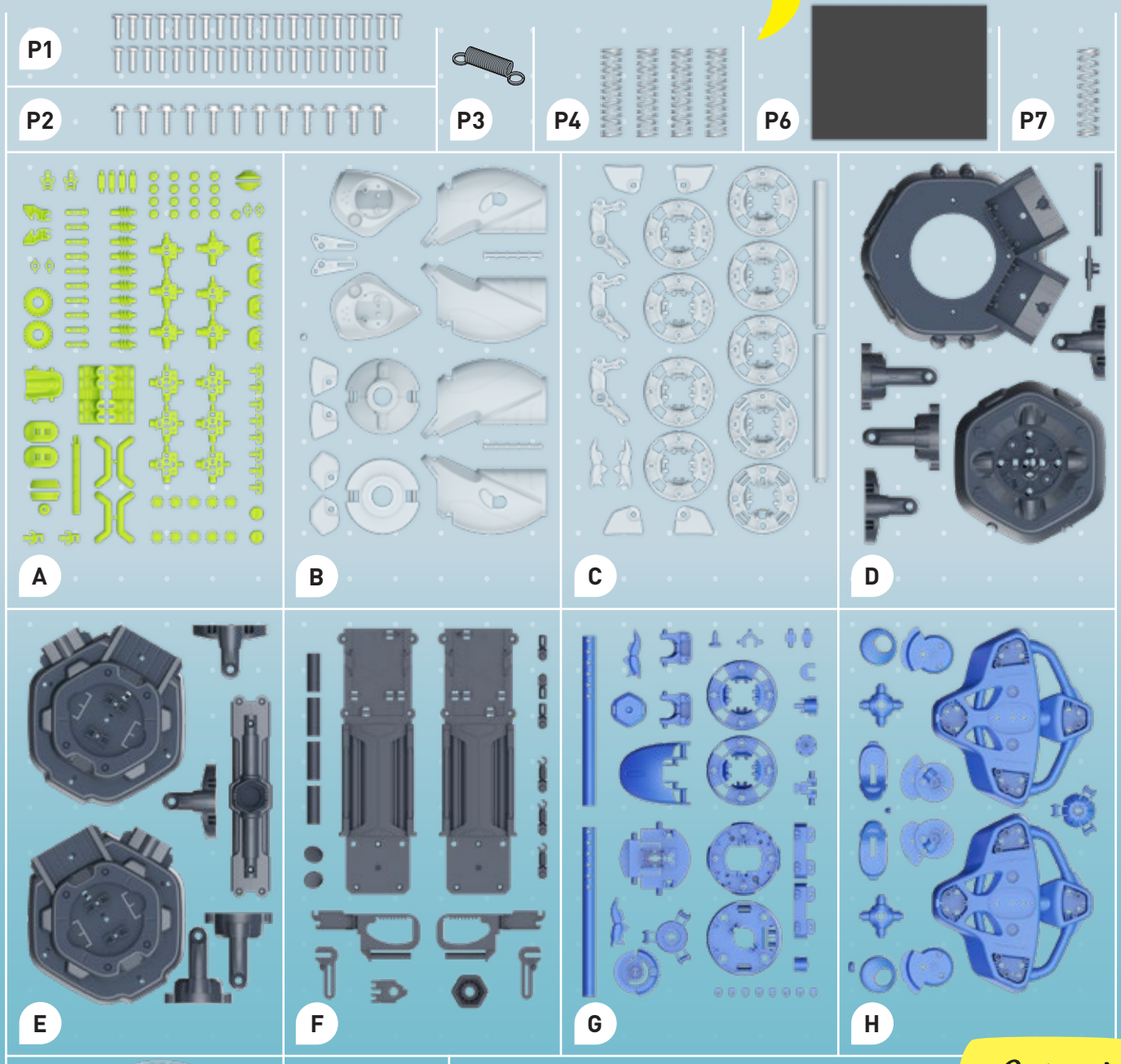
Franckh-Kosmos Verlags-GmbH & Co. KG, Pfizerstr. 5-7, 70184 Stuttgart, Germany | +49 (0) 711 2191-0 | www.kosmos.de
Thames & Kosmos, 89 Ship St., Providence, RI, 02903, USA | 1-800-587-2872 | www.thamesandkosmos.com

THAMES & KOSMOS

KIT CONTENTS

What's inside your experiment kit:

Good to know!
If you are missing any parts, please contact Thames & Kosmos customer service.



Wow!
That's a lot of parts!

Checklist:

✓	No.	Description	Quantity	Item No.
◯	P1	Screw	39	728707
◯	P2	Wide-headed screw	12	728707
◯	P3	Tension spring	1	728708
◯	P4	Spring, stronger (14 coils)	4	728708
◯	P5	Nylon cable (approx. 800 cm)	1	728706
◯	P6	Sheet of foam pads	1	728708
◯	P7	Spring, weaker (10 coils)	1	728708
◯	P8	Lubricant packet	1	723607

YOU WILL ALSO NEED:
Small Phillips-head screwdriver, diagonal cutter or scissors and nail file, pen, ruler (there is a ruler printed on the box), small cup, paper towel, cotton swab

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YOU WILL FIND ADDITIONAL INFO IN THE CHECK IT OUT SECTIONS ON PAGES 46 – 47 AND 62 – 63.





Yay!
Let's begin!

✓	No.	Description	Quantity	Item No.
○	A	Frame A with parts A1 – A25	1	728698
○	B	Frame B with parts B1 – B15	1	728702
○	C	Frame C with parts C1 – C10	1	728699
○	D	Frame D with parts D1 – D6	1	728700
○	E	Frame E with parts E1 – E5	1	728703
○	F	Frame F with parts F1 – F13	1	728701
○	G	Frame G with parts G1 – G26	1	728704
○	H	Frame H with parts H1 – H11	1	728705

620506-02-140725

WARNING!

WARNING. Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled. Strangulation hazard — long cables may become wrapped around the neck.

Keep the packaging and instructions as they contain important information.

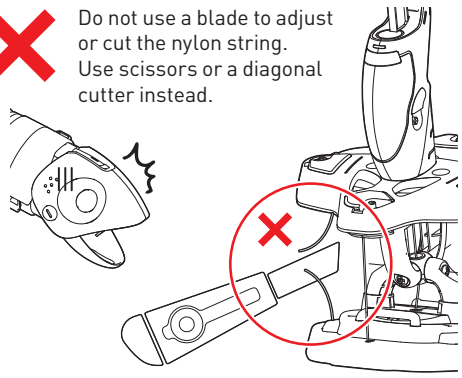
HOW TO CORRECTLY TIGHTEN SCREWS

Use a screwdriver in the correct size (e.g. PH1). Pay attention to the following instructions in order to properly install the screws:

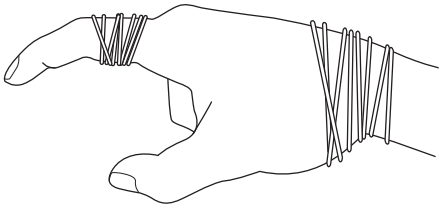
- Place the screwdriver in the head of the screw.
- Turn the screws clockwise.
- If you feel resistance, continue turning a bit further, until the screw is secure.

Always tighten screws completely!
If they are not securely tightened, pieces may come loose and the model may not function correctly.

Do not use a blade to adjust or cut the nylon string. Use scissors or a diagonal cutter instead.

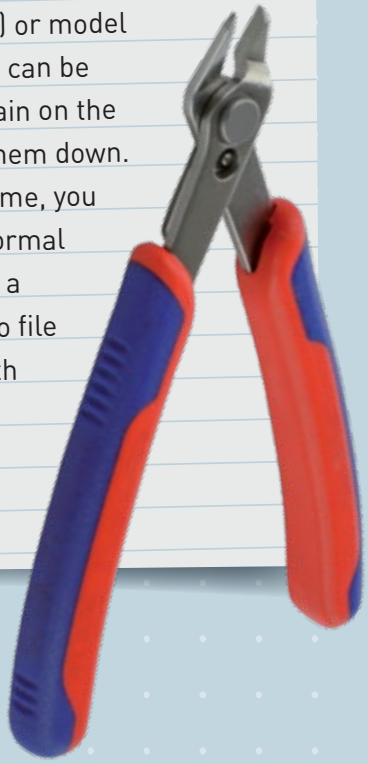


Do not wrap the nylon cable around any part of your body.



THE RIGHT TOOL

Using the right tool can make assembling your models easier and it can also make your models work better in the end. It is best to cut the plastic parts out of their frames with a small diagonal cutter (such as those used for electronics work) or model pliers. Using these tools, the parts can be precisely cut so that no burrs remain on the parts and there is no need to file them down. If you don't have these pliers at home, you can use scissors and a nail file. Normal scissors do not cut as precisely as a diagonal cutter, so you may have to file some of the rough edges down with the nail file.



IMPORTANT INFORMATION

Dear Parents!

Children want to explore, understand, and create new things.
They want to try things and do it by themselves. They want to gain knowledge!
They can do all of this with Thames & Kosmos experiment kits.
With every single experiment, they grow smarter and more knowledgeable.

Before building and experimenting, read the instructions together with your child and discuss the safety instructions.

Support your child with advice and a helping hand, especially during tricky assembly steps or experiments. Some assembly steps require more strength, which you may need to provide.

Building this model is an exciting and educational project that requires several hours to complete. Go slowly and take plenty of breaks. It's a good idea to break up the assembly over several days. It's best to work on the assembly somewhere where you can leave the materials out until it is completed, so that it won't need to be repeatedly moved or packed and unpacked.

To prevent damage to the work surface on which your child is building, provide them with a mat or other surface protection.

When cutting the plastic parts out of the frames with the diagonal cutter or scissors, special care must be taken, not just because of the sharp edges on the tools, but also because the plastic parts can yield sharp edges or burrs. These can be removed with the help of the diagonal cutter or a nail file. Supervise your child when they are using the sharp tools until you trust that they can handle the tools independently.

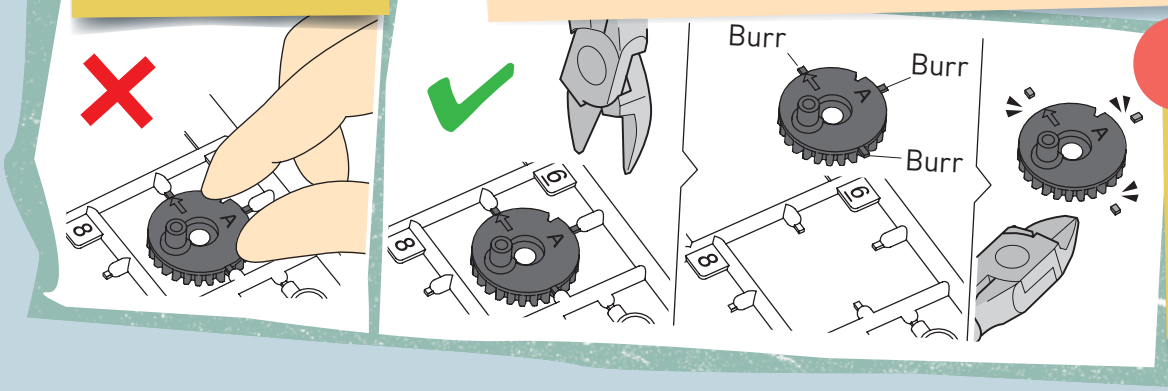
To help with assembly, we have created videos of difficult assembly steps that can be viewed by scanning the respective QR codes with a mobile device (cell phone or tablet) with Internet access. With your permission, your children can use these videos to guide construction.

We hope you and your child have a lot of fun building and playing with the Bionic Robotic Arm!

TIPS

IMPORTANT: REMOVE THE PARTS FROM THE FRAMES ONLY WHEN THEY ARE NEEDED. REMOVE EXCESS MATERIAL BEFORE ASSEMBLY WITH THE HELP OF A DIAGONAL CUTTER OR A NAIL FILE.

Do not remove the parts with your hands!



Make sure the burrs are completely removed to avoid malfunction.



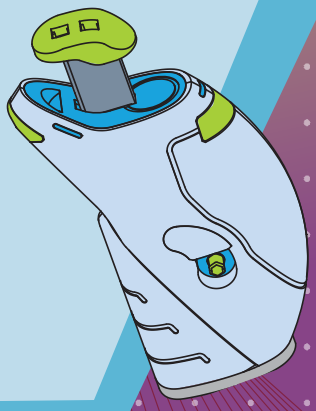
Assembling THE BIONIC ROBOTIC ARM

The Bionic Robot Arm can do lots of cool things completely without electricity! We've even prepared a little game for you! But before you can play, the Bionic Robotic Arm must be assembled.

The Bionic Robotic Arm has a complex mechanical construction that requires patience and persistence to build. Assembly is exciting and takes several hours. Go through the steps carefully, take regular breaks, and get help from an adult when necessary so that everything works smoothly in the end!

HOW LONG WILL THIS TAKE?

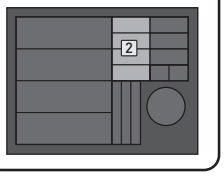
Shrimp and adjustment tool	10-20 min	Eel head and claw	30-40 min
Buckles	60-90 min	Upper body	60-90 min
Right Joystick	60-90 min	Lower body	60-90 min
Left Joystick	60-90 min	Final assembly and adjustment	60-90 min

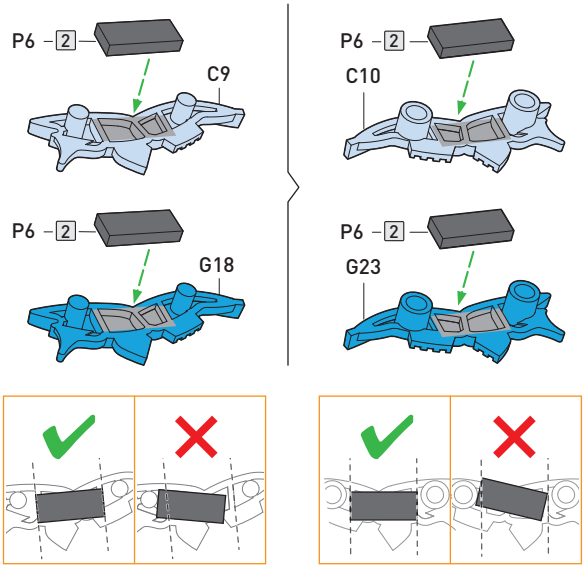


ASSEMBLING THE SHRIMP

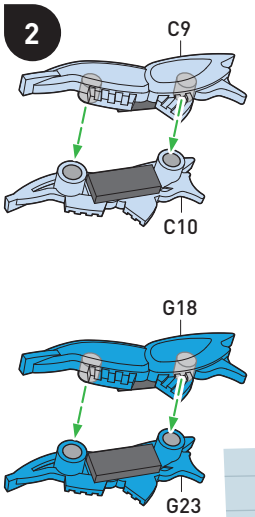
1

P6 Sheet of foam pads





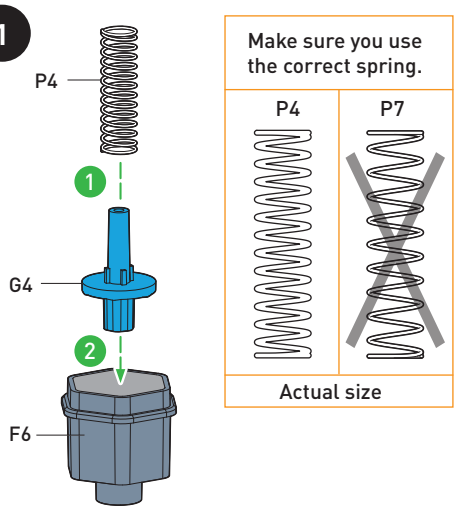
2



THE SHRIMP WILL BE USED FOR THE "CATCH THE SHRIMP" GAME ON P. 60

ASSEMBLING THE ADJUSTMENT TOOL

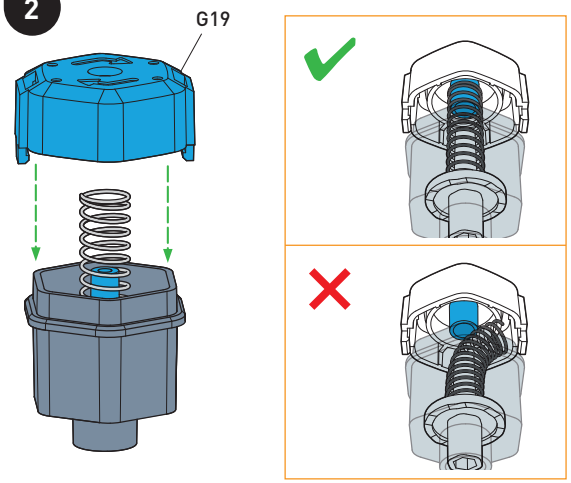
1



Make sure you use the correct spring.

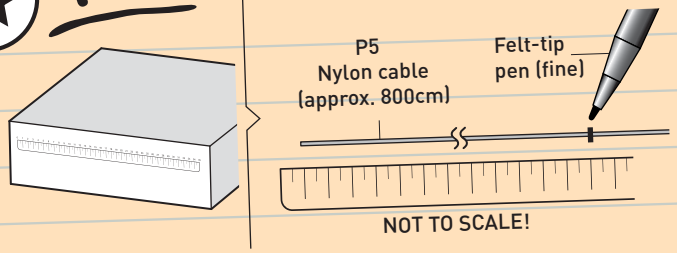
Actual size

2



MEASURING THE NYLON CABLE

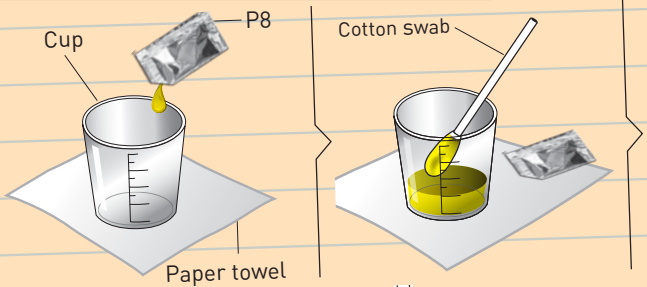
TIPS



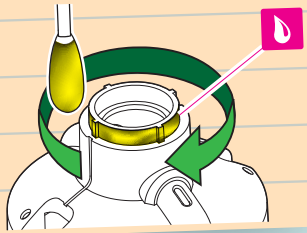
USE THE RULER ON THE BOTTOM OF THE BOX TO MEASURE AND MARK BEFORE CUTTING.

LUBRICATING THE PARTS

When you see this symbol in the instructions, lubricate the part as shown.



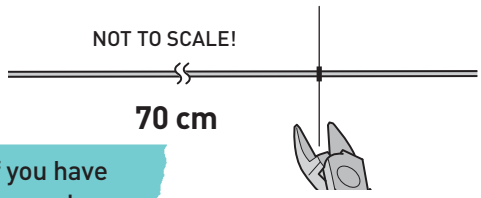
Lubricate only the shaded areas.



ASSEMBLING THE CABLE BUCKLES

CABLE BUCKLES
Scan this QR code to see a video of these steps.

1



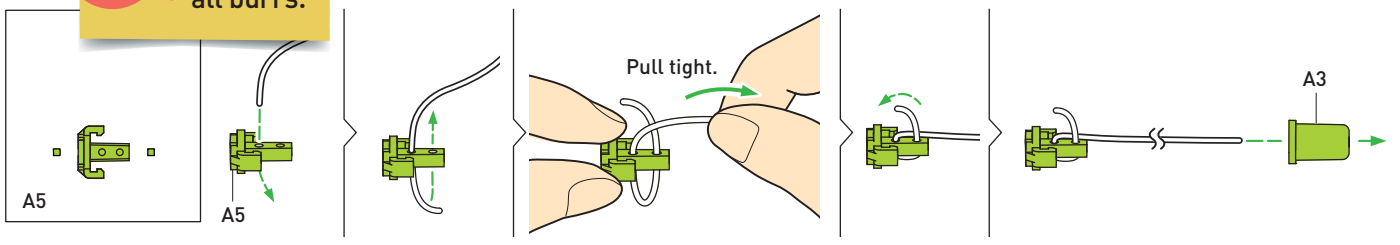
Ask an adult if you have trouble with these steps.

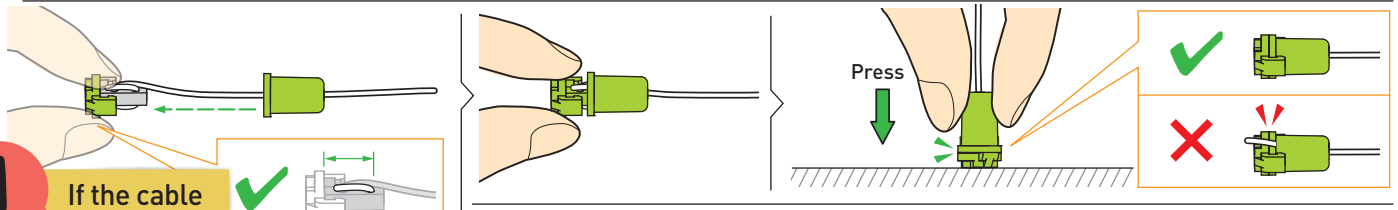
Using the ruler on the box, measure **70 cm** of the cable and cut with scissors or a diagonal cutter.

x8

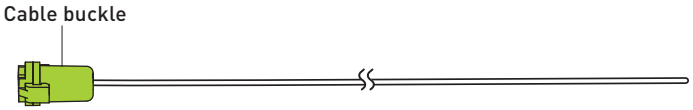
2

Remove all burrs.





If the cable is poking out a bit too much, you may trim it. Do not trim more than 1cm.

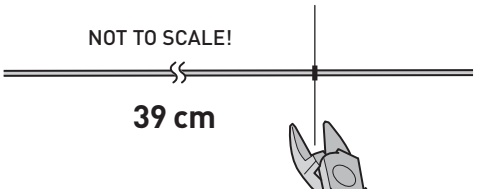


x8

ASSEMBLING THE GRIPPER BUCKLE

GRIPPER BUCKLE
Scan this QR code to see a video of these steps.

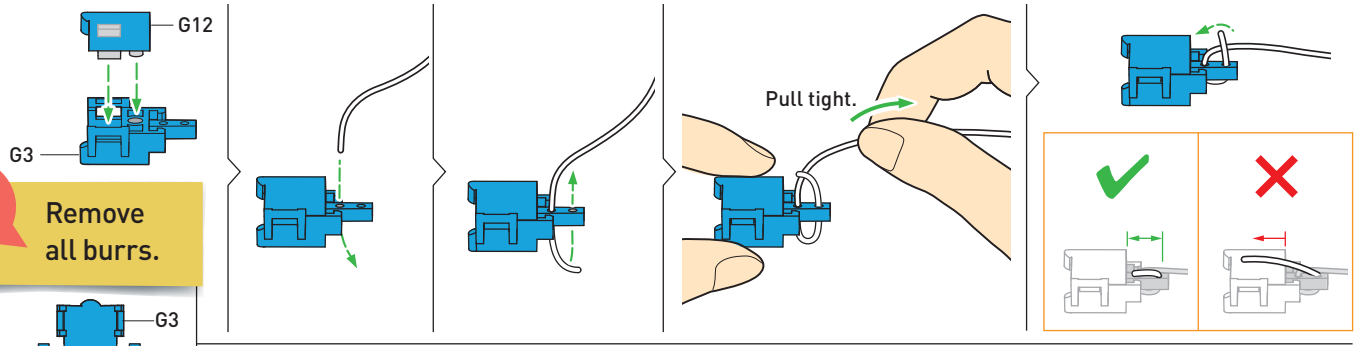
1



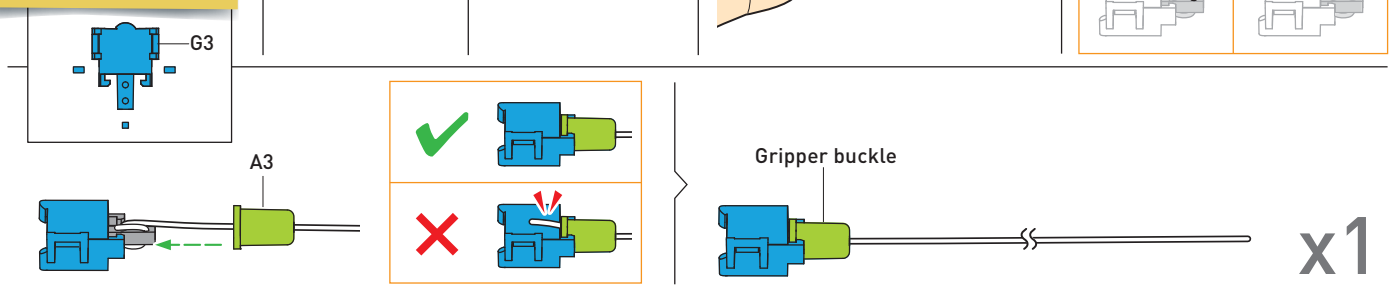
Using the ruler on the box, measure **39 cm** of the cable and cut.

x1

2



Remove all burrs.



x1

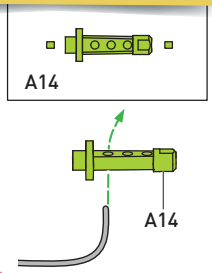
ASSEMBLING THE GEAR BUCKLES

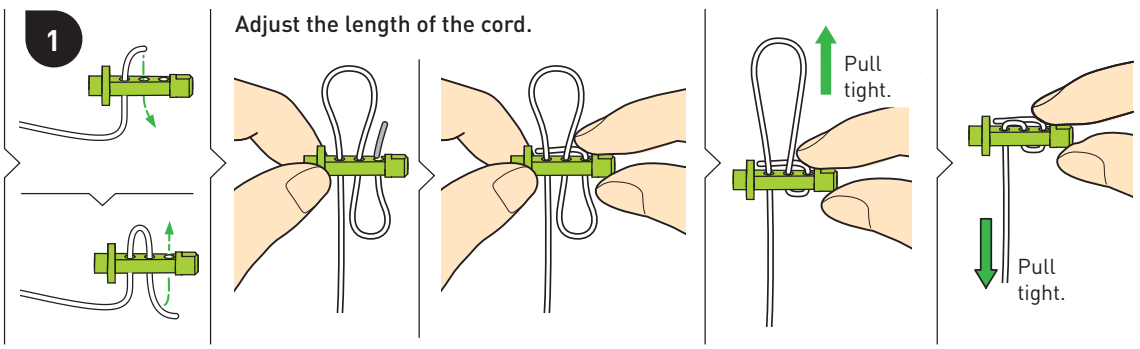
Using the ruler on the box, measure **35 cm** of the cable and cut.

x2

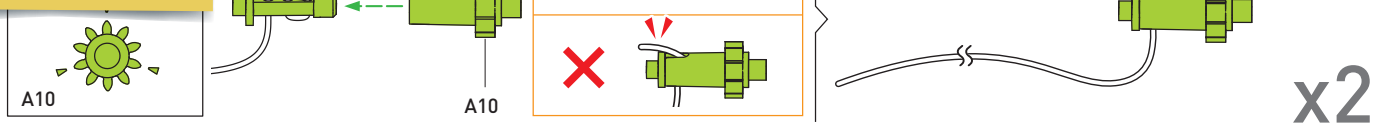
GEAR BUCKLES
Scan this QR code to see a video of these steps.

Remove all burrs.





Remove all burrs.



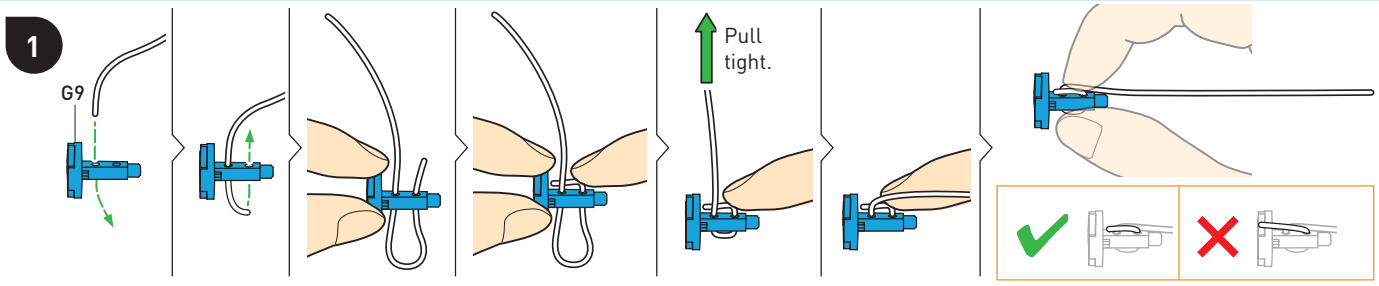
x2

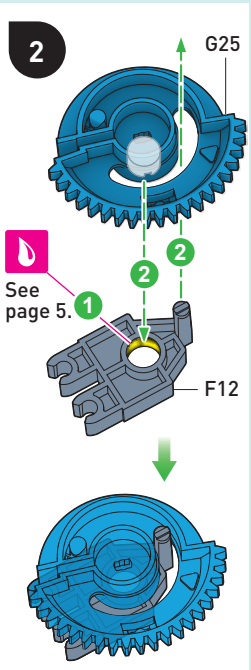
ASSEMBLING THE ROTARY BUCKLE

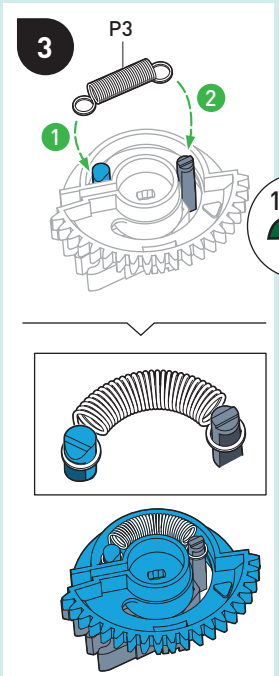
Using the ruler on the box, measure **47 cm** of the cable and cut.

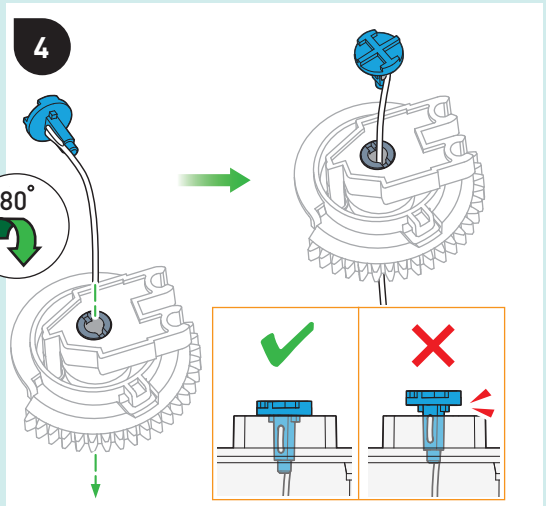
x1

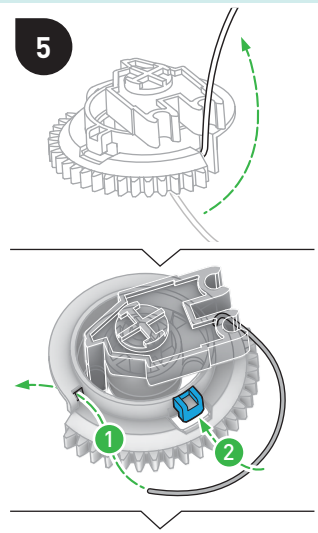
ROTARY BUCKLE
Scan this QR code to see a video of these steps.

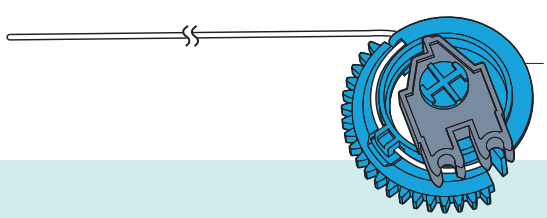










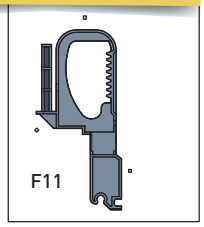


x1

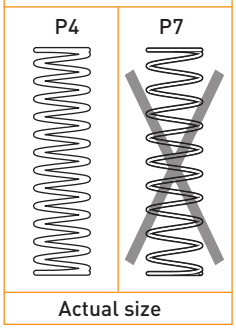
ASSEMBLING THE RIGHT JOYSTICK

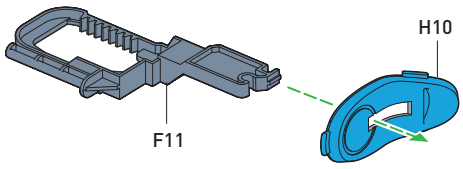
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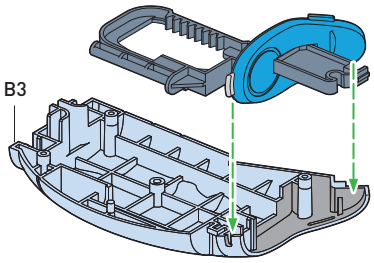
Remove all burrs.

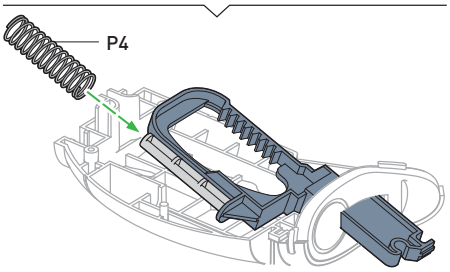


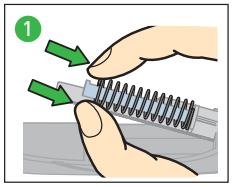
Make sure you use the correct spring.

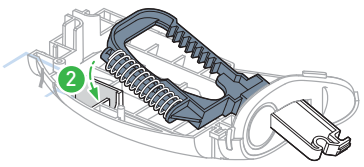


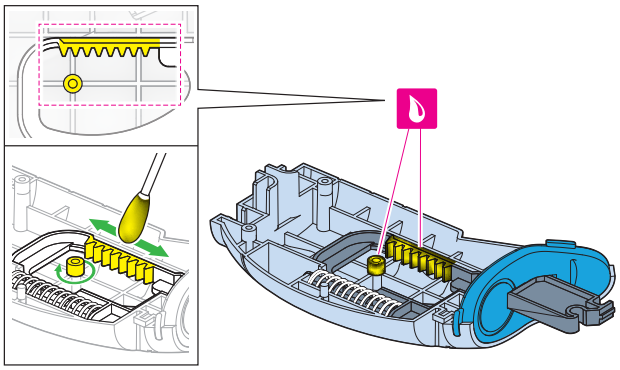


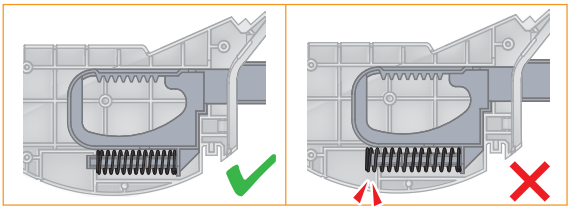




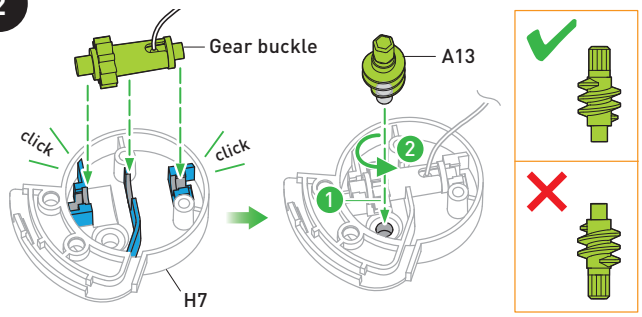


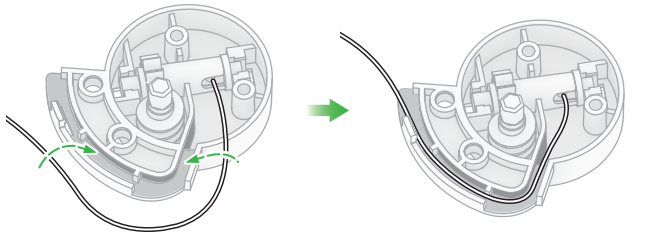


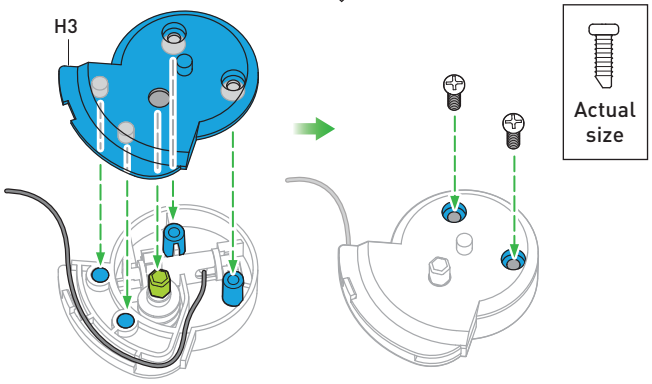




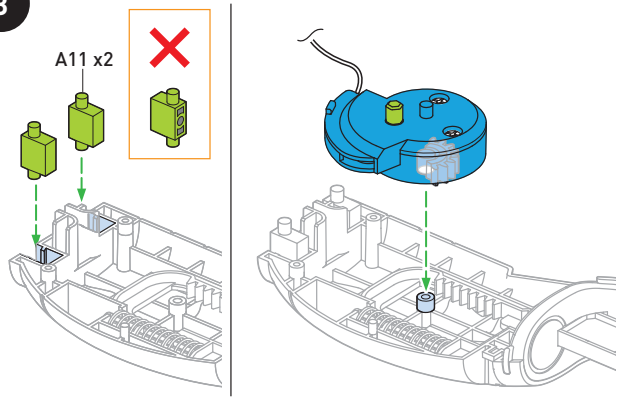
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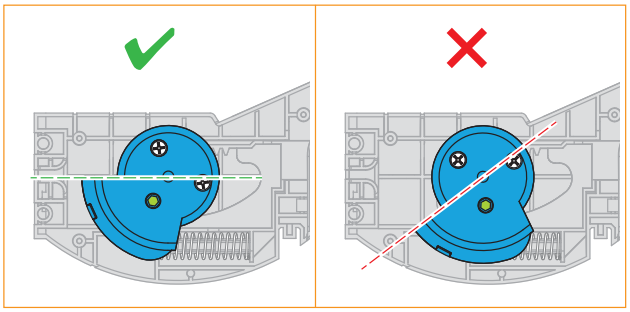




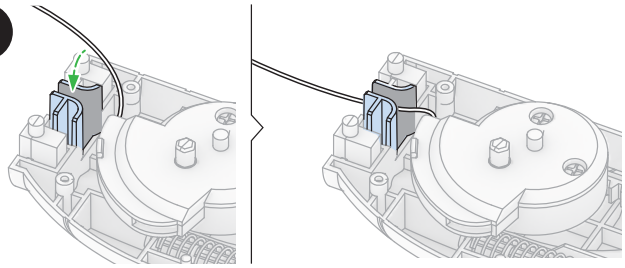


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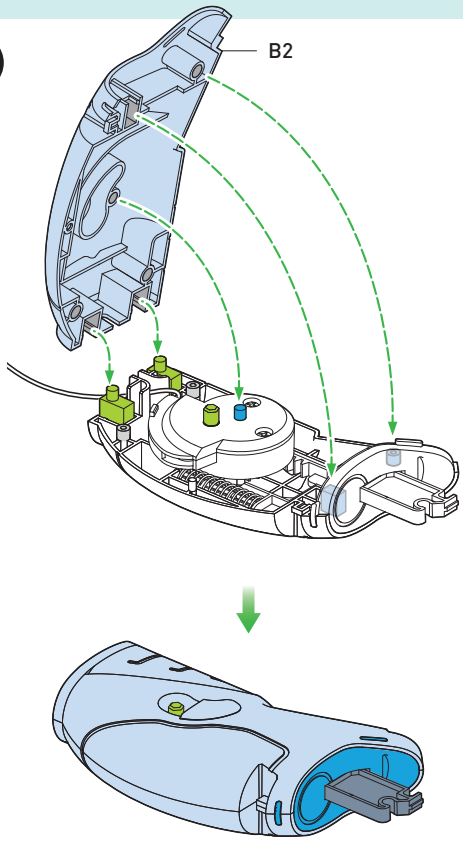




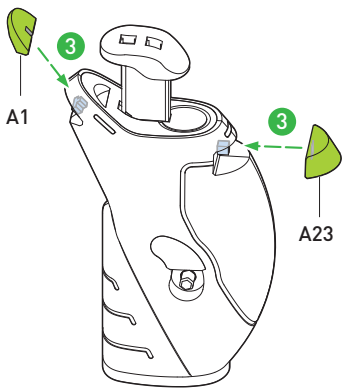
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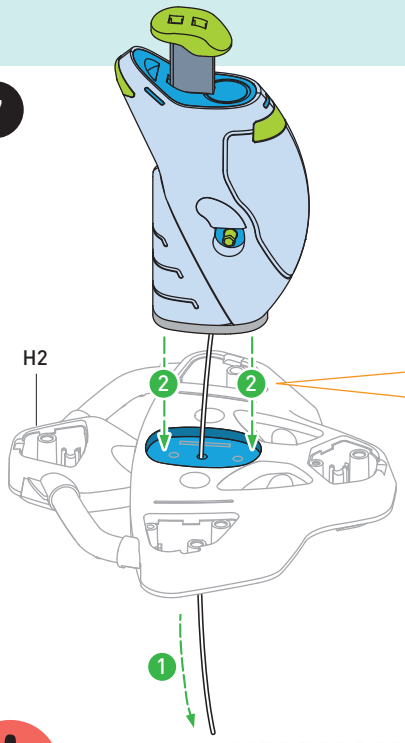
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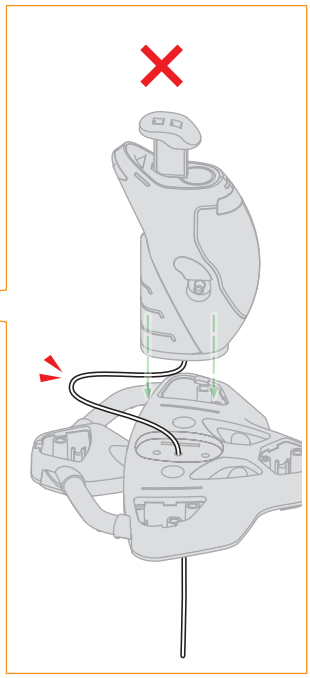


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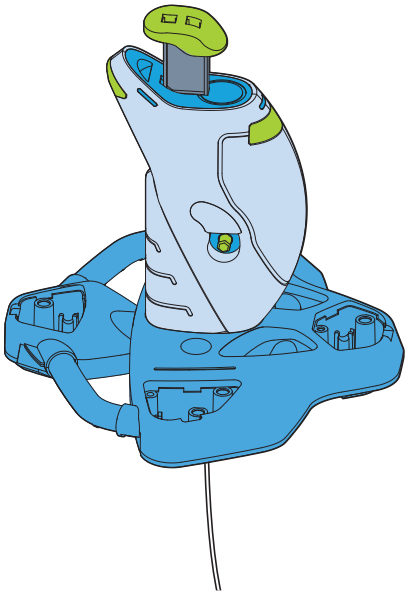


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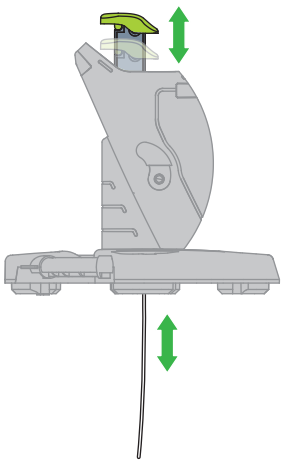




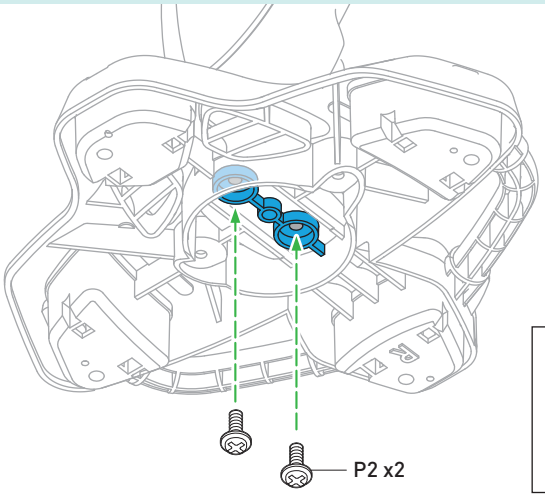
Pull the nylon cable straight before assembly.



Test



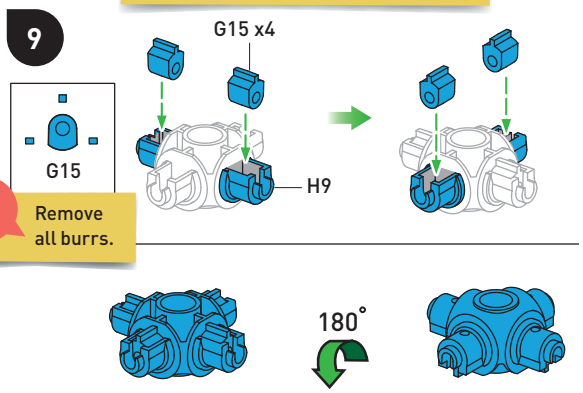
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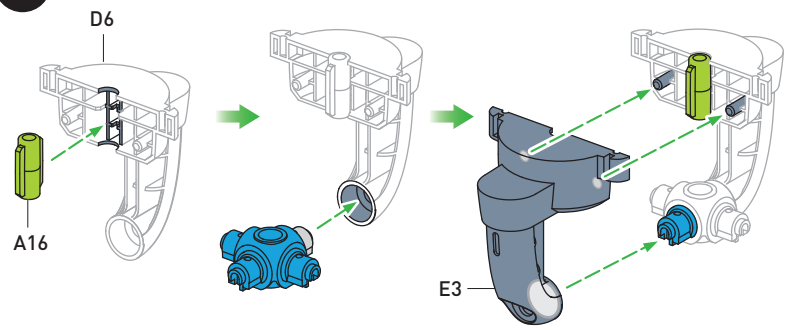
Use the tabletop to press G15 into place if it's too difficult with just your hands.

9

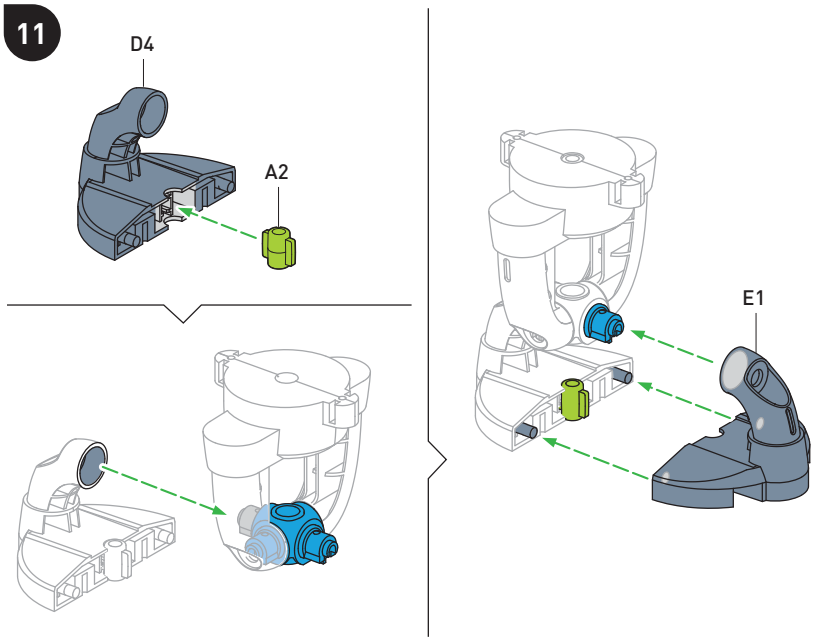


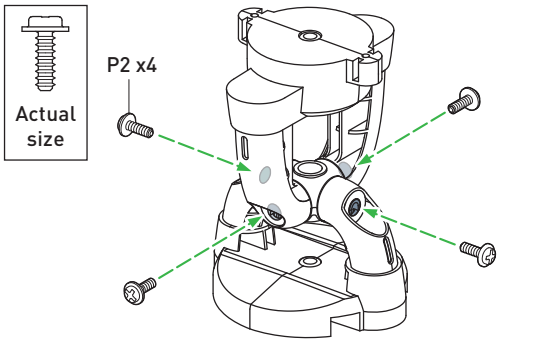
Remove all burrs.

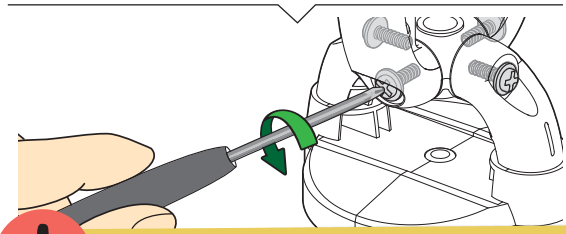
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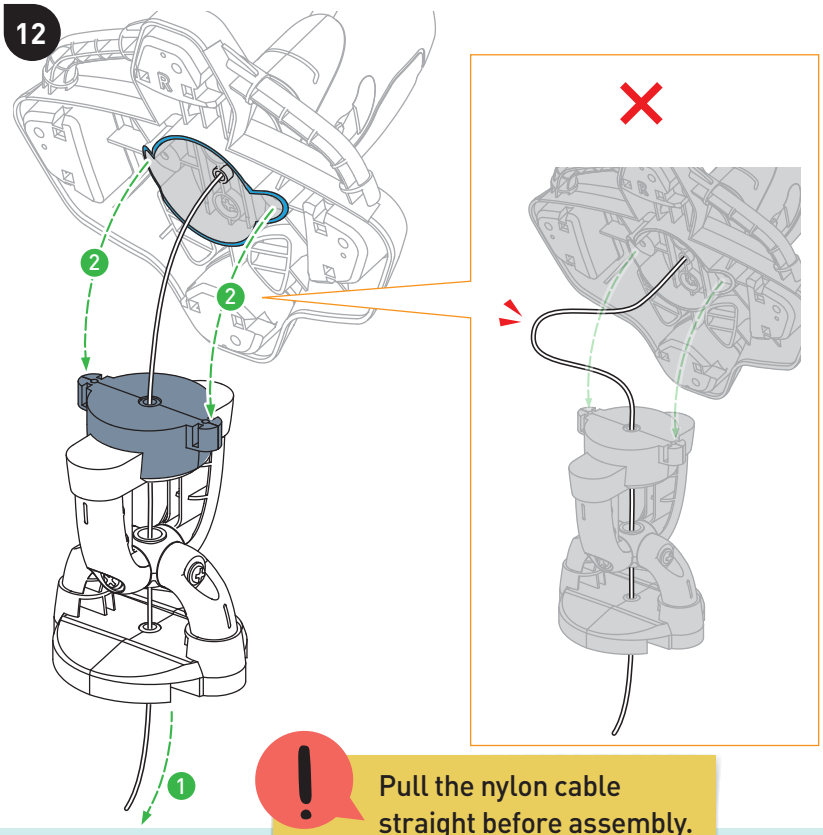


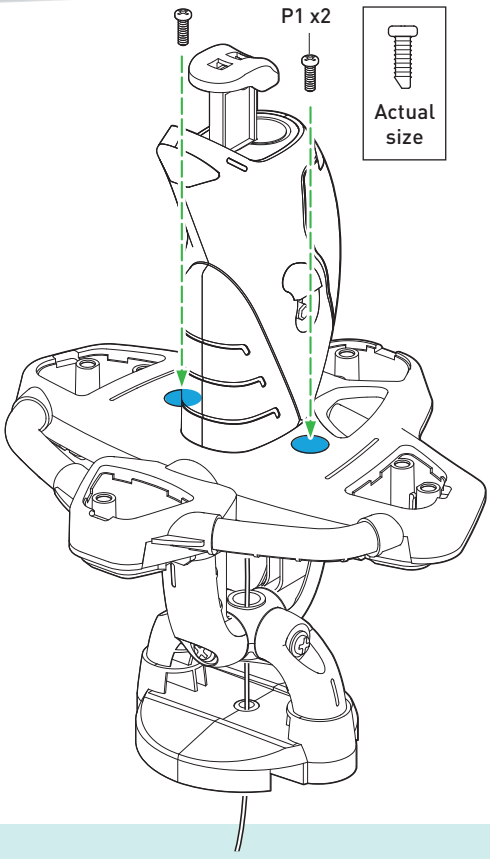




After fully screwing in the P2 x4, loosen them again by a half turn.

