

EXPERIMENT MANUAL

Saltwater Fuel Cell Robot



THAMES & KOSMOS

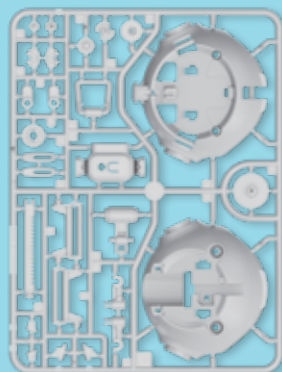
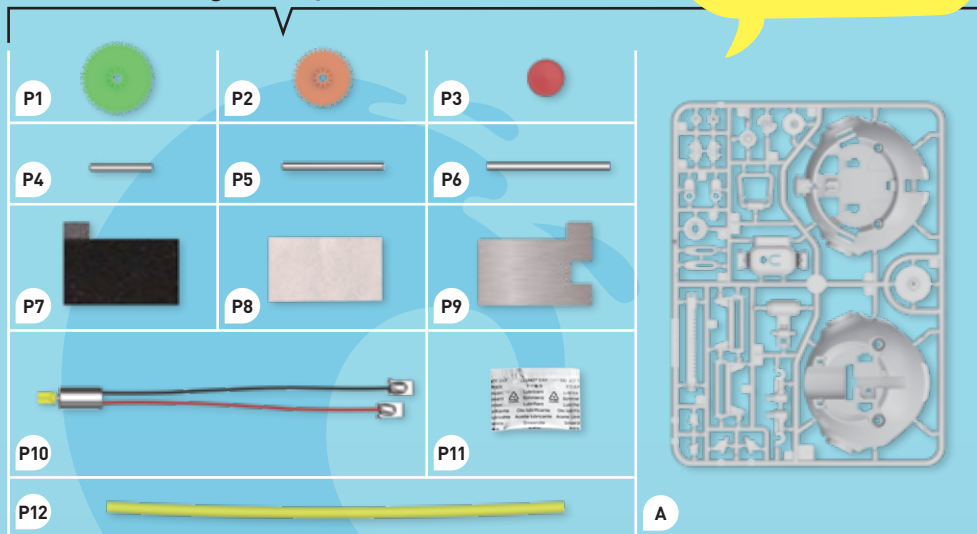


KIT CONTENTS

Good to know!

If you are missing any parts, please contact Thames & Kosmos technical support.

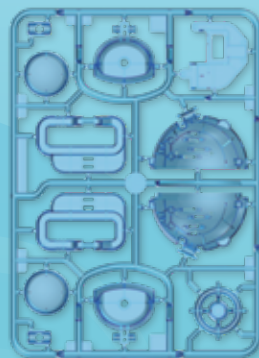
What's inside your experiment kit:



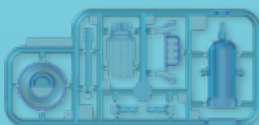
A

Checklist:

✓ No.	Description	Quantity	Part No.
○ P1	Gear (green)	2	730059
○ P2	Gear (orange)	1	730059
○ P3	Red cap	1	730060
○ P4	Round metal rod, short	1	730059
○ P5	Round metal rod, long	1	730059
○ P6	Hexagonal metal rod	1	730059
○ P7	Air cathode, black	1	730062
○ P8	Non-woven fabric	2	730063
○ P9	Magnesium plate	3	730063
○ P10	Motor	1	730060
○ P11	Non-toxic lubricant packet	1	723607
○ P12	Tube	1	730060
○ A	Frame A with parts A1 - A24	1	730056
○ B	Frame B with parts B1 - B9	1	730057
○ C	Frame C with parts C1 - C6	1	730058



B



C

Wow!

So many parts!

TABLE OF CONTENTS

Kit Contents **Inside front cover**
 Table of Contents **1**
 Safety Information **2**
 Important Information **3**

ASSEMBLY INSTRUCTIONS BEGIN ON PAGE 4

Assembling the Gearbox **4**
Assembling the Body **6**
Assembling the Fuel Cell **14**
Assembling the Feet **16**

Operating Instructions **18**
 Maintaining the Fuel Cell **23**
 Troubleshooting **24**

Woohoo!
Let's go!



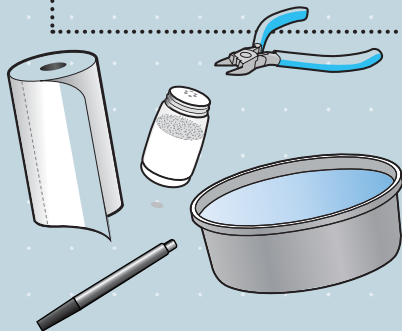
TIP

YOU WILL FIND
ADDITIONAL INFORMATION
 IN THE **CHECK IT OUT** SECTION
 ON PAGES 26–28.



YOU WILL ALSO NEED:

Diagonal cutter or scissors and nail file, Phillips-head screwdriver, ruler, fine permanent marker, paper towels, table salt, plastic cup, teaspoon, water



SAFETY INFORMATION

WARNING



Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled.

WARNING: This toy is only intended for use by children over the age of 8 years, due to accessible electronic components.

Instructions for parents or caregivers are included and shall be followed.

Keep the packaging and instructions as they contain important information.

May only be operated when fully assembled.

Proper assembly must be checked by an adult before use.

WARNING! This kit contains functional sharp edges or points. Do not injure yourself!

INSTRUCTIONS FOR HANDLING THE FUEL CELL MODULE

- *** Assemble the fuel cell module according to the assembly instructions (see page 14) under adult supervision: The air cathode (carbon plate) and magnesium plate must not touch each other, otherwise a short circuit will occur, which will prevent the fuel cell from functioning.
- *** Please note the information on operating the fuel cell (see page 18) and on its maintenance/cleaning (see page 23).
- *** Connect the contact modules (see pages 4 and 13) with the correct polarity. To do this, observe the markings on the robot, which indicate the contact module to be connected on that side (BLK: connect the contact module with the black cable; RED: connect the contact module with the red cable).
- *** Do not use any other energy source than the supplied fuel cell, i.e. no batteries or cable.
- *** The fuel cell must be removed from the toy when not in use. After each experiment, take care of the fuel cell (see page 24), i.e. remove the fuel cell and clean all individual parts, dry them and store them safely.
- *** The cable ends of the motor and the assembled contact modules must not be inserted into a power socket.
- *** Protect the robot from moisture and only operate it indoors.



THE RIGHT TOOL

The right tool can make assembling your model much easier and it can also make your model 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.

Notes on Disposal of Electric and Electronic Components

The electronic components of this product are recyclable. For the sake of the environment, do not throw them into the household trash at the end of their lifespan.

They must be delivered to a collection location for electronic waste, as indicated by the following symbol:



Please contact your local authorities for the appropriate disposal location.

IMPORTANT INFORMATION

Dear Parents and Supervising Adults,

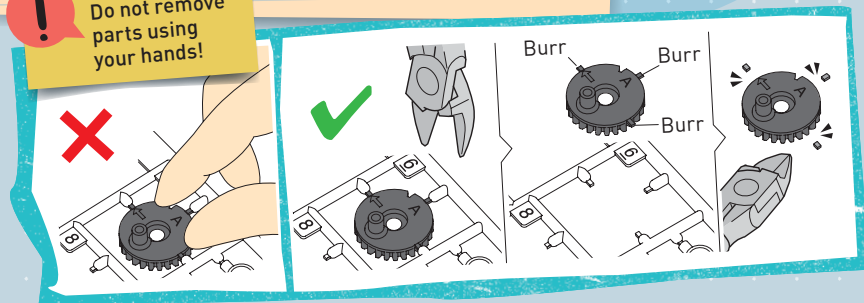
Children want to be amazed, understand, and create new things. They want to try everything out and do it for themselves. They want to know! They can do all of this with Thames & Kosmos experiment kits. We hope you and your child have a lot of fun experimenting with Saltwater Fuel Cell Robot.

- Before building and experimenting, read the instructions together with your child and discuss the safety information together. Stand by to assist your child with any challenging steps of assembly or usage.
- If your child is working on a table top, give them something to work on to prevent damage to the furniture.
- Particular care must be taken when cutting the plastic parts out of the frames, as sharp points can be created. These can be removed with the help of diagonal cutters or scissors and a nail file. Please supervise your child whenever they are using scissors or diagonal cutters until you feel they are ready to use the tools independently
- Building the robot is an exciting, educational project and takes several hours. It is best to build it in a place where the materials can be left lying out so that it does not have to be moved.
- Since the robot is operated with saltwater, it should be experimented with on a waterproof and durable surface.
- The Robot's fuel cell should be cleaned regularly and the water in the hoses replaced to prevent contamination. To do this, remove all hoses from the robot and rinse them with tap water. Remove the fuel cell and follow the cleaning instructions on page 23. Then drain the water and lay all parts out to dry before using the robot again. If the robot is not to be used for a long time, all parts should first be cleaned and dried.