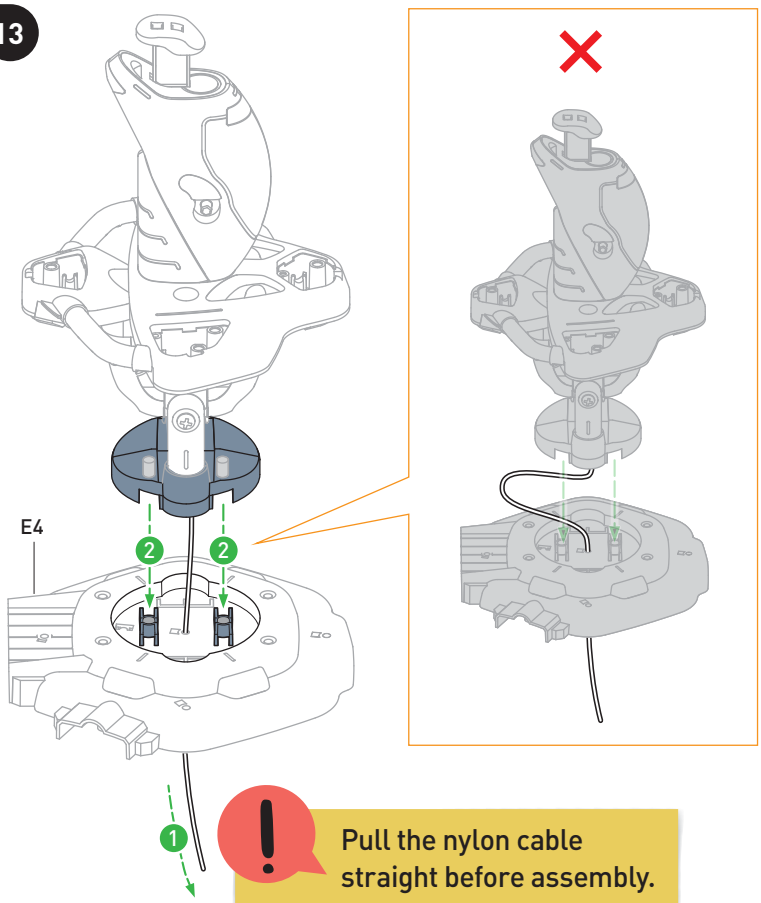
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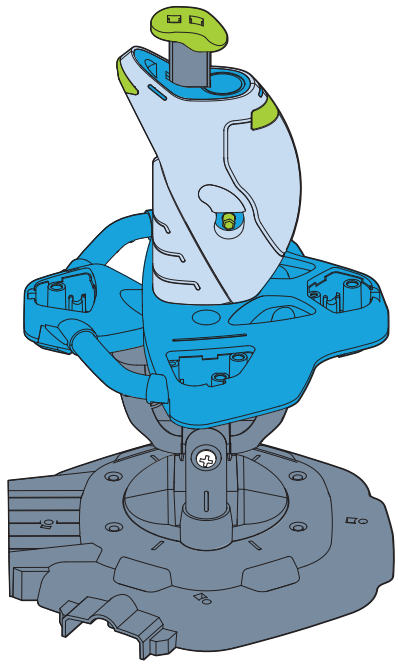


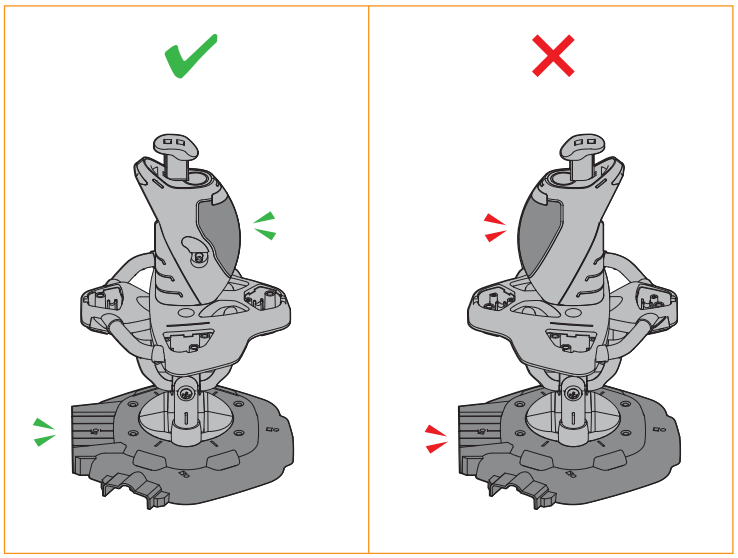
Pull the nylon cable straight before assembly.

13

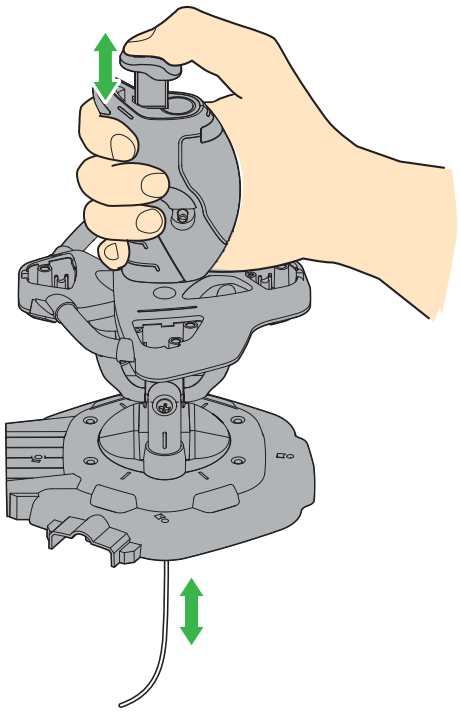


Pull the nylon cable straight before assembly.

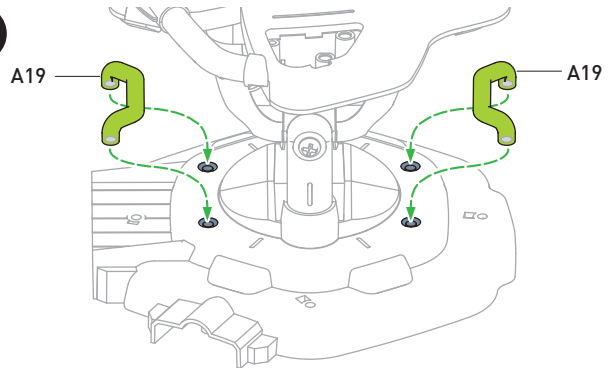


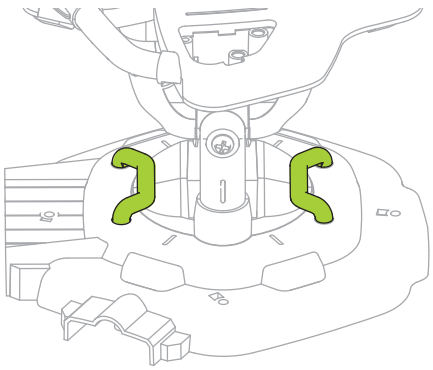


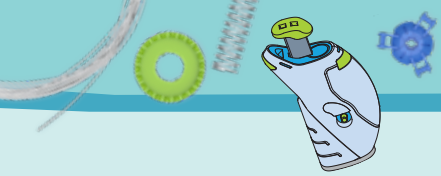
Test



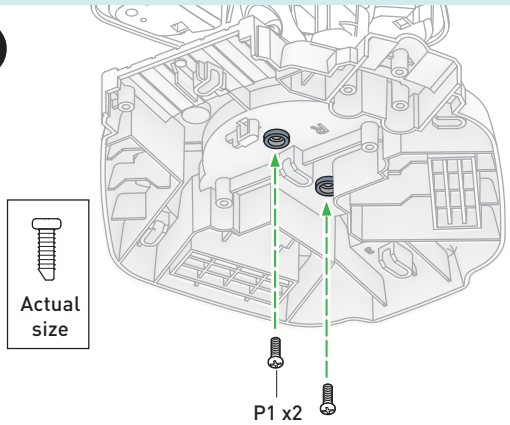
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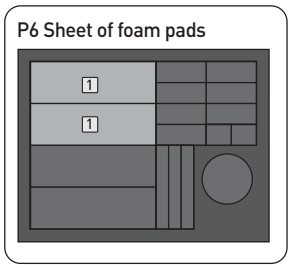


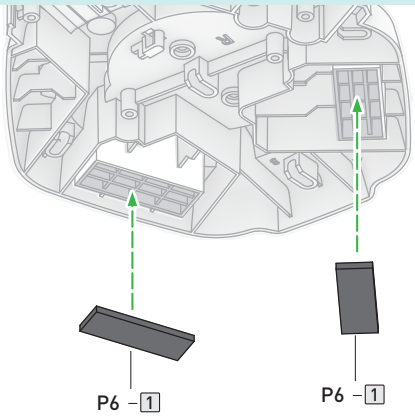


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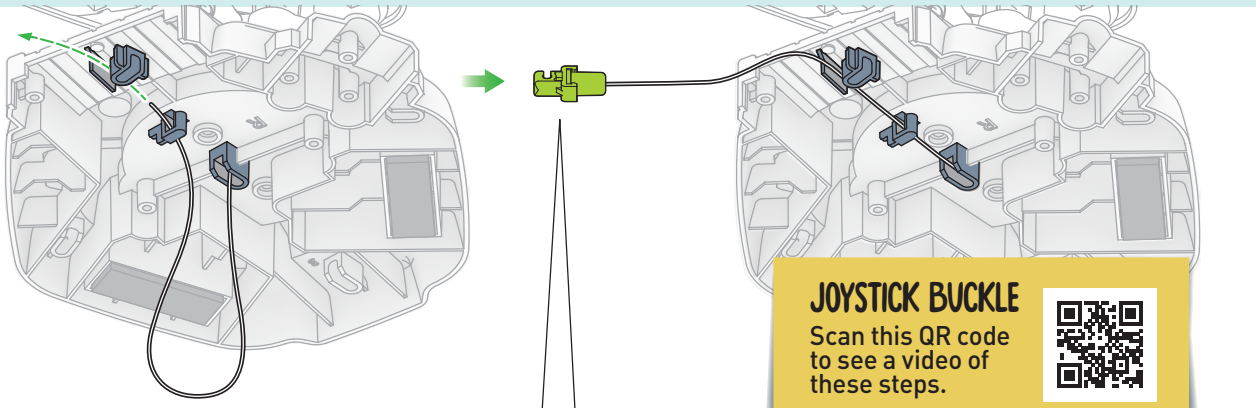


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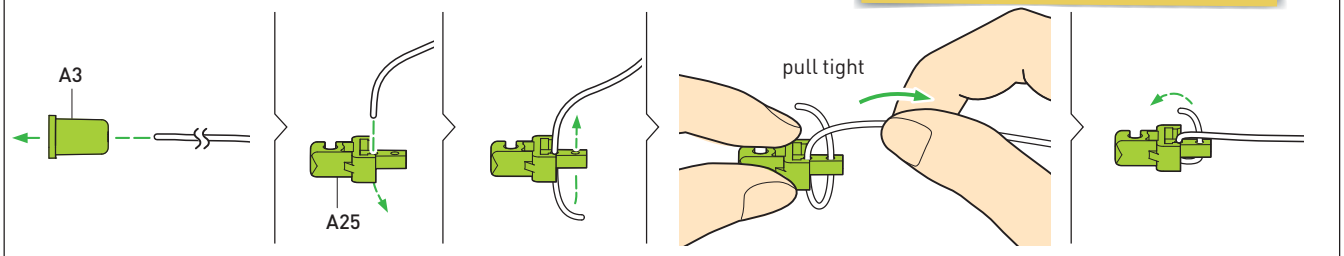


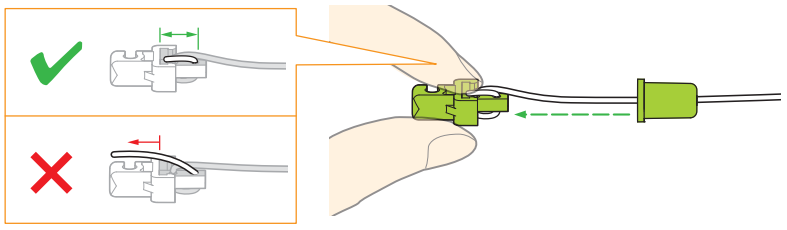
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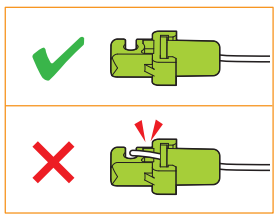


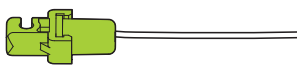
JOYSTICK BUCKLE

Scan this QR code to see a video of these steps.



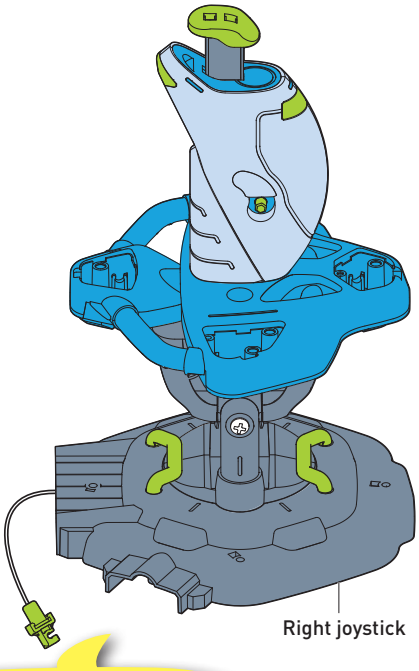






Ask an adult if you have trouble with this step.

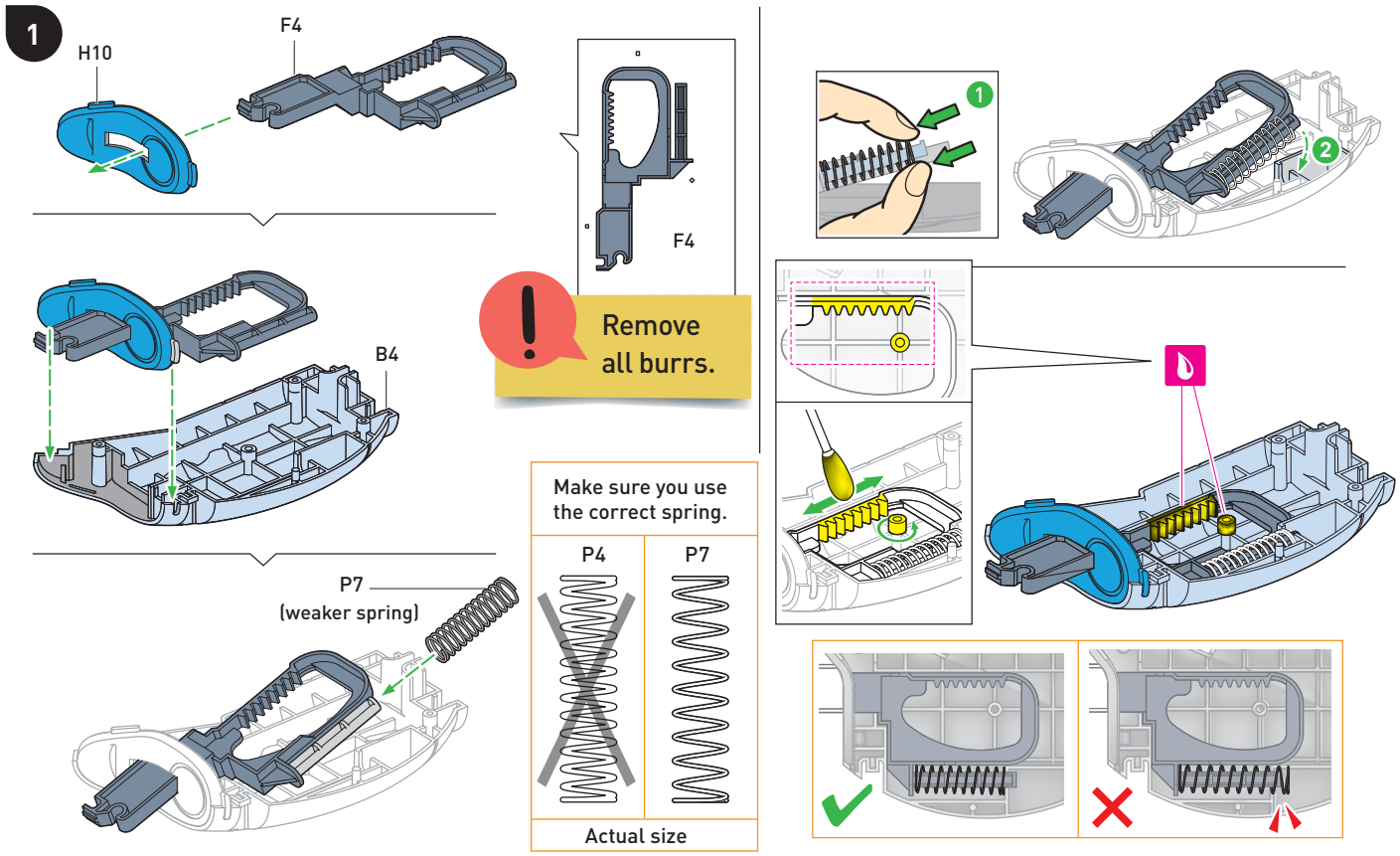


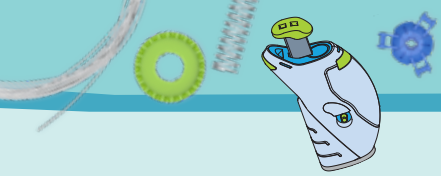


Nicely done!

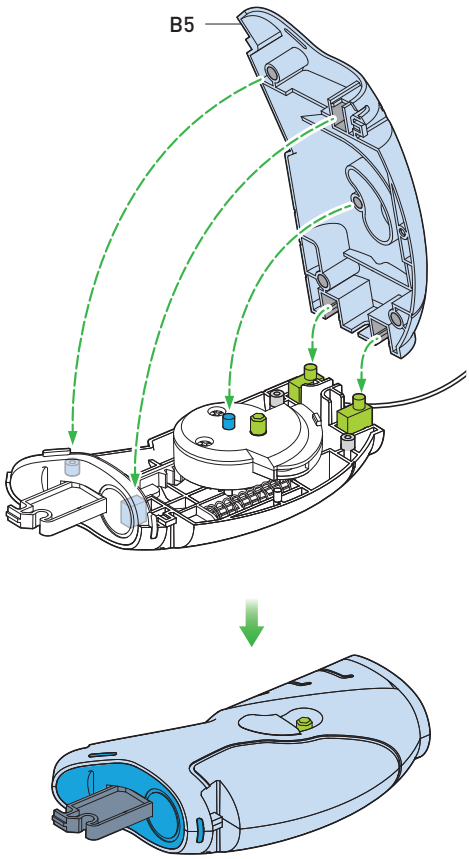
Consider taking a break before starting the next joystick.

ASSEMBLING THE LEFT JOYSTICK

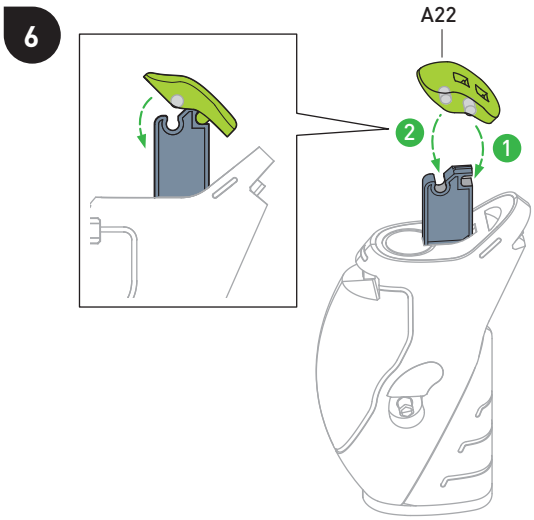


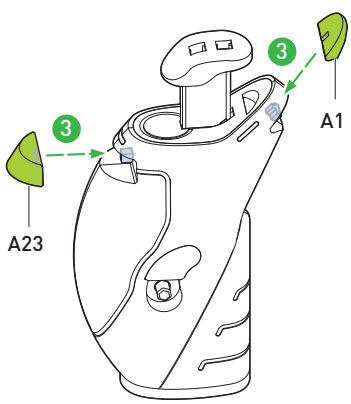


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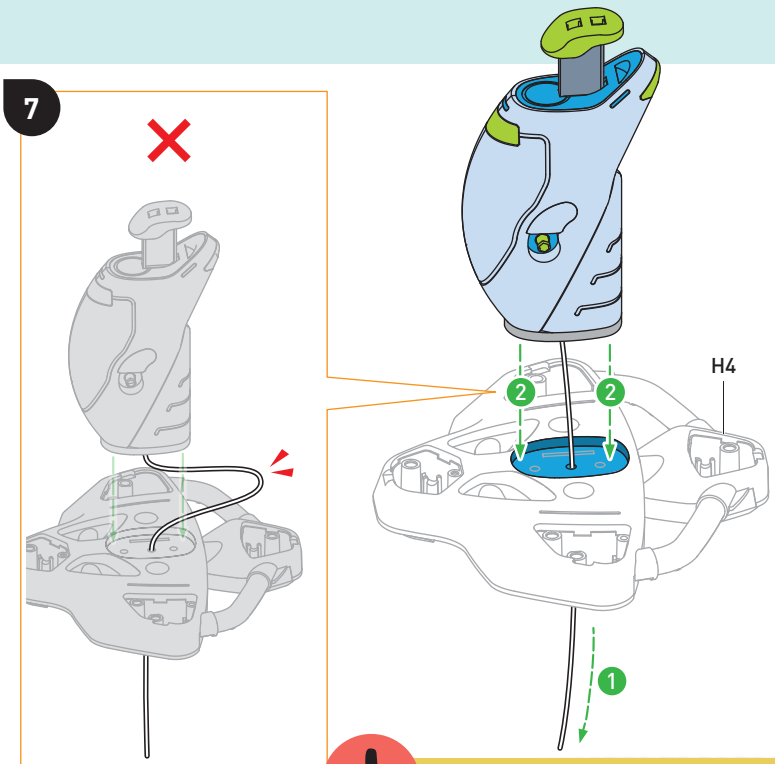


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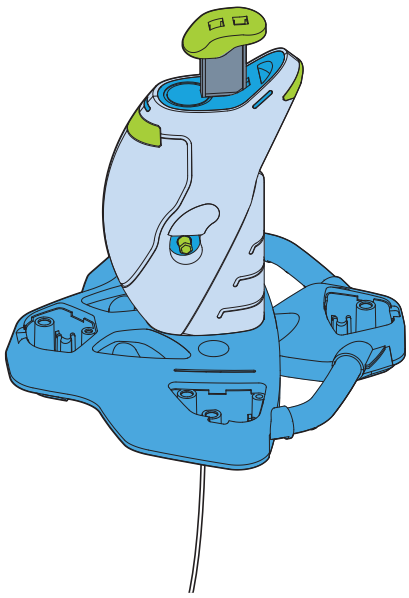




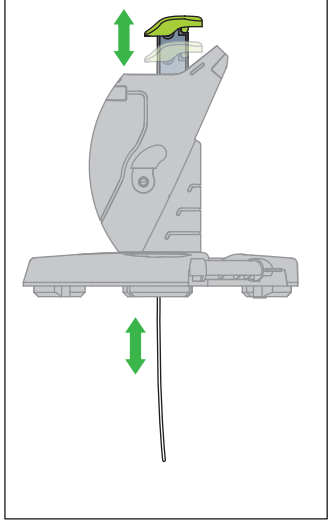
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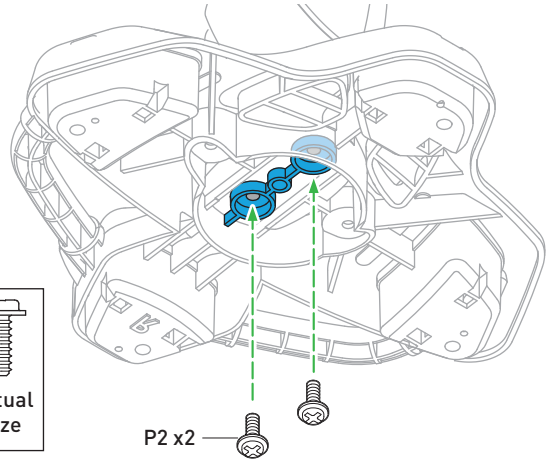
Pull the nylon cable straight before assembly.



Test

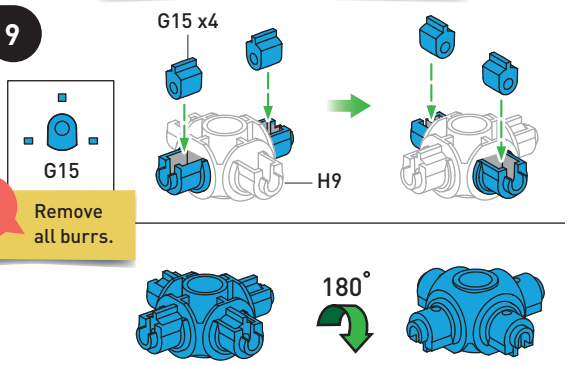


8



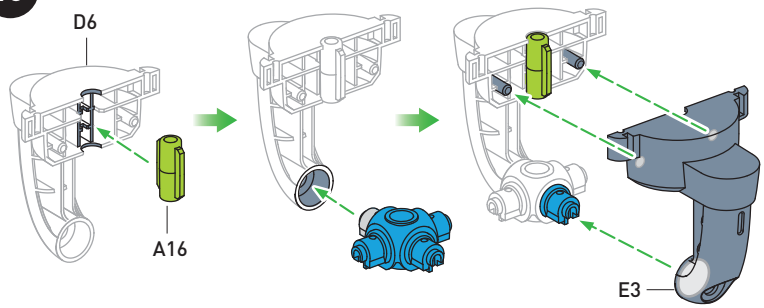
Use the tabletop to press G15 into place if it's too difficult with just your hands.

9

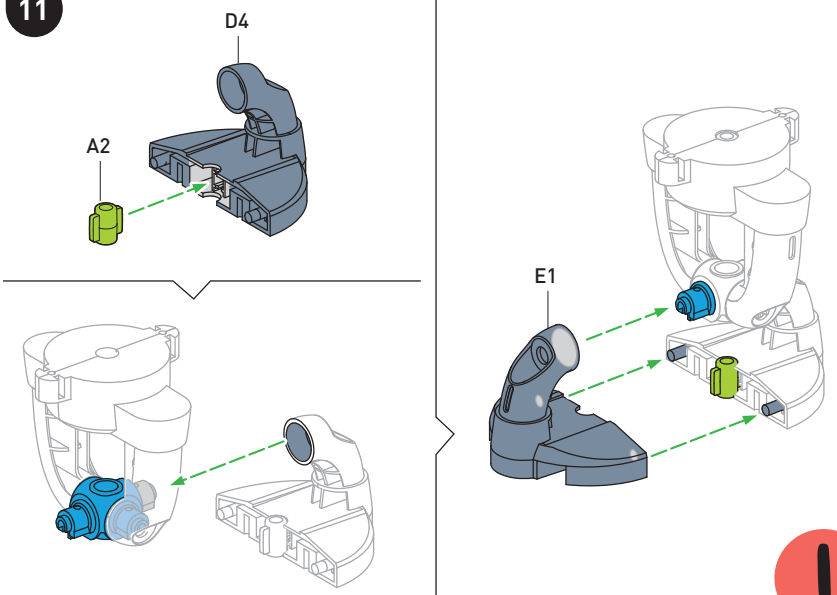


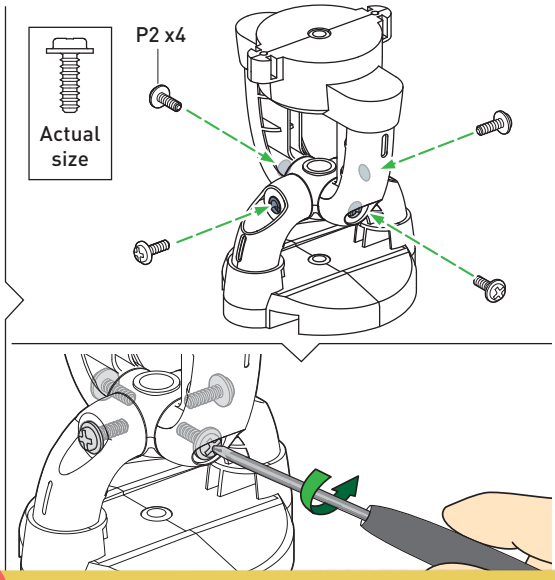
Remove all burrs.

10



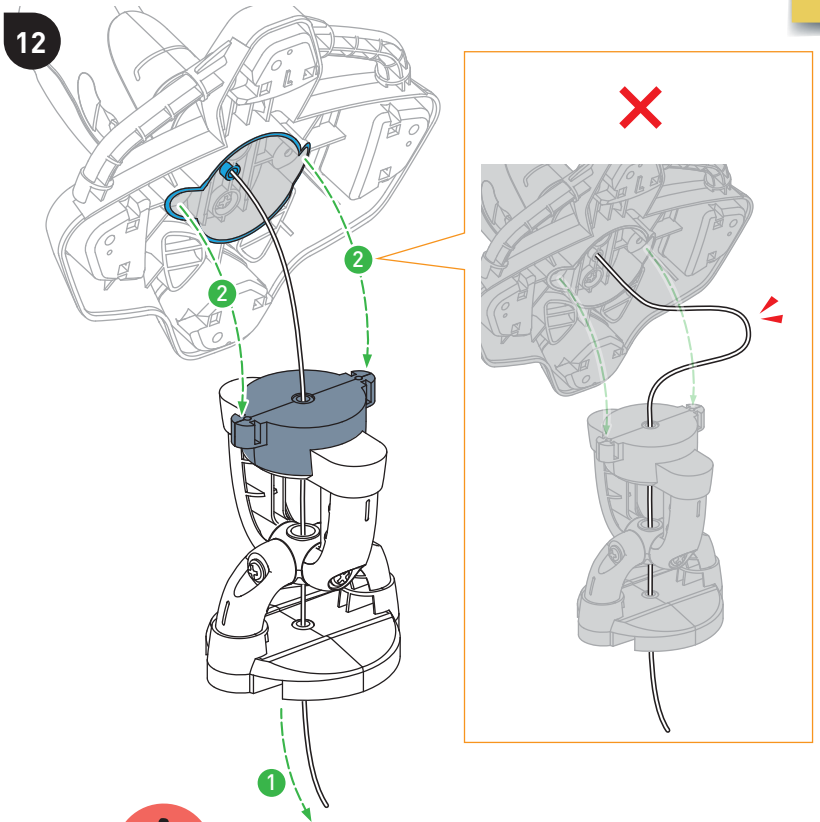
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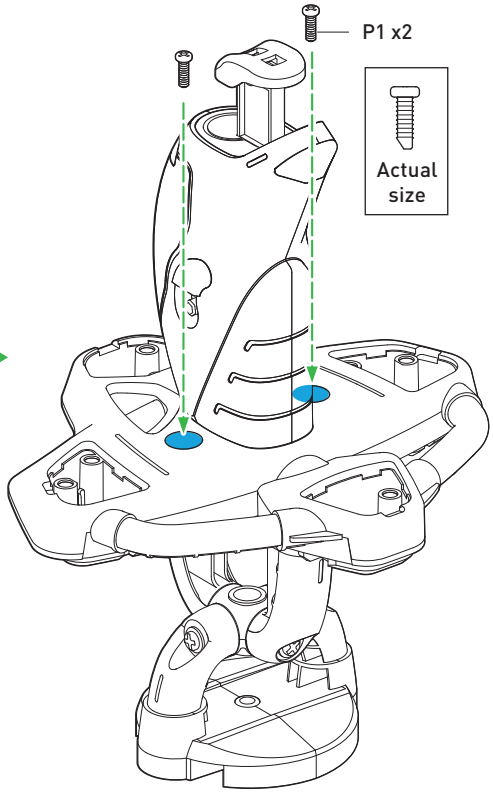




After fully screwing in the four P2s, loosen them again by a half turn.

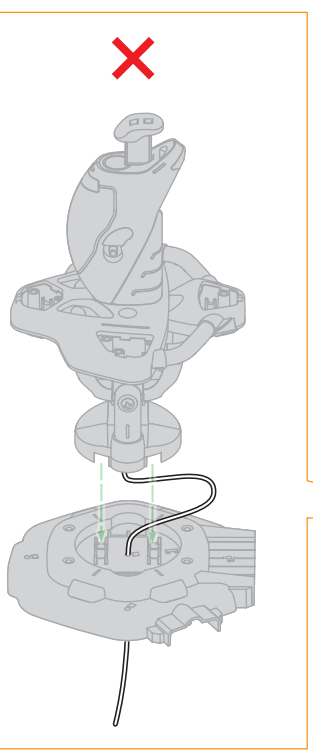
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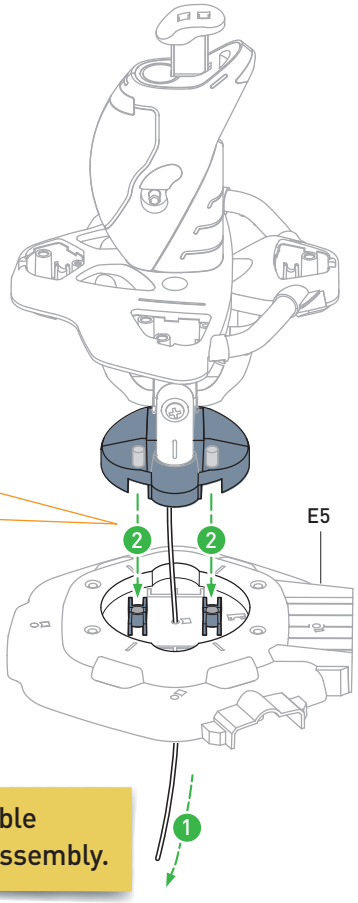


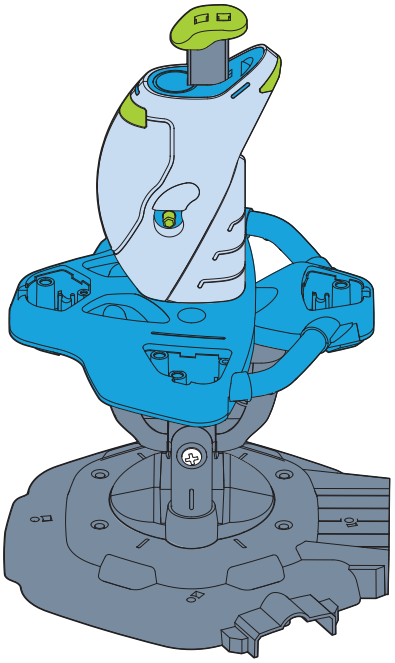


Pull the nylon cable straight before assembly.

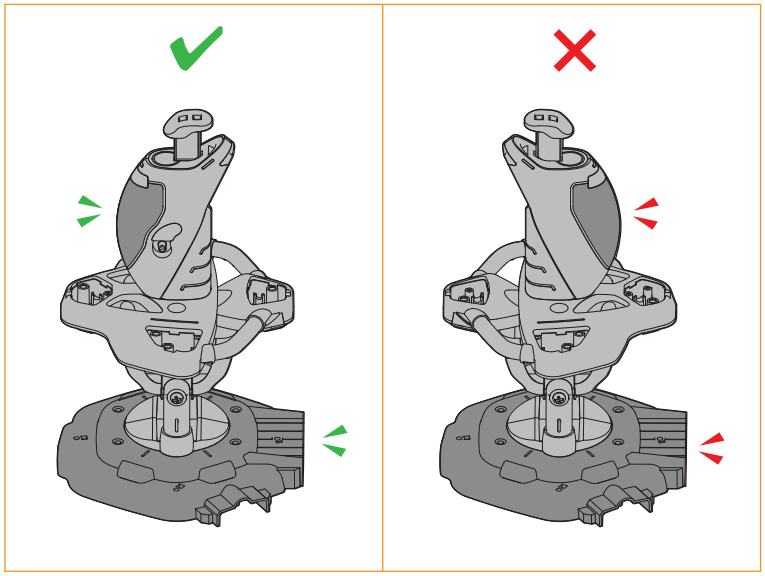
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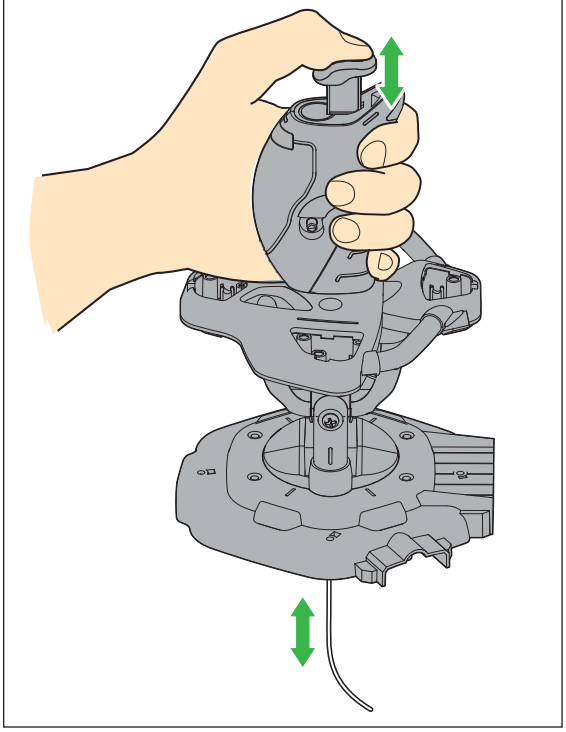




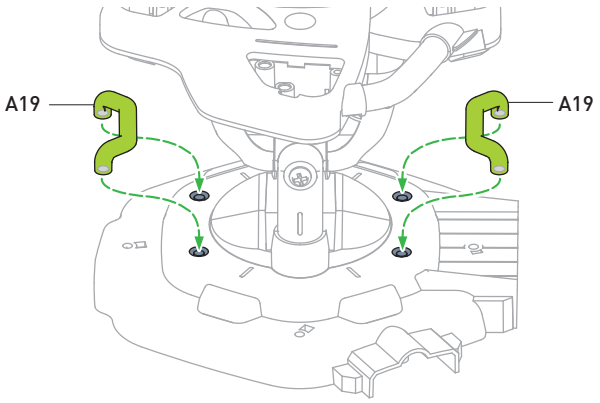
Pull the nylon cable straight before assembly.

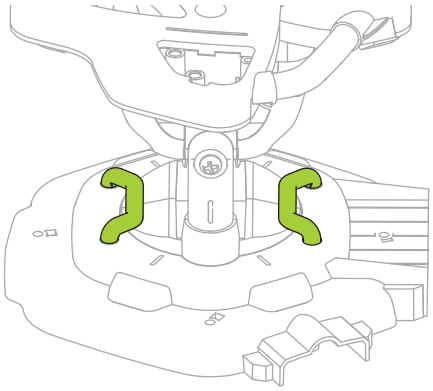


Test

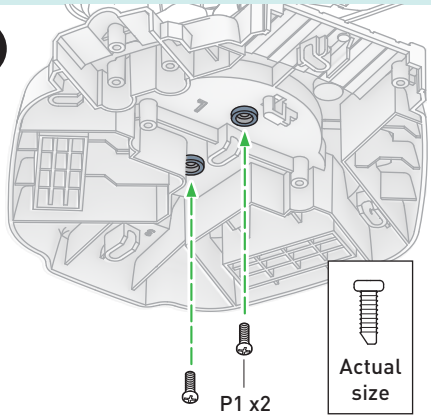


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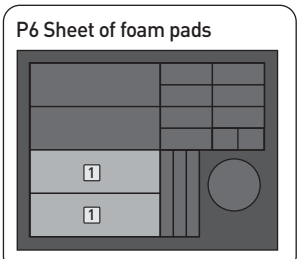


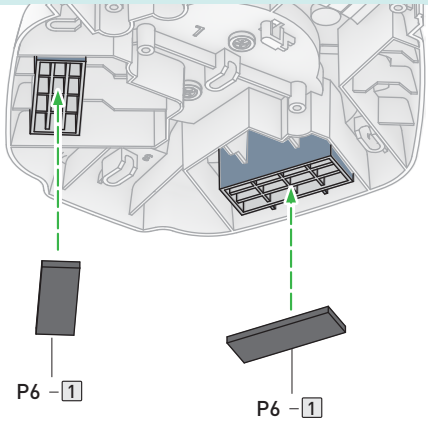
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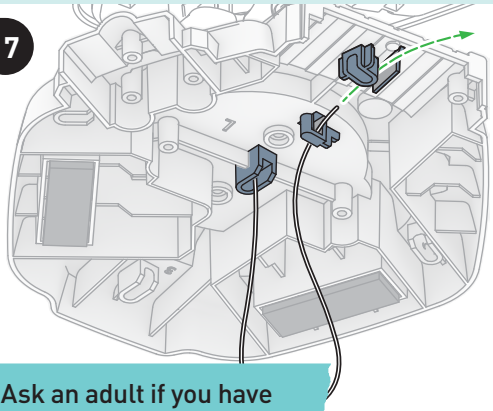
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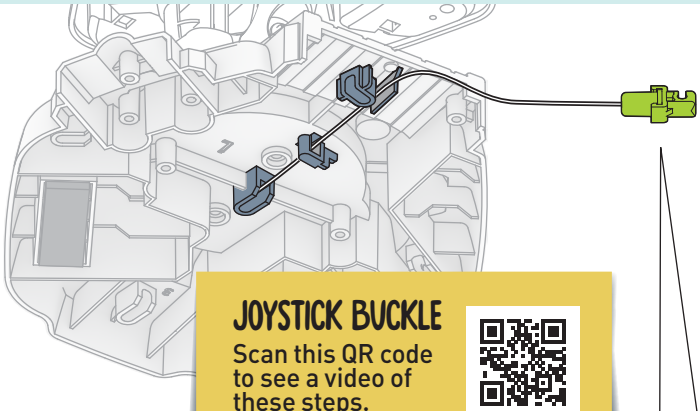
P6 Sheet of foam pads





17

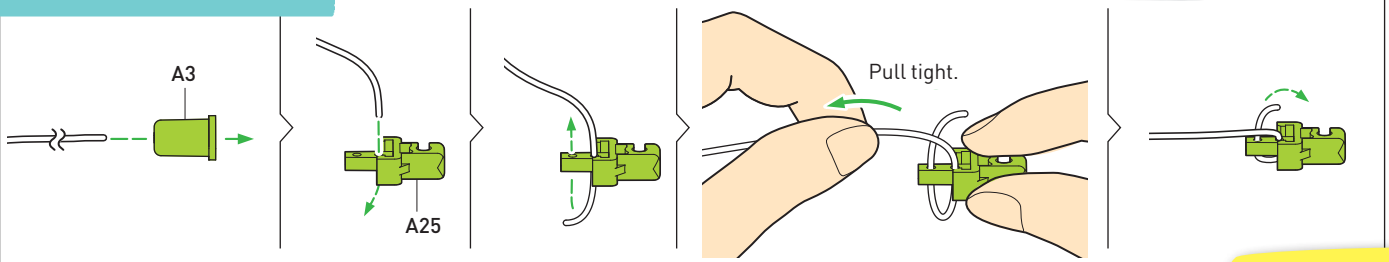


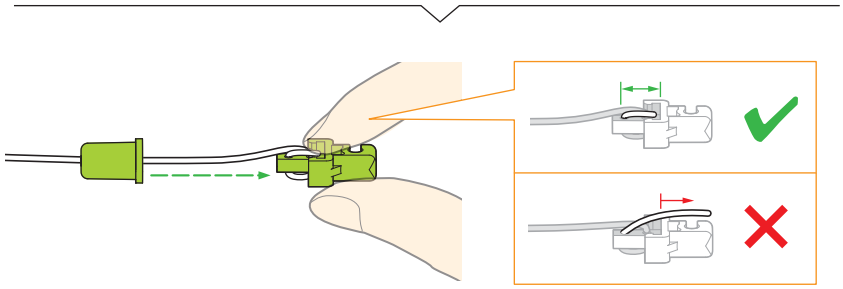


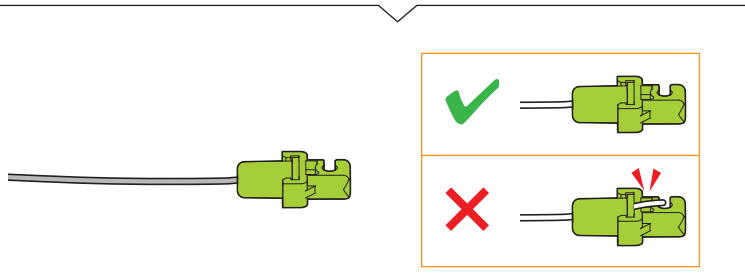
JOYSTICK BUCKLE

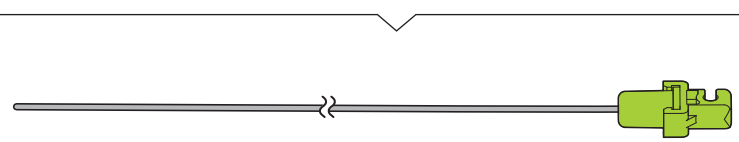
Scan this QR code to see a video of these steps.

Ask an adult if you have trouble with this step.

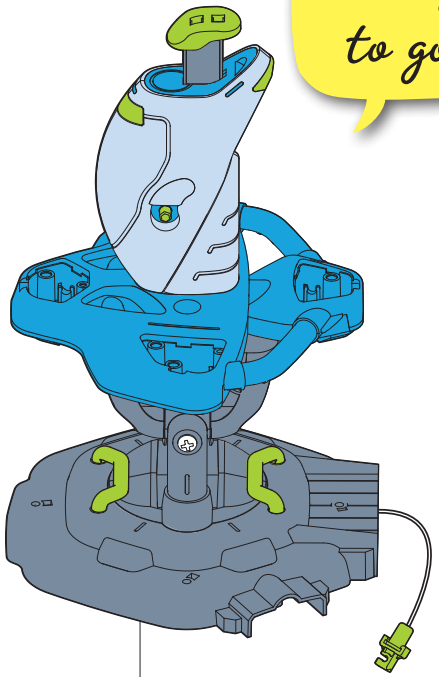






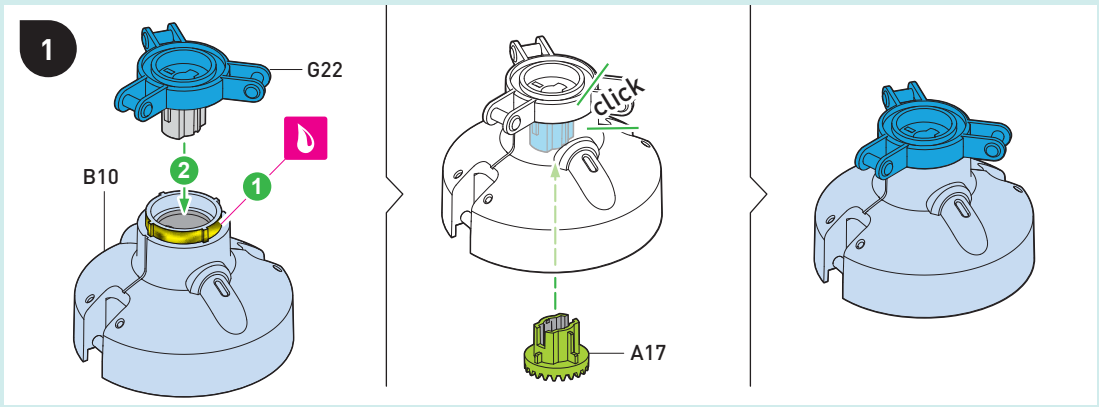


Way to go!