**IMPORTANT:**

REMOVE THE PARTS FROM THE FRAMES ONLY WHEN THEY ARE NEEDED. REMOVE EXCESS MATERIAL (BURRS) BEFORE ASSEMBLY USING A DIAGONAL CUTTER OR A NAIL FILE.

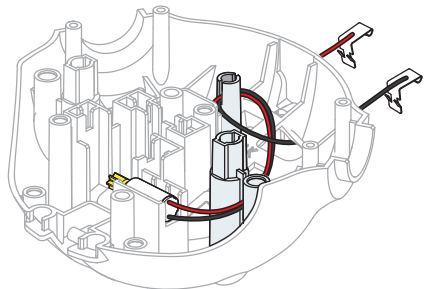
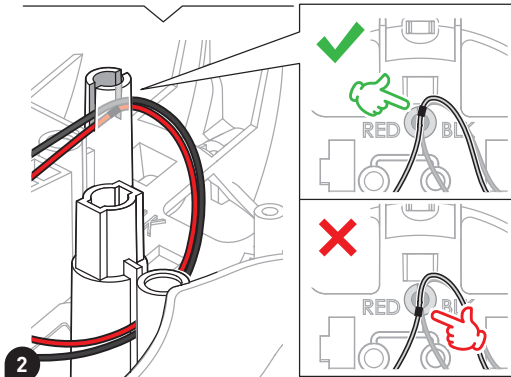
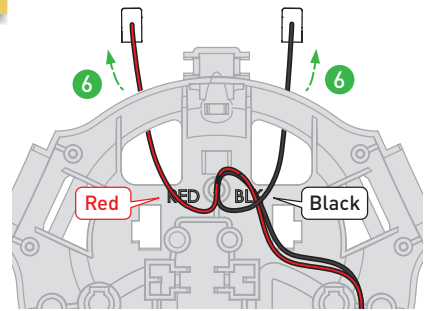
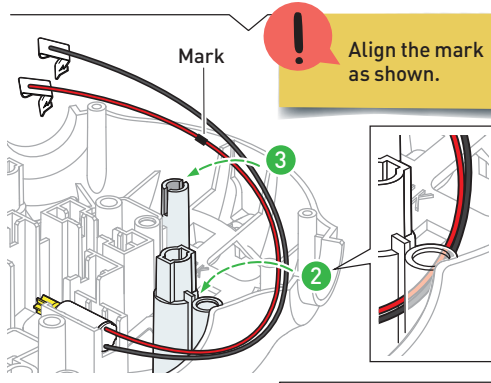
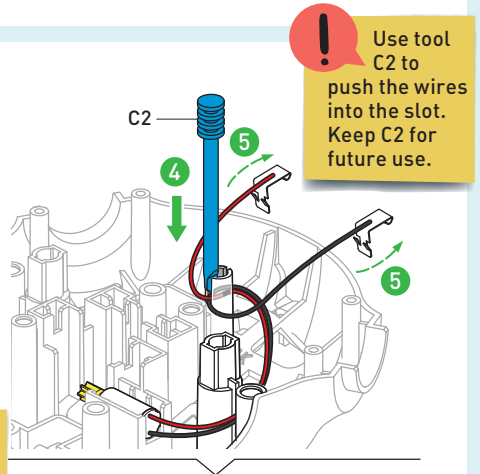
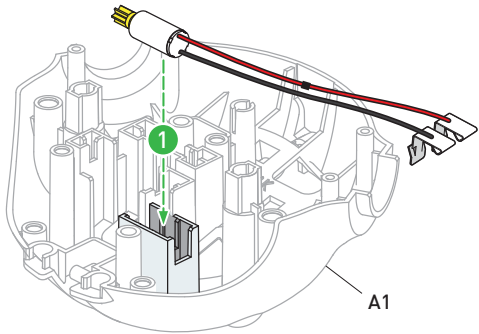
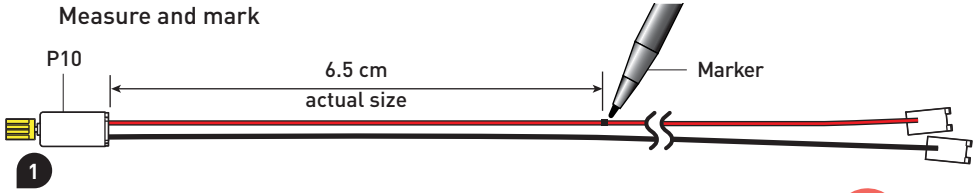
! Do not remove parts using your hands!