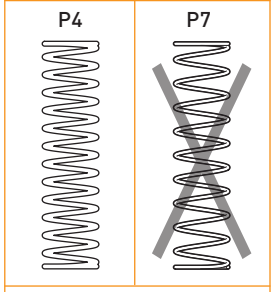


Left joystick

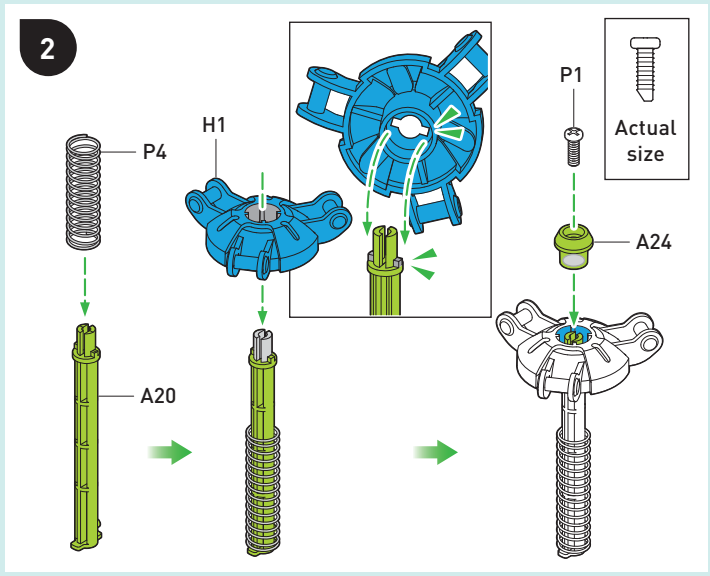
ASSEMBLING THE CLAW

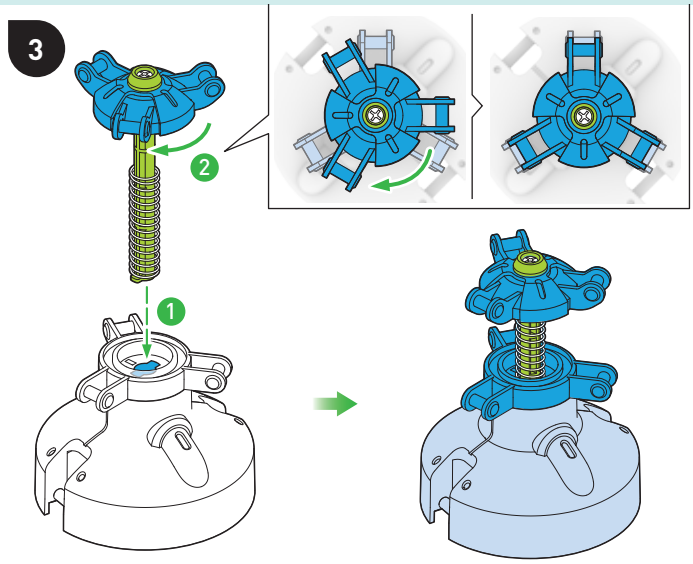


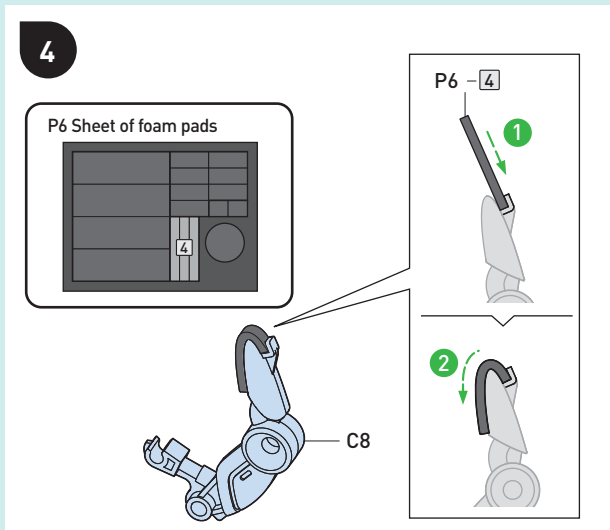
For both the claw and the eel head, make sure you use the correct spring.

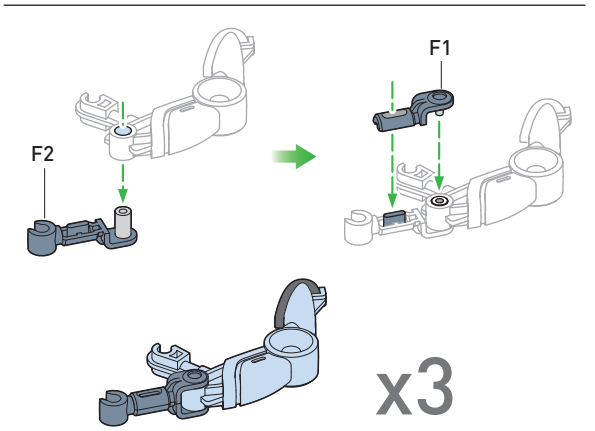


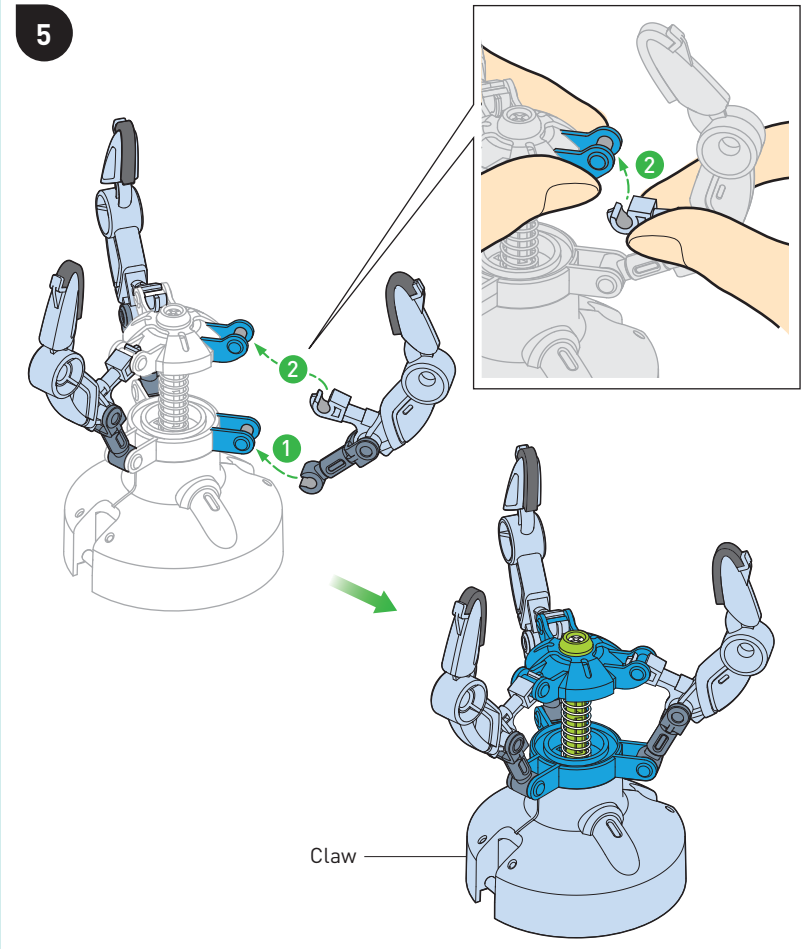
Actual size



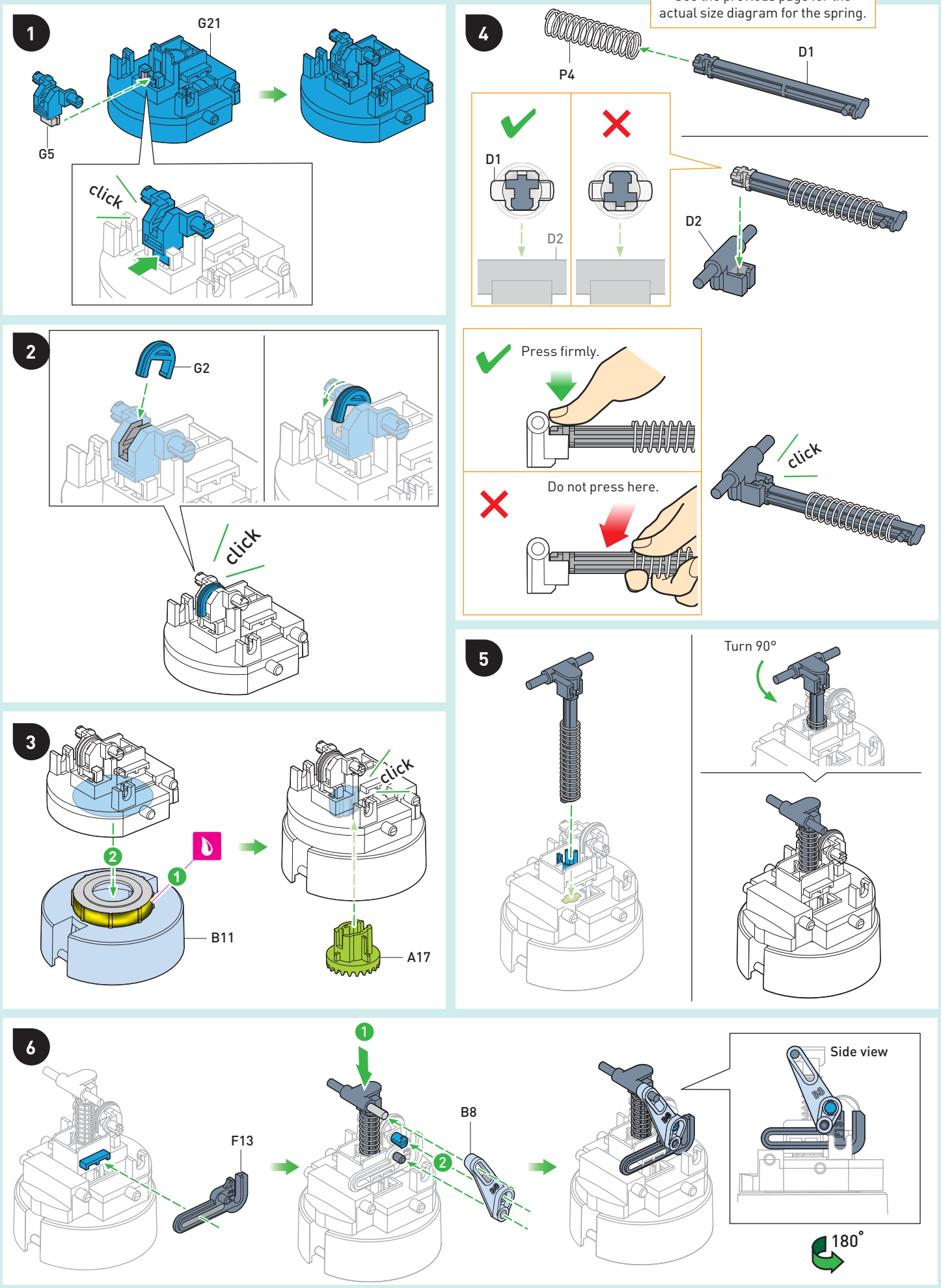


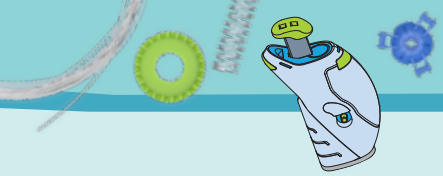




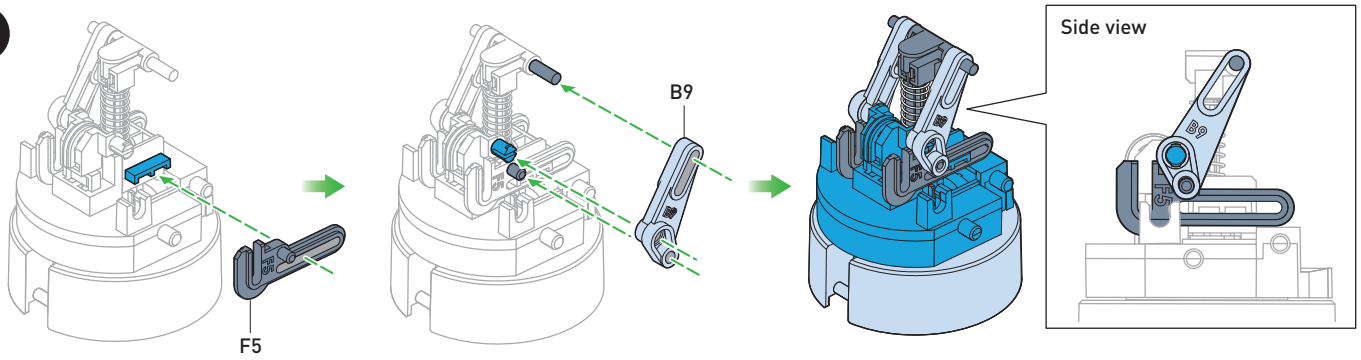


ASSEMBLING THE GARDEN EEL HEAD

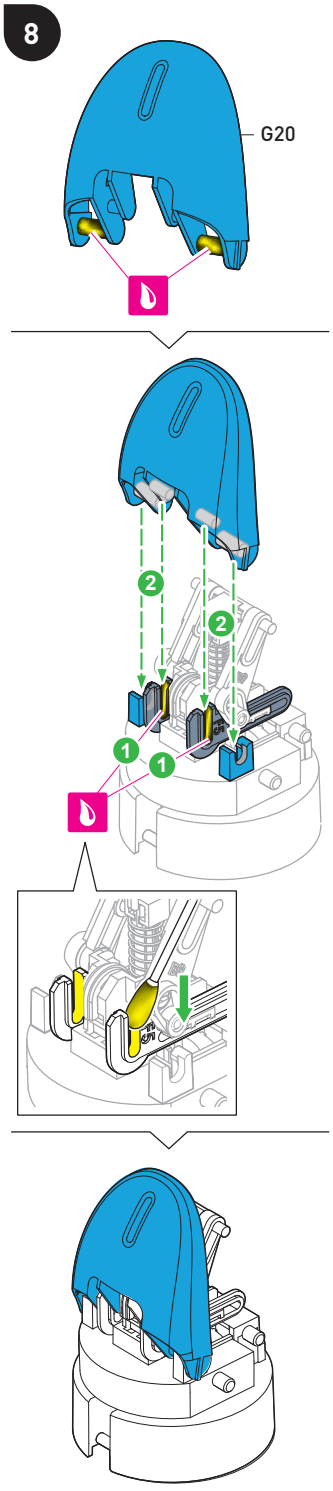




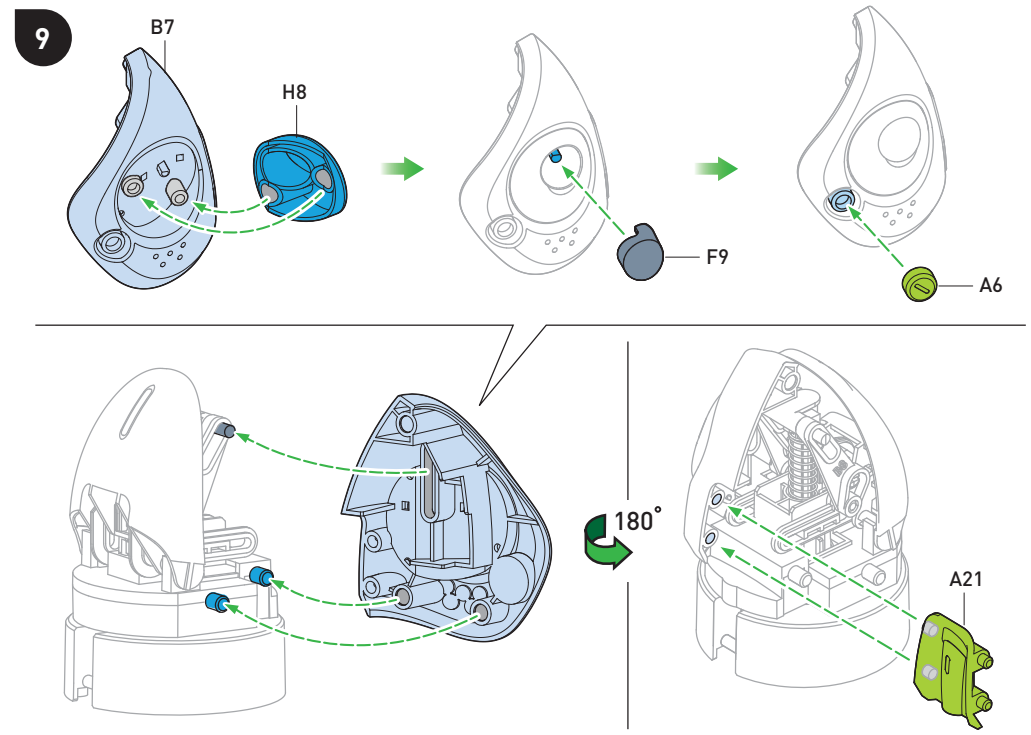
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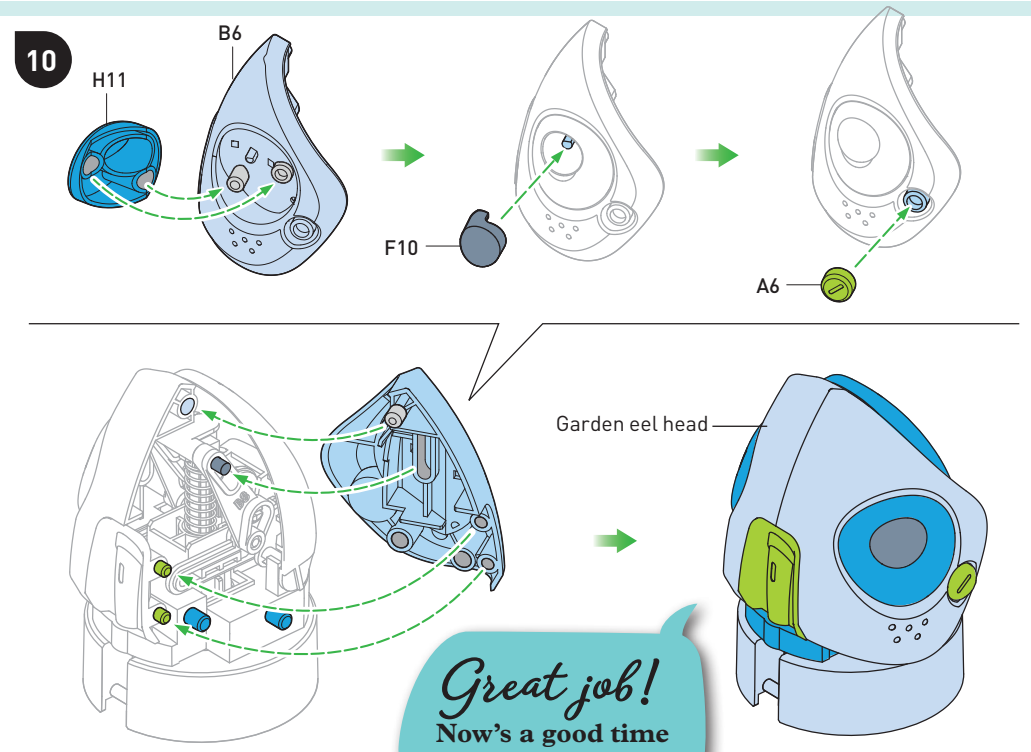
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9



10

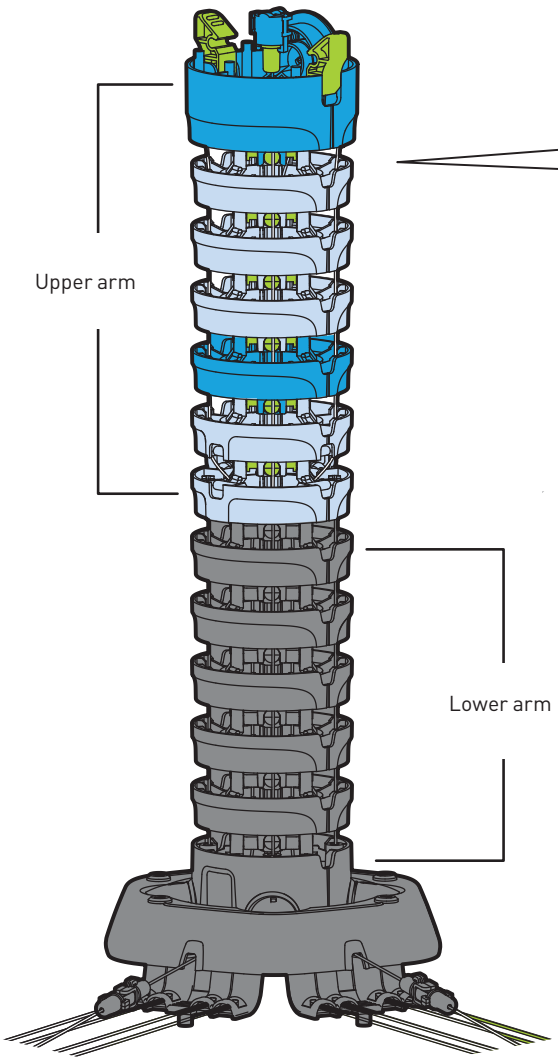


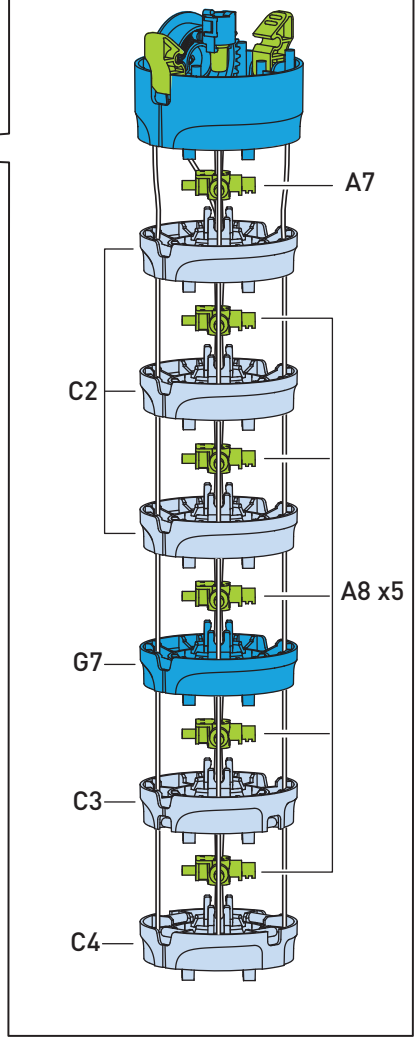
Great job!
Now's a good time for a break!

ASSEMBLING THE UPPER ARM

UPPER ARM

Scan this QR code to see a video of these steps.

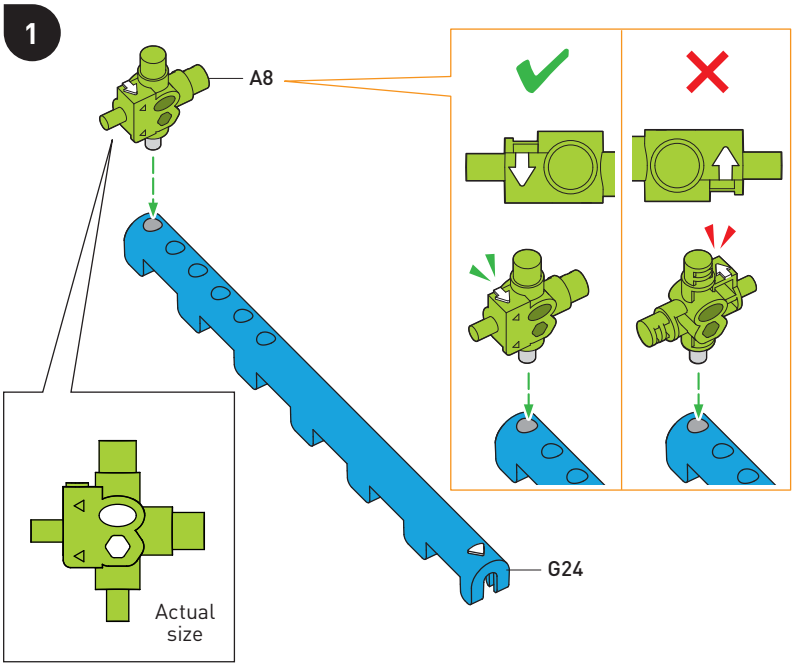


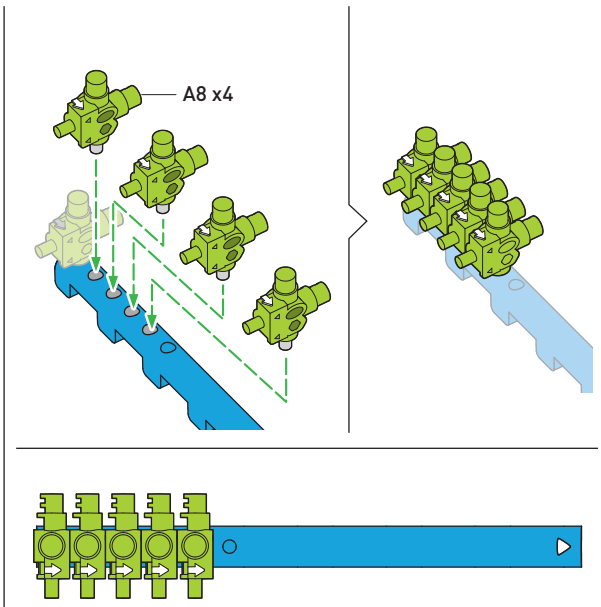


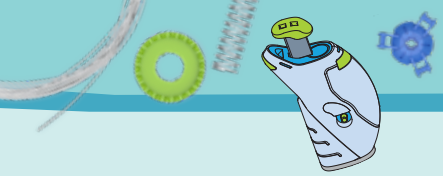
Full upper arm assembly

Ready?
Let's go !

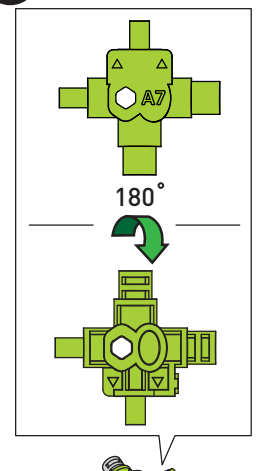
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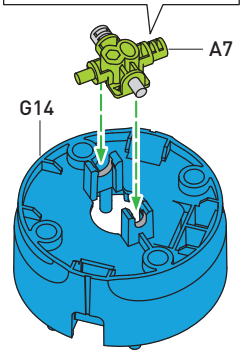


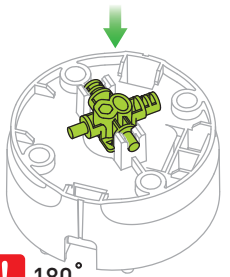


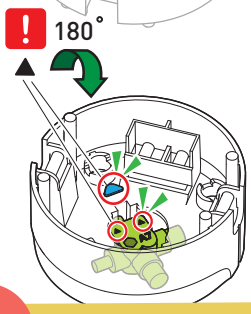


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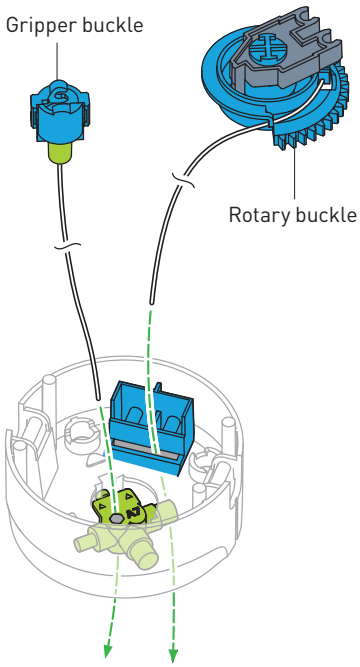


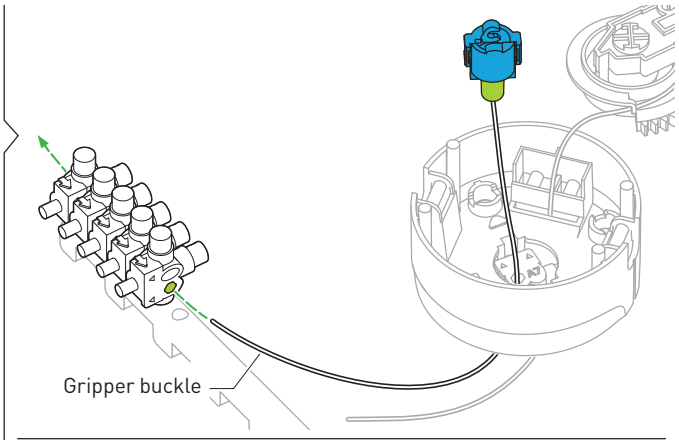


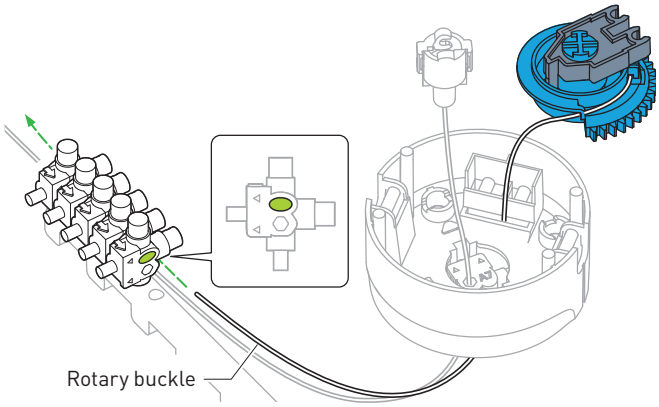


Make sure that the arrows on A7 point in the same direction as the arrow on G14!

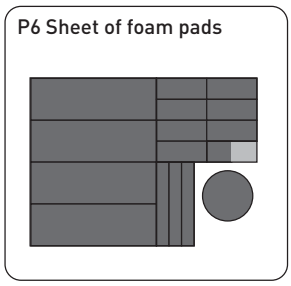
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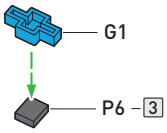


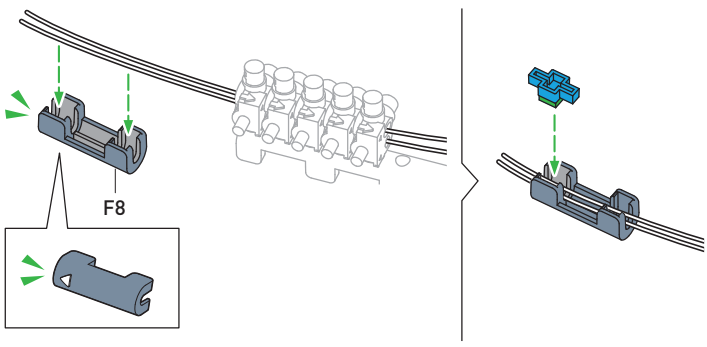


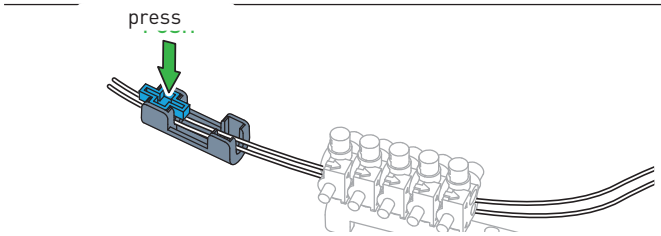


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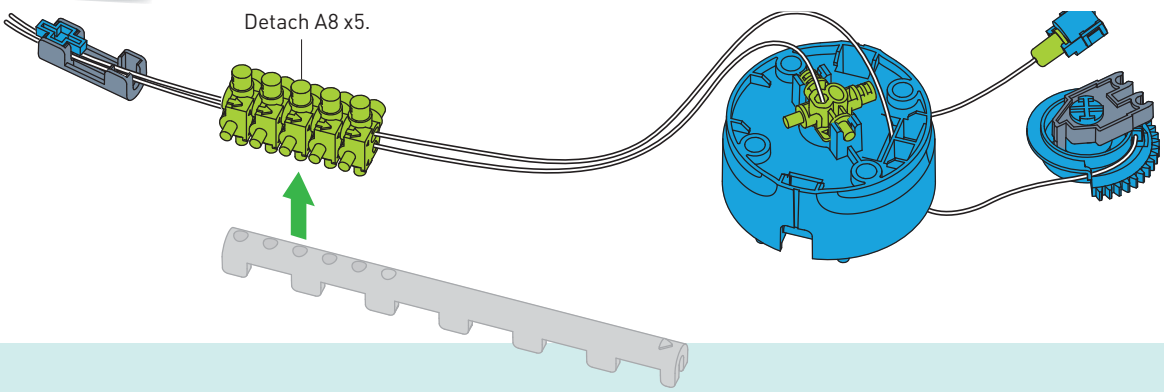




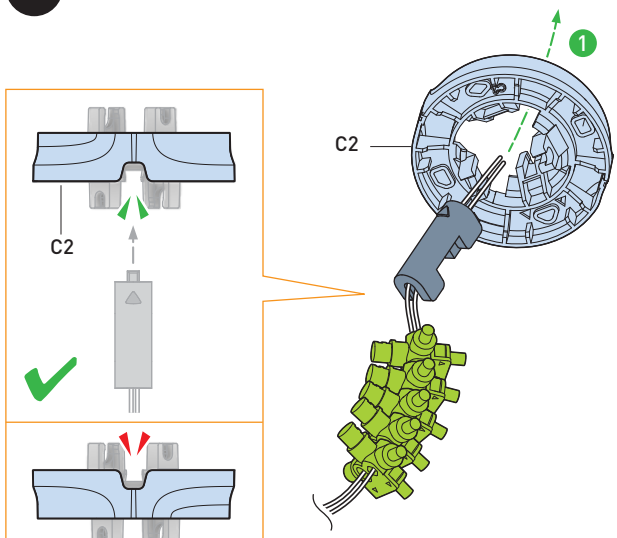




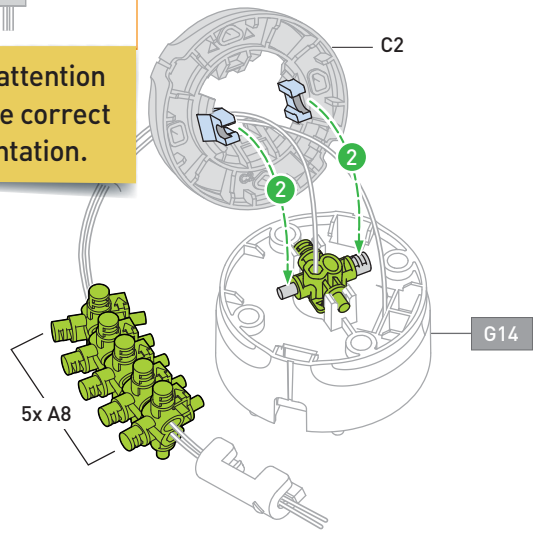
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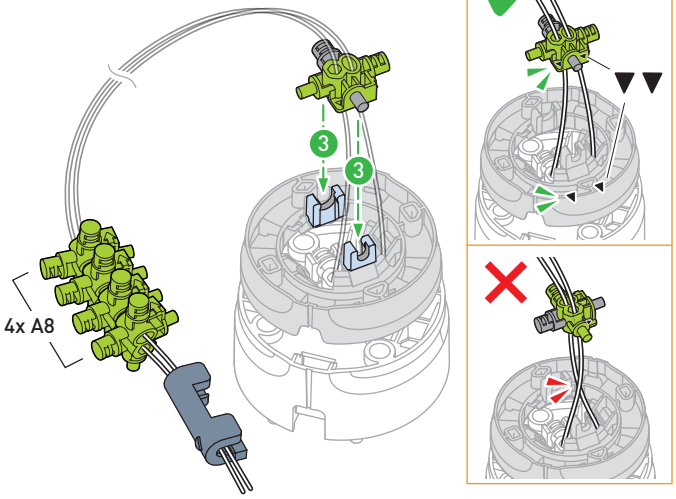


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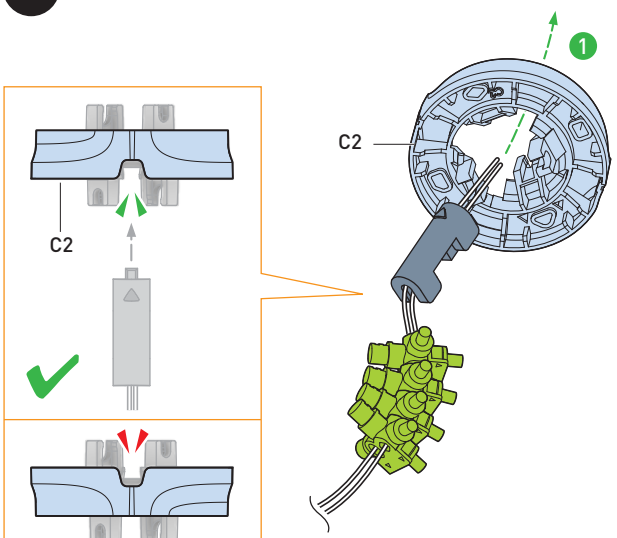


Pay attention to the correct orientation.

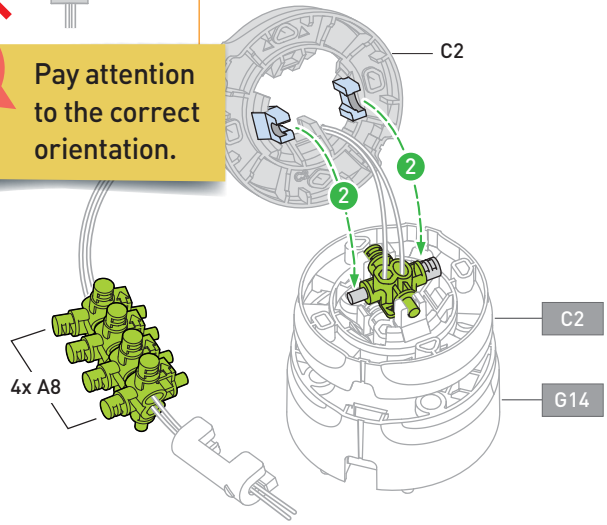


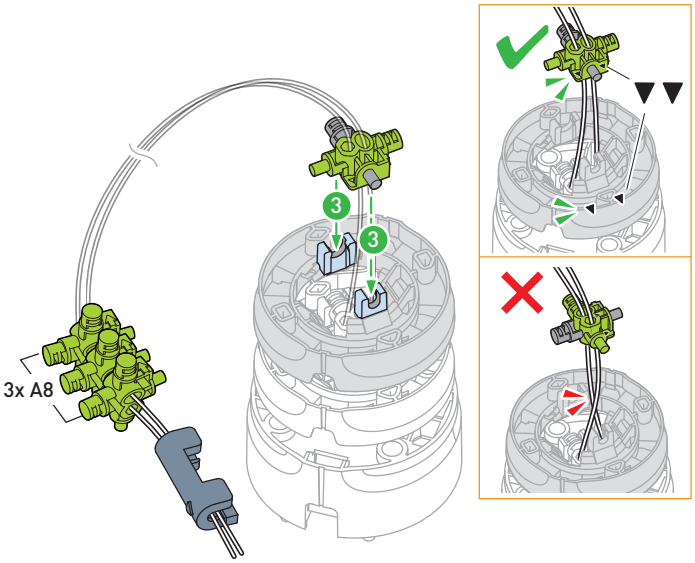


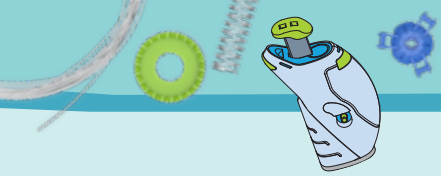
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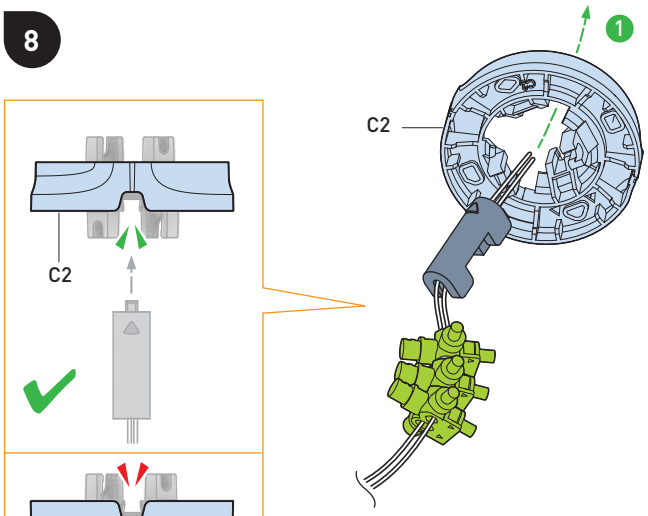
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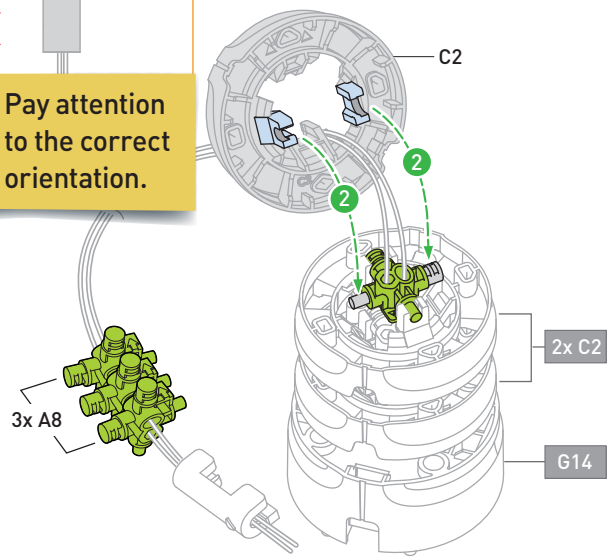


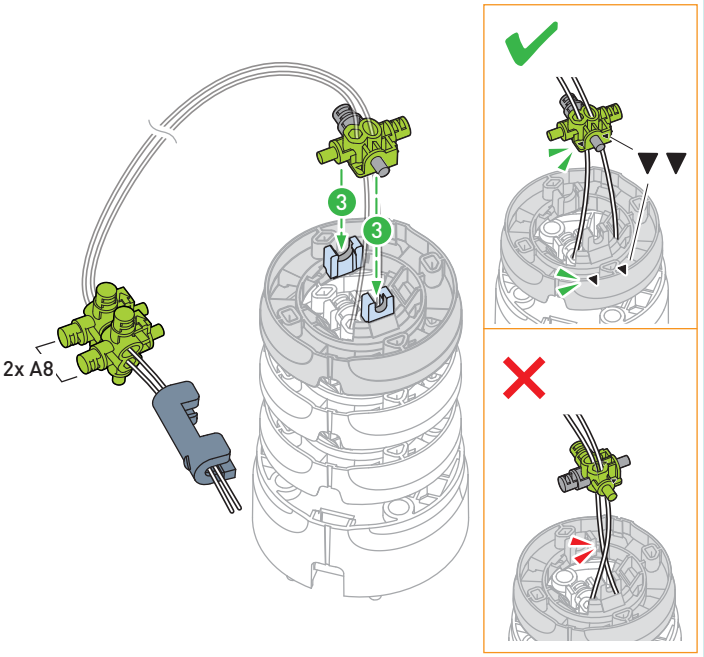


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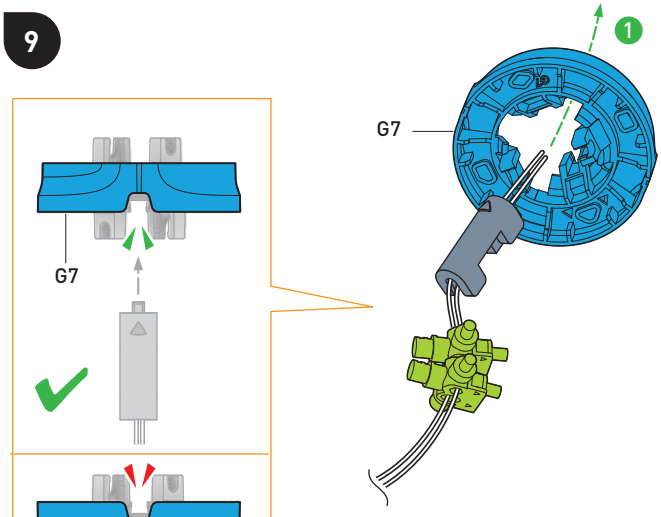


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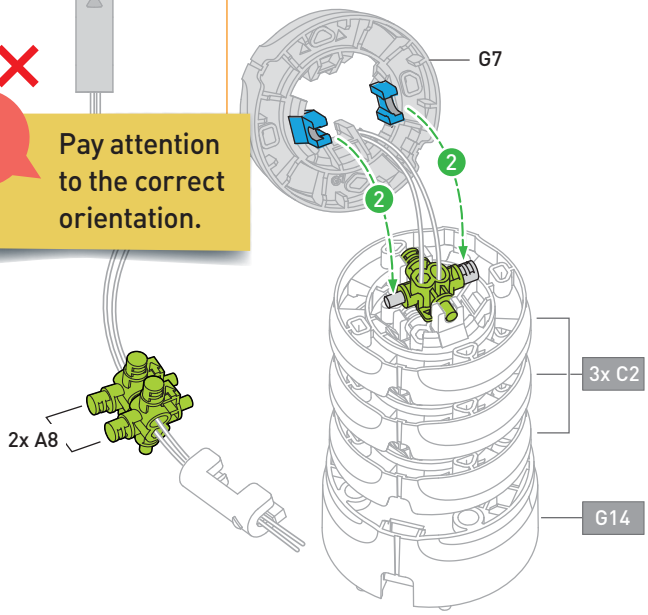


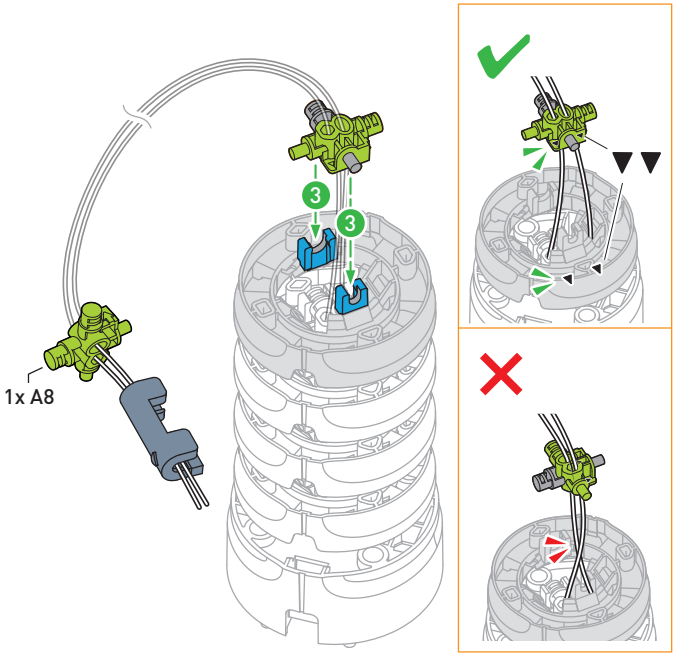


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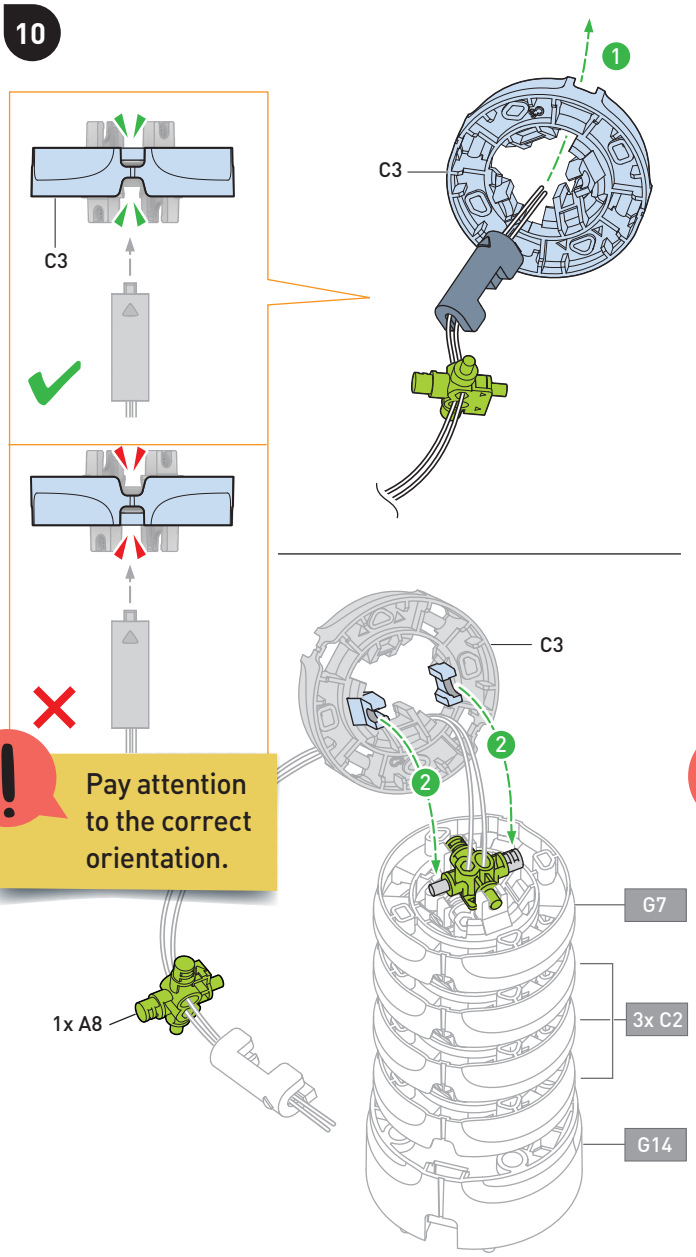


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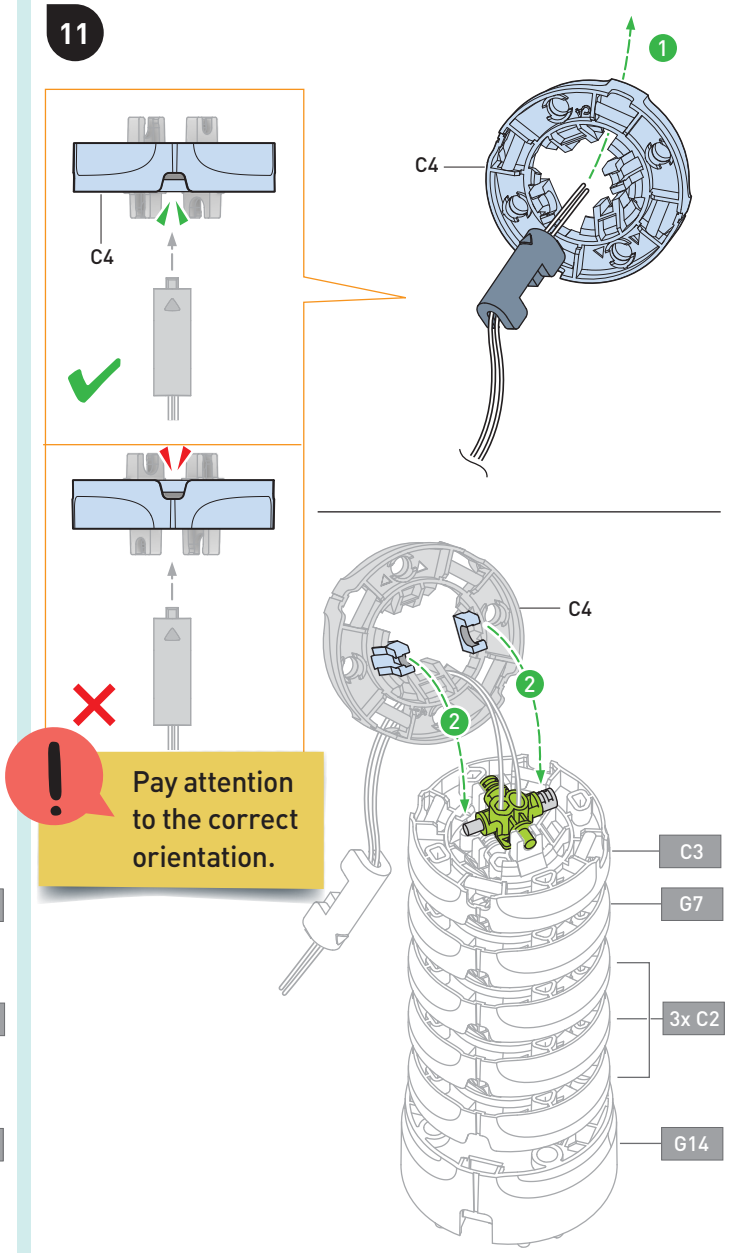