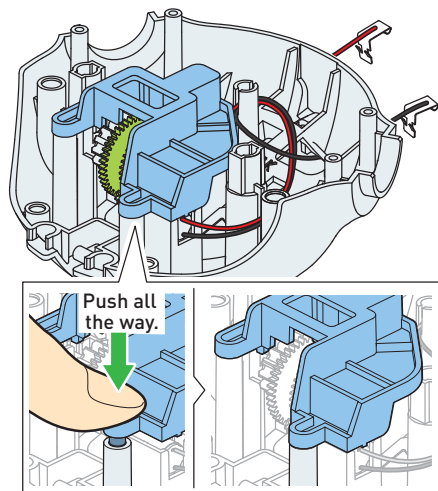
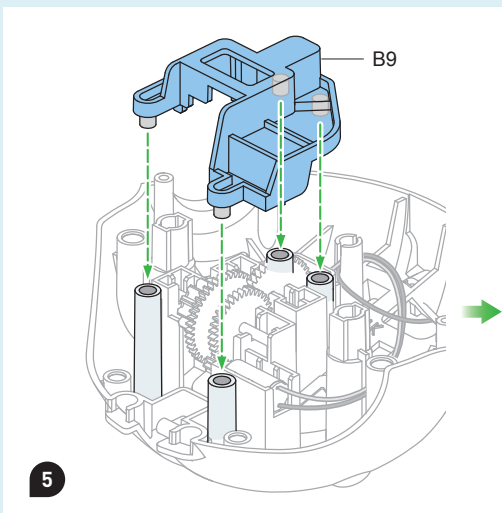
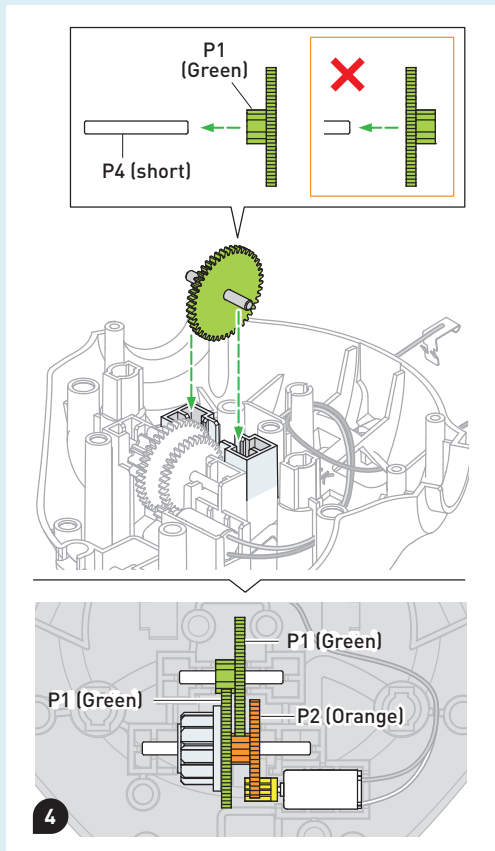
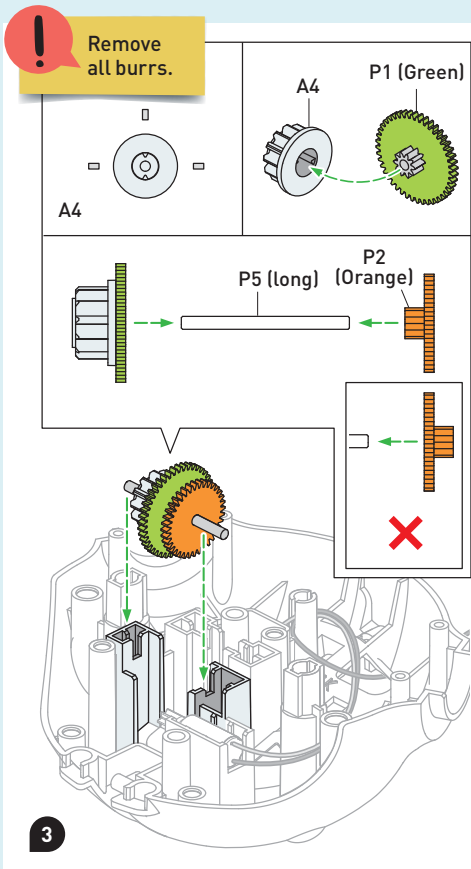