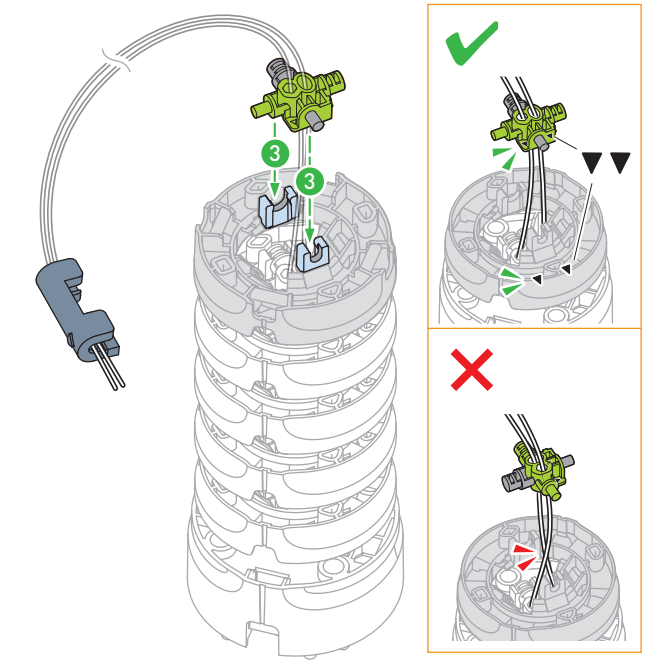


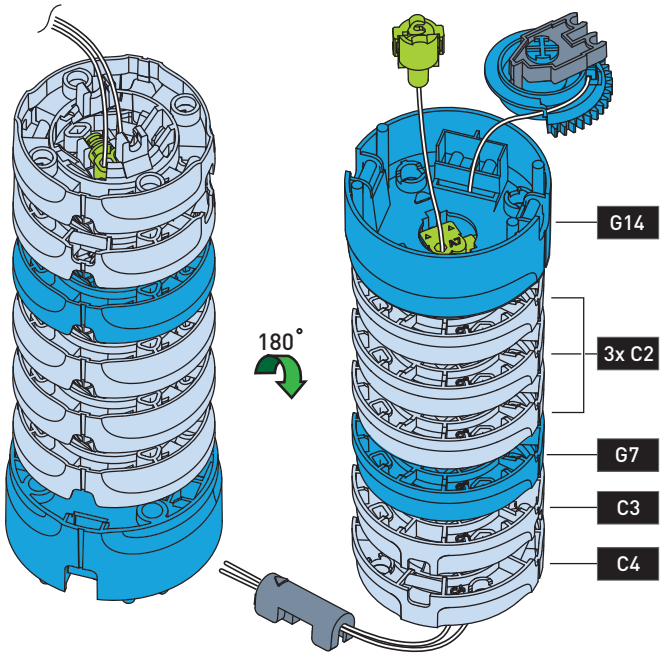
10


C3
1
C3
C3
2
2
Pay attention to the correct orientation.
G7
1x A8
3x C2
G14

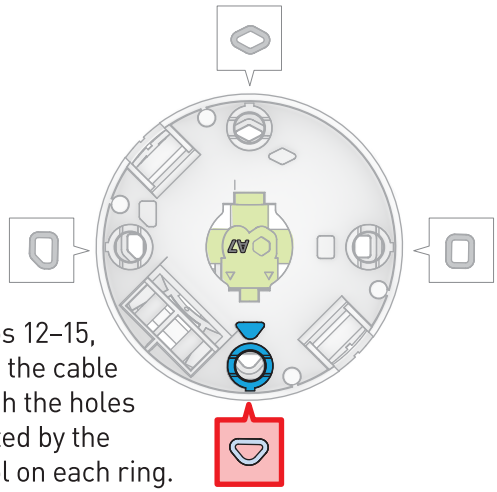
11


C4
1
C4
C4
2
2
Pay attention to the correct orientation.
C3
G7
3x C2
G14

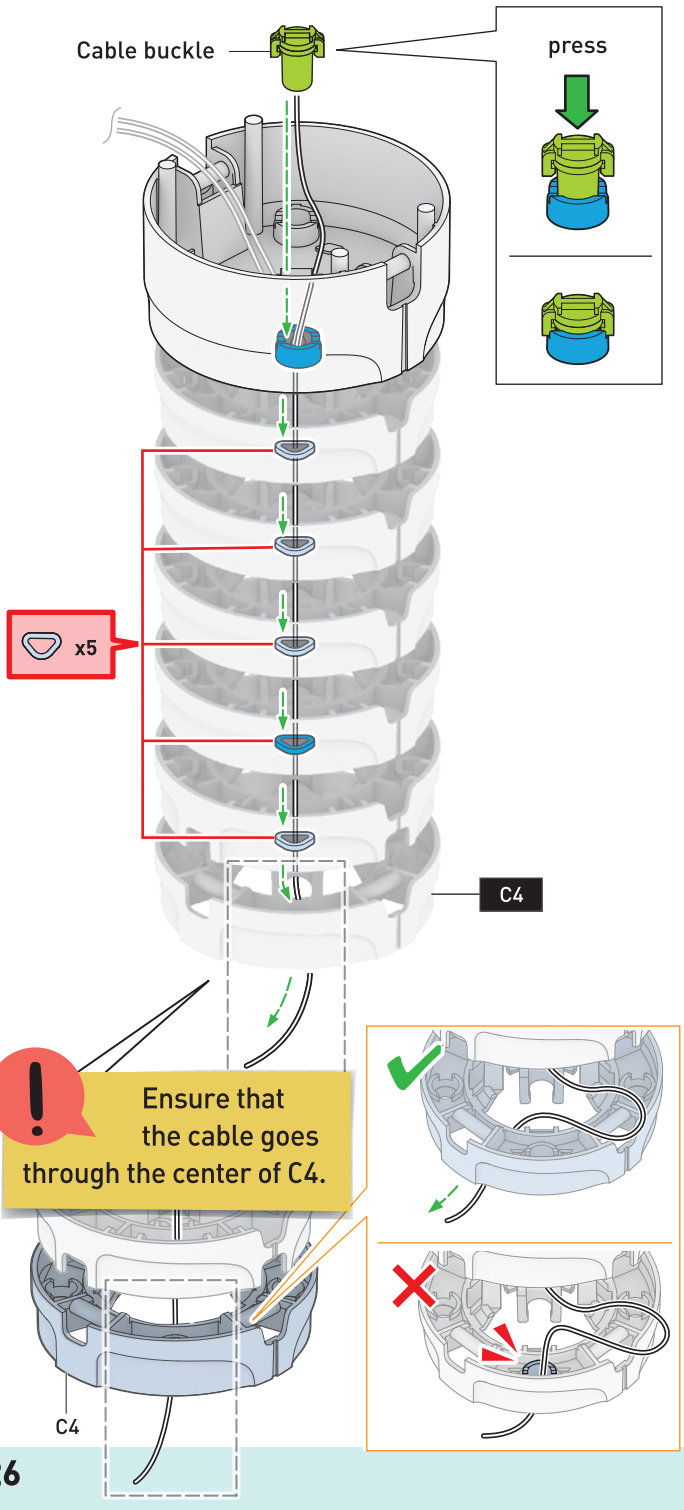

3
3


180°
G14
3x C2
G7
C3
C4

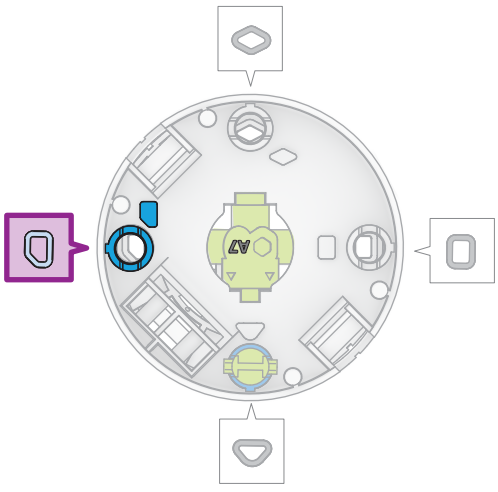
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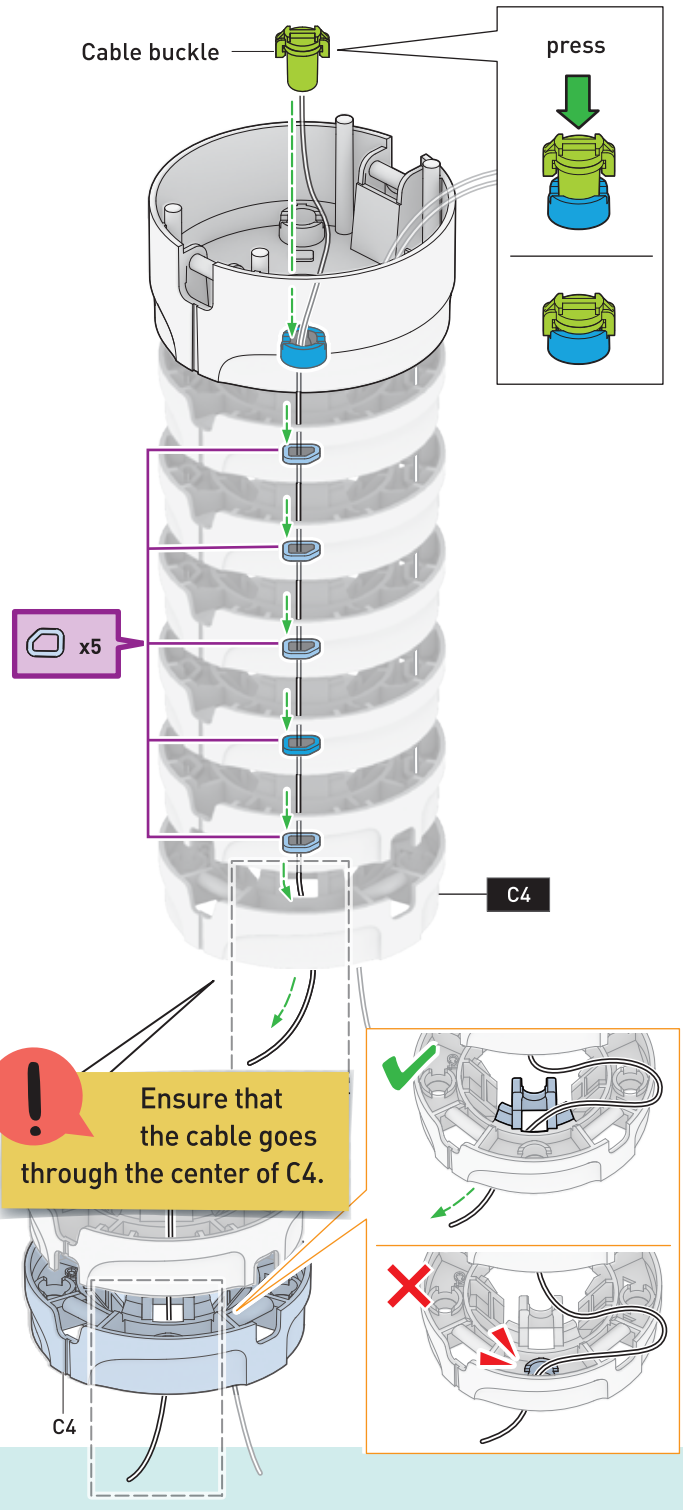


In steps 12–15, thread the cable through the holes indicated by the symbol on each ring.

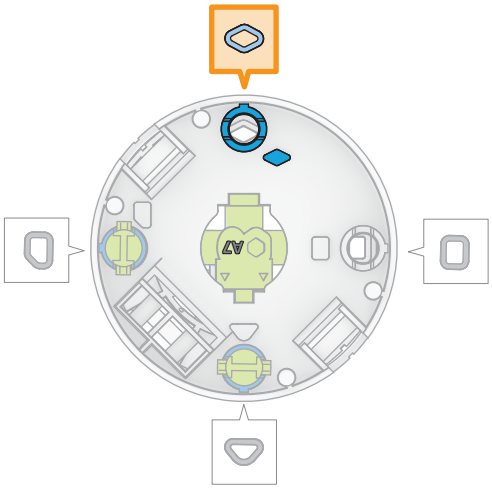


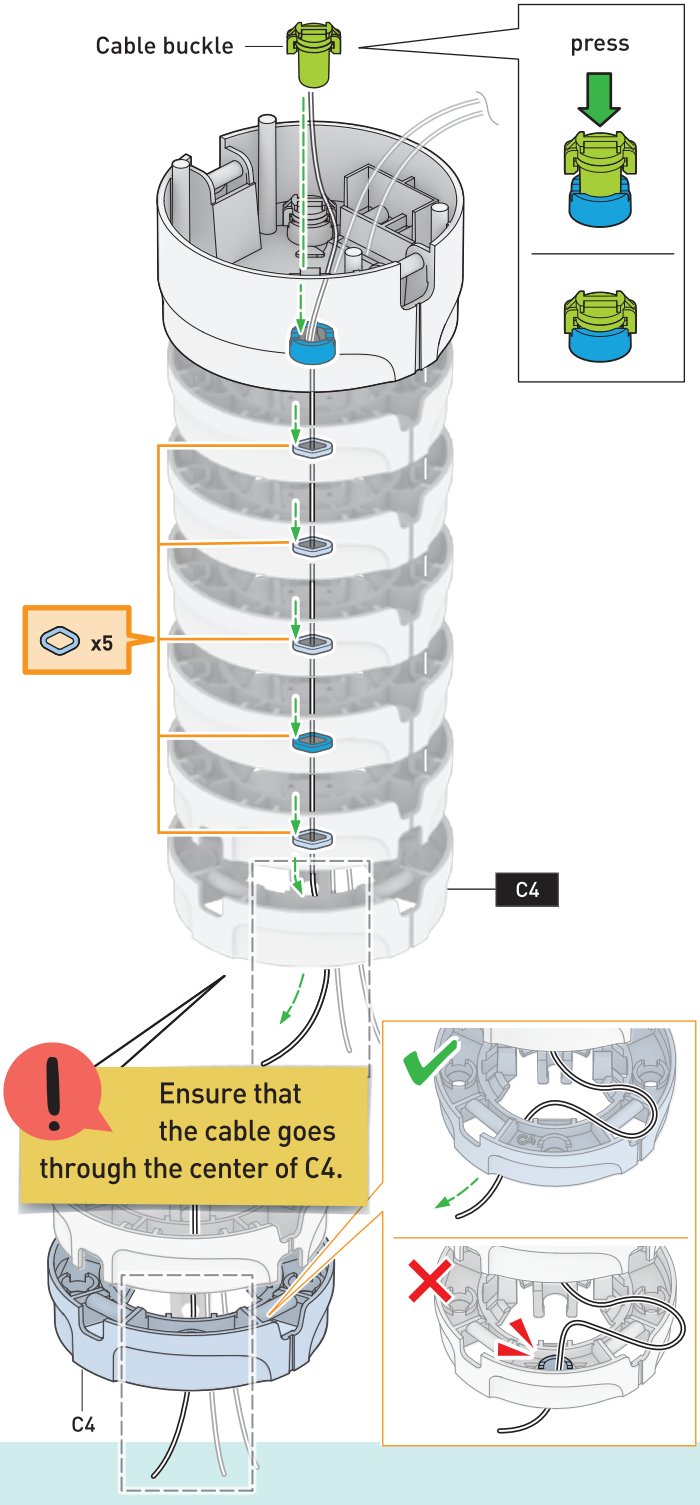
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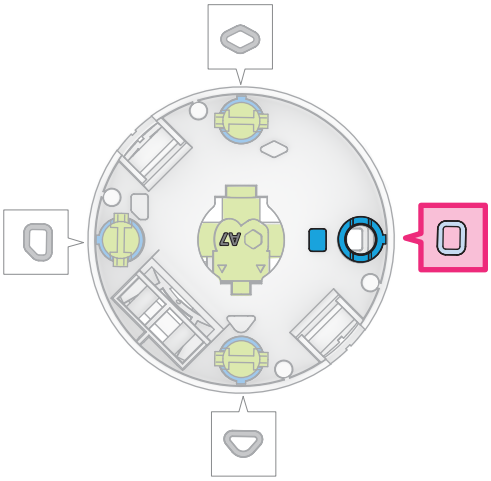


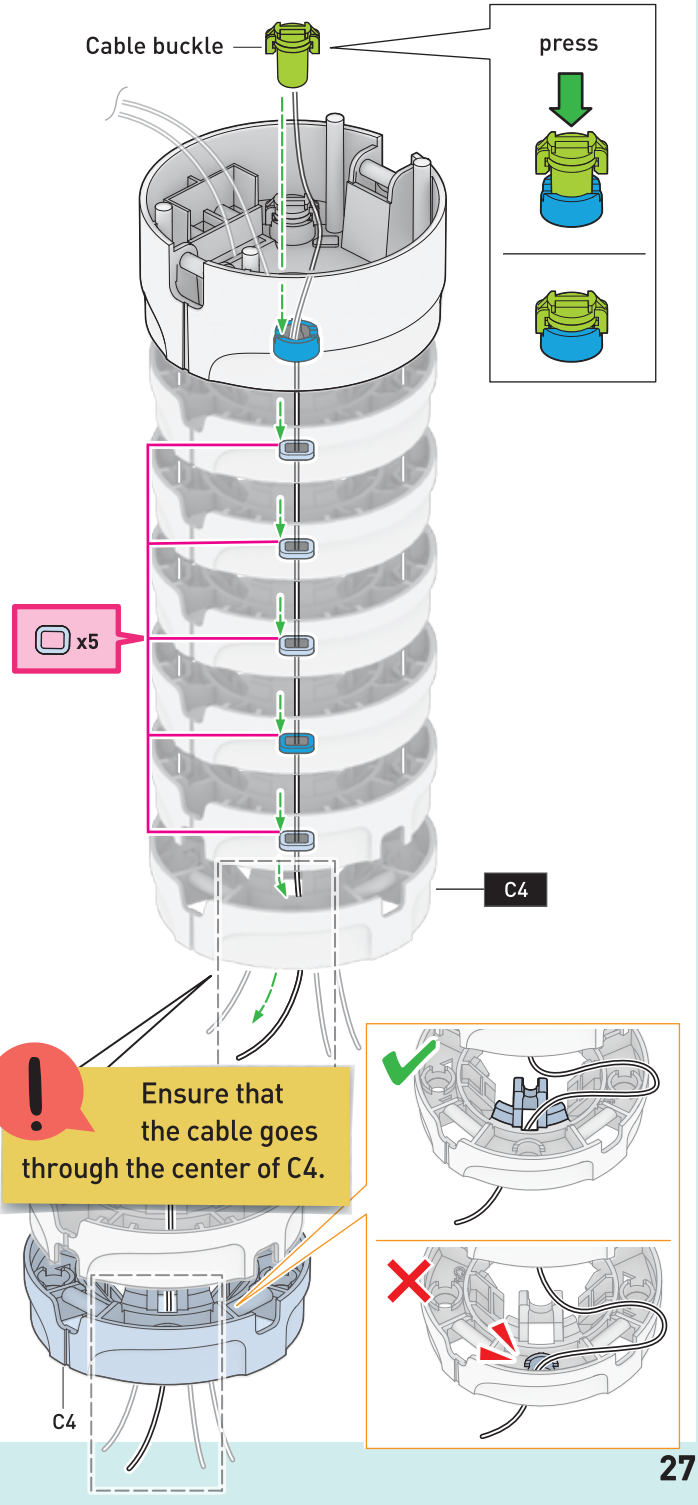
14



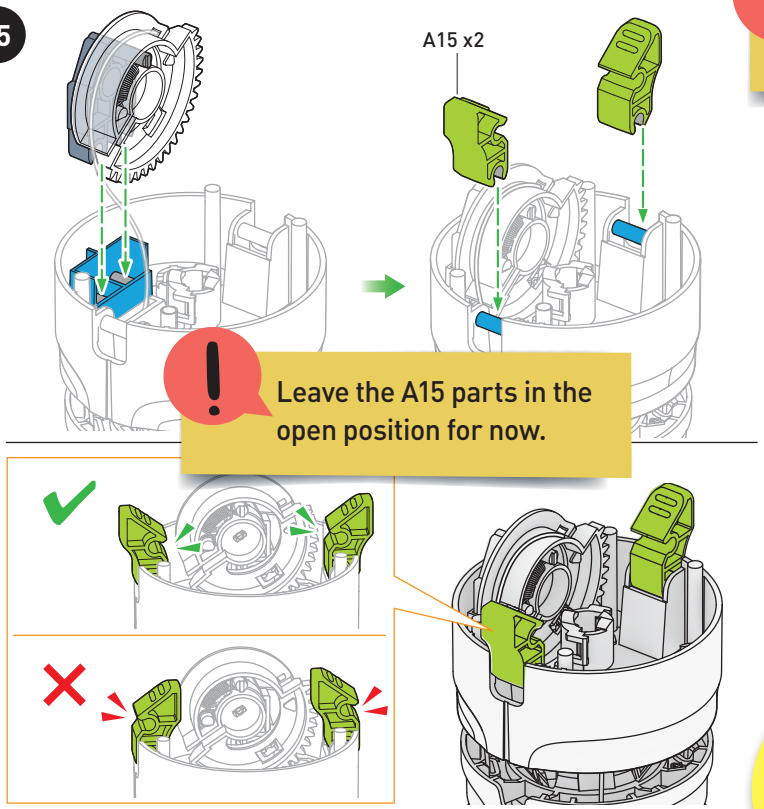

Cable buckle
press
x5
C4
Ensure that the cable goes through the center of C4.
C4

15



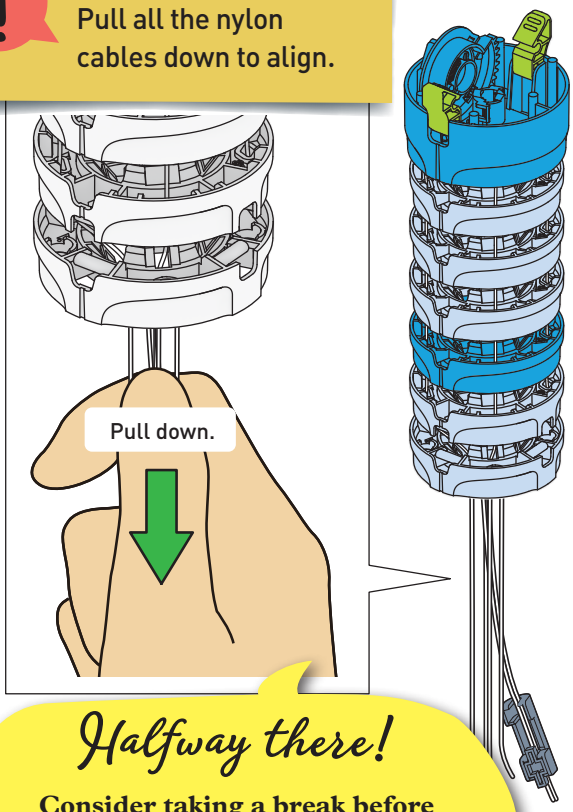

Cable buckle
press
x5
C4
Ensure that the cable goes through the center of C4.
C4

15



Leave the A15 parts in the open position for now.

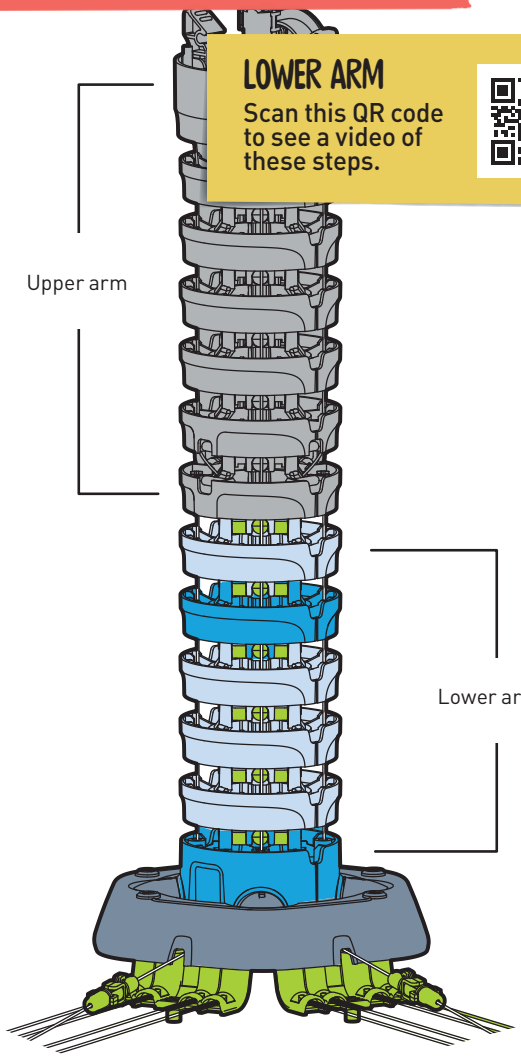
Pull all the nylon cables down to align.



Halfway there!

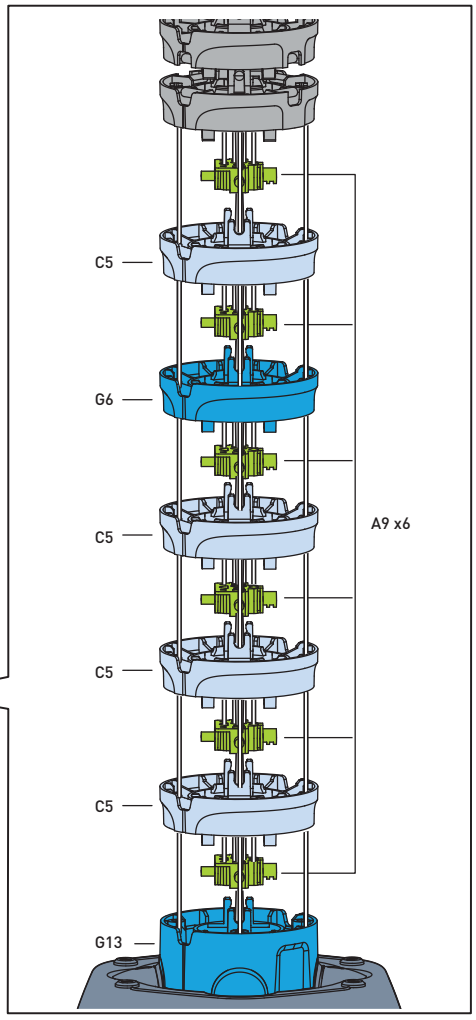
Consider taking a break before starting the lower arm.

ASSEMBLING THE LOWER ARM

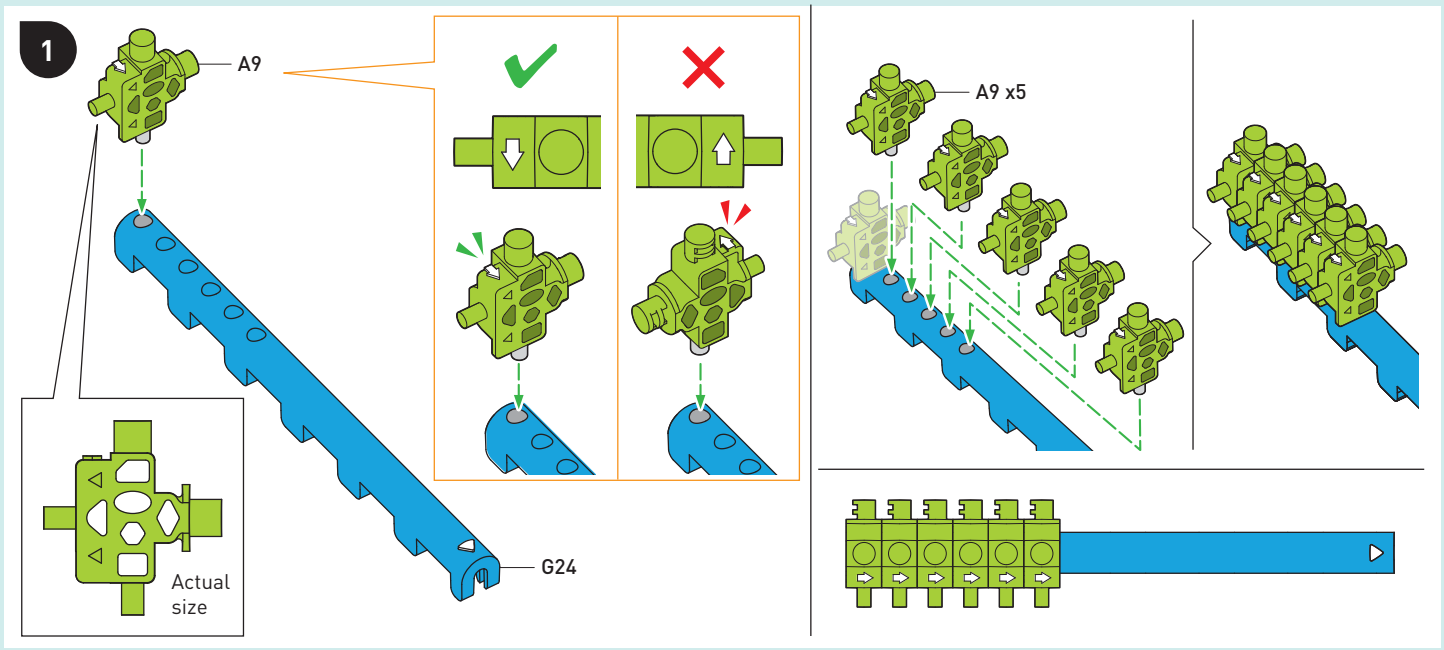


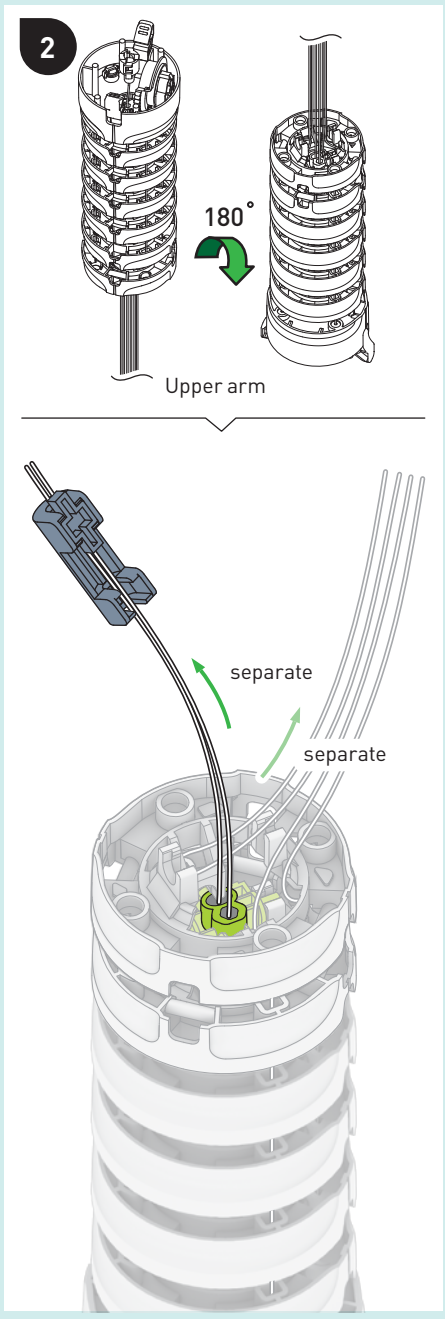
LOWER ARM

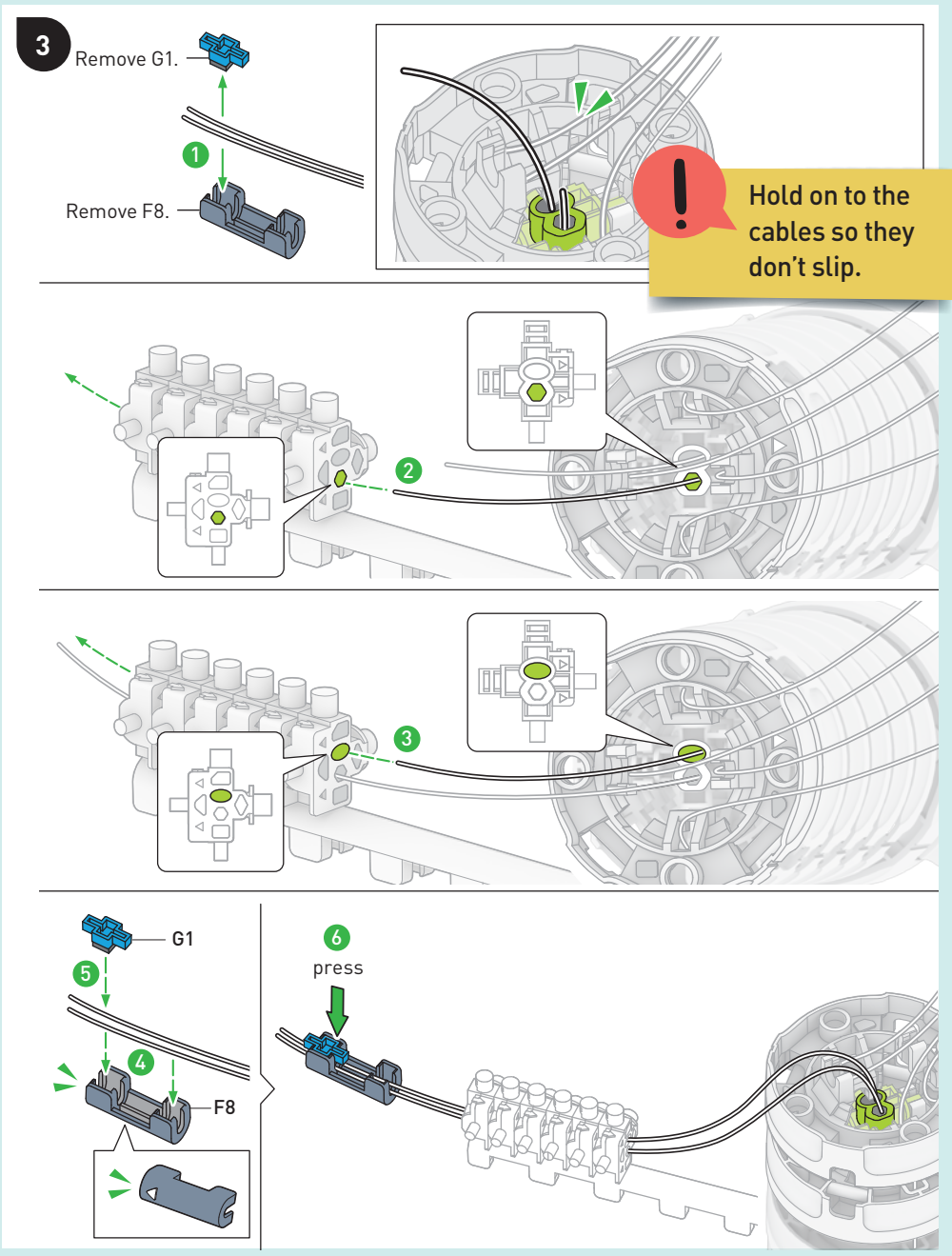
Scan this QR code to see a video of these steps.

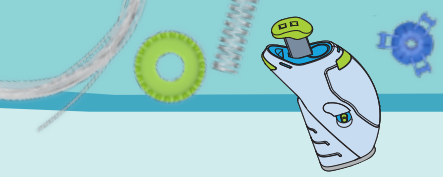


Full lower arm assembly


1
A9
G24
Actual size
A9 x5

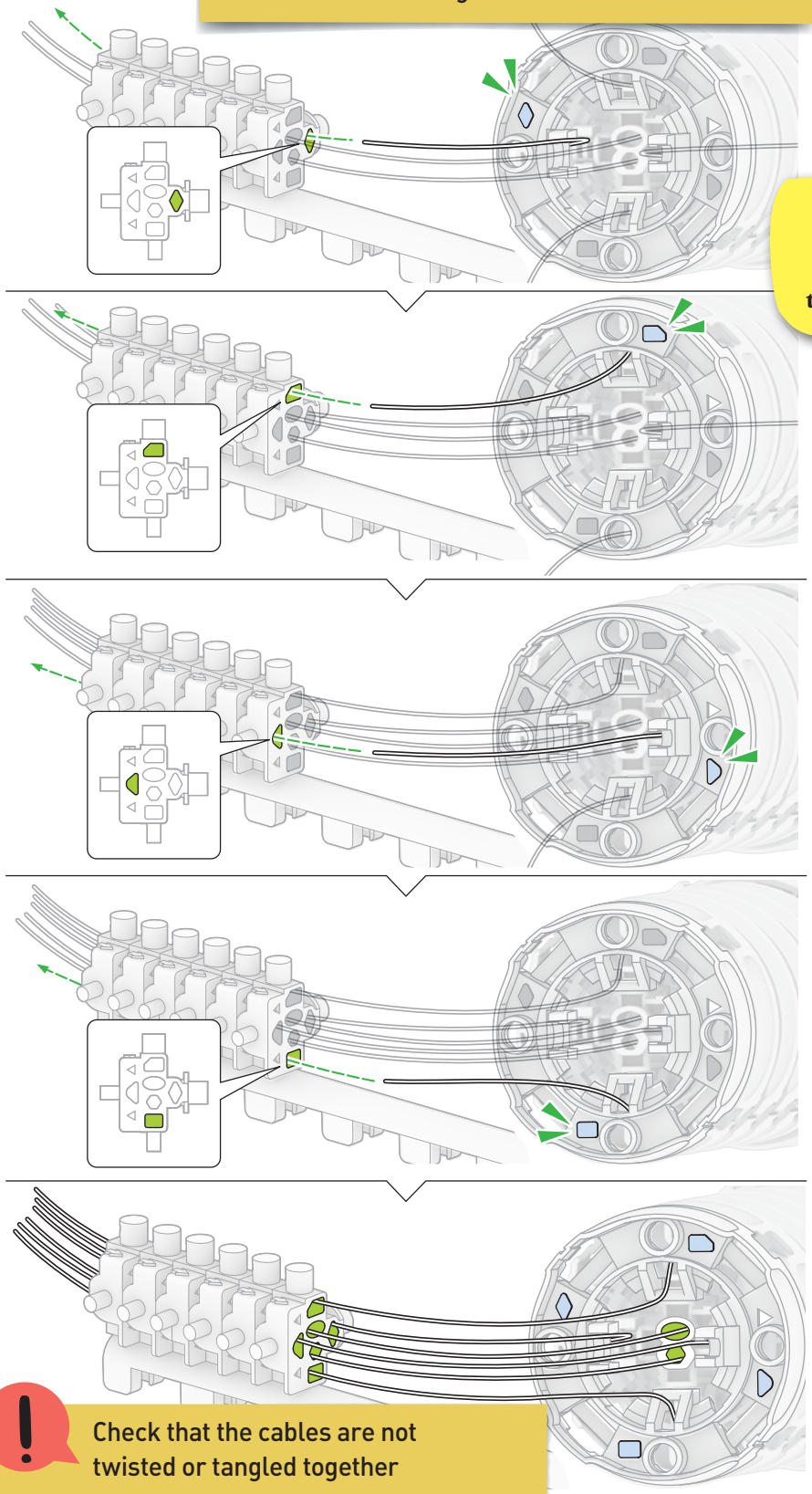

2
180°
Upper arm
separate
separate


3
Remove G1.
1
Remove F8.
Hold on to the cables so they don't slip.
2
3
G1
5
4
F8
6
press

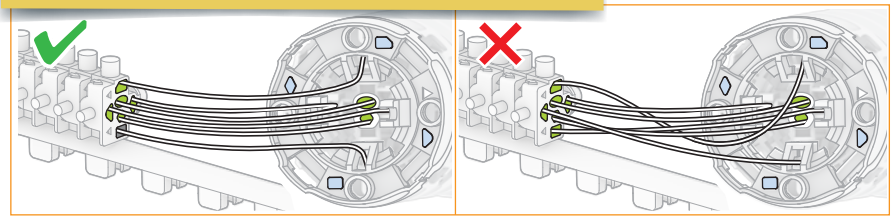


4

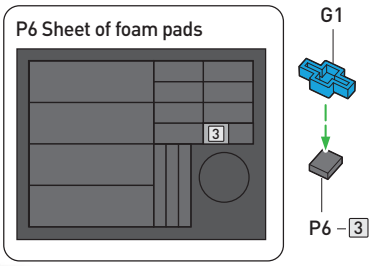
Thread the cables one at a time, taking care not to tangle them with the others.



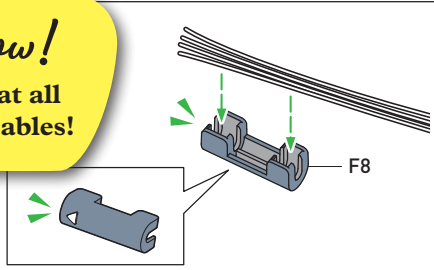
Check that the cables are not twisted or tangled together

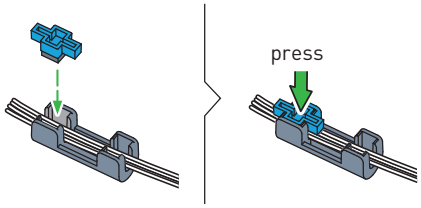


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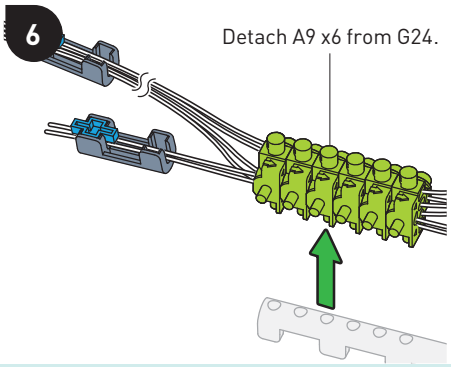


Wow!
Look at all those cables!

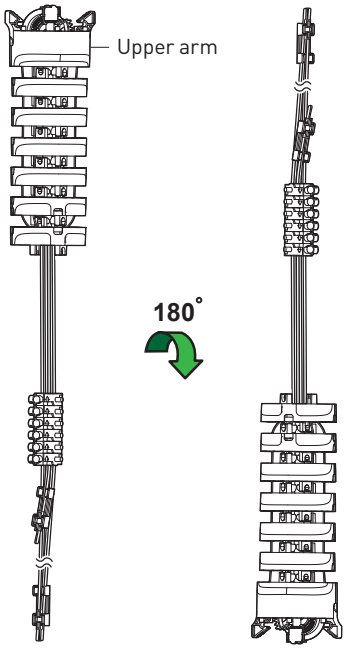




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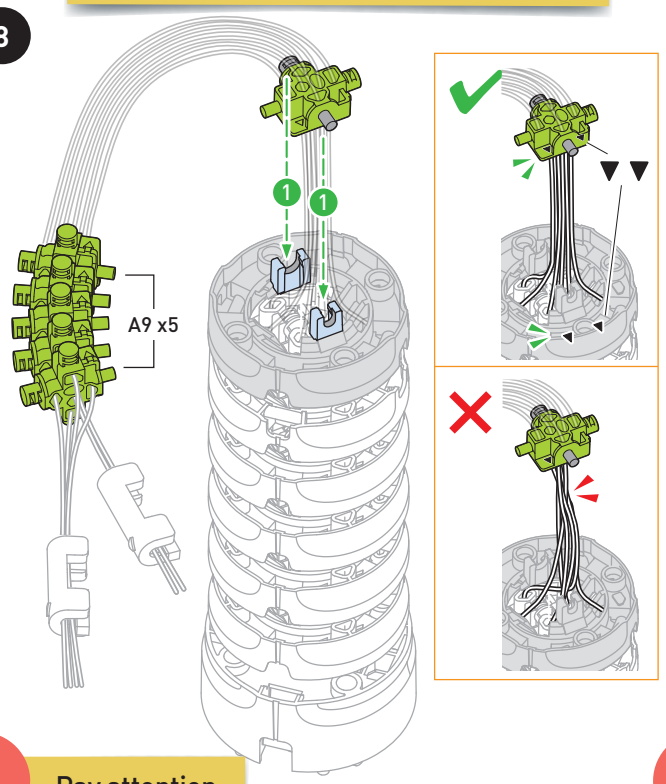


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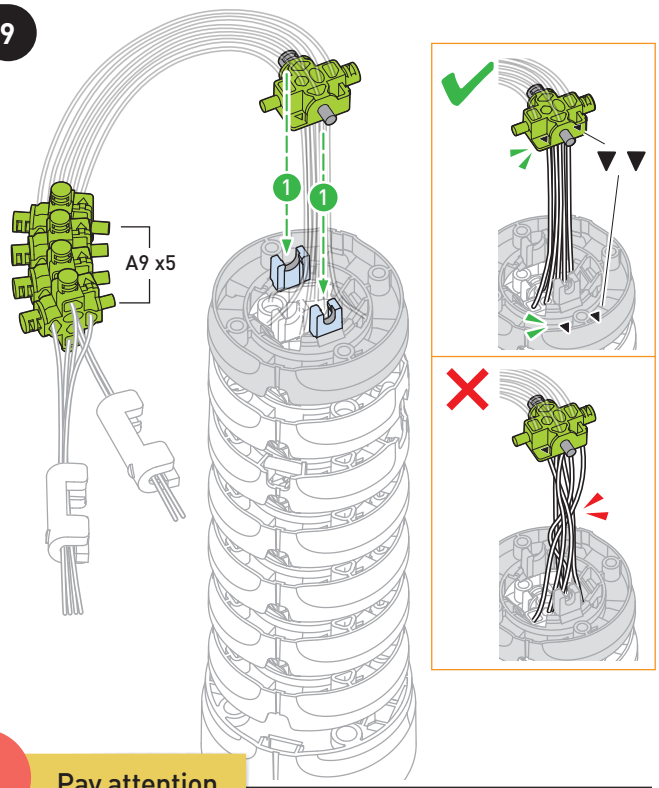


In the following steps, be careful not to tangle the cables.

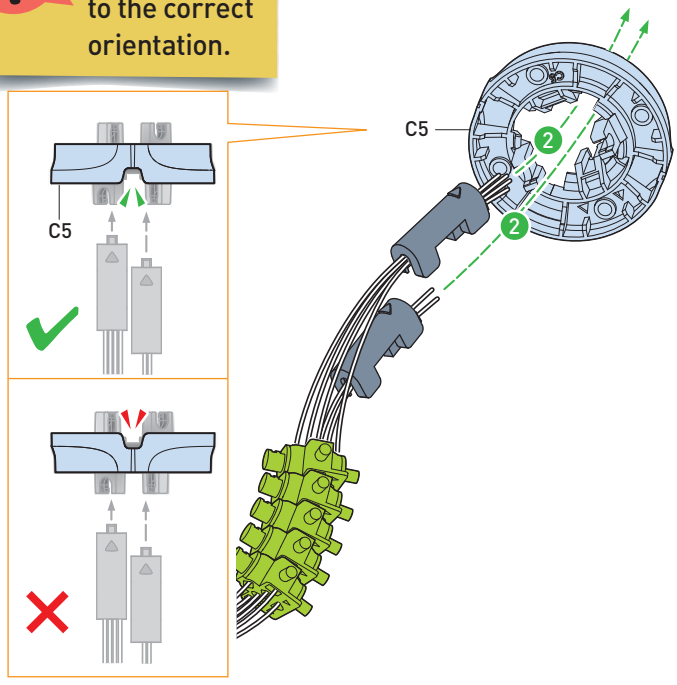
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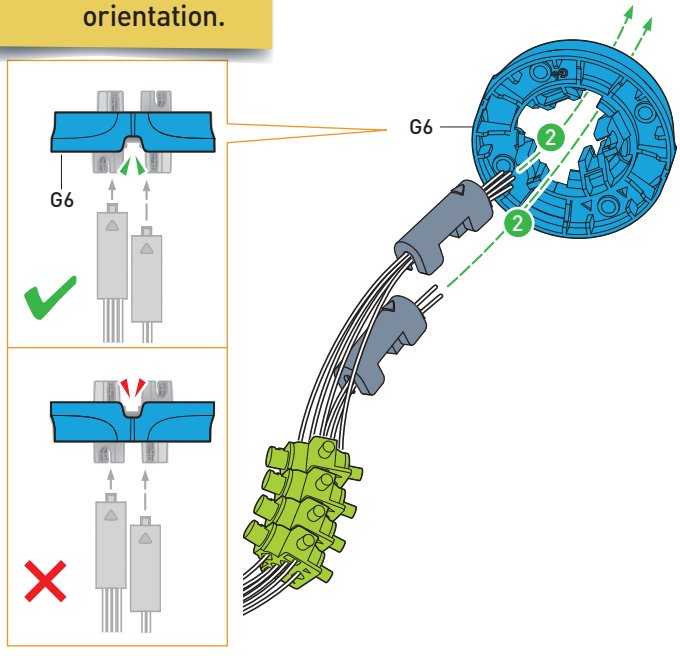
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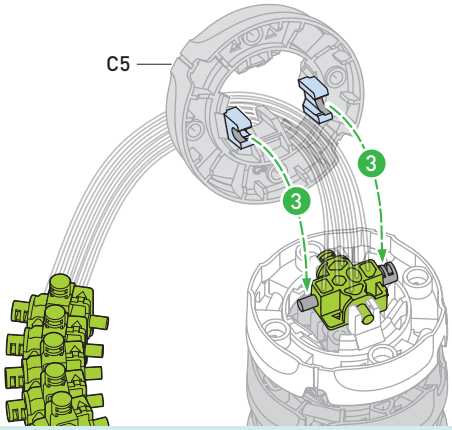


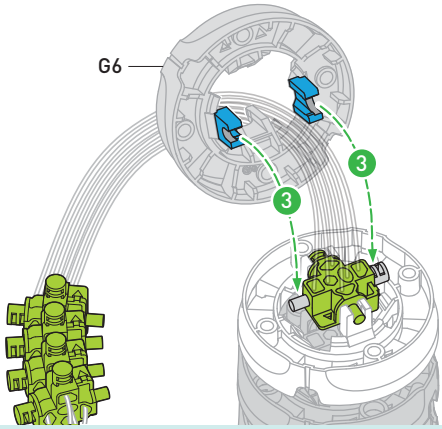
Pay attention to the correct orientation.



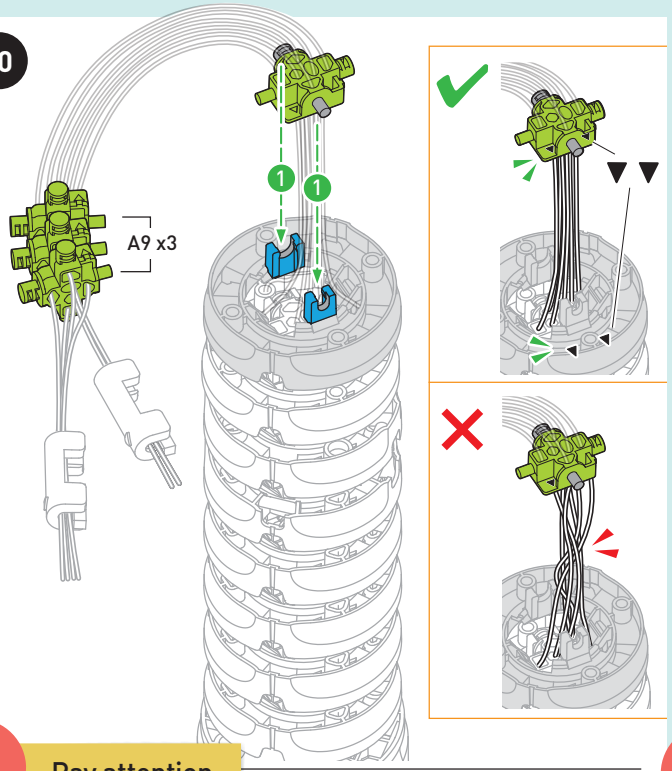
Pay attention to the correct orientation.



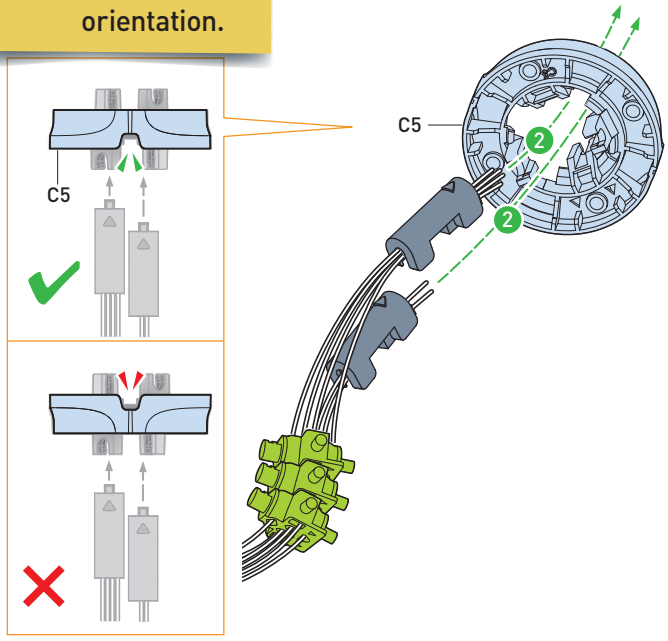


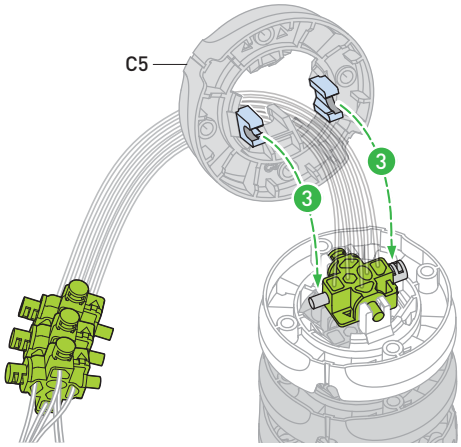


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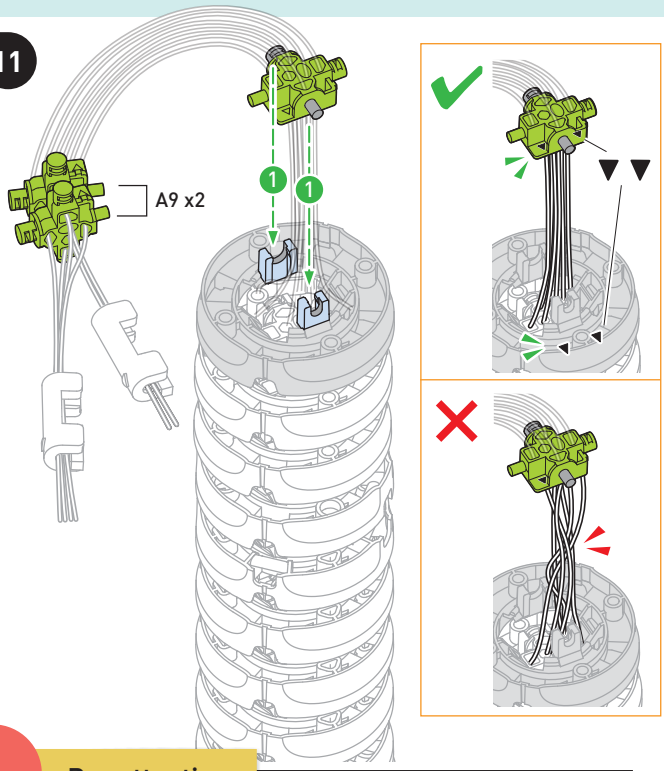


Pay attention to the correct orientation.

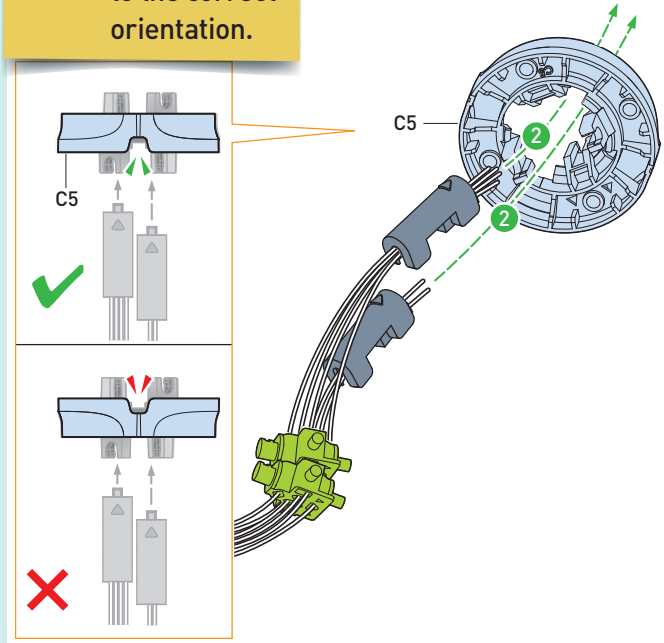


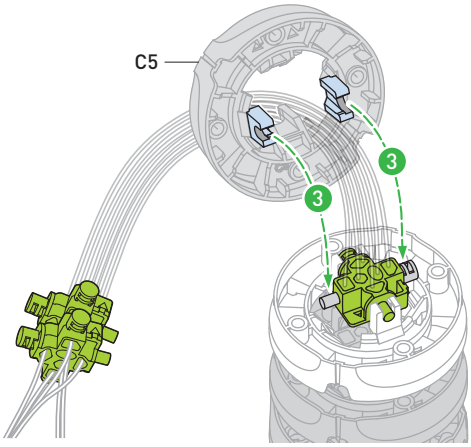


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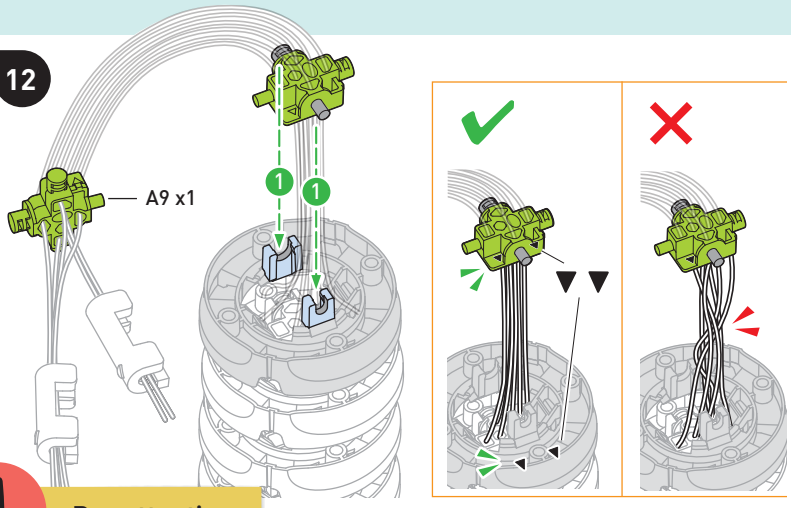


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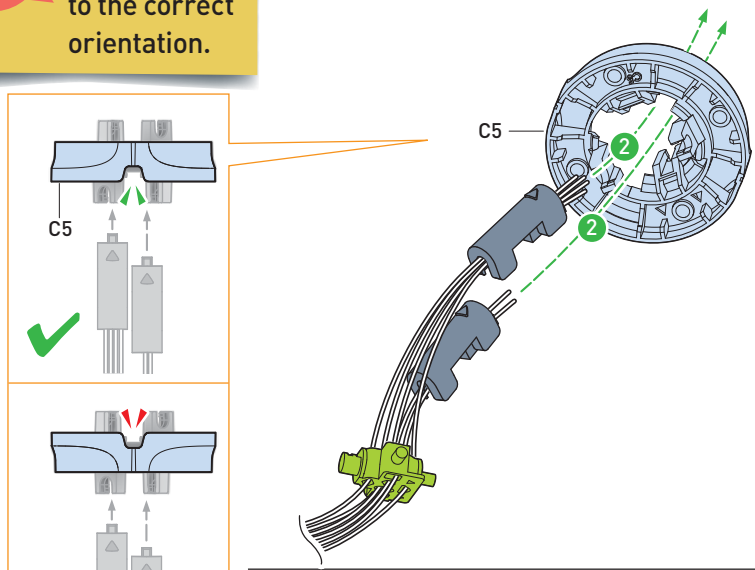


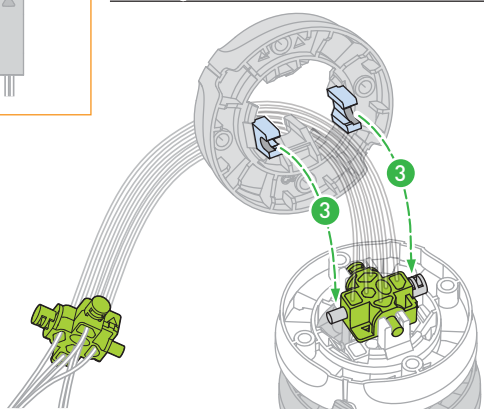


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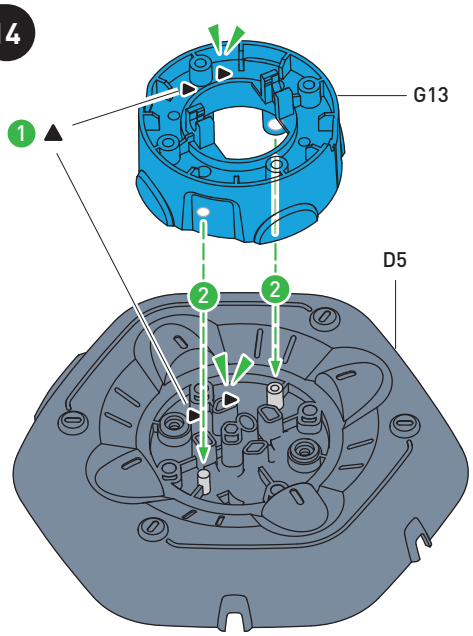


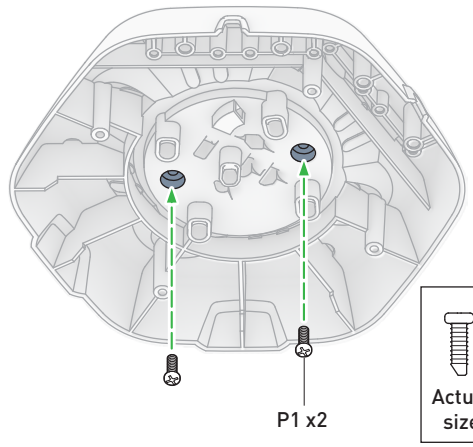
Pay attention to the correct orientation.

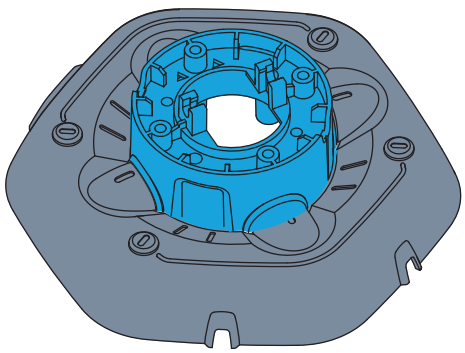




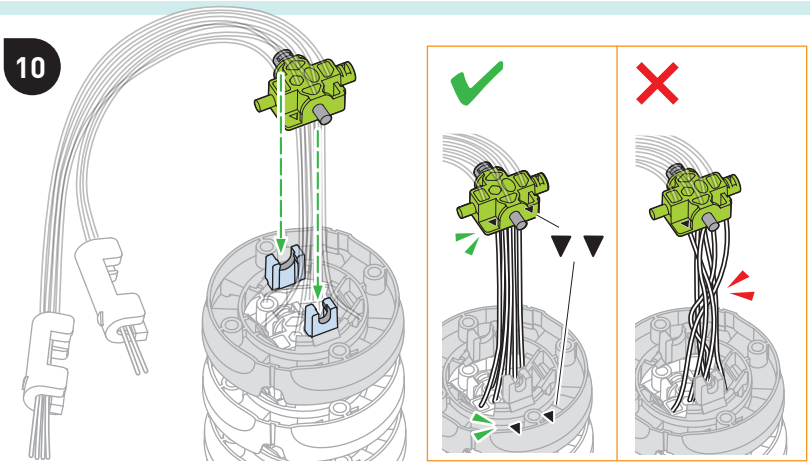
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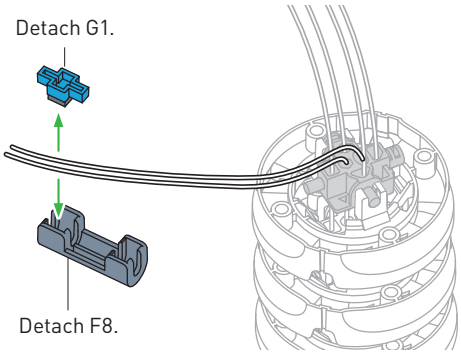




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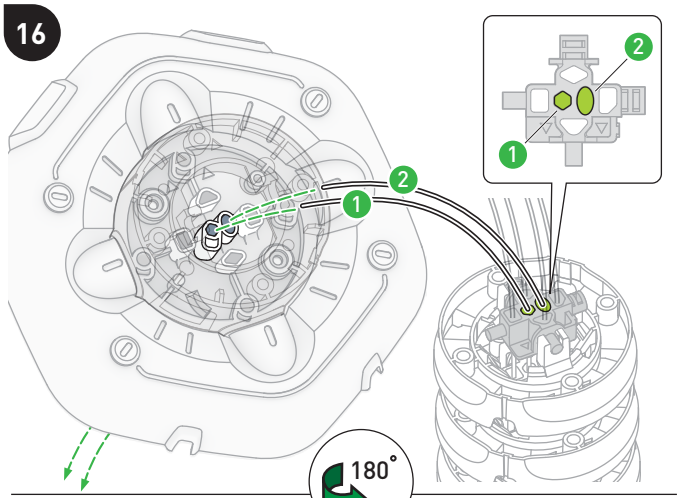
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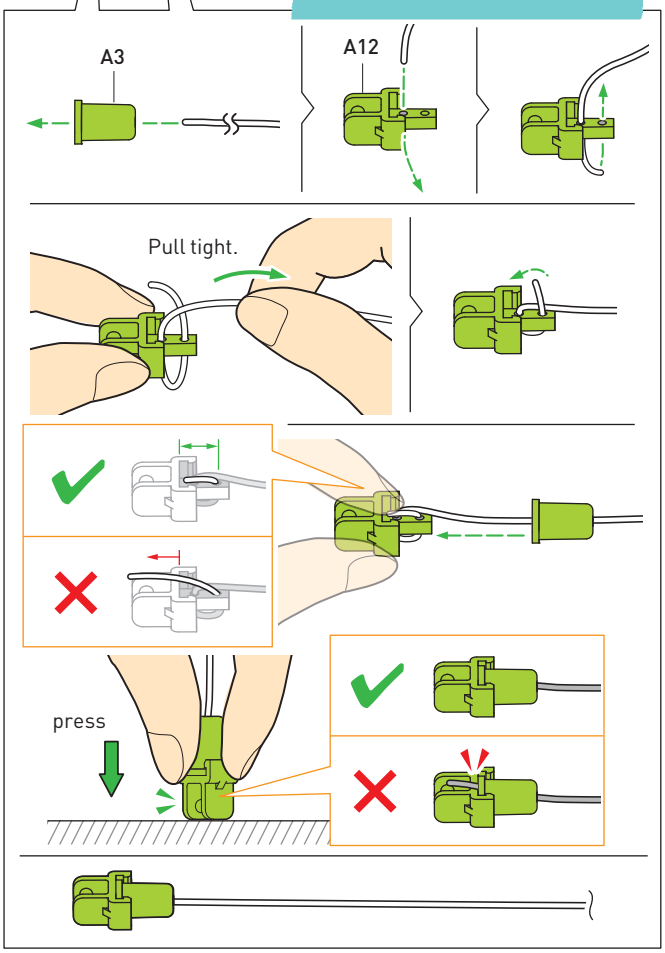
ATTACHING THE UPPER AND LOWER ARM

Thread the cables one at a time, taking care not to tangle them with the others.

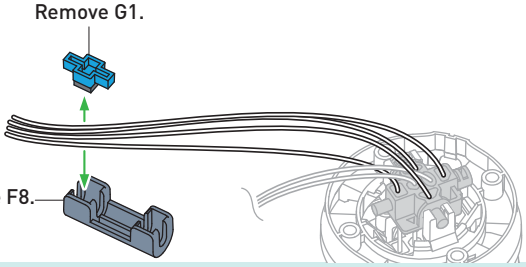
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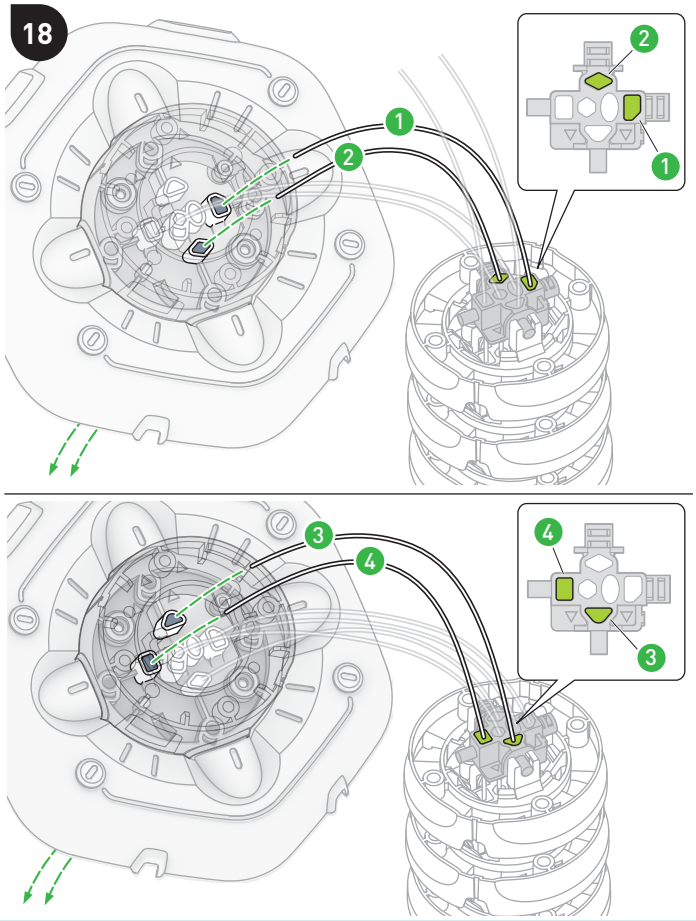
Ask an adult if you have trouble with this step.



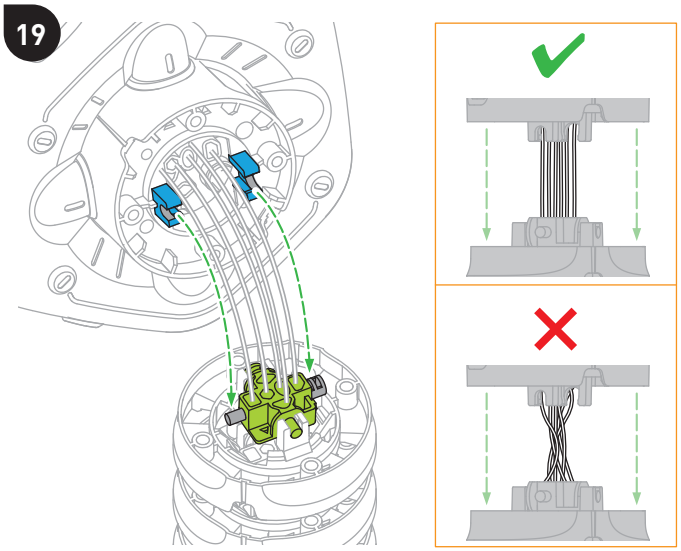
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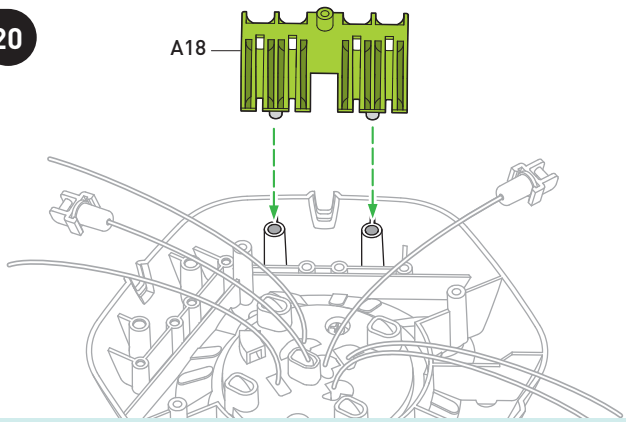
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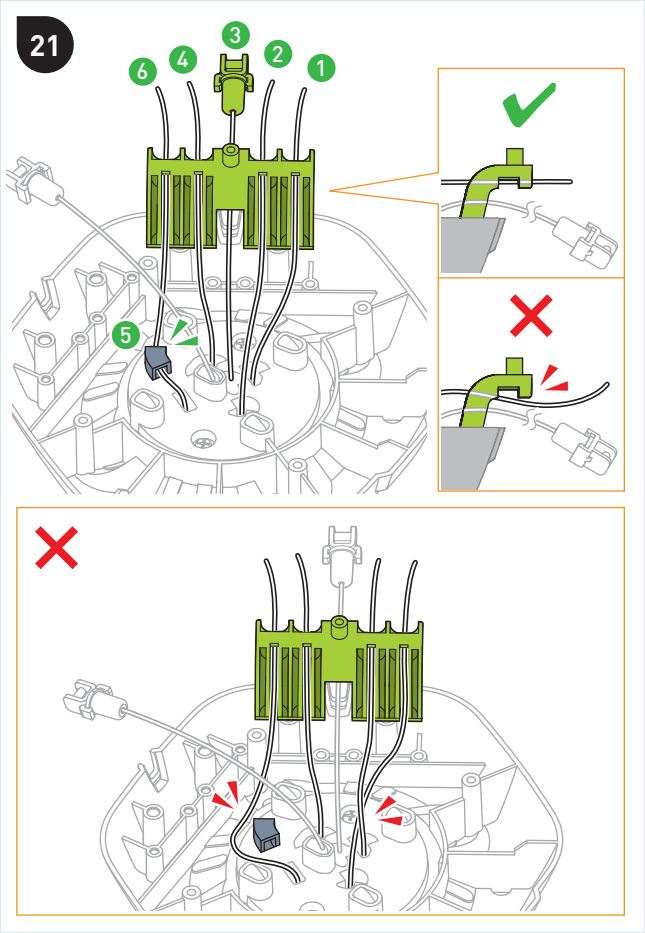


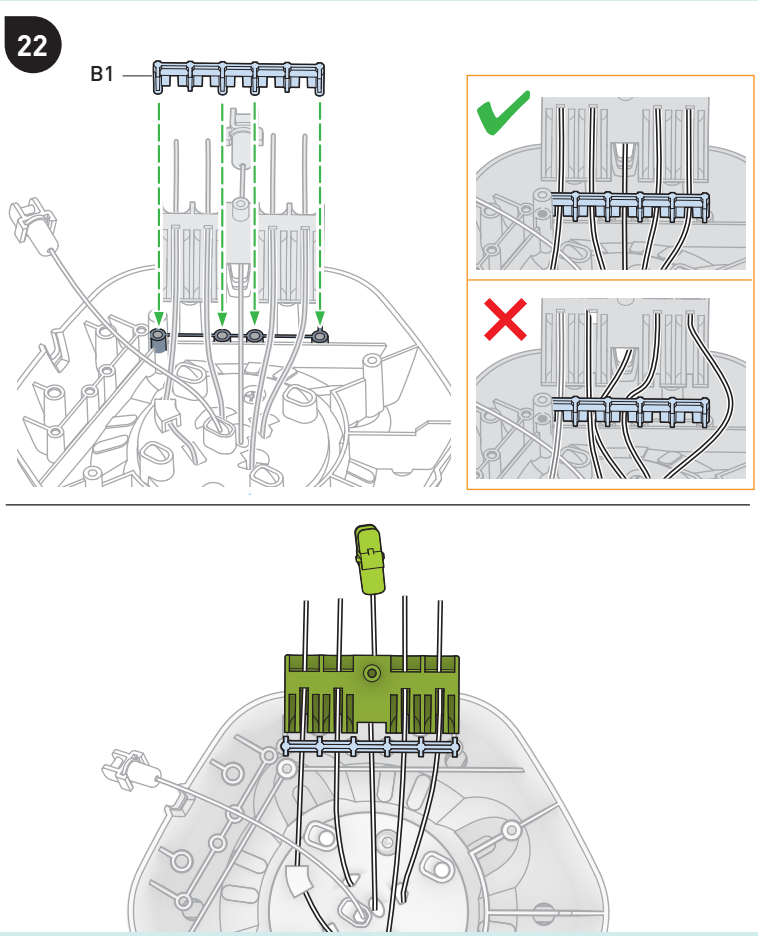
19

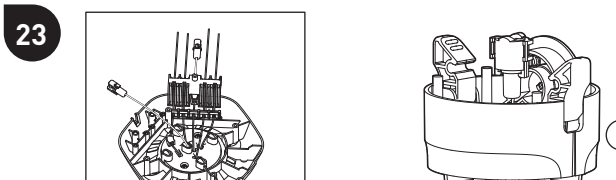


20

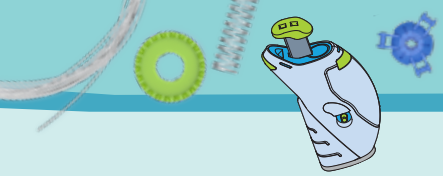



21
6
4
3
2
1
5

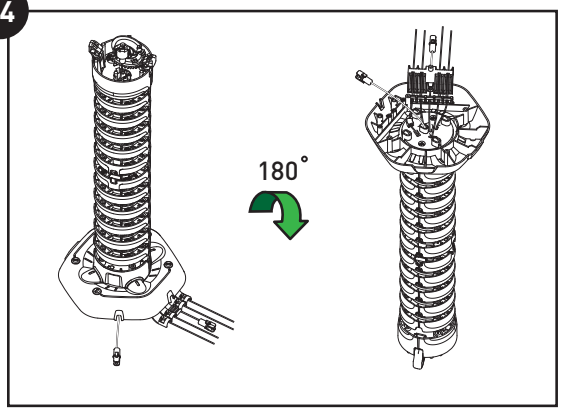

22
B1

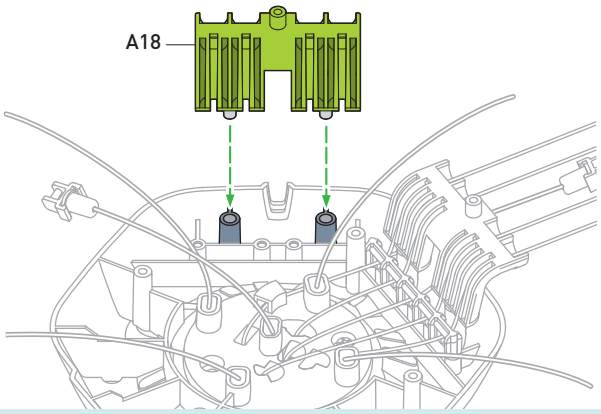


23
180°
C4
7th piece from the top
1
2
3
4
5
6
7
8
9
10
11
12
13
String buckle
x4
press
C4
2
1

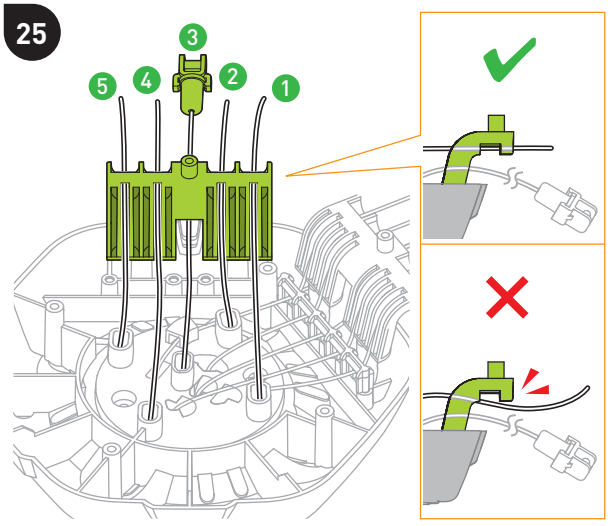


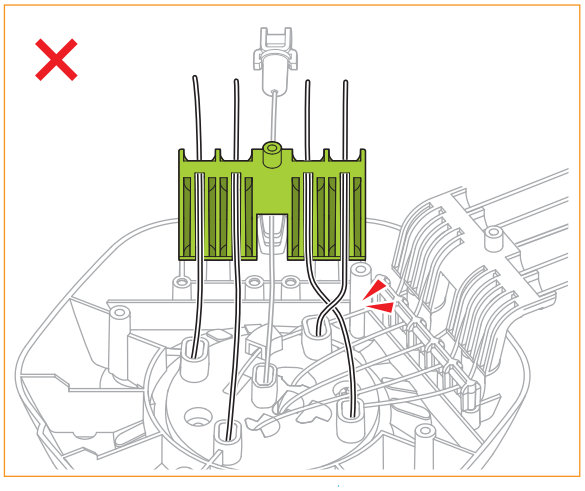
24



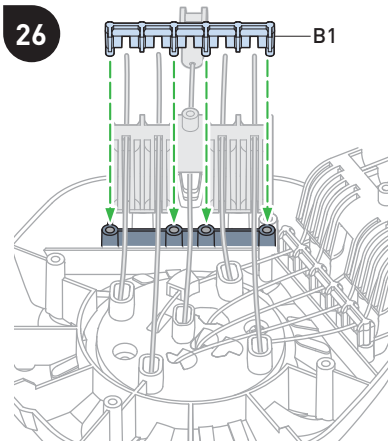


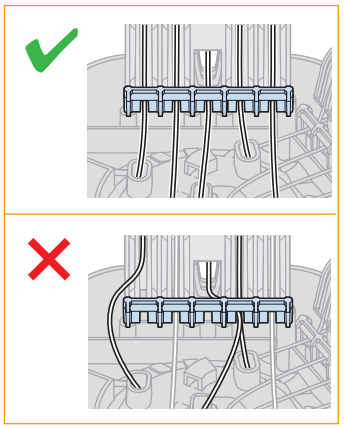
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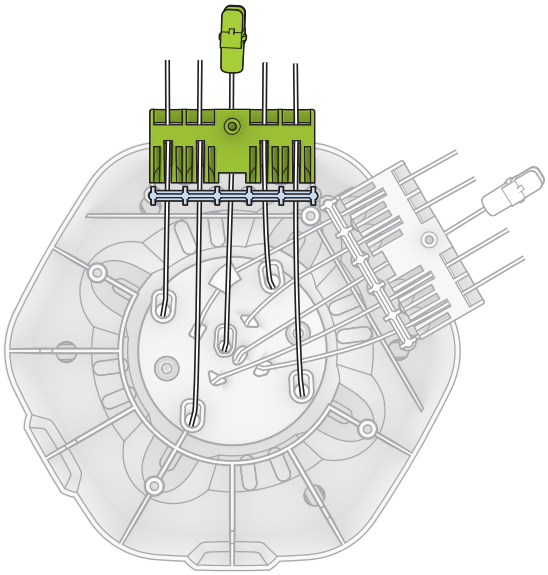




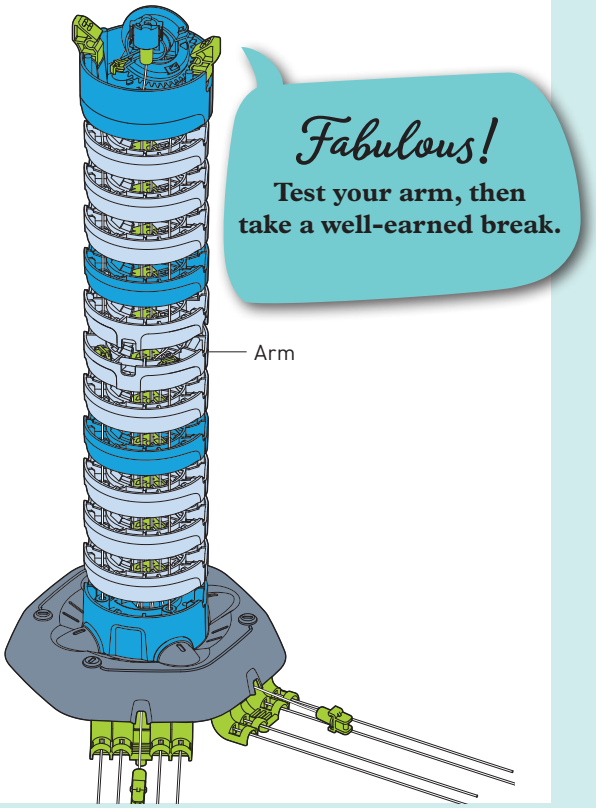
26







180˚



Fabulous!

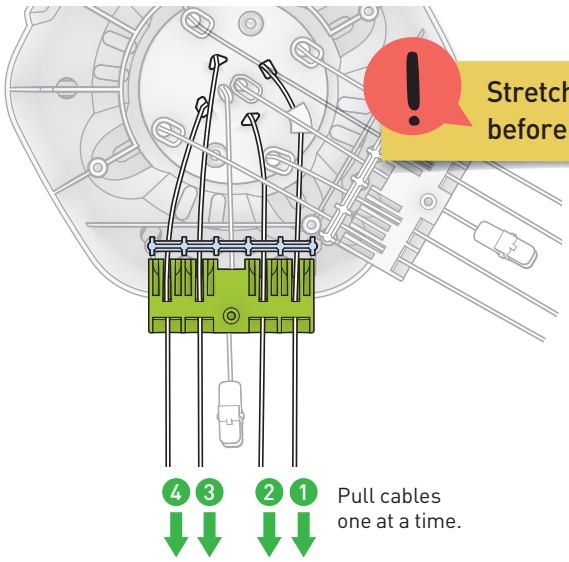
Test your arm, then take a well-earned break.

TESTING THE ARM

Scan this QR code to see a video of these steps.

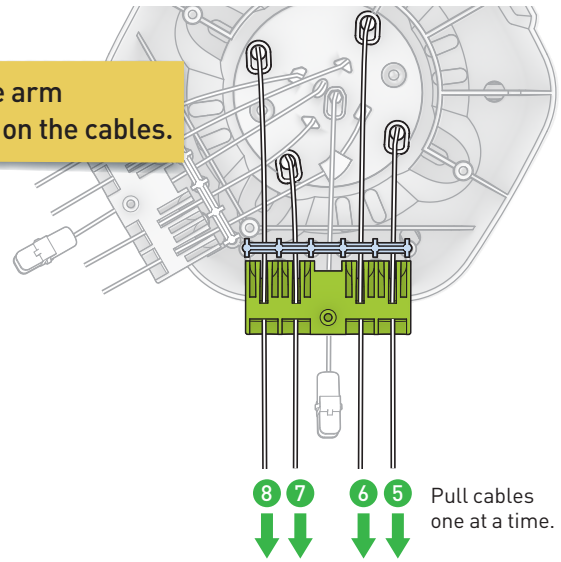
Test

Upper arm	Lower arm



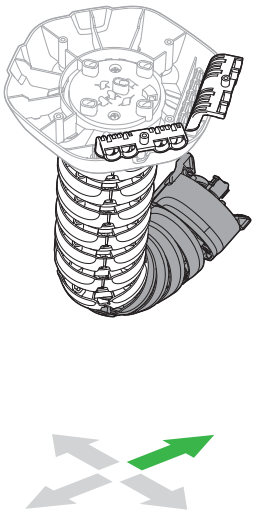
Stretch out the arm before pulling on the cables.

4 3 2 1 Pull cables one at a time.

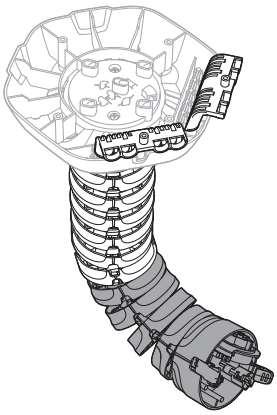


8 7 6 5 Pull cables one at a time.

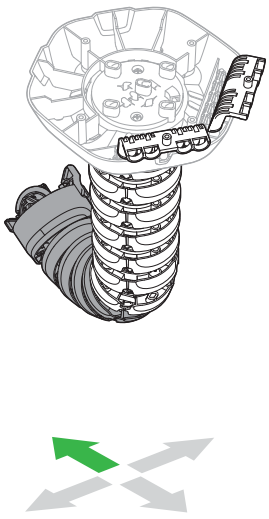
Pull cable 1.



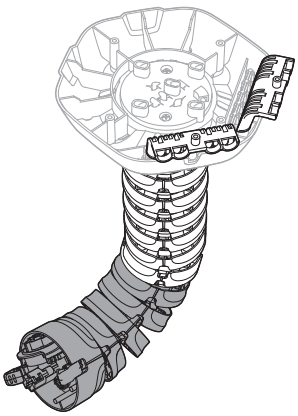
Pull cable 2.



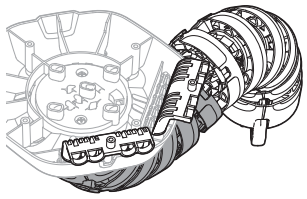
Pull cable 3.



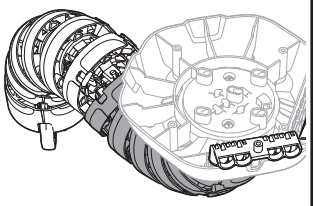
Pull cable 4.



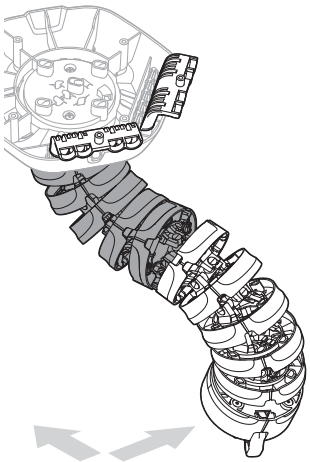
Pull cable 5.



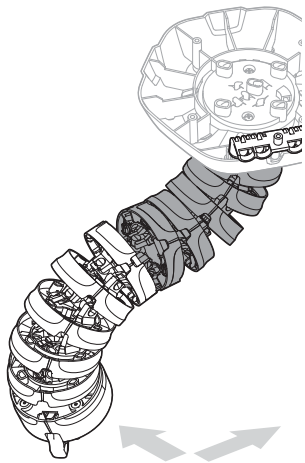
Pull cable 6.



Pull cable 7.

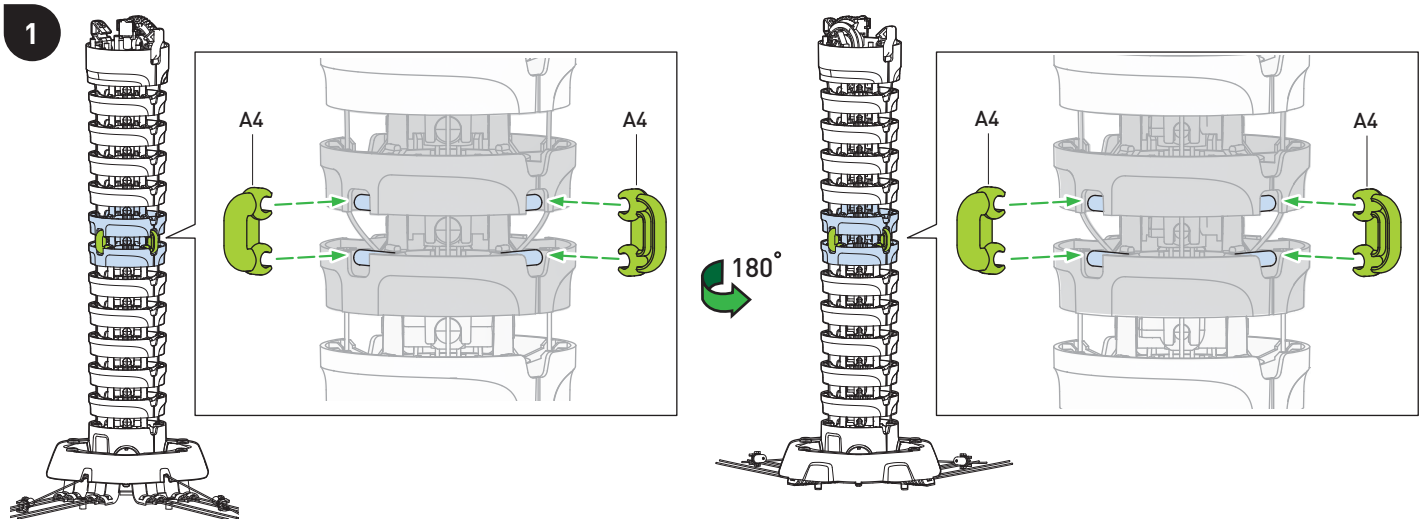


Pull cable 8.

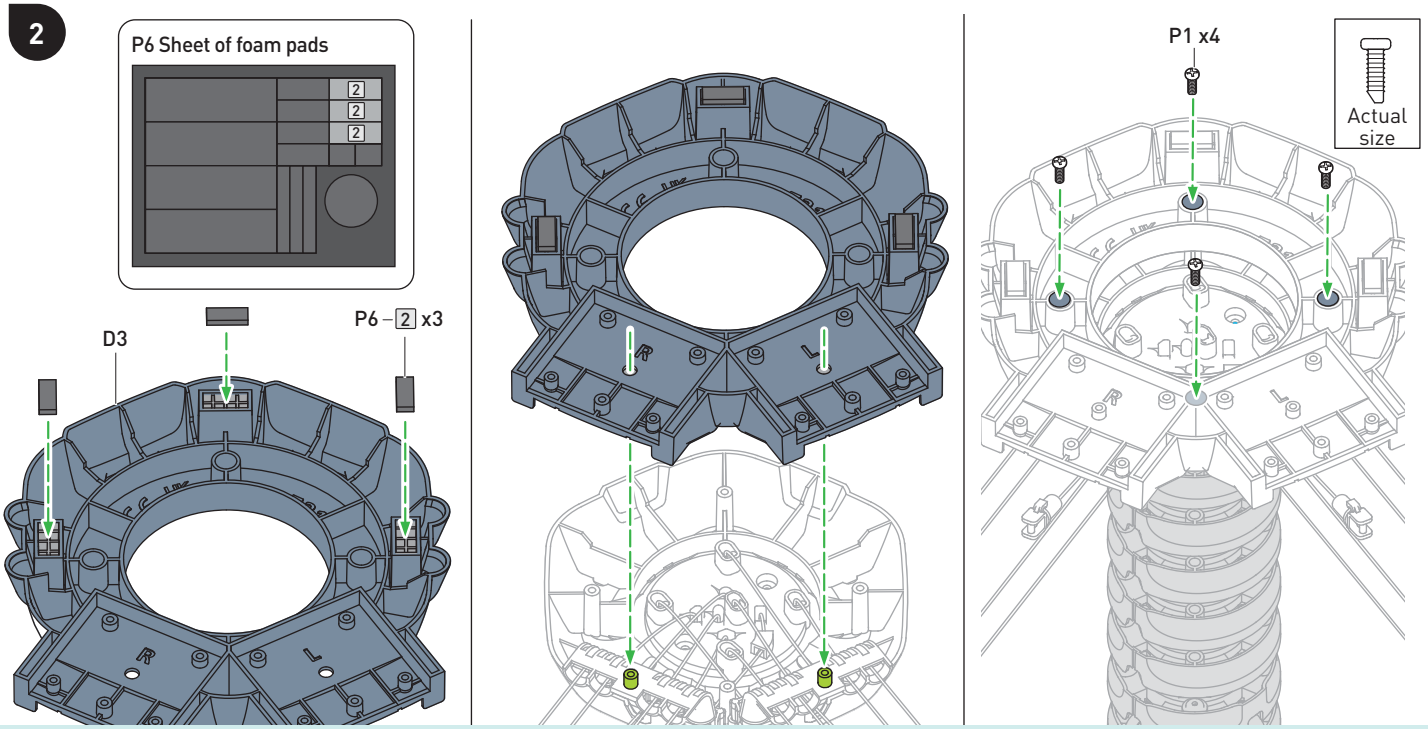


FINAL ASSEMBLY

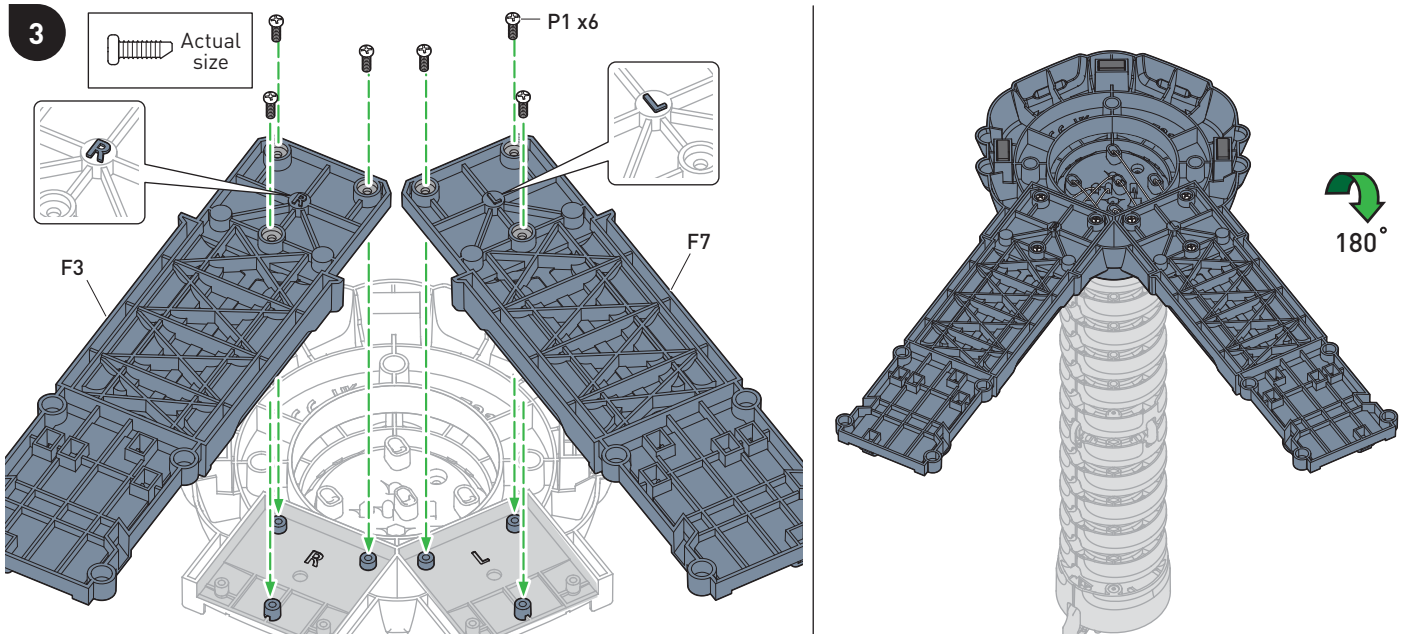
1



2



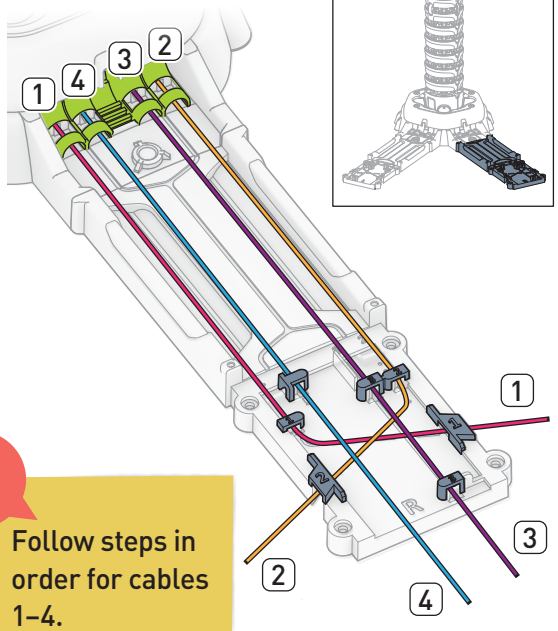
3

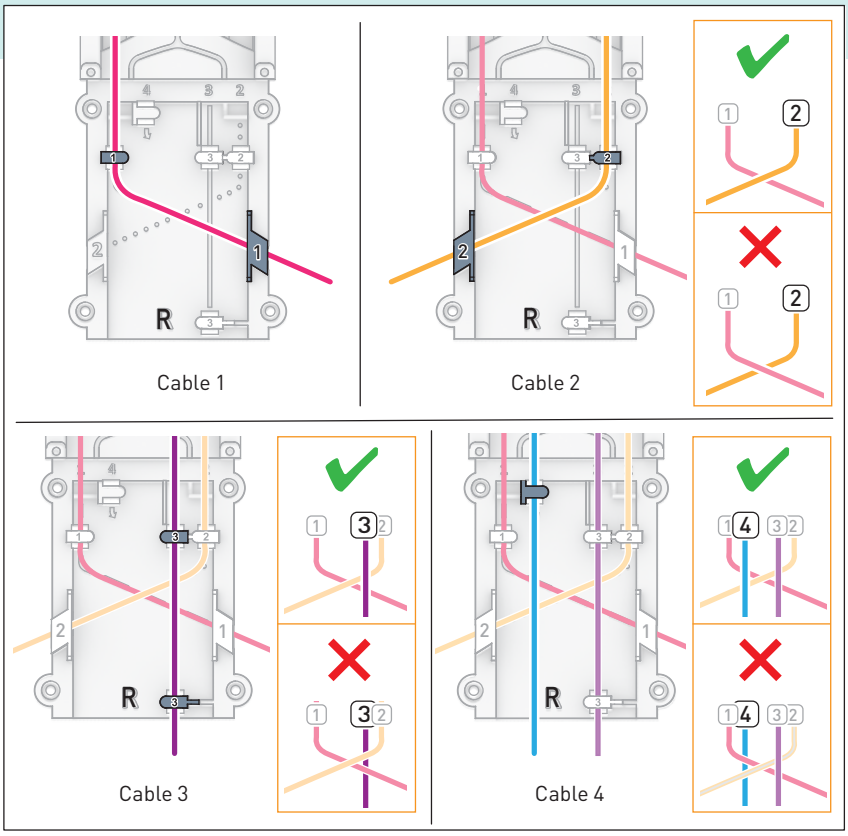


THREADING CABLES

Scan this QR code to see a video of these steps.