And most importantly: Have fun with your Saltwater Fuel Cell Robot!

ASSEMBLING THE GEARBOX

Measure and mark

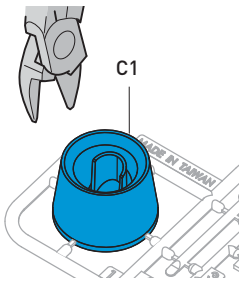




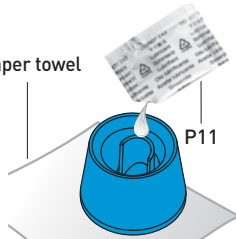
HANDLING THE LUBRICANT



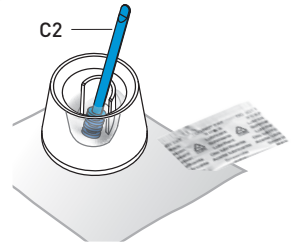
After applying the lubricant, clean tool C2 with a paper towel before using it for other assembly steps.



Paper towel



Be careful not to spill any lubricant.



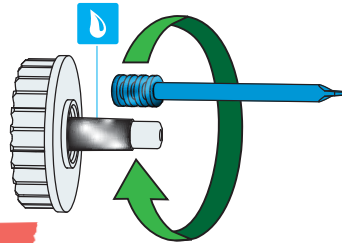
= Lubricant

When you see this symbol, lubricate the part.



Lubricate only the area marked in gray. The lubricant is non-toxic, but work carefully and do not touch the lubricant with your hands or get it into your eyes. (It can stain clothes and irritate eyes). Dispose of leftover lubricant in the household trash after assembly. Do not pour it down the drain.

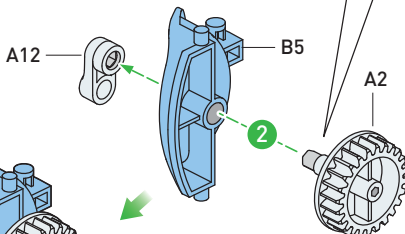
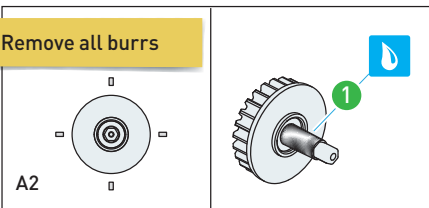
Lubricate this part