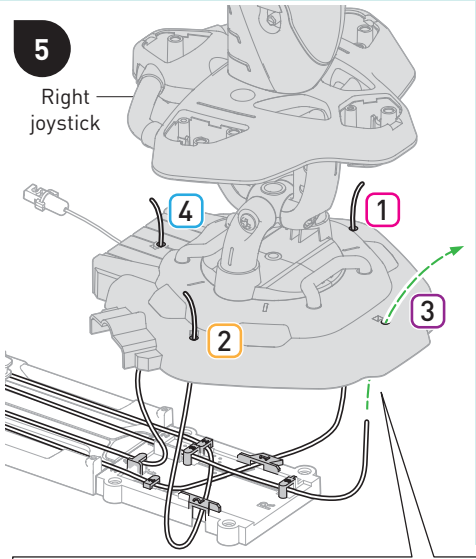
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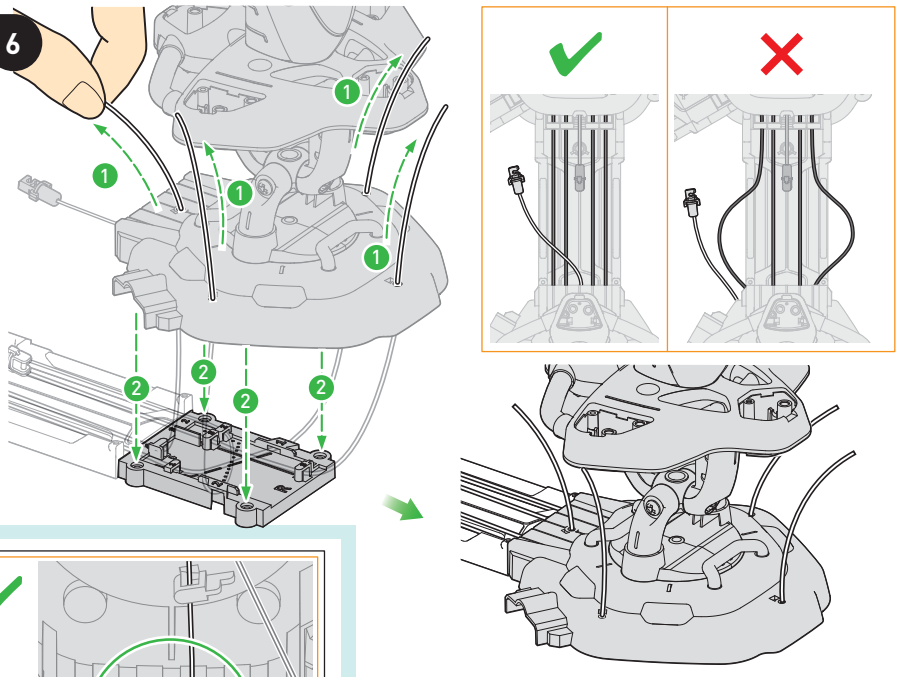


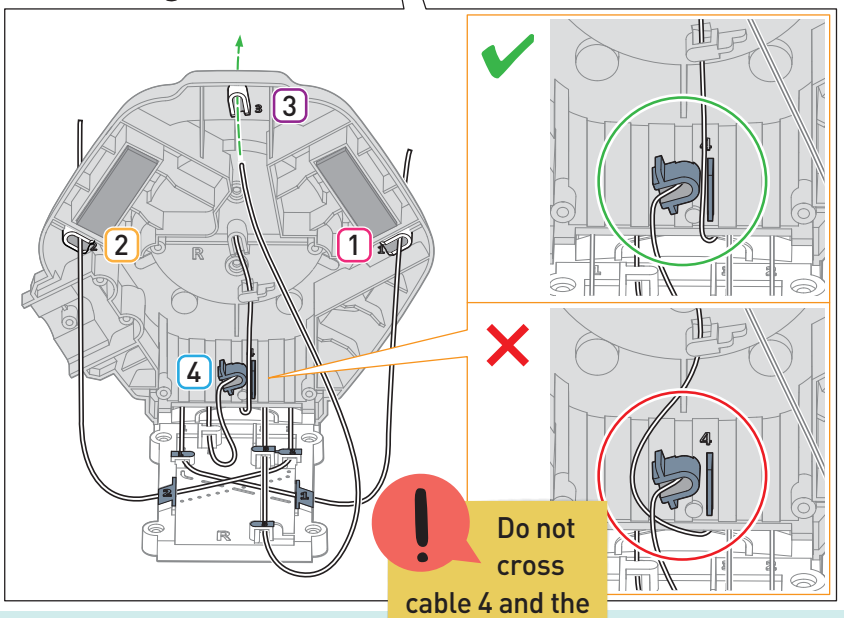
Follow steps in order for cables 1–4.

5



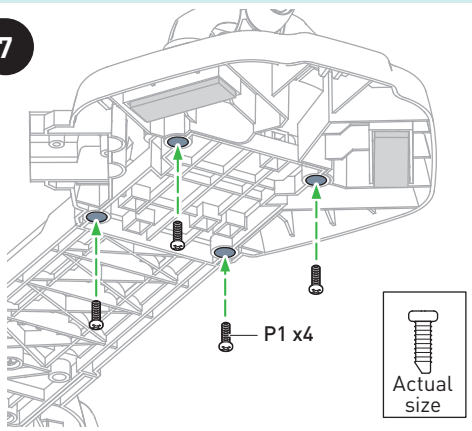
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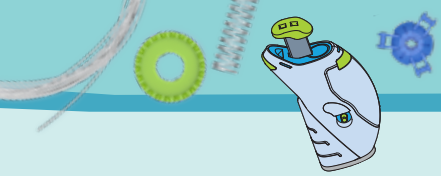




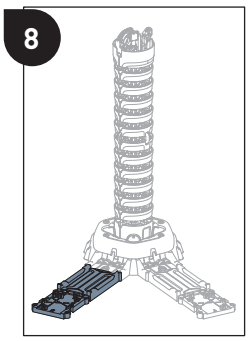
Do not cross cable 4 and the central cable.

7

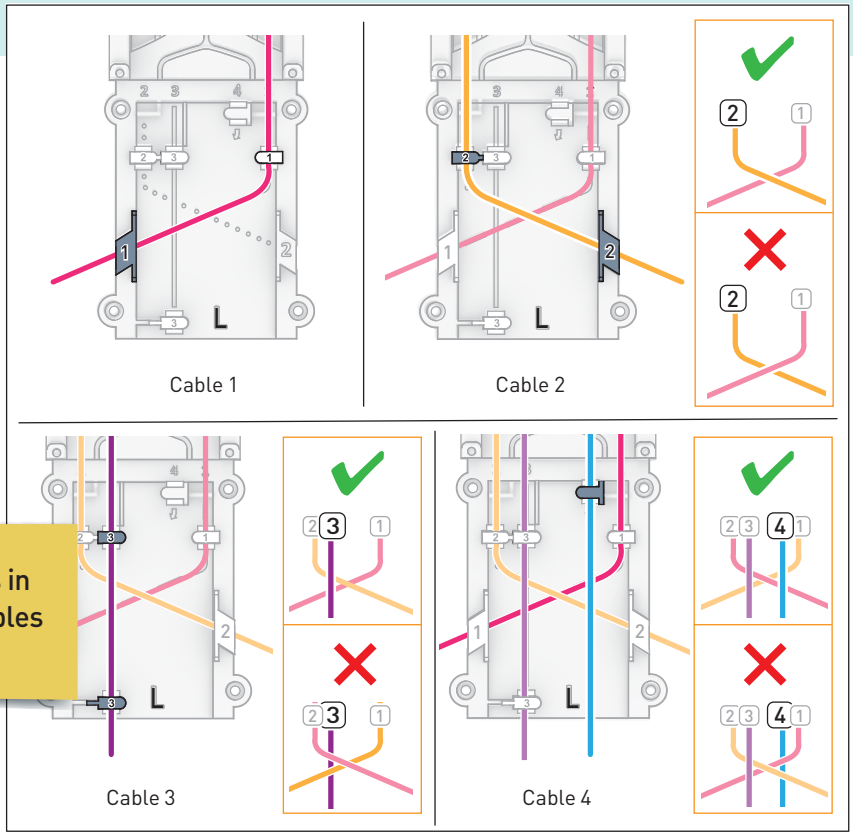




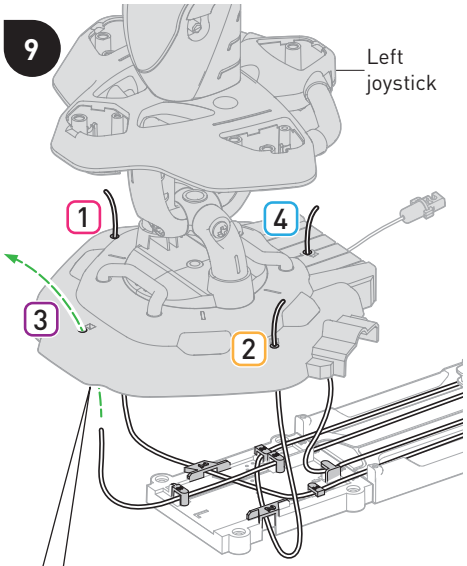
8



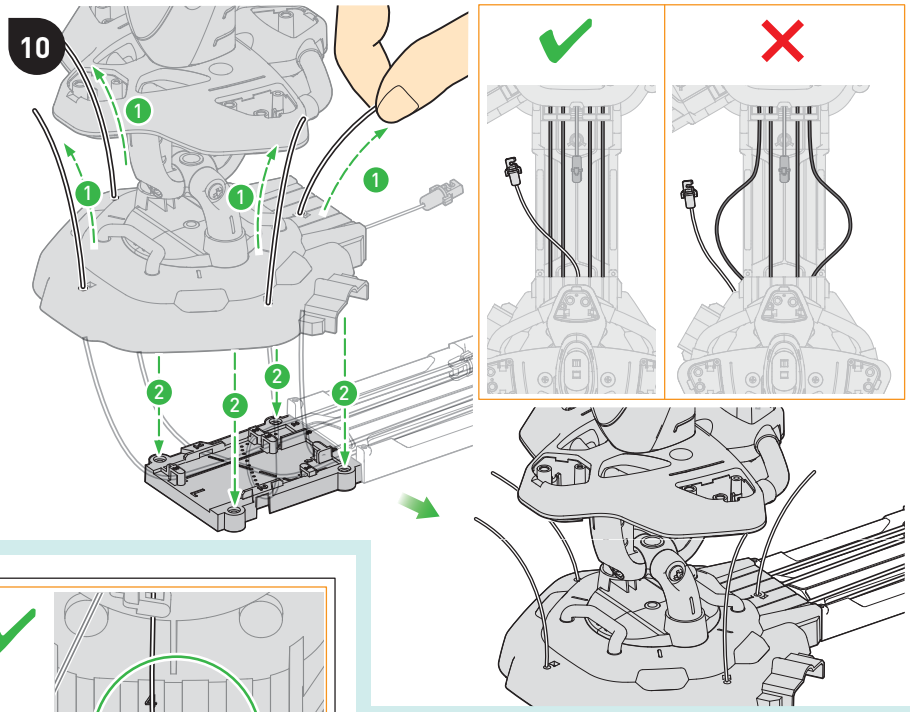
Follow steps in order for cables 1–4.

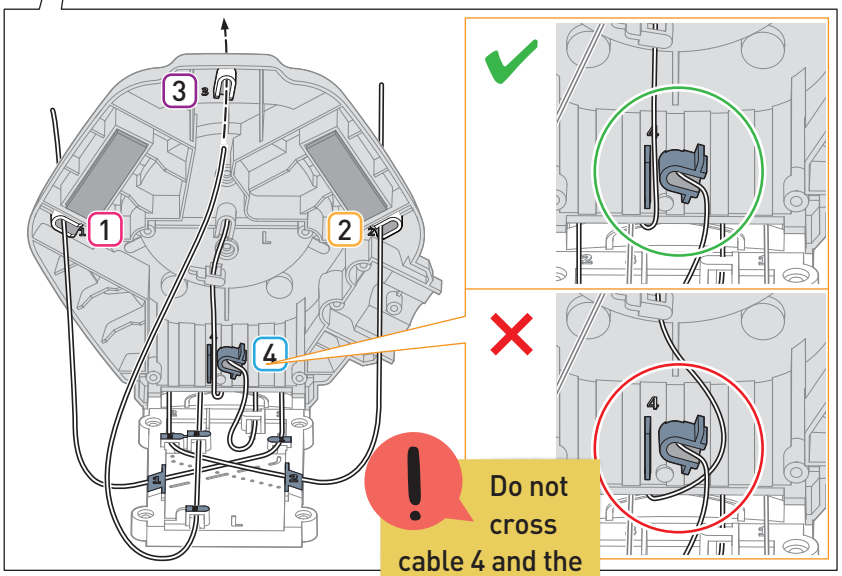


9



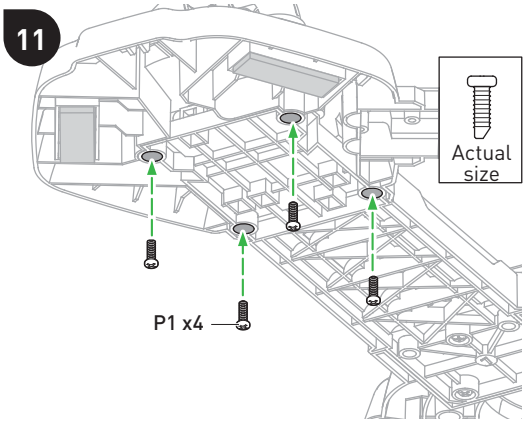
10



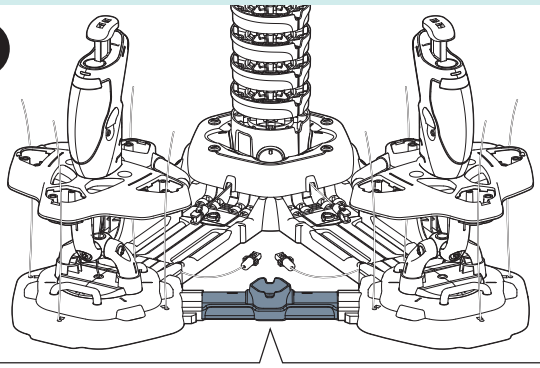


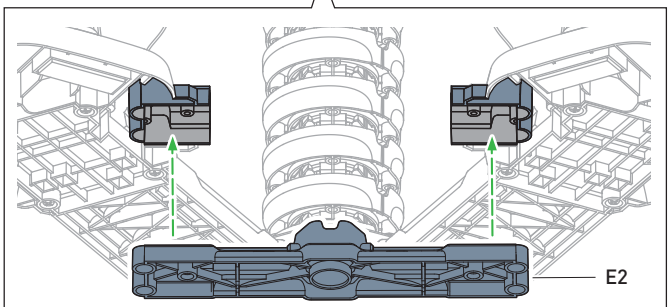
Do not cross cable 4 and the central cable.

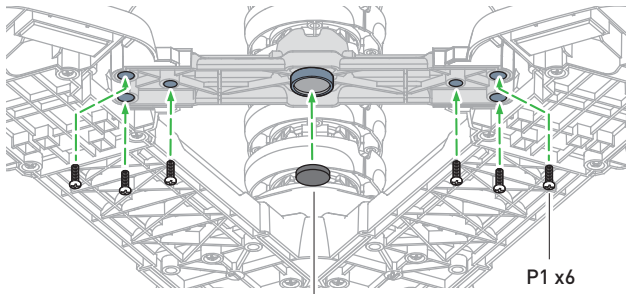
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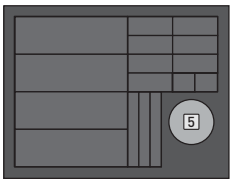
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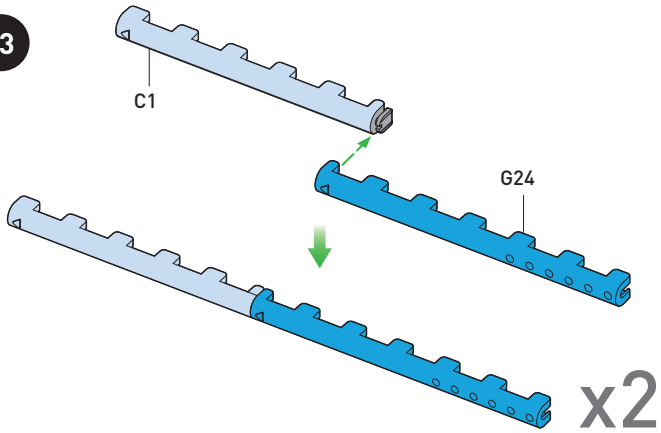


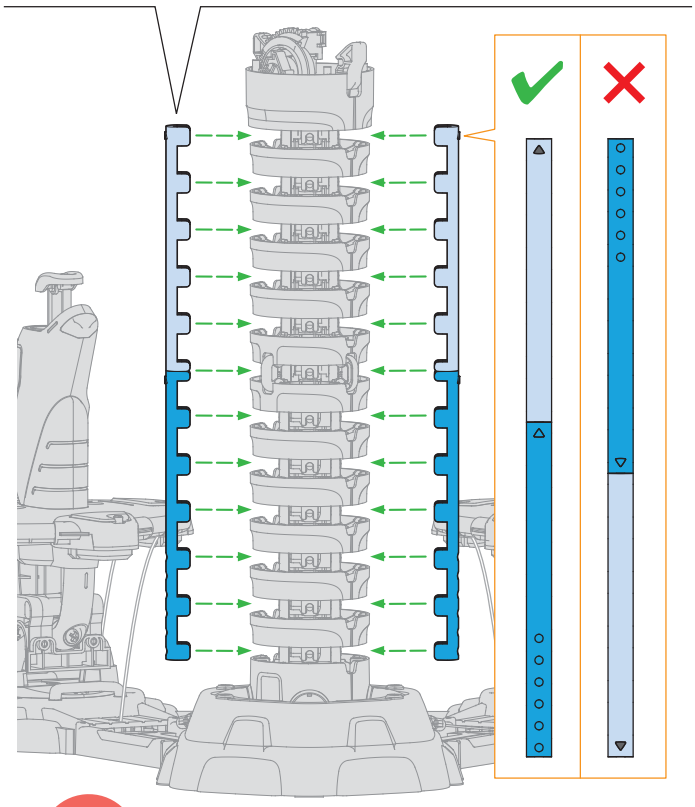


P6 Sheet of foam pads

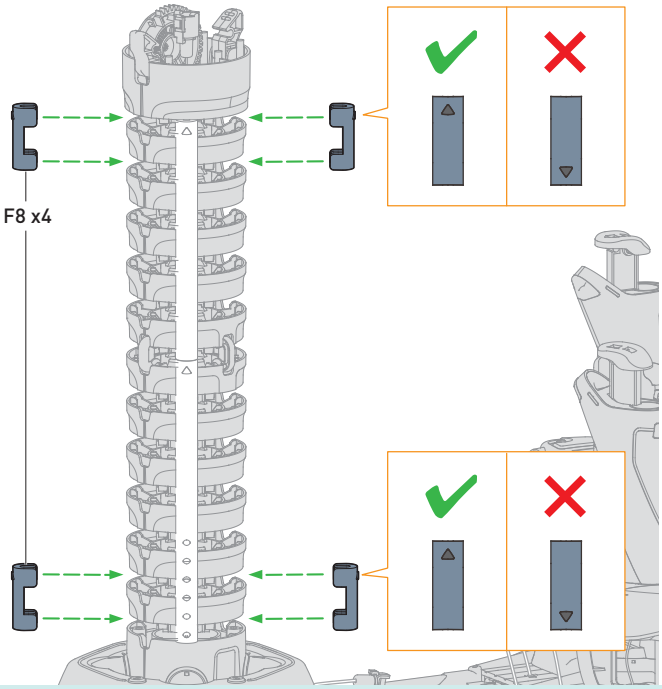


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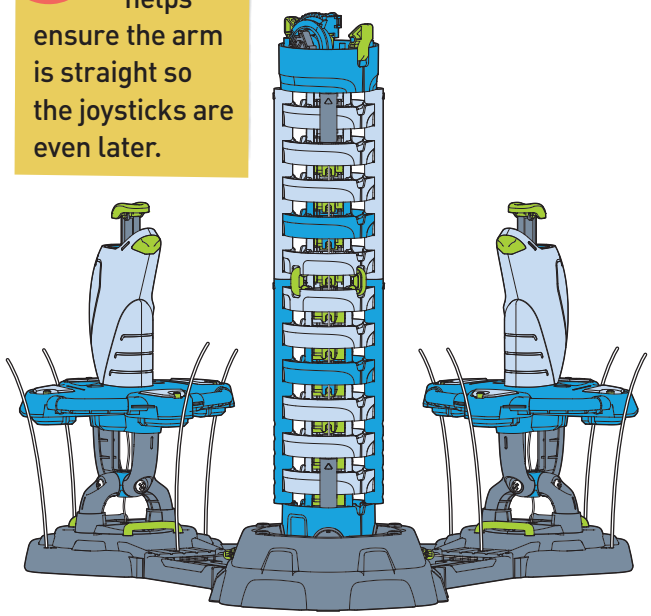




14

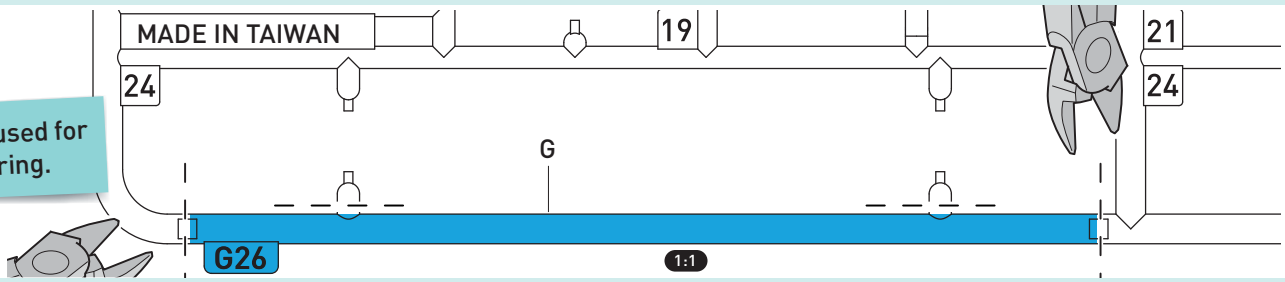


This step helps ensure the arm is straight so the joysticks are even later.

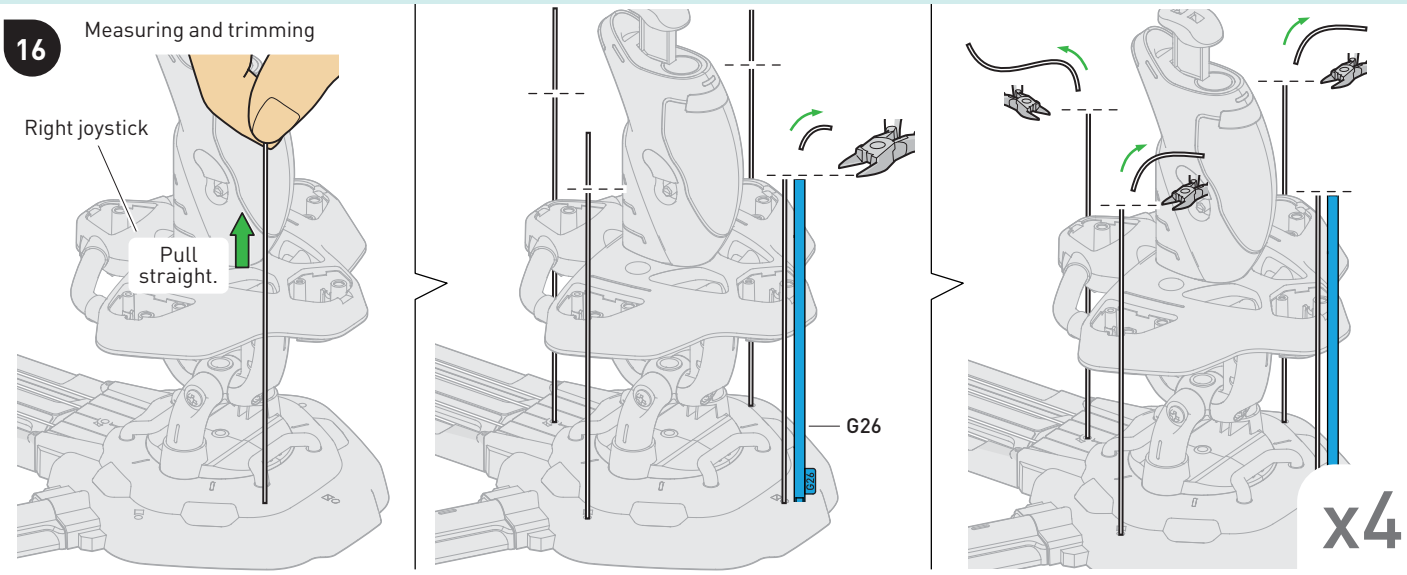


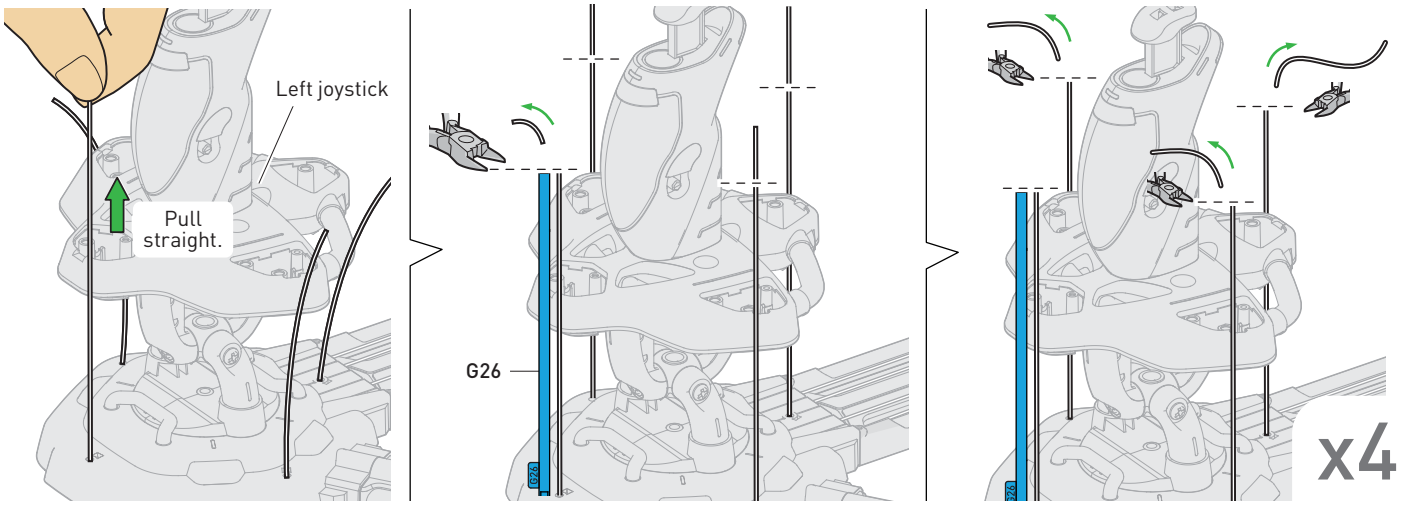
15

G26 is used for measuring.

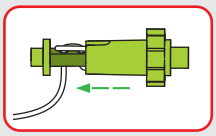


16 Measuring and trimming

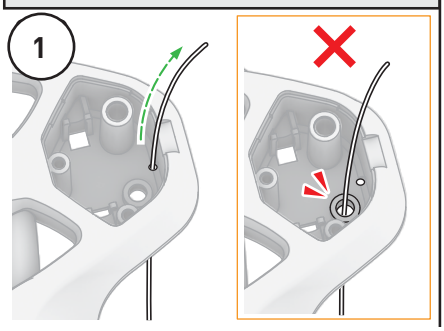




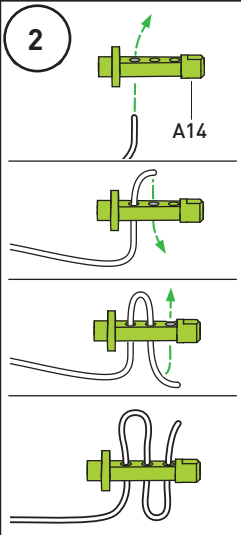
Follow these assembly steps when you see this icon in steps 17–25:

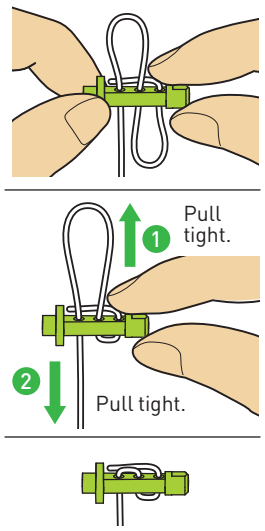


1

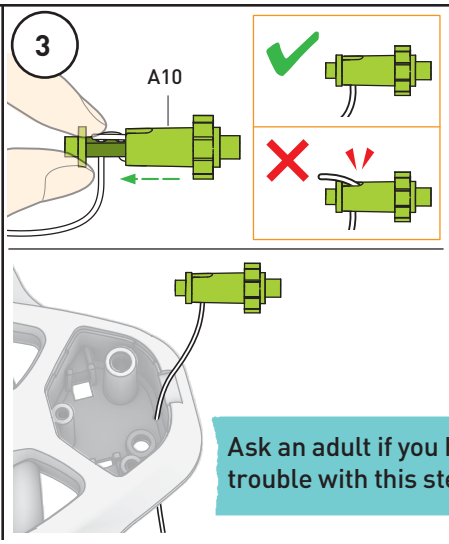


2

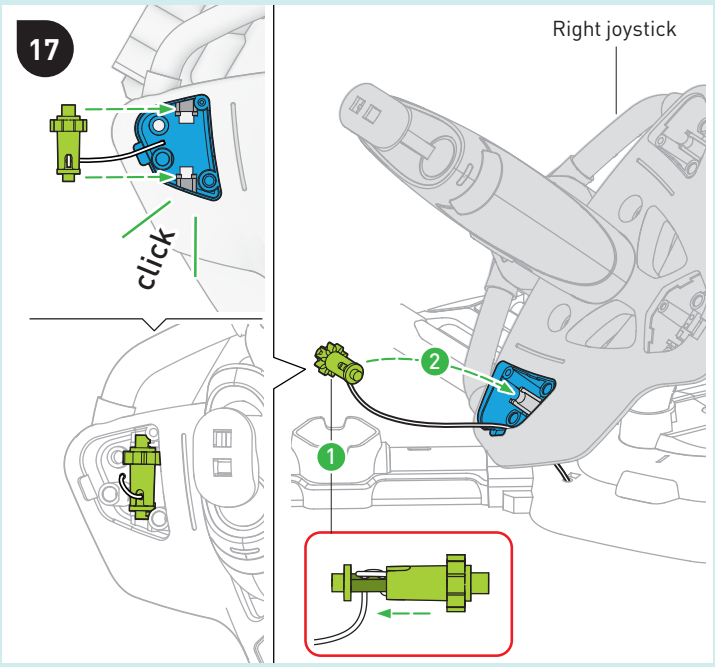


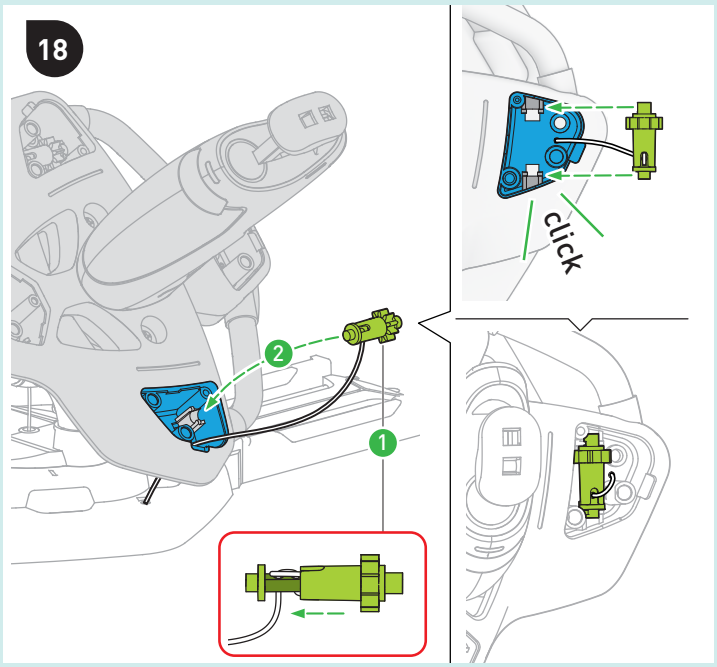


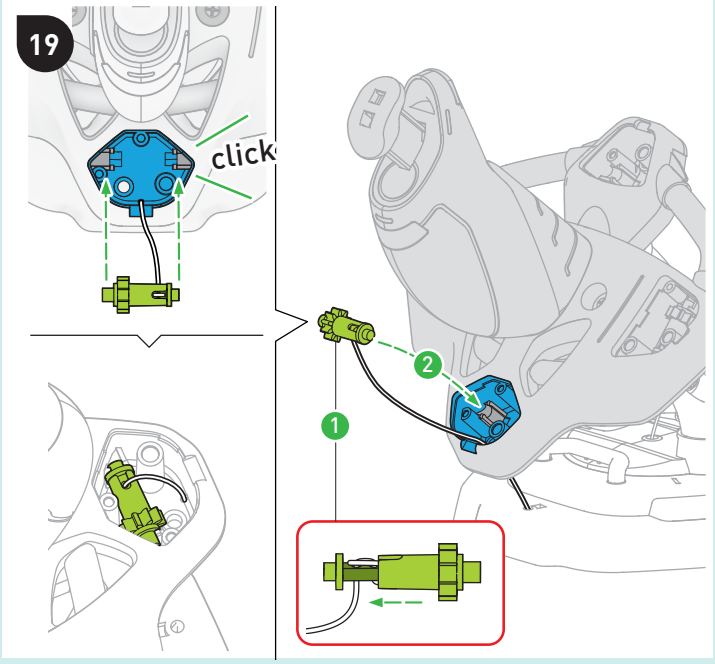
3

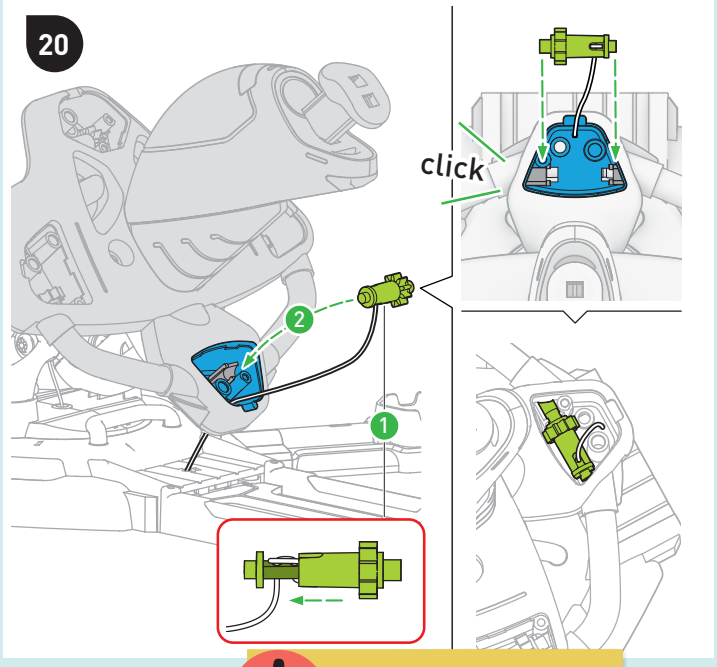


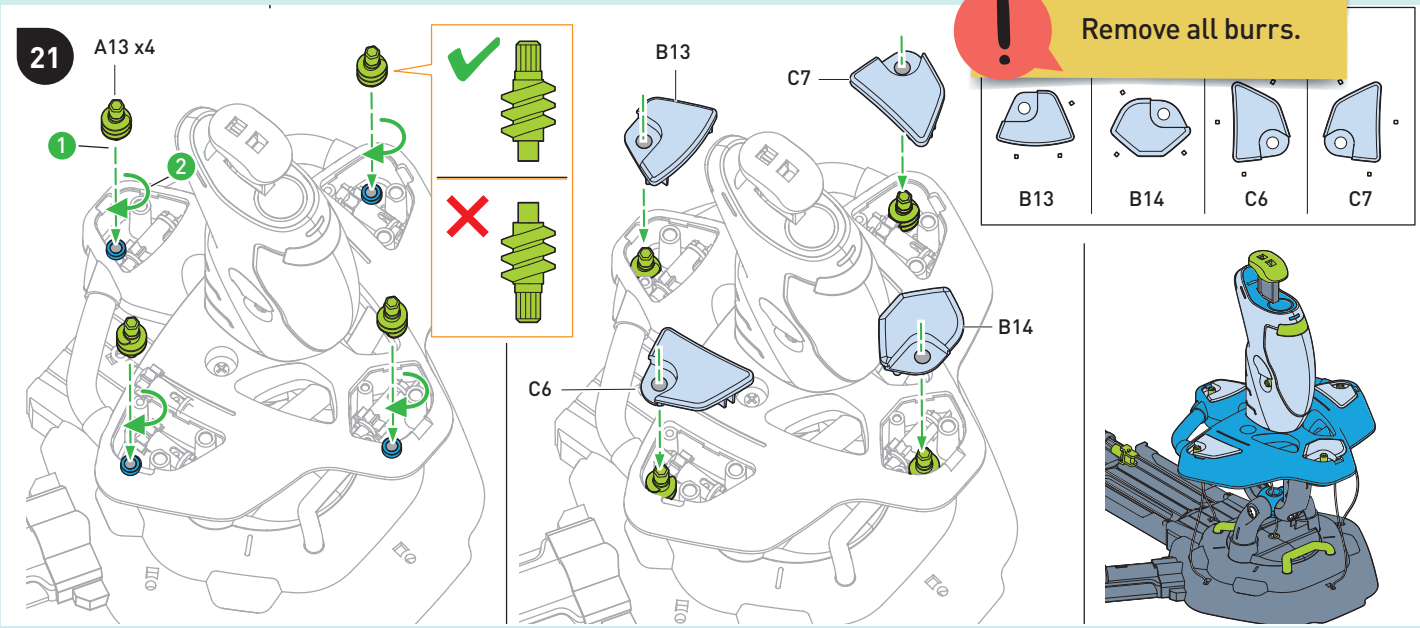
Ask an adult if you have trouble with this step.

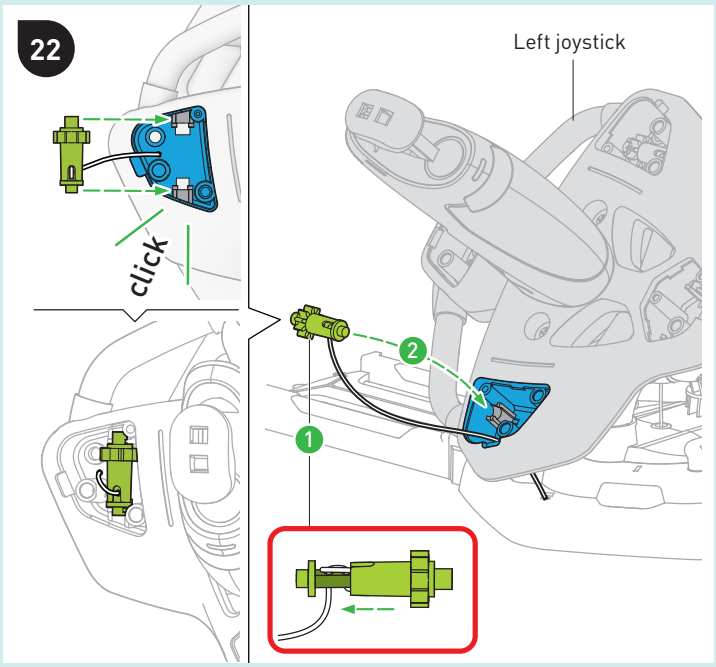

17
Right joystick
click
1
2

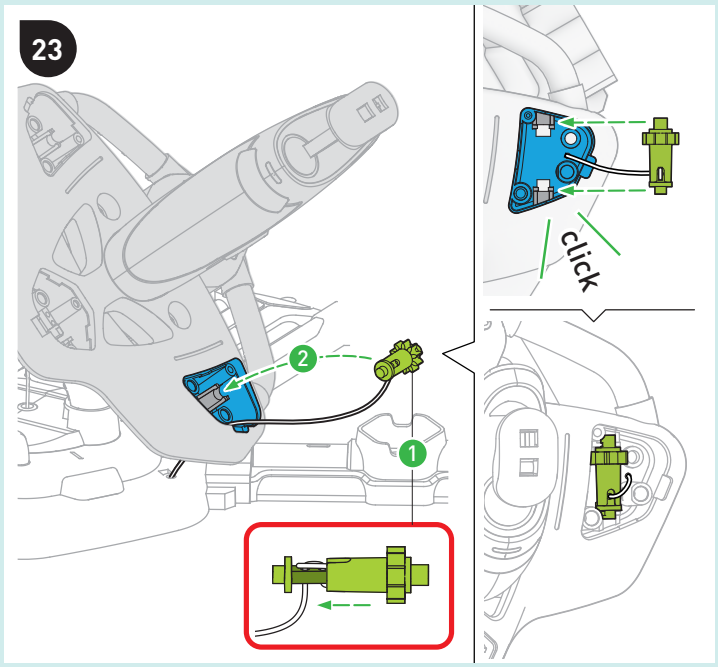

18
click
1
2

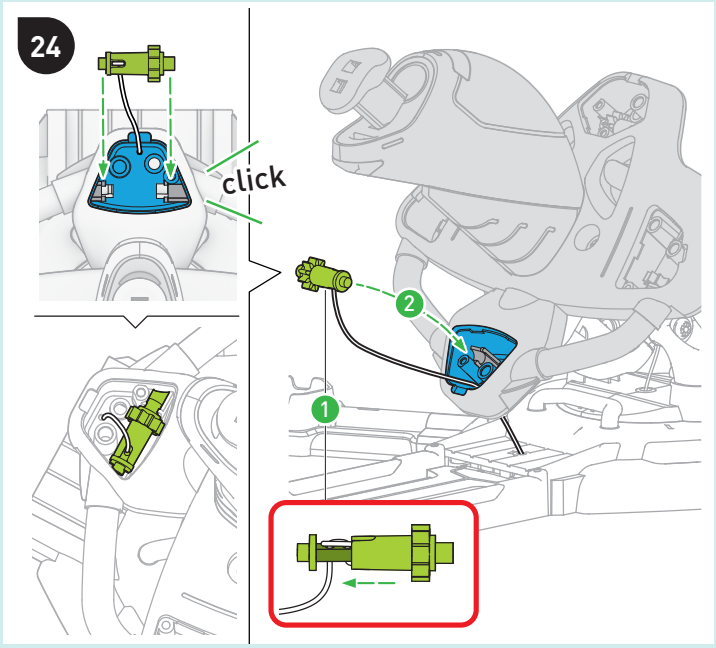

19
click
1
2

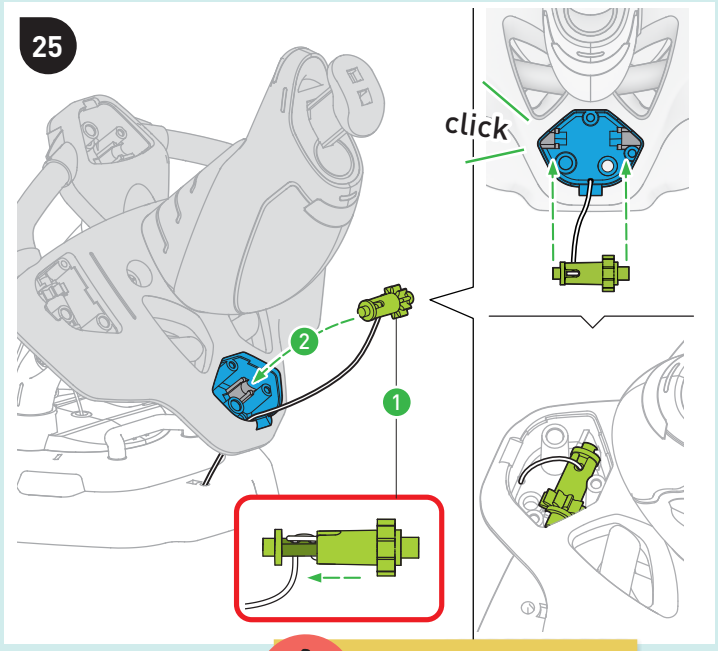

20
click
1
2

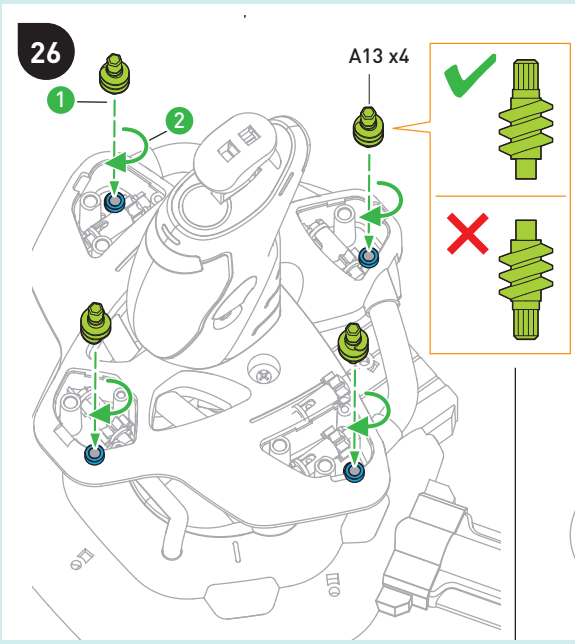

21
A13 x4
1
2
B13
C7
B14
C6
Remove all burrs.
B13
B14
C6
C7

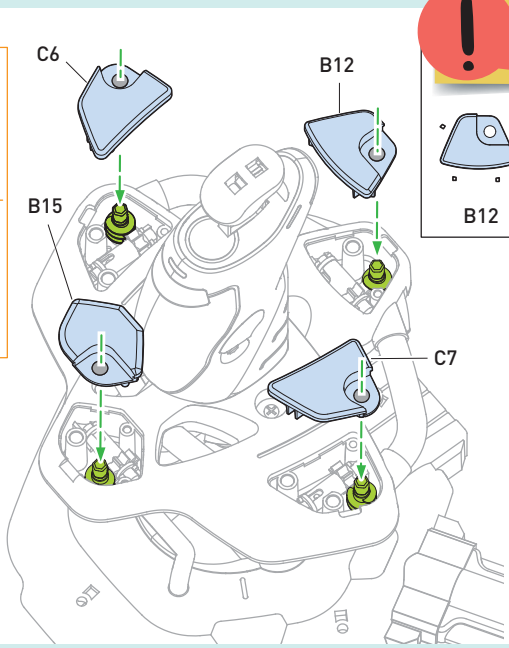

22
Left joystick
click
1
2

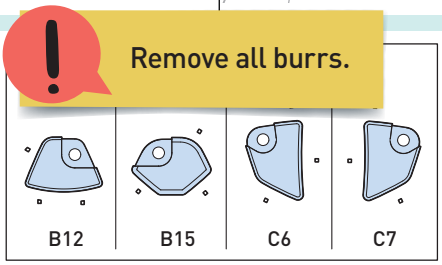

23
click
1
2

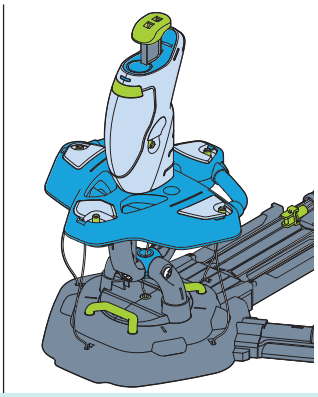

24
click
1
2


25
click
1
2

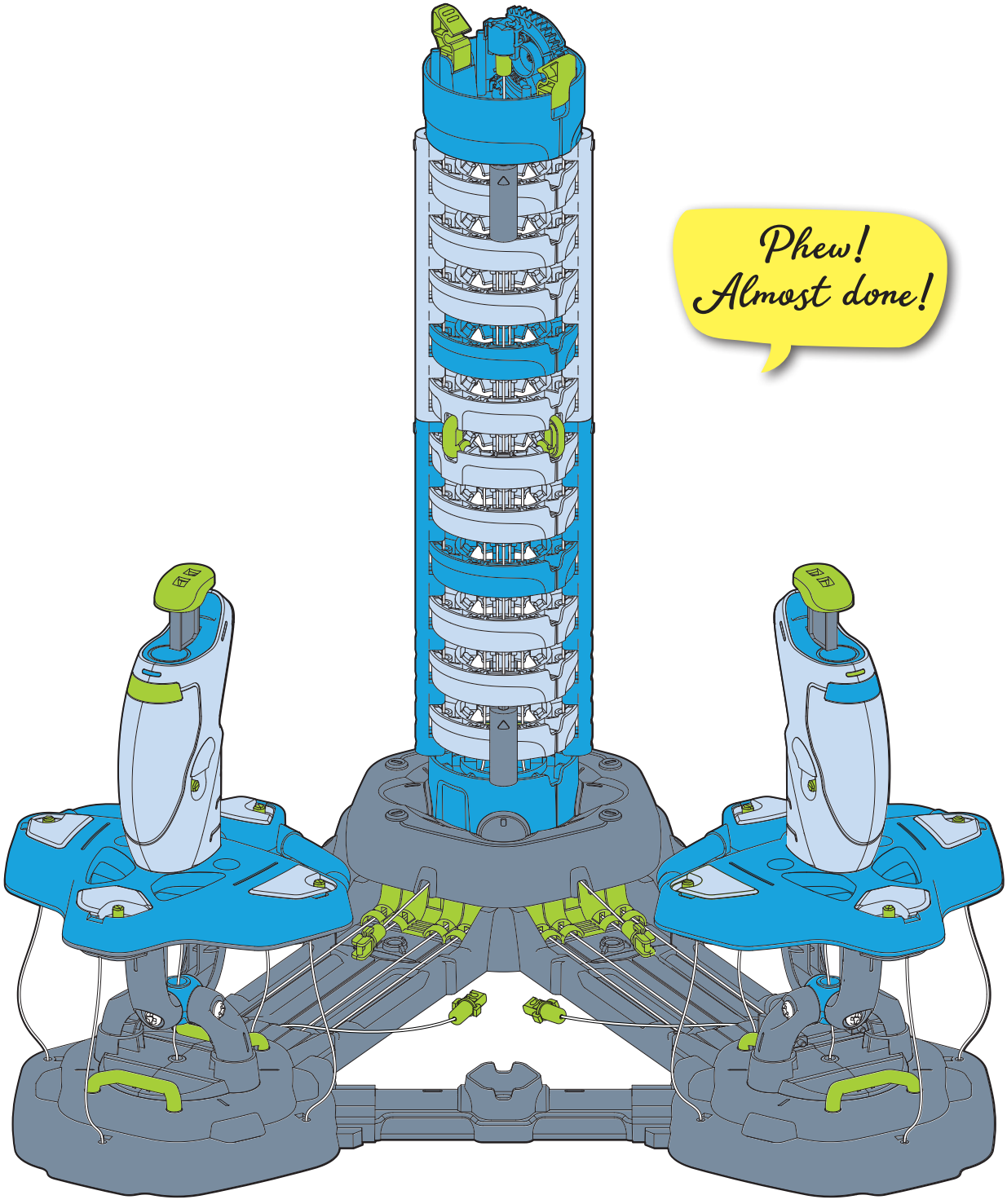

26
1
2
A13 x4


C6
B12
B15
C7


Remove all burrs.
B12
B15
C6
C7



24



CHECK IT OUT

Machines and Robots as

Humanity's Helpers



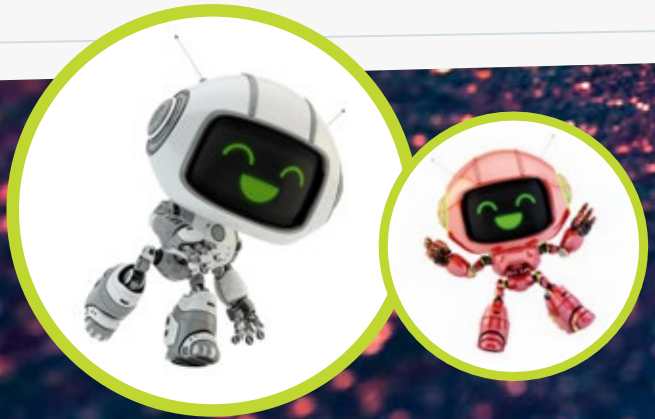
Nowadays, robots and other machines have become commonplace as helpers. Since the 1950s, robots of all kinds have eased the workload of factory workers all over the world. For example, hardly any part of a car's assembly process happens without robots.

These industrious helpers **screw and weld** together automobile parts on the assembly line, which would take people a lot of time and effort. But robots can also be found outside of factories. In houses, for example, vacuuming robots help to keep household dust in check.

WHAT IS A ROBOT, ANYWAY?!

ROBOTS ARE MACHINES THAT FOLLOW PREVIOUSLY-PROGRAMMED INSTRUCTIONS. THE WORD ROBOT COMES FROM THE CZECH WORD "ROBOTA," WHICH MEANS SOMETHING LIKE "FORCED LABOR." A ROBOT ONLY FOLLOWS THE COMMANDS FOR WHICH IT HAS BEEN PROGRAMMED.





AI — ARTIFICIAL INTELLIGENCE

The field of robotics is always evolving. Currently, artificially intelligence — AI for short — is an important topic. Artificial intelligences are able to learn large amounts of information independently. Based on what it has learned, the AI can react to specific situations and make decisions. For instance, a robot named Pepper can analyze the **facial expressions, gestures, and emotions** of different people. Based on that information, Pepper reacts to the person interacting with it in various ways.



TRENDY!

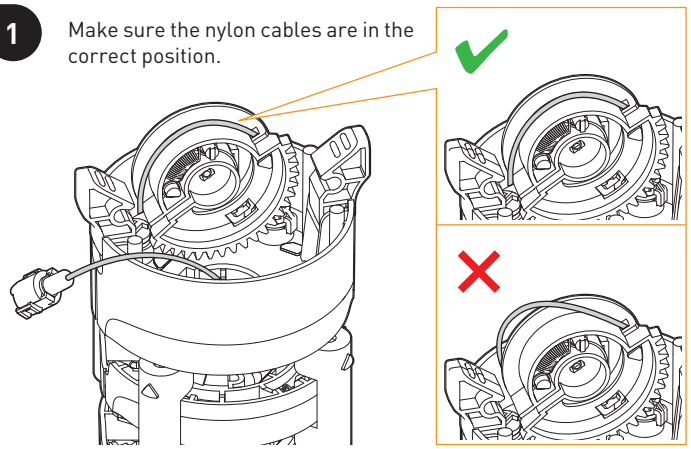
The global leader in robotics is the Asian country of Japan. Robots can be found there in many different areas. In some hotels and restaurants, robots greet guests, help chop vegetables and prepare dishes in the kitchen, or serve meals. There are also cafes where are no people working — only robots **prepare and serve drinks** to customers.



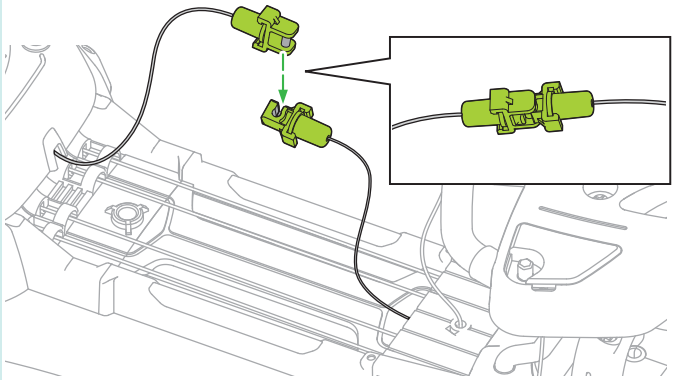
ADJUSTING THE NYLON CABLES

ADJUSTING CABLES
Scan this QR code to see a video of these steps.

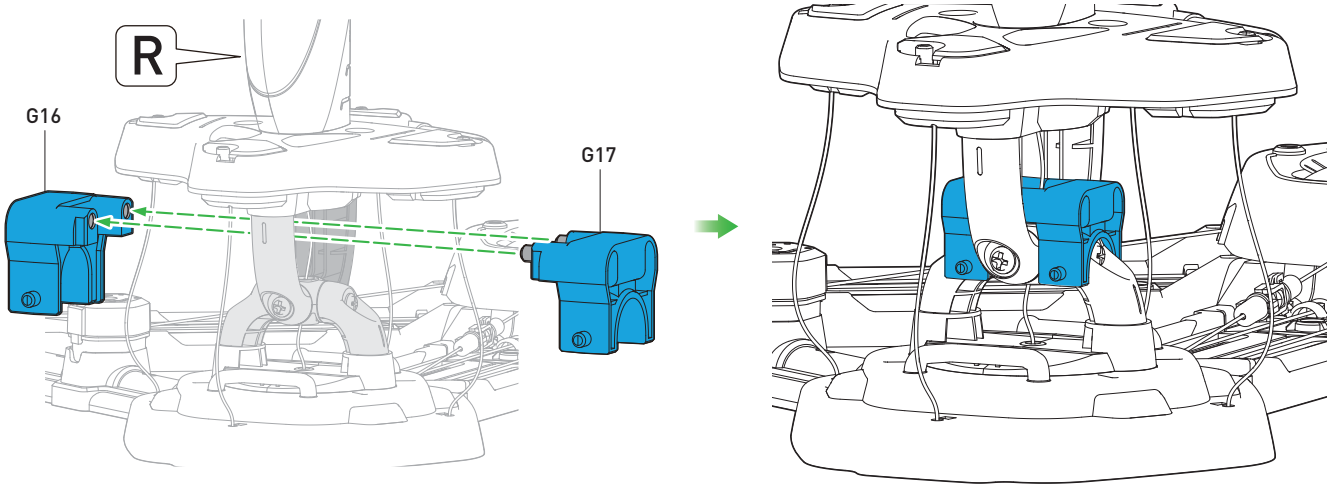
1 Make sure the nylon cables are in the correct position.



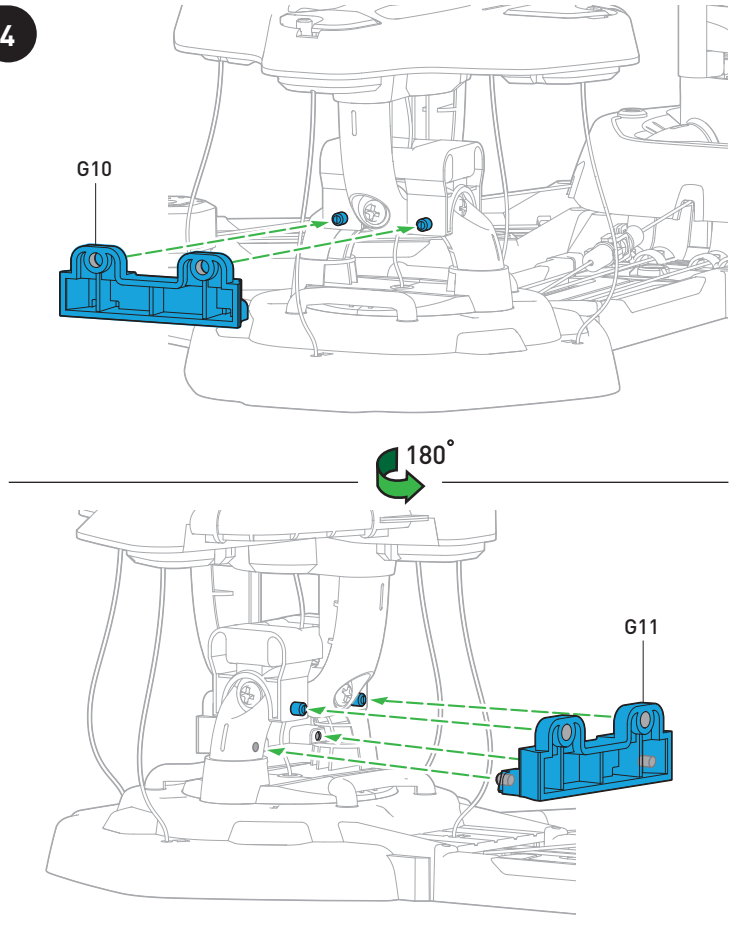
2 Connect the buckles on the right joystick

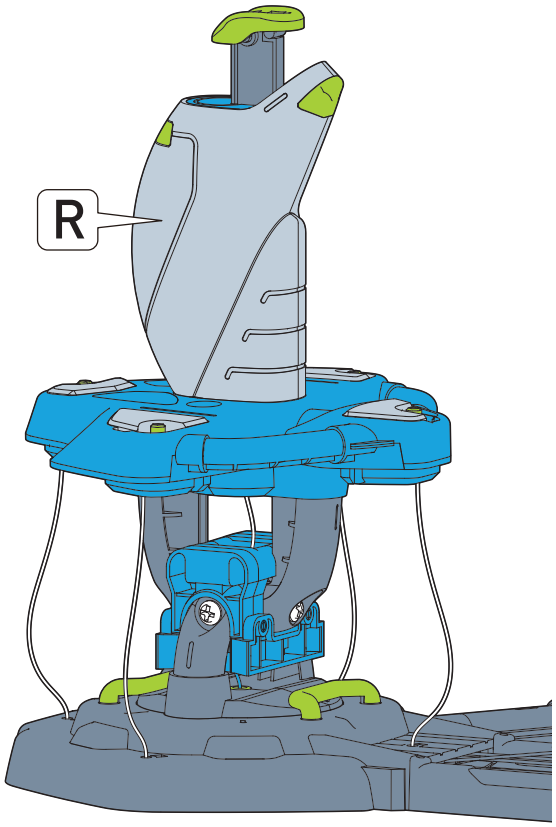


3



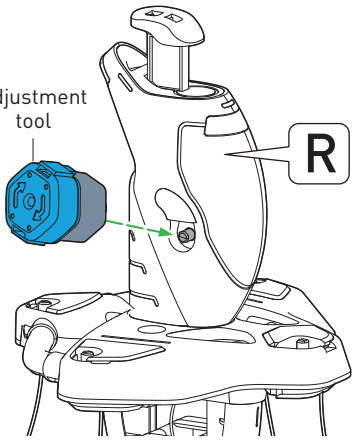
4

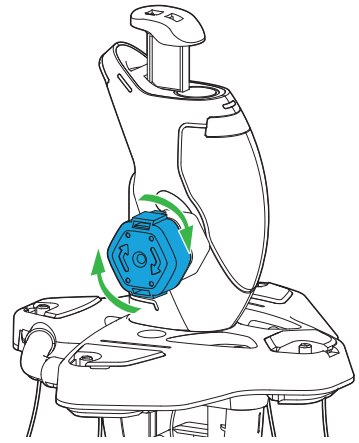


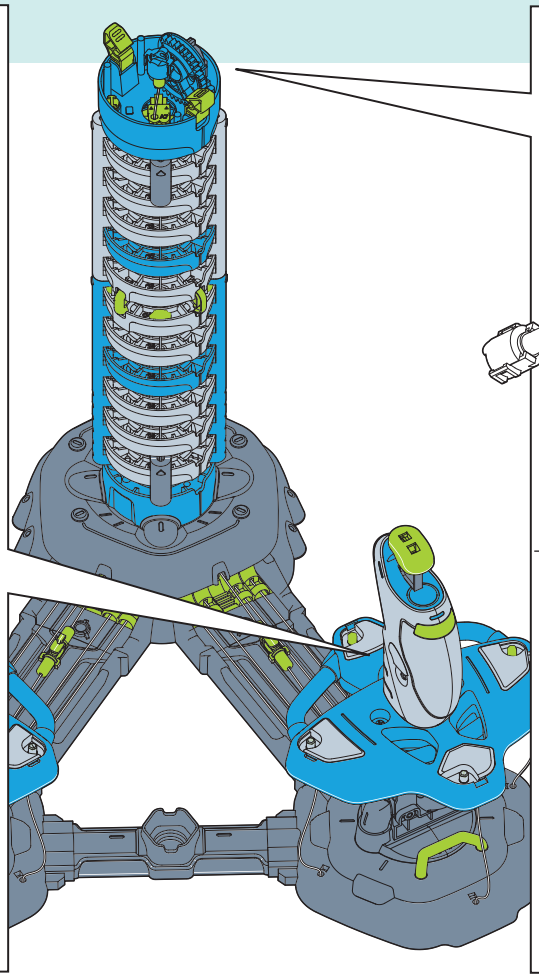


5

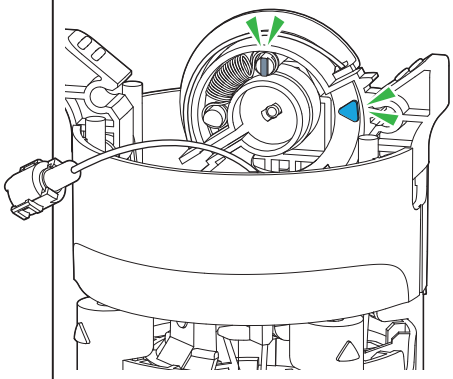
Adjustment tool

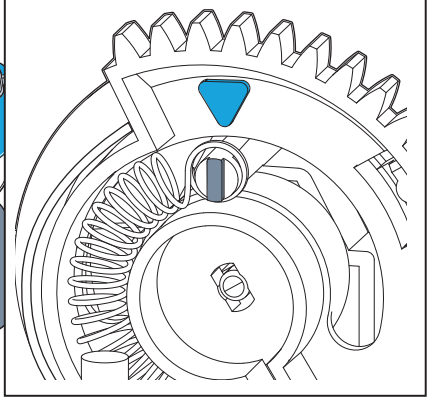




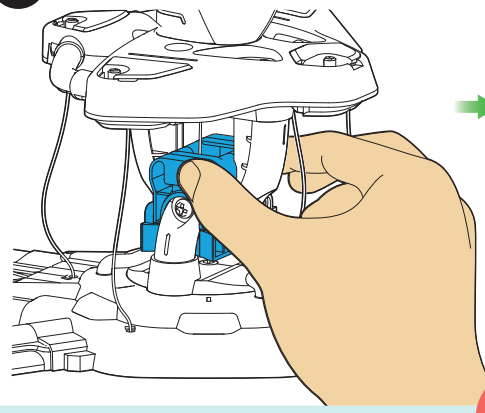


Rotate the adjustment tool while observing the position of the triangle. The triangle should align with the mark on the spring post (see below).

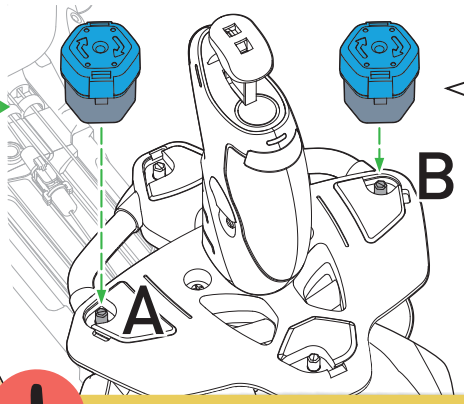




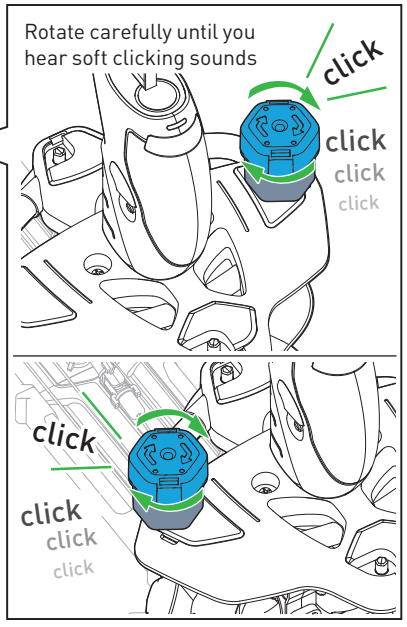
6 Hold both sides of the support pieces with your thumb and forefinger.



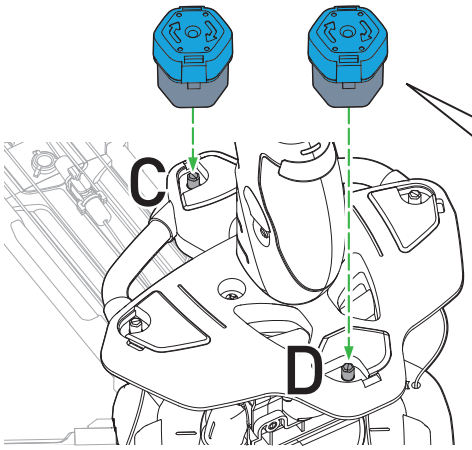
Use the adjustment tool to adjust the left (A) and right (B) points.



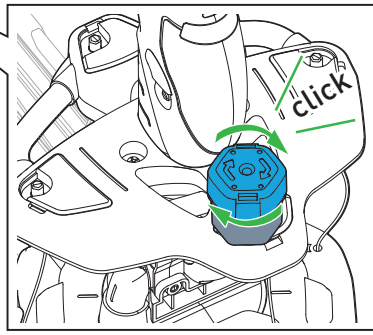
Rotate carefully until you hear soft clicking sounds



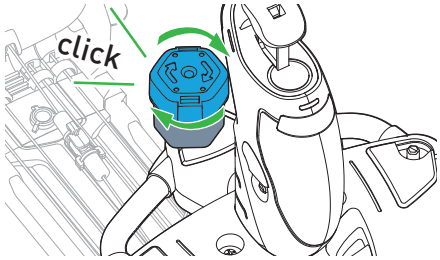
7 Use the adjustment tool to adjust the top (C) and bottom (D) points.

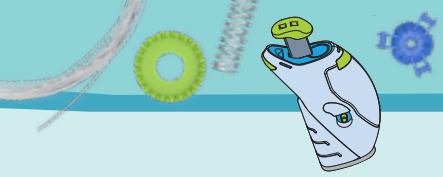


! If the joystick is leaning to one side, loosen that side until it is no longer leaning, and then tighten the other side.

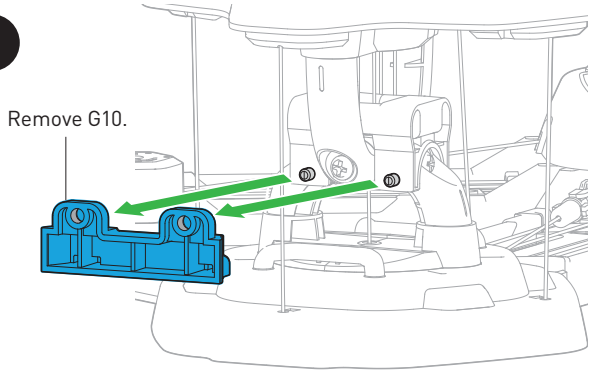


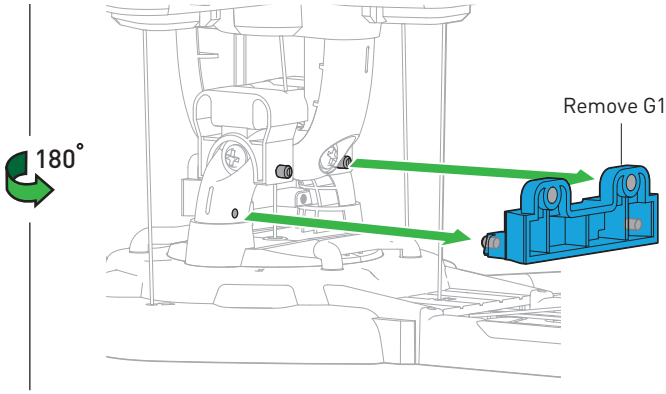
Rotate carefully until you hear soft clicking sounds

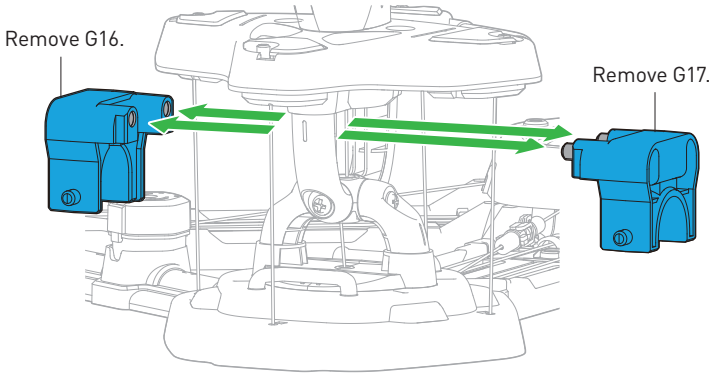


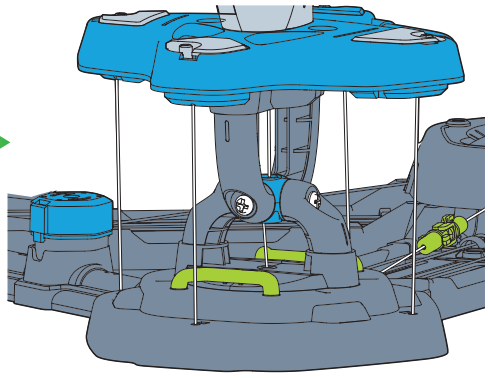


8

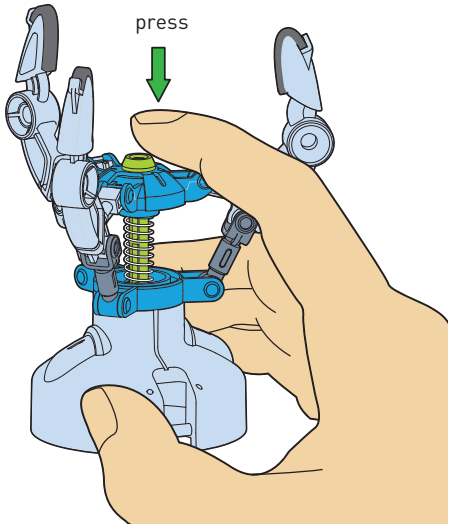


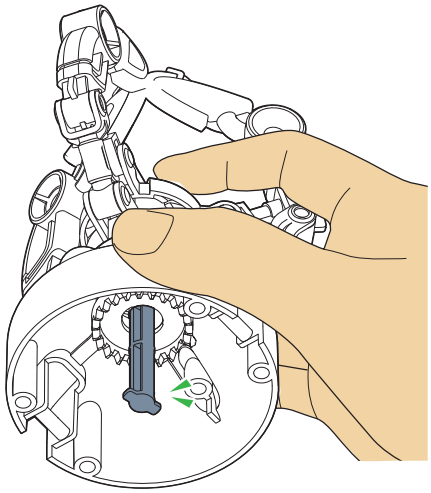




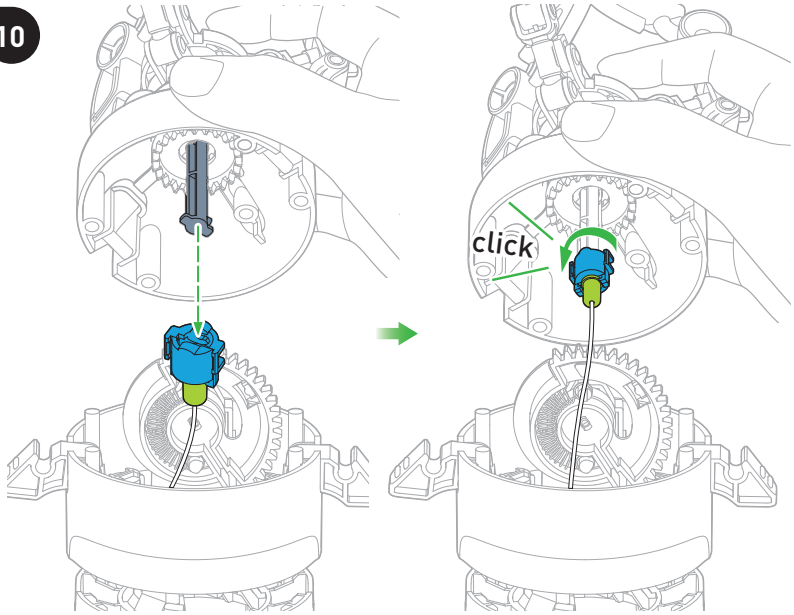


9

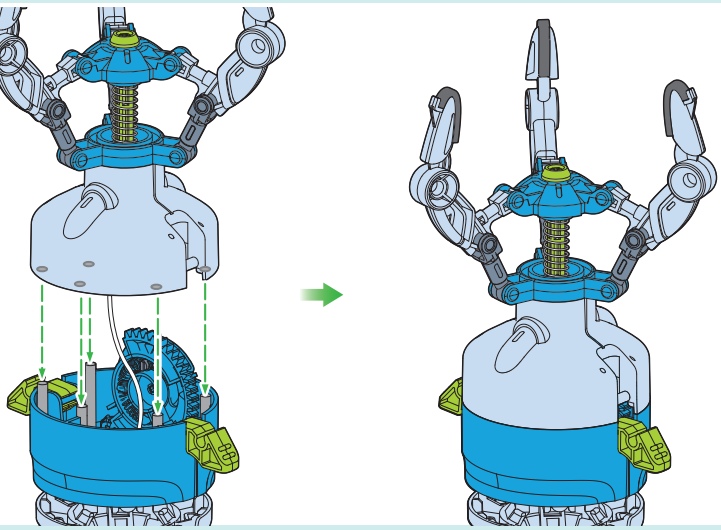




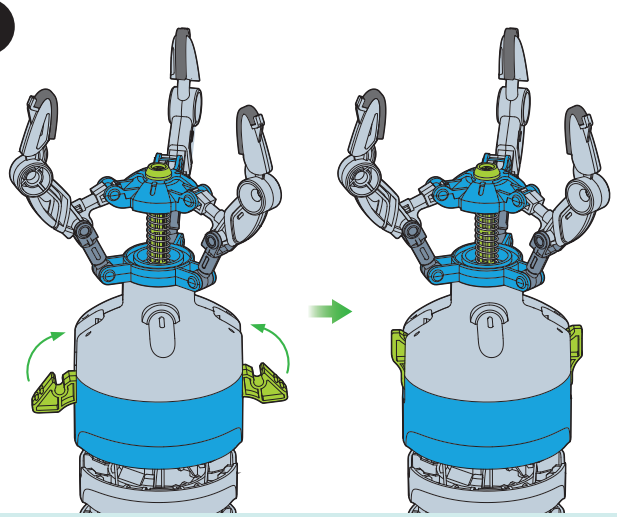
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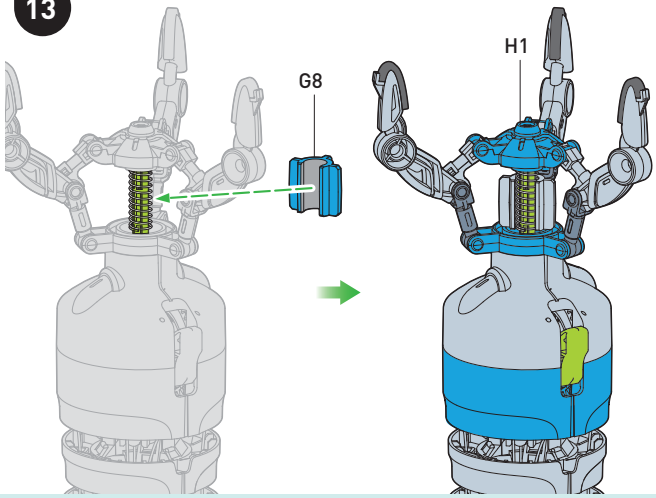
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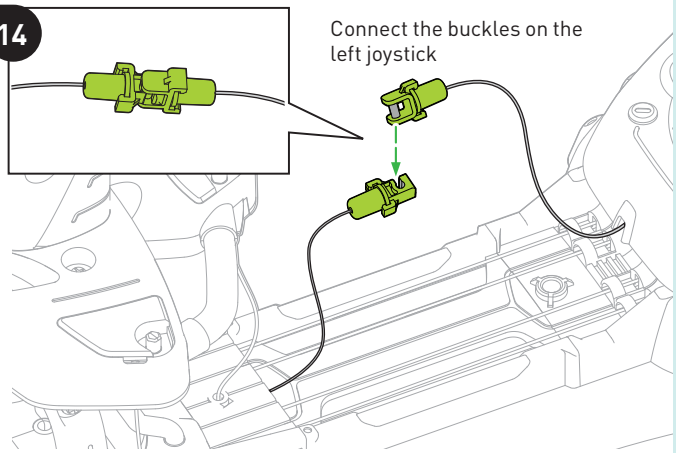
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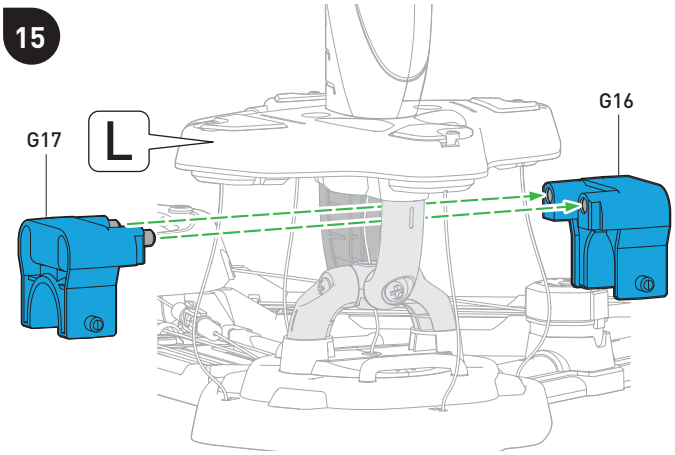
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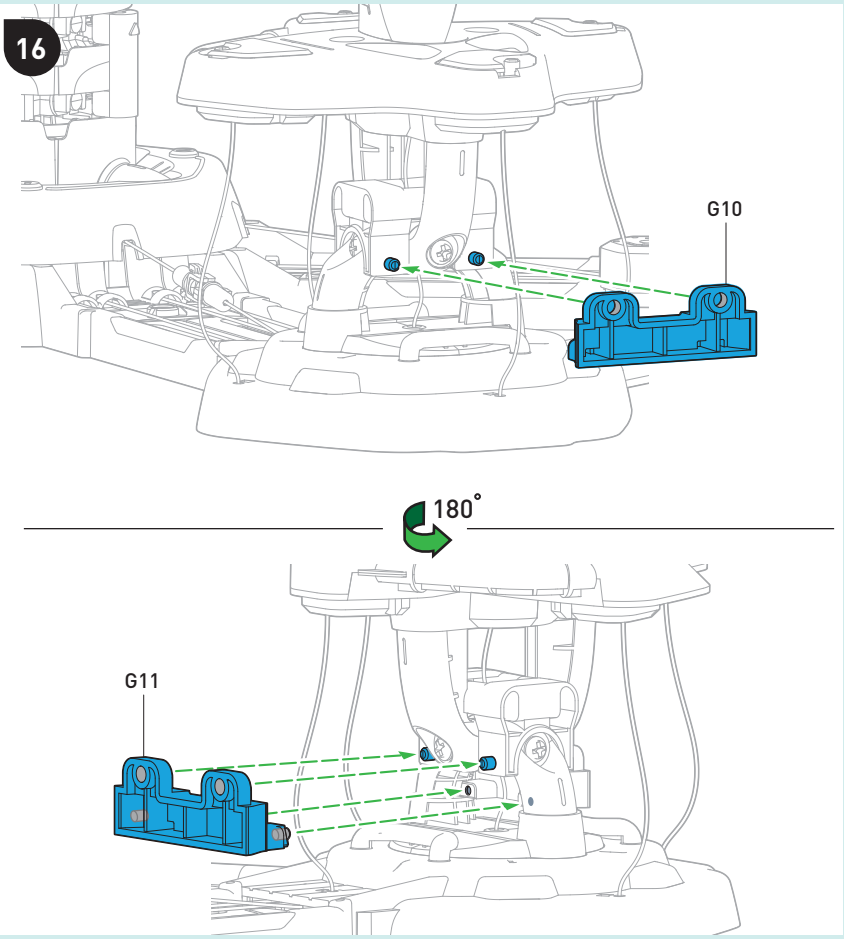
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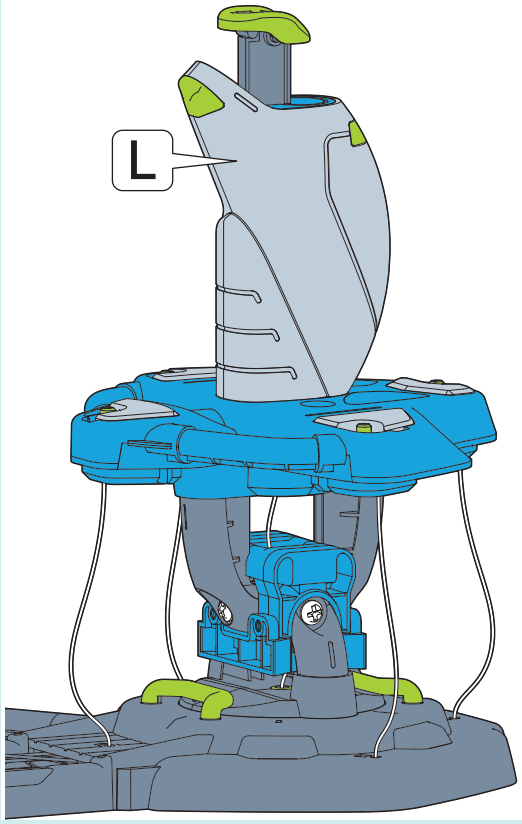
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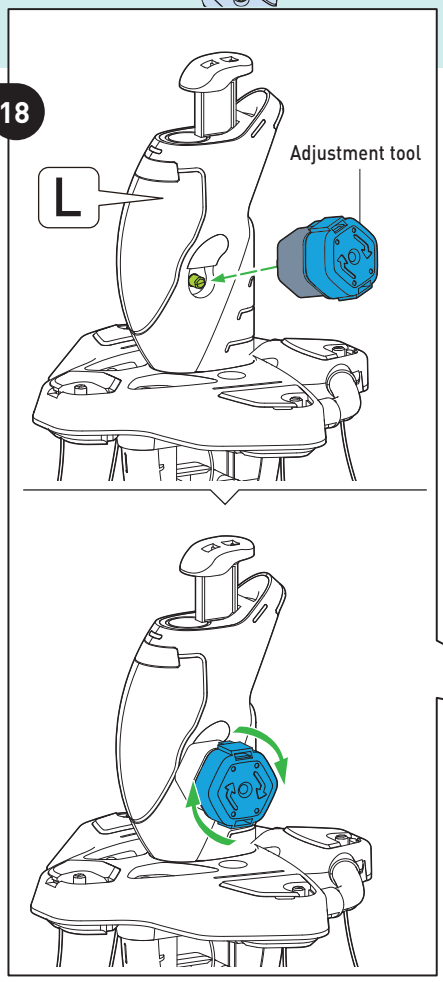
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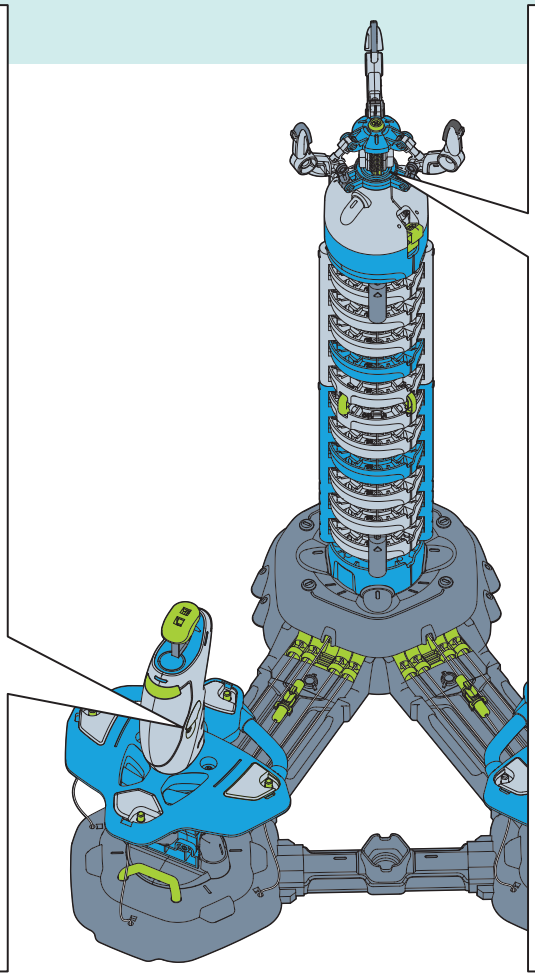


17

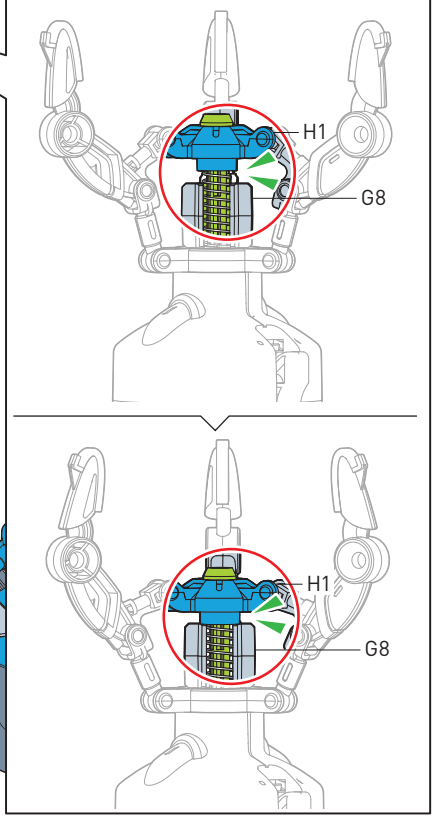


18

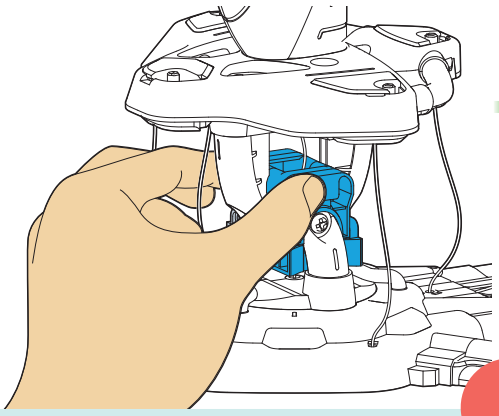




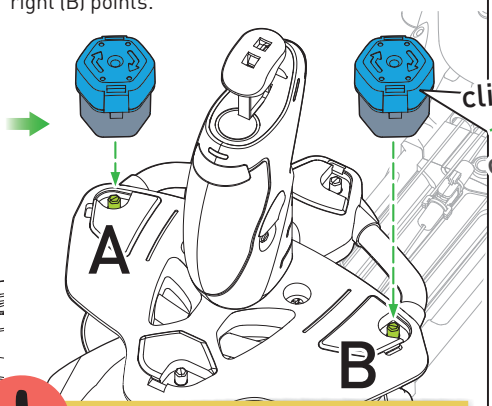
Rotate the adjustment tool and observe the gap between H1 and G8. Rotate until H1 and G8 are touching.



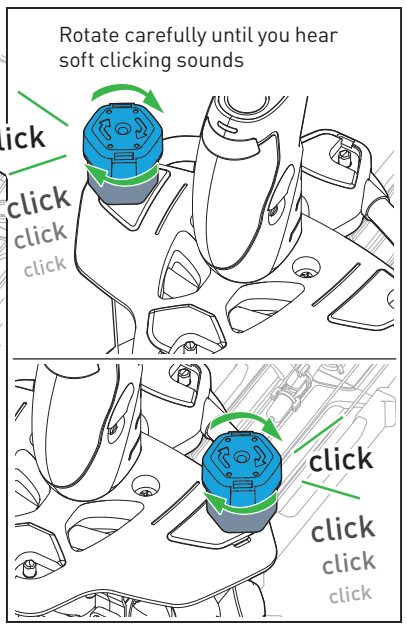
19 Hold both sides of the support pieces with your thumb and forefinger.



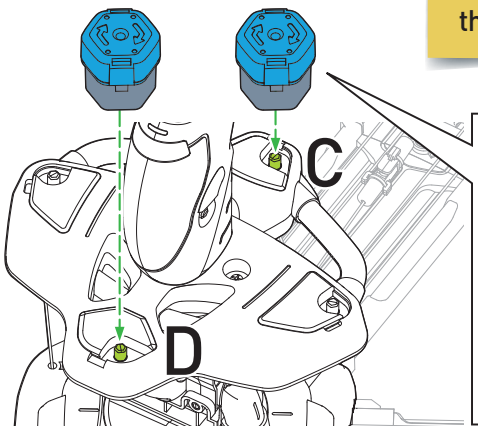
Use the adjustment tool to adjust the left (A) and right (B) points.

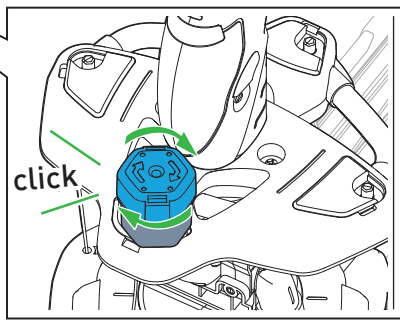


Rotate carefully until you hear soft clicking sounds

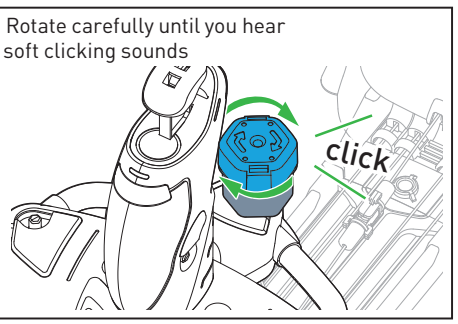


20 Use the adjustment tool to adjust the top (C) and bottom (D) points.



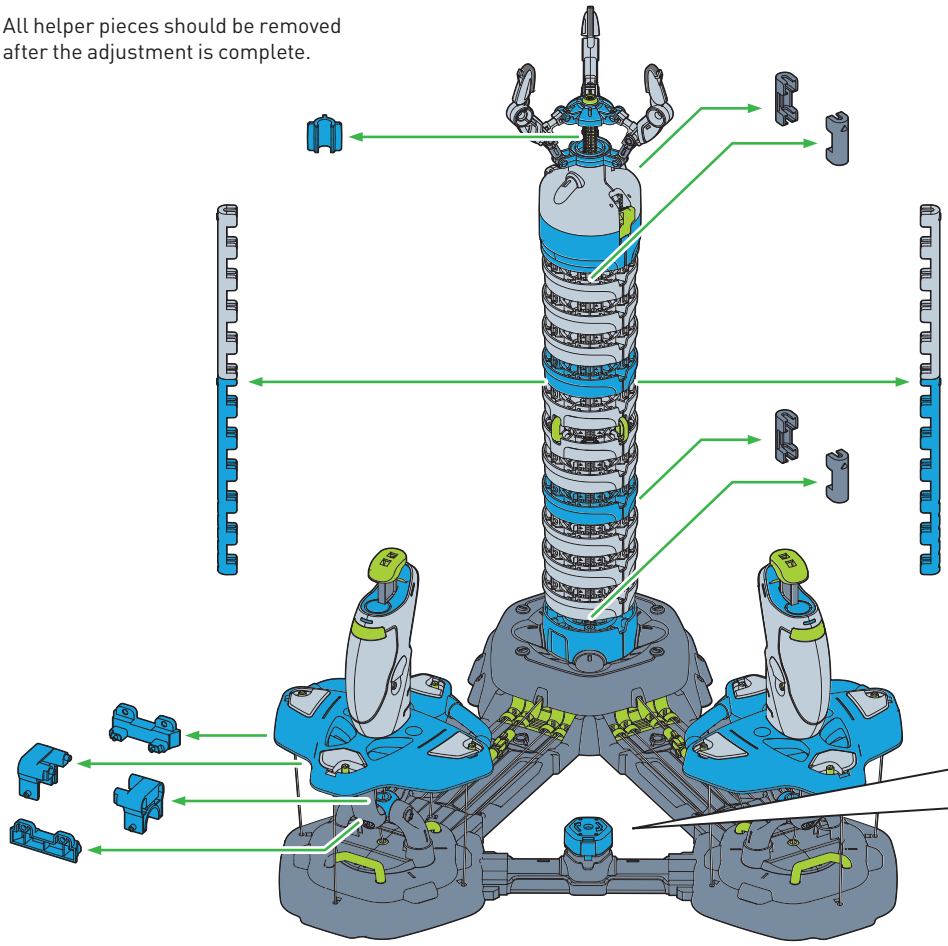


Rotate carefully until you hear soft clicking sounds



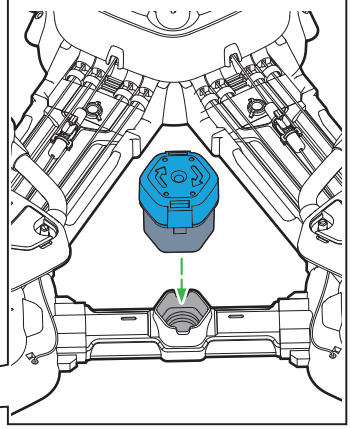
! If the joystick is leaning to one side, loosen that side until it is no longer leaning, and then tighten the other side.

21 All helper pieces should be removed after the adjustment is complete.



When removing the helper pieces, the arm will bend together somewhat. Don't worry, that's normal.

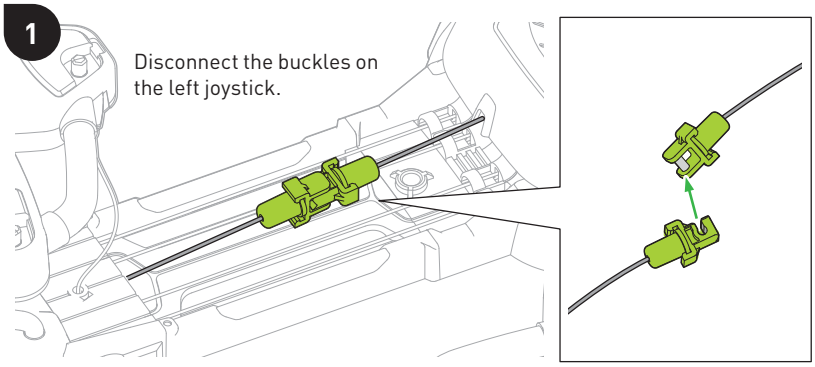
Storage for the adjustment tool



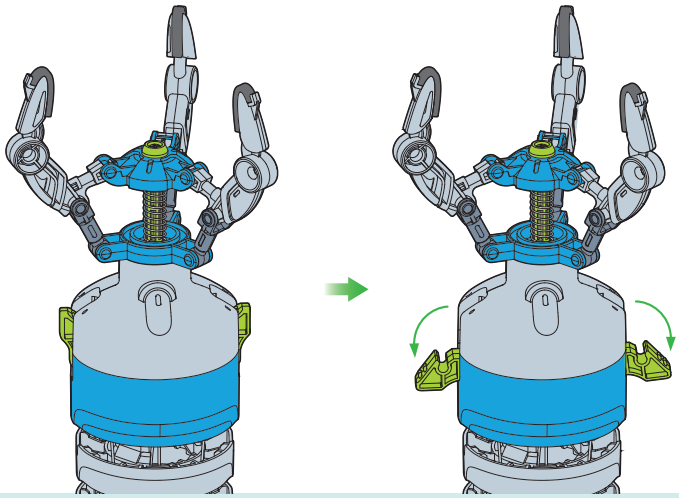
✔ Finished!

SWITCHING FROM CLAW TO EEL HEAD

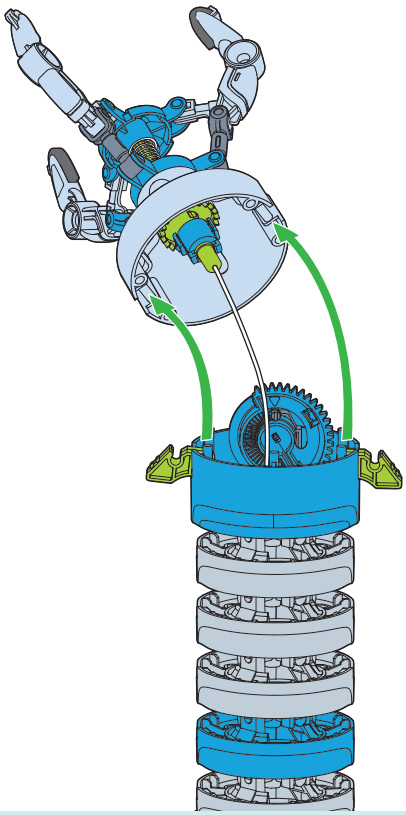
1 Disconnect the buckles on the left joystick.