ASSEMBLING THE BODY

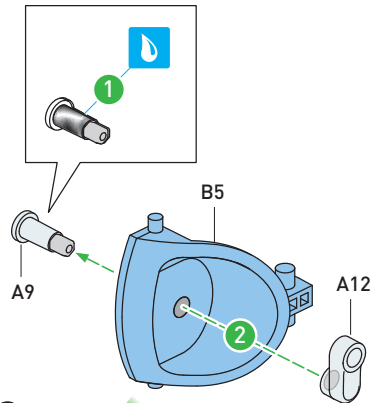


Remove all burrs



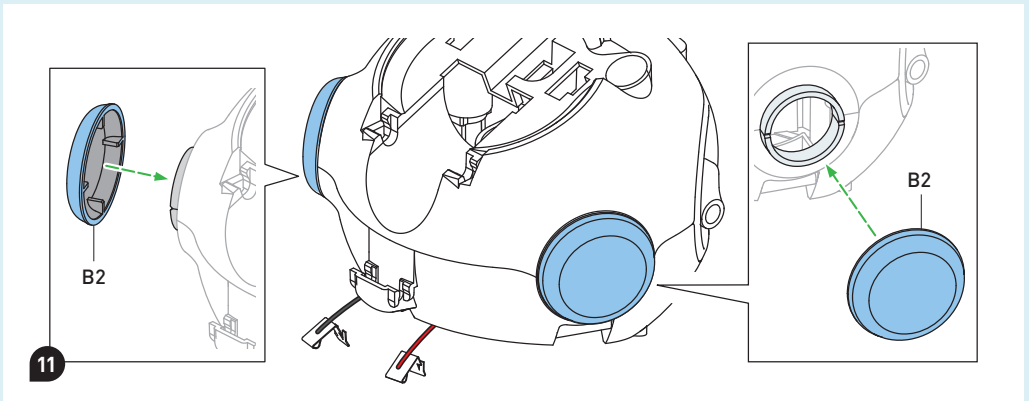
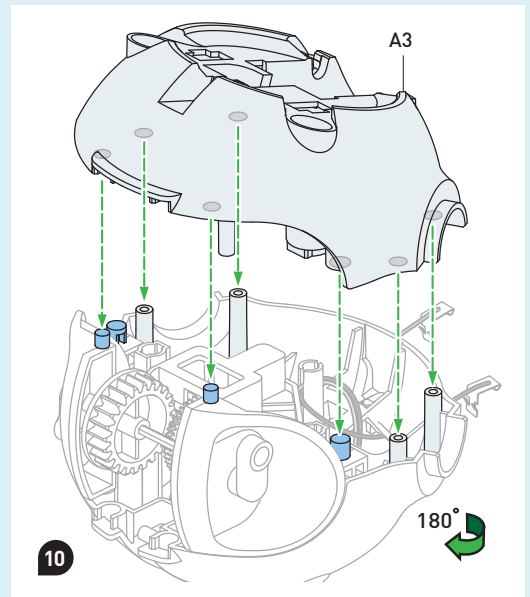
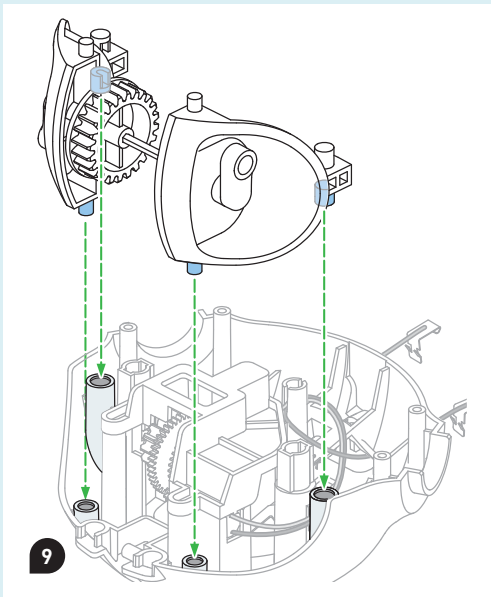
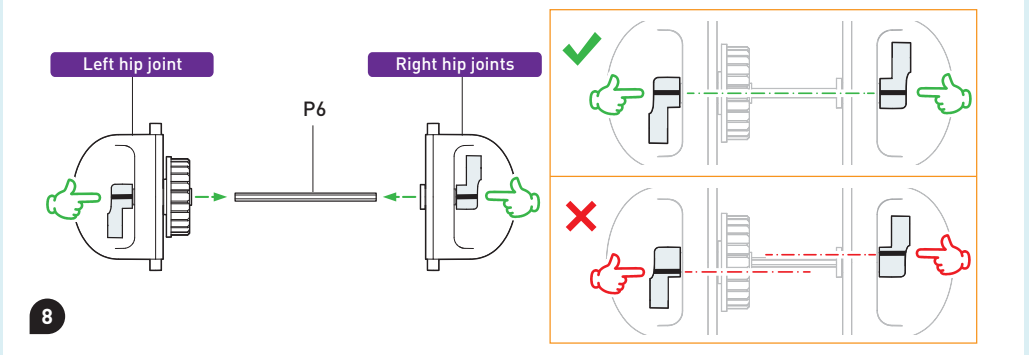
Left hip joint

6



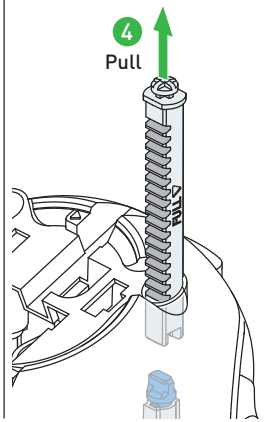