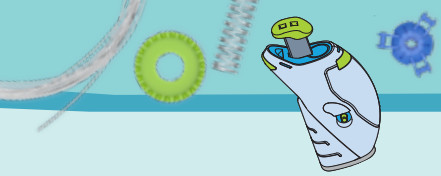


2

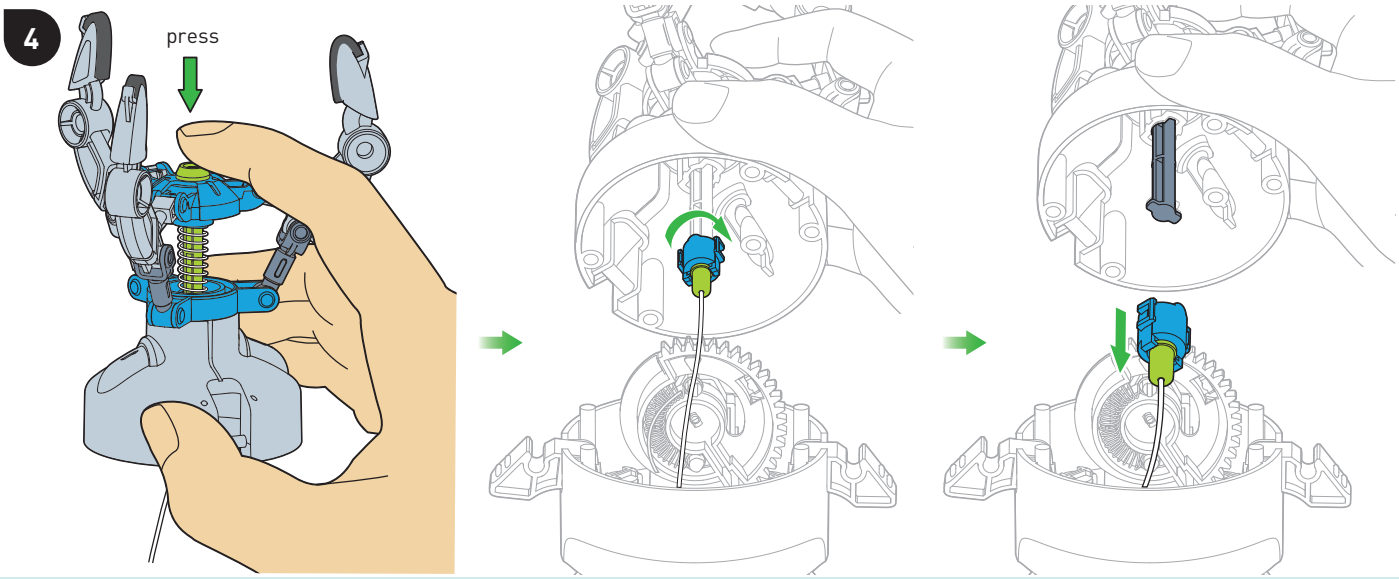


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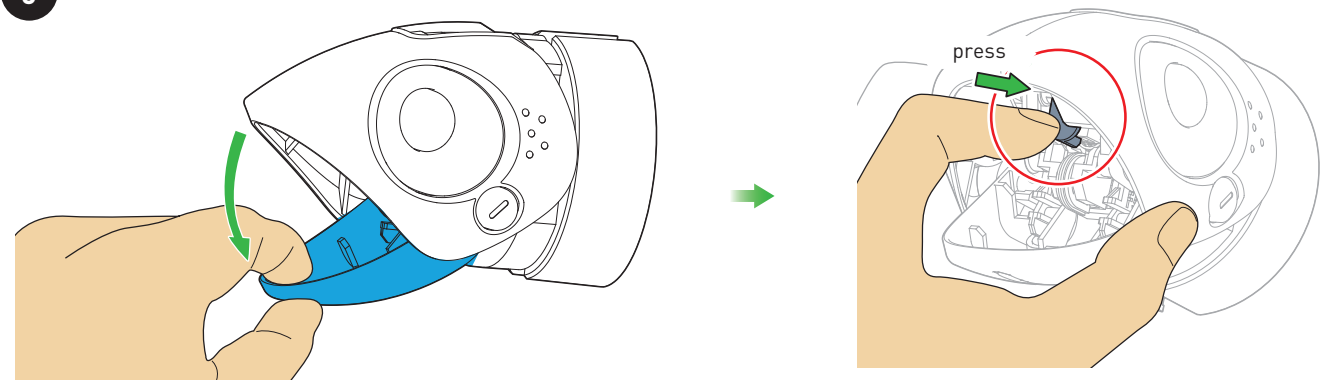




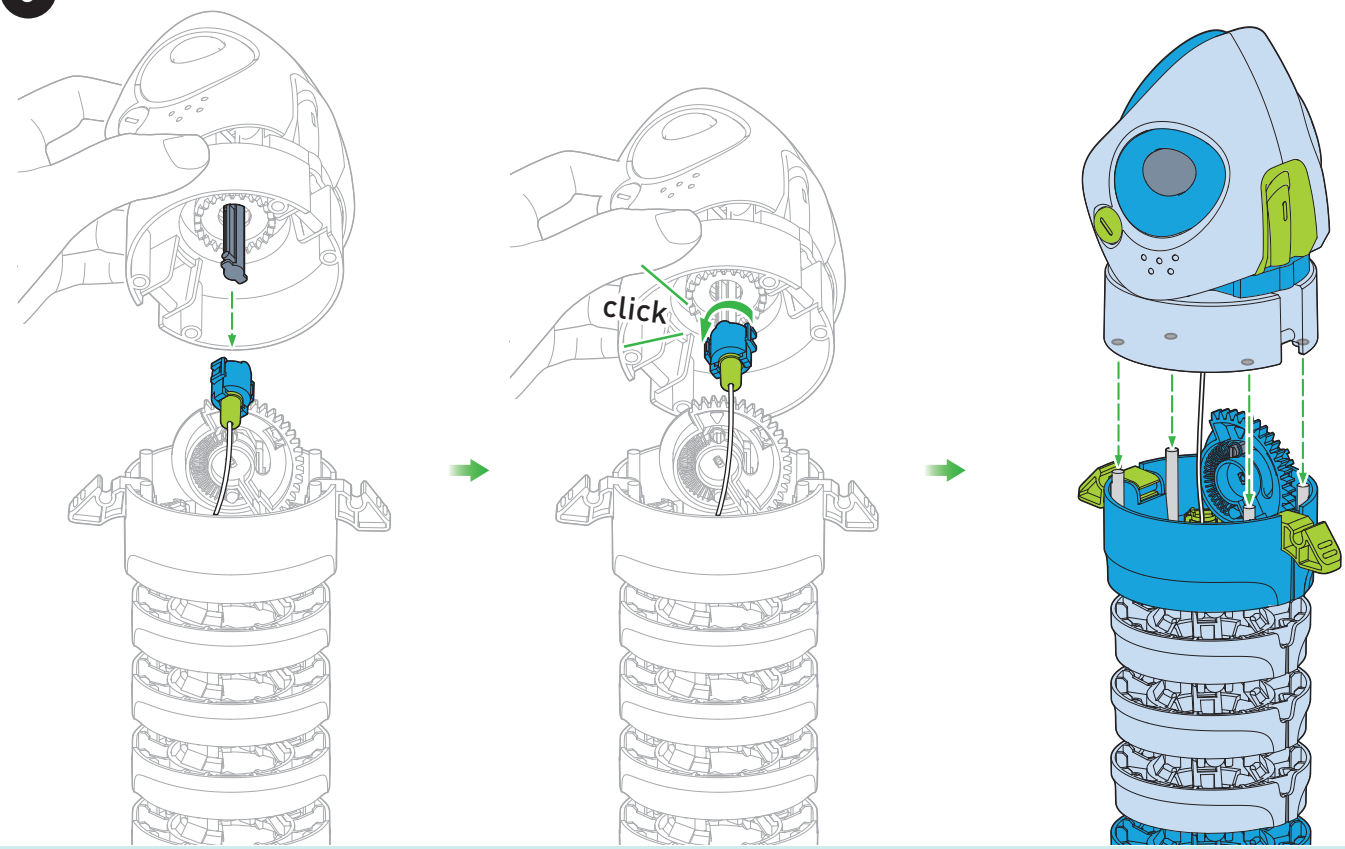
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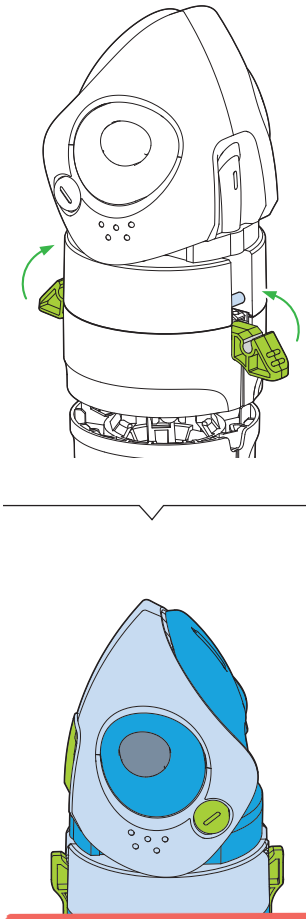
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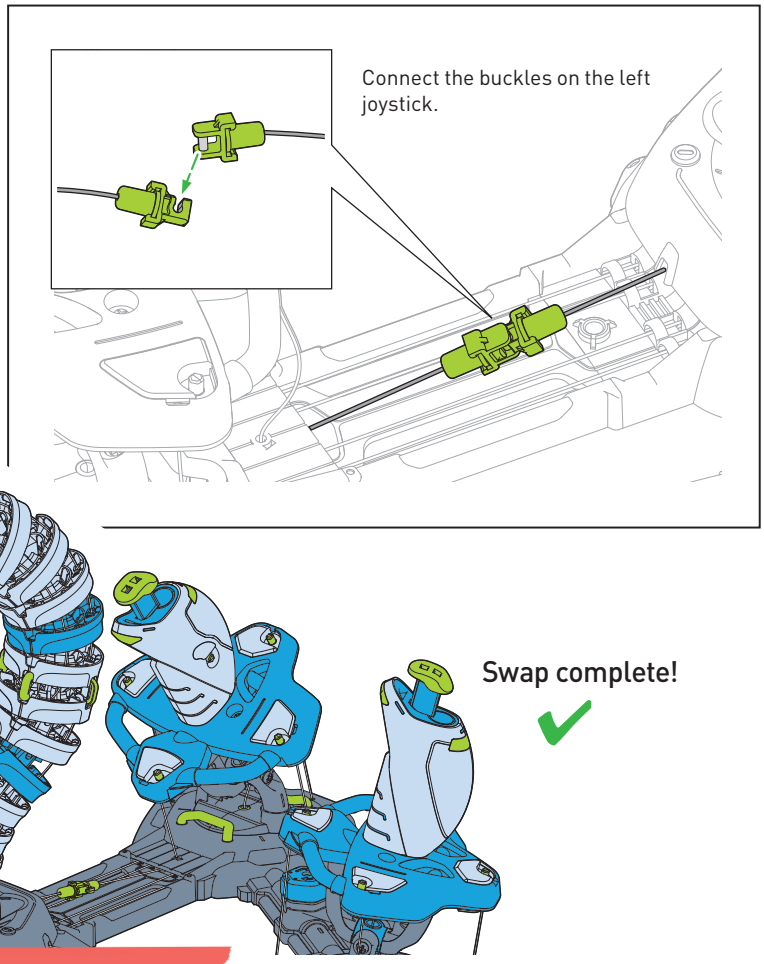
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7



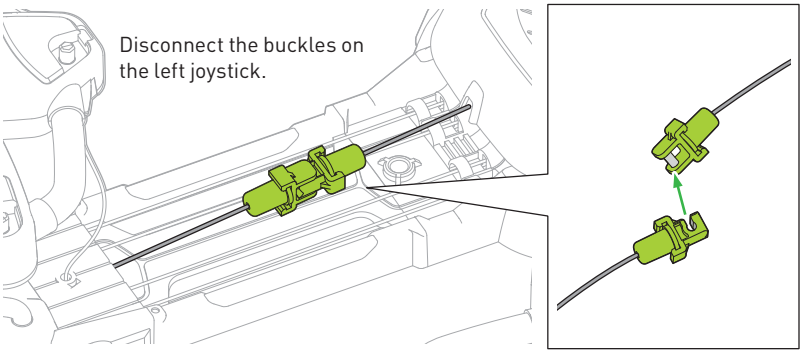
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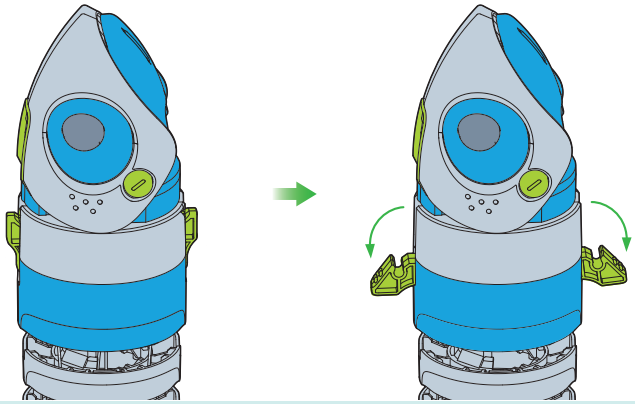
Swap complete!

SWITCHING FROM EEL HEAD TO CLAW

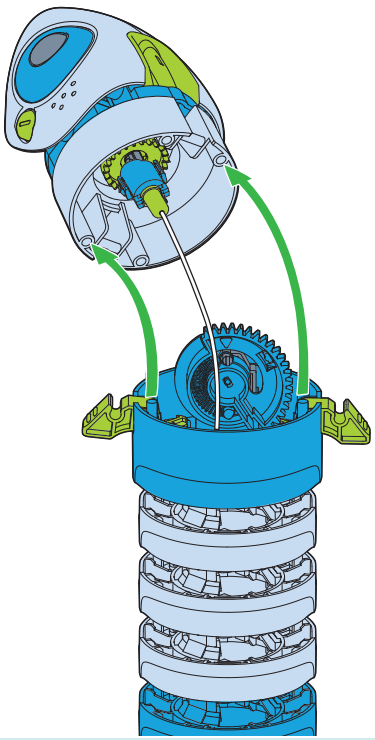
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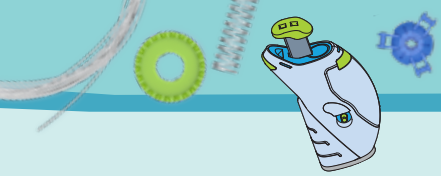


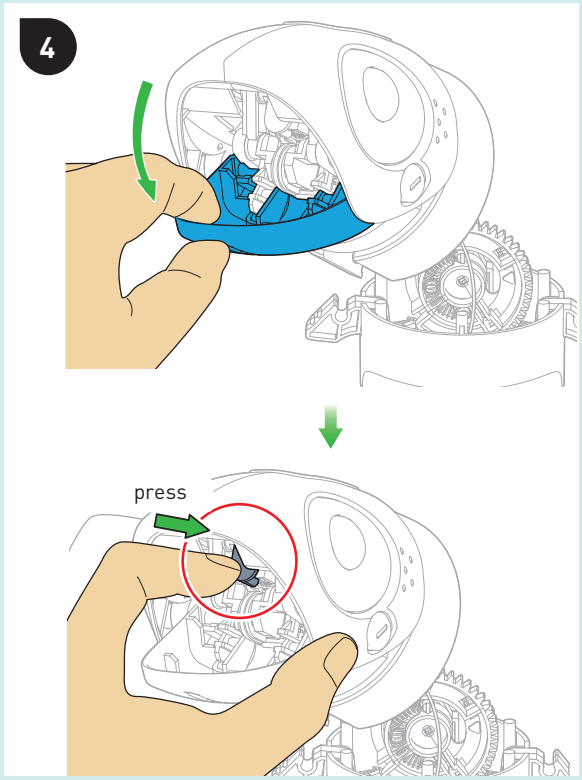
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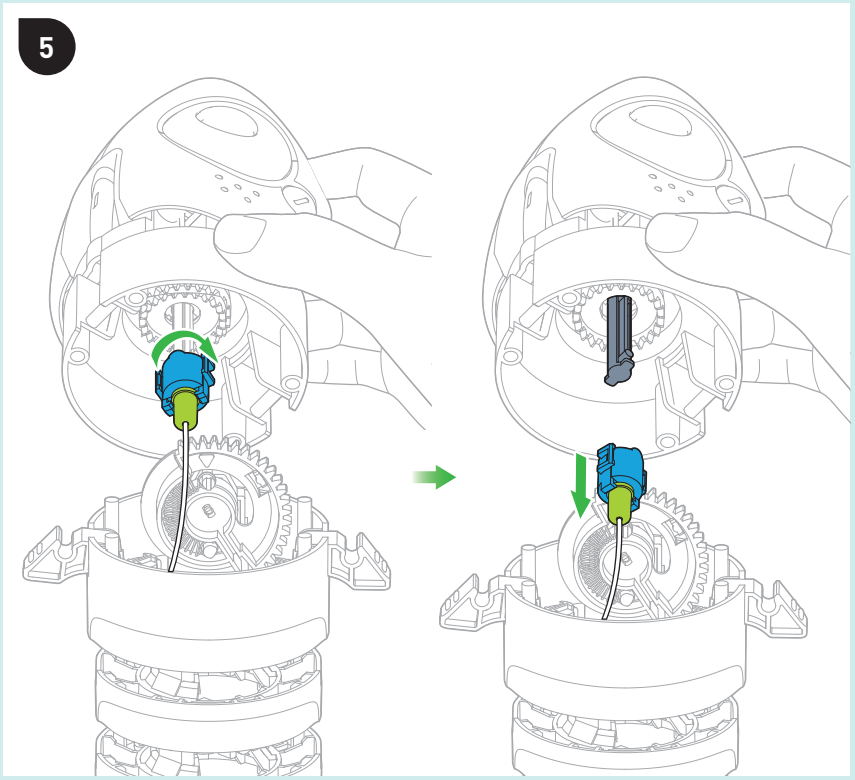


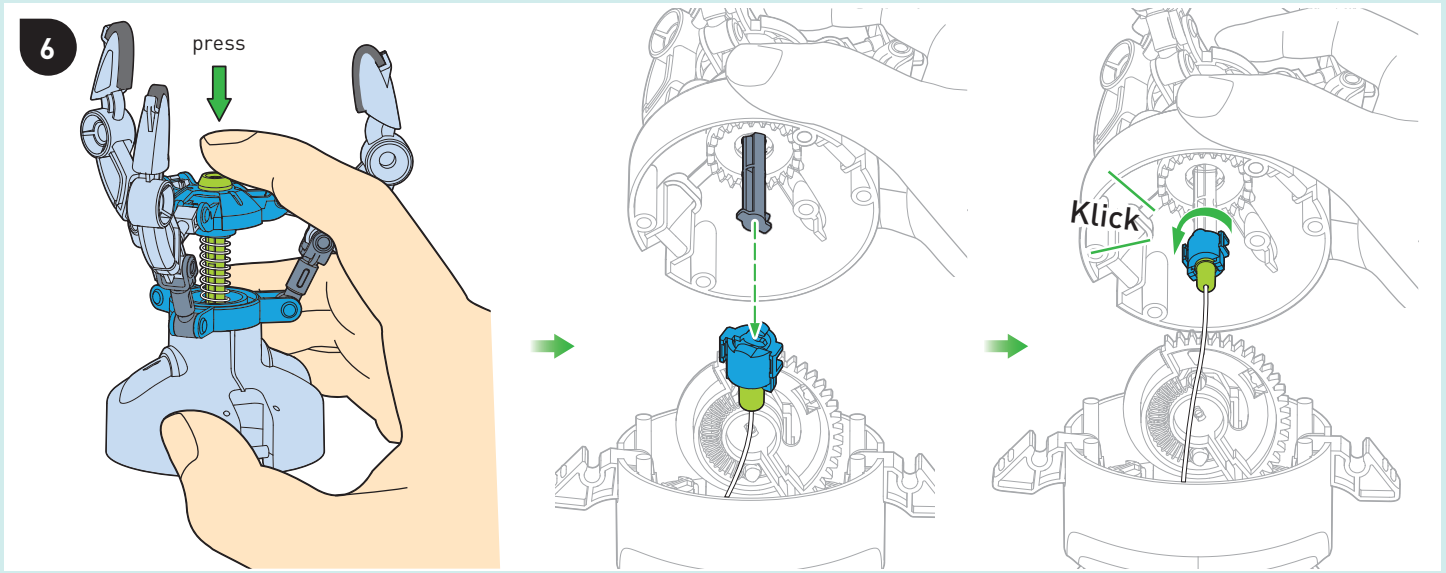
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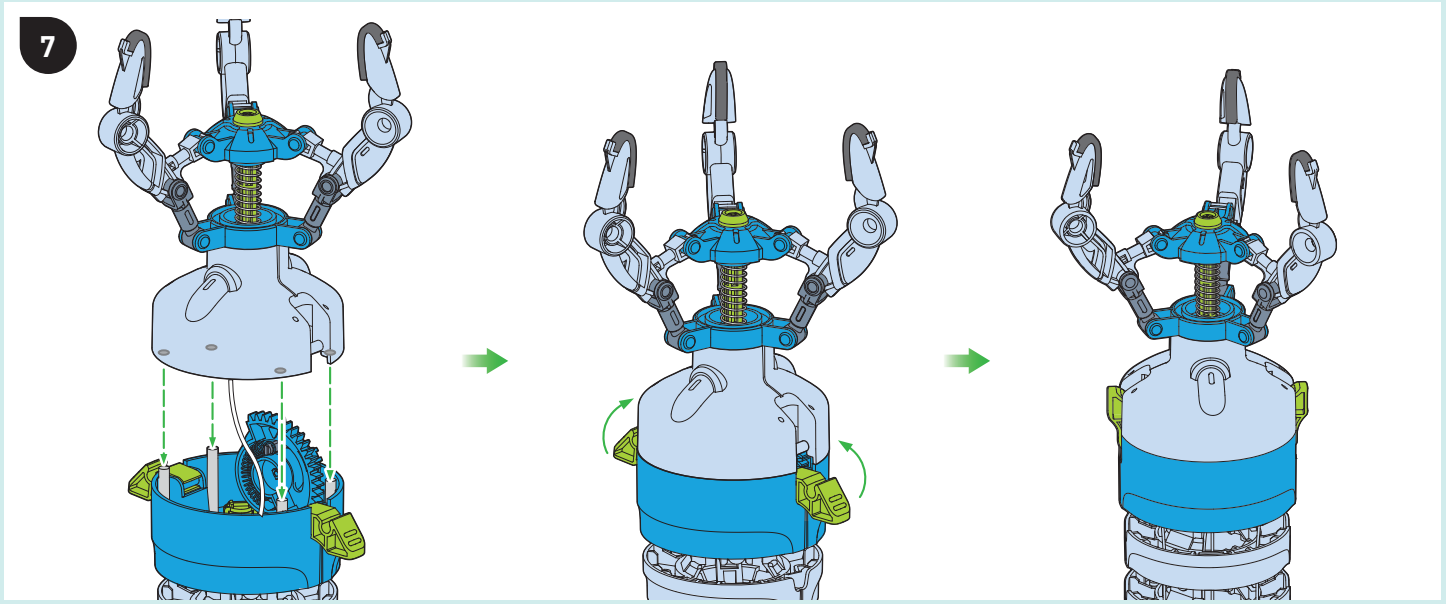




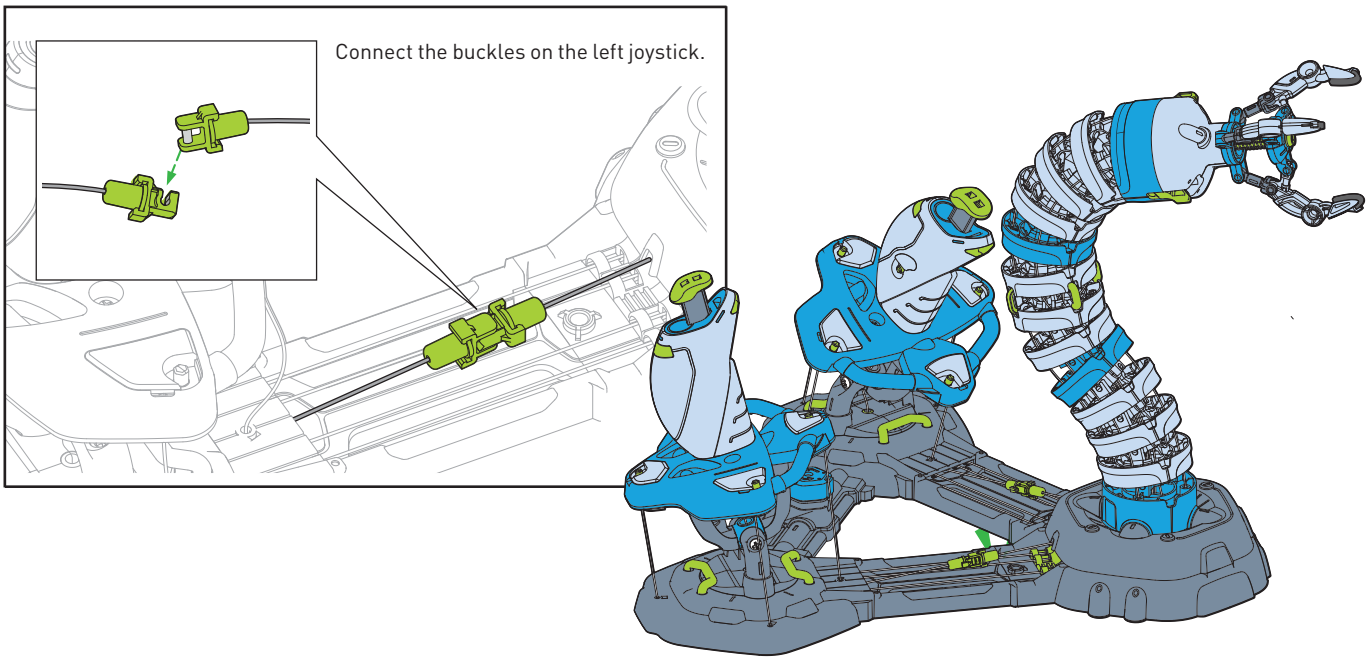

4
press


5


6
press
Klick


7

8


Connect the buckles on the left joystick.


Incredible work!
Now let's see what it can do!

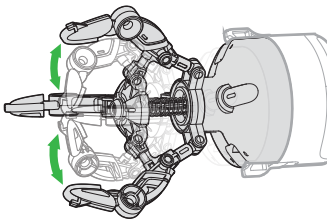


Awesome!

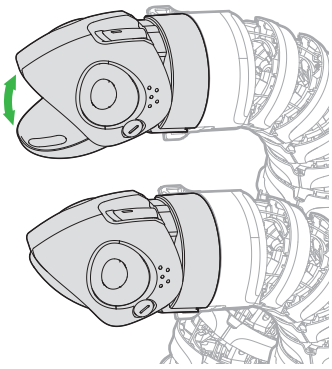
You've successfully assembled your Bionic Robotic Arm! On the next few pages you will learn how to use it and what you should pay attention to while using it. You can also find helpful tips should problems arise, and interesting information on the subject of bionics!

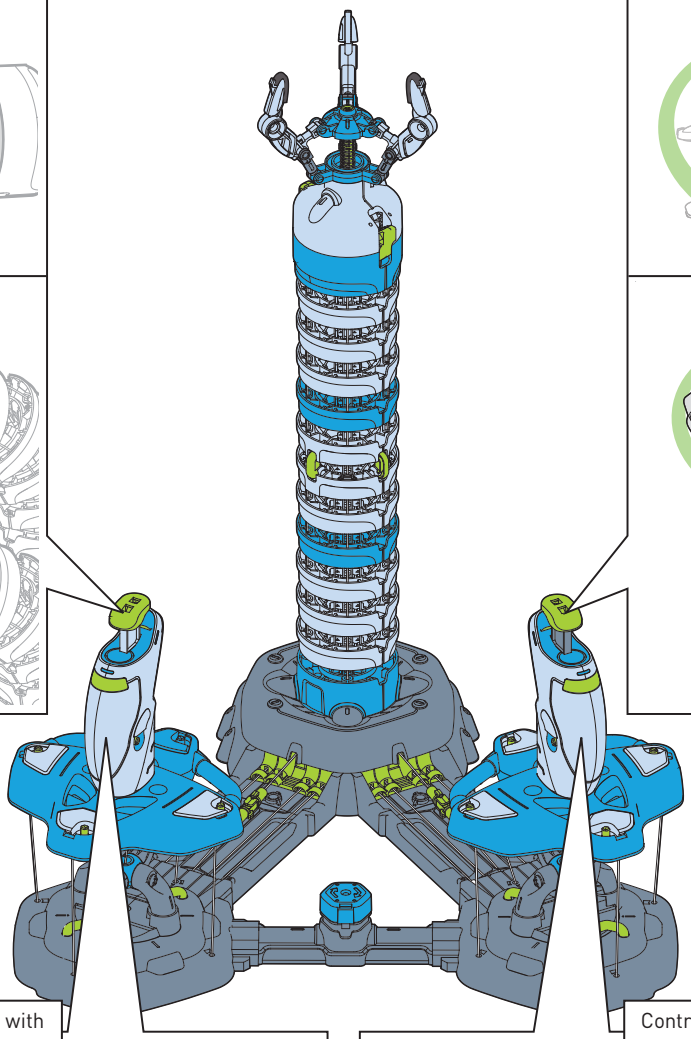
HOW TO PLAY

Claw

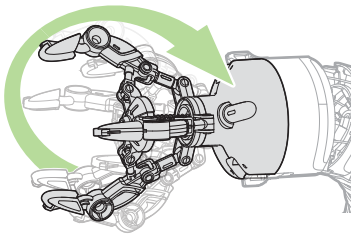


Garden eel head

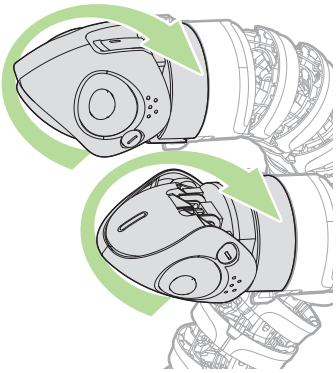




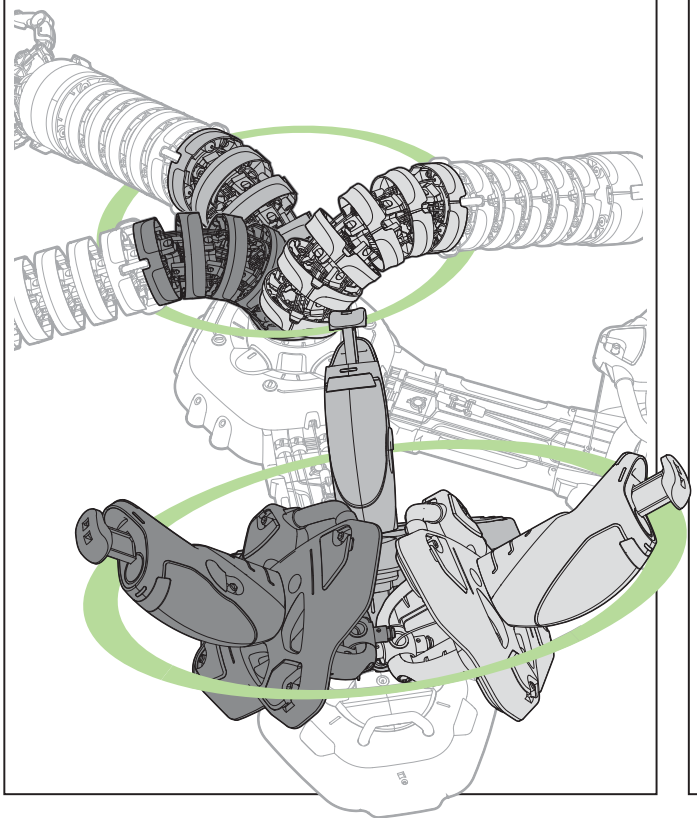
Claw



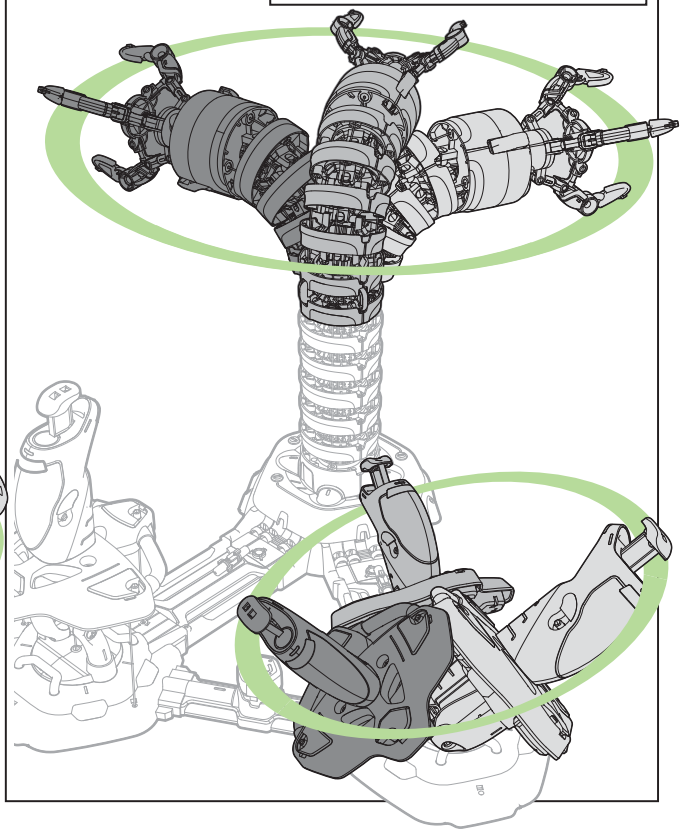
Garden eel head



Control the lower part of the arm with the left joystick.



Control the upper part of the arm with the right joystick.



CATCH THE SHRIMP!

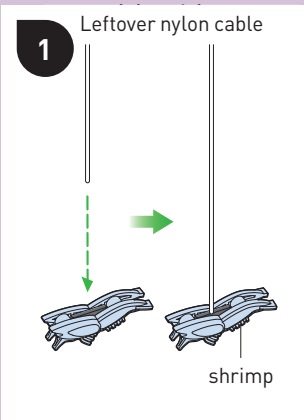


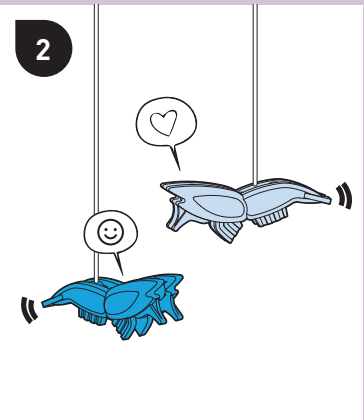


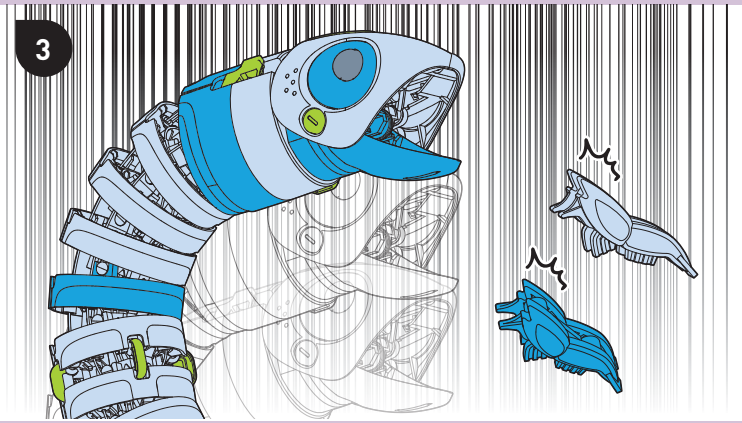
Of course, we've also prepared a little game for you! To play, you will have to attach the garden eel head to your Bionic Robotic Arm. The goal is to catch the shrimp!

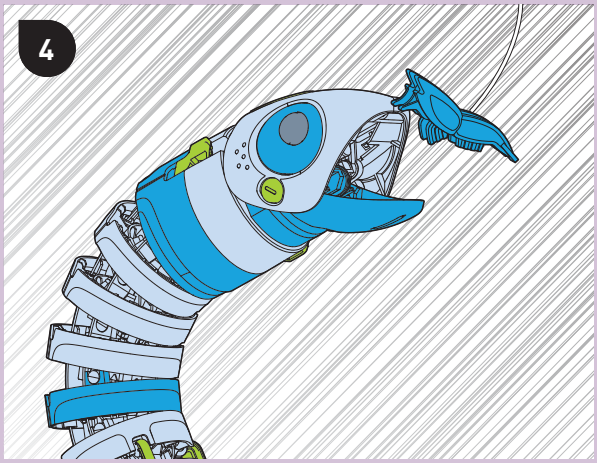
Take the leftover nylon cable, and attach it to the little shrimp that you made back on page 5. Hang them near your robotic arm, and try to catch them!

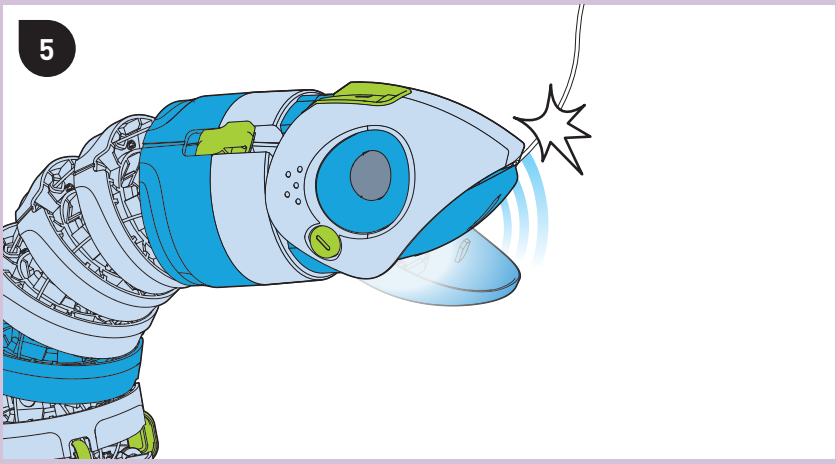
To make it a little harder, get a friend or a family member to join you. They'll hold the shrimp near the Bionic Robotic Arm and move them slowly back and forth. Try to catch them on the move!

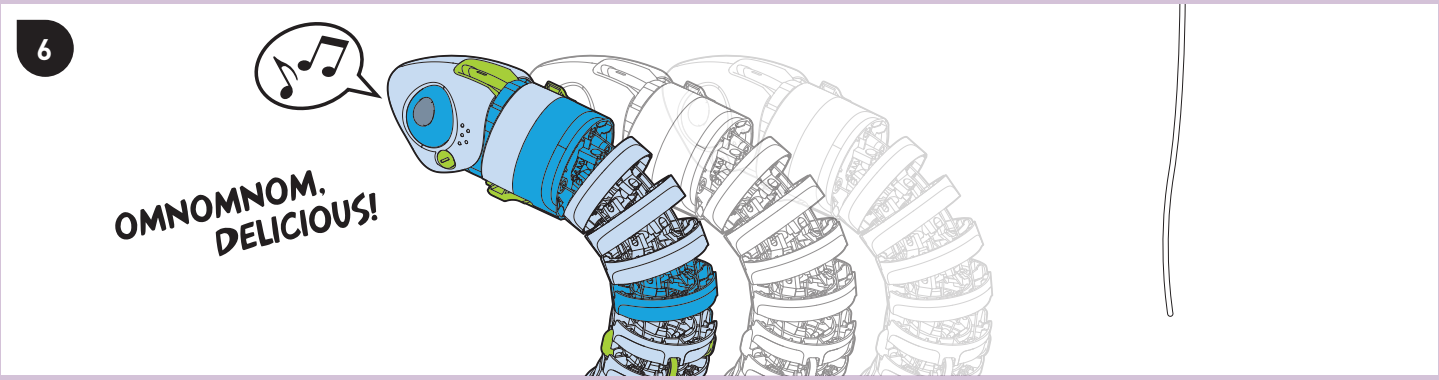












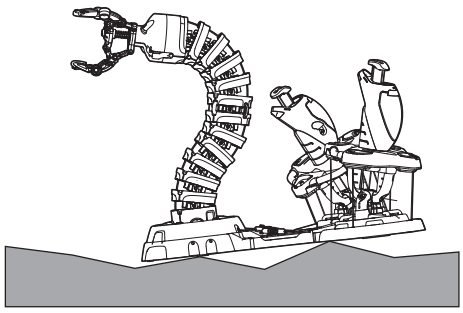
HOW LONG DOES IT TAKE YOU TO CATCH THE SHRIMP?

Grab a stopwatch and time yourself! Start the stop watch before touching the robotic arm, and stop it when you catch the shrimp! Record your time in this table!

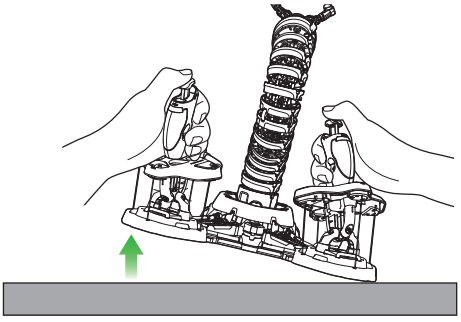
Attempt 1		Attempt 5		Attempt 9	
Attempt 2		Attempt 6		Attempt 10	
Attempt 3		Attempt 7		Attempt 11	
Attempt 4		Attempt 8		Attempt 12	

HANDLING AND PRECAUTIONS

✕ Avoid uneven surfaces.



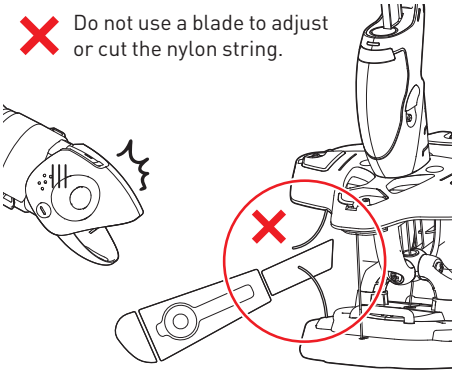
✕ Do not lift from the joysticks.



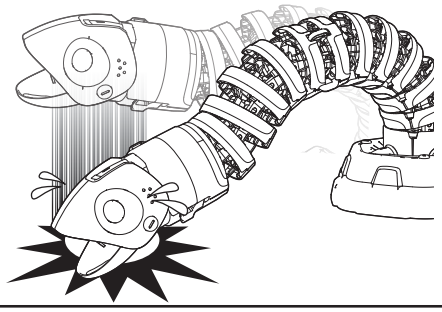
✕ Do not twist the joysticks.



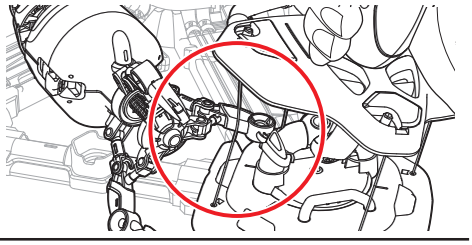
✕ Do not use a blade to adjust or cut the nylon string.



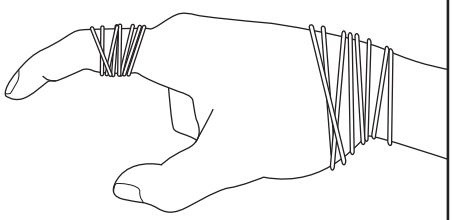
✕ Avoid hitting the arm hard against surfaces.



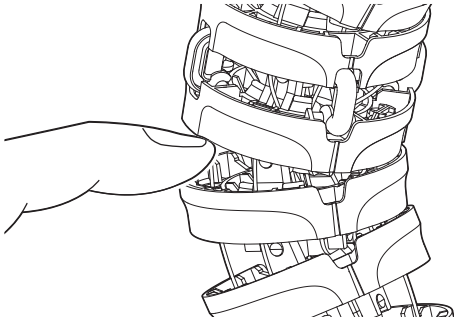
✕ If the claw is caught on the joystick, do not pull hard on the joystick. Gently disentangle the claw by hand.



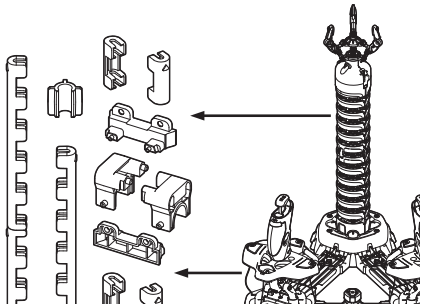
✕ Do not wrap the nylon cable around any part of your body.



✕ Do not put your fingers in any slits or moving parts.



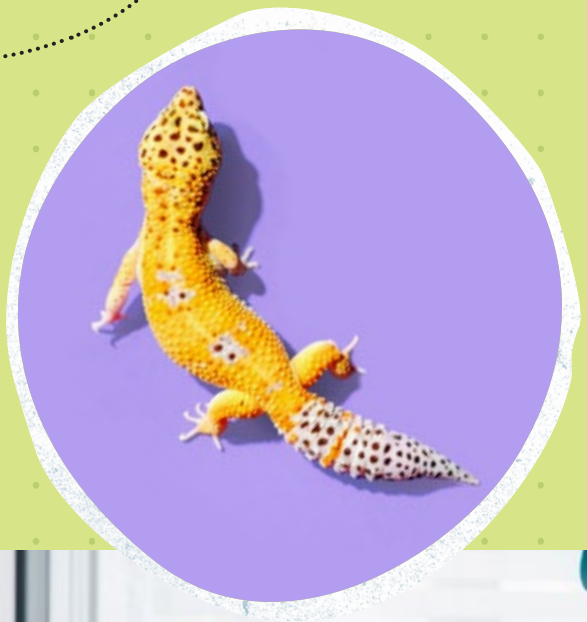
✕ All helper pieces must be removed before operating the joysticks.



BIONICS



Nature offers a variety of interesting strategies that organisms use to solve problems or complete tasks. The word bionic comes from "**bio-**" and "electro**nic.**" The field of bionics has to do with studying and understanding nature's solutions and applying them to technology. One famous example is hook and loop fasteners, like Velcro, which were inspired by burrs. Burrs are a type of seed case covered in little hooks, which can fasten into the fur of passing animals. An imitation of this mechanism can now be found on shoes, clothing, and more.



Bionics can also sometimes be found in toys! You can find the biological inspiration for the **Thames & Kosmos Gecko Run** marble run right in the name. The kit's nano-adhesive pads cling to smooth surfaces like the feet of a gecko. A gecko can effortlessly stick to surfaces like glass and stone thanks to microscopic hairs on its feet.

GECKO RUN



AN ELEPHANT'S TRUNK

Your Bionic Robotic Arm was also inspired by nature's technology. It might remind you of the trunk of an elephant. The trunk is an elephant's most important tool. It serves not only as a scent organ, but also used for touching, sucking, and grabbing. Thanks to about 40,000 muscles, the trunk is extremely strong, and has very good fine motor control despite its size. In comparison, we humans have about 656 muscles in total.



With the Bionic Robotic Arm, you operate a grabbing arm modeled on an elephant trunk.





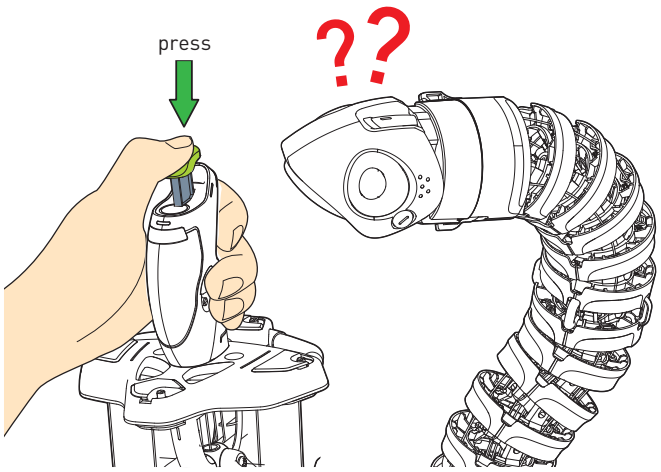
GARDEN EEL

With the "fish head," your Bionic Robotic Arm looks more like a garden eel. Garden eels live on the sandy ocean floor in "gardens" — colonies of up to a thousand individuals — from which they get their name. The holes that the little eels live in are dug using their pointed tails. They are the only vertebrates that live their whole lives in one place, hardly ever moving around. Like your Bionic Robotic Arm, they wave the front part of their bodies back and forth to grab food.

A

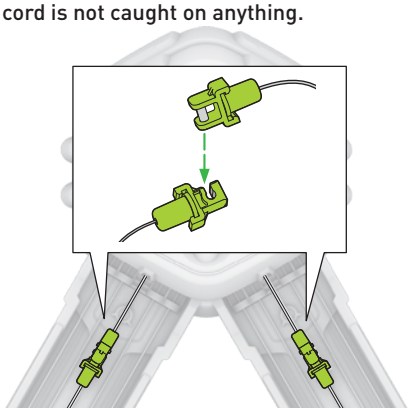
PROBLEM

The claw or eel head does not open well.



SOLUTION

1. Make sure that the buckles are securely fastened, and the cord is not caught on anything.

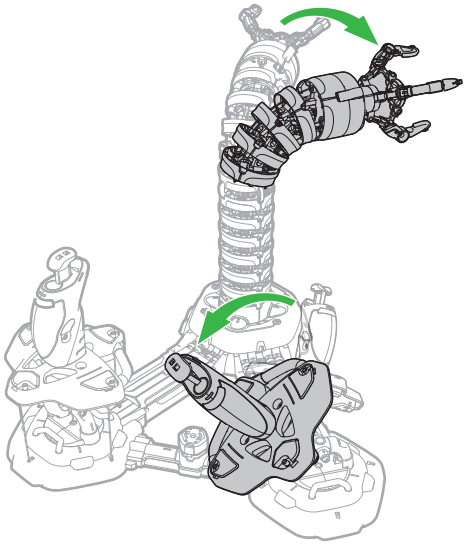


2. Check that steps 7–17 on pages 11–14 and 7–17 on pages 16–19 were performed correctly.

B

PROBLEM

The arm moves opposite to the movement of the joysticks.



SOLUTION

Check the following steps in order until the problem is resolved:

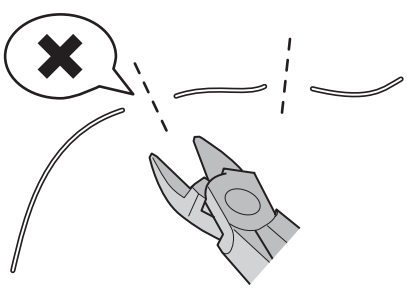
1. Steps 2–26 on pages 31–38.

2. Steps 4–11 on pages 41–42.

C

PROBLEM

The nylon cord was cut to the wrong length and can't be used.



SOLUTION

Substitute 0.8mm nylon string or fishing line.

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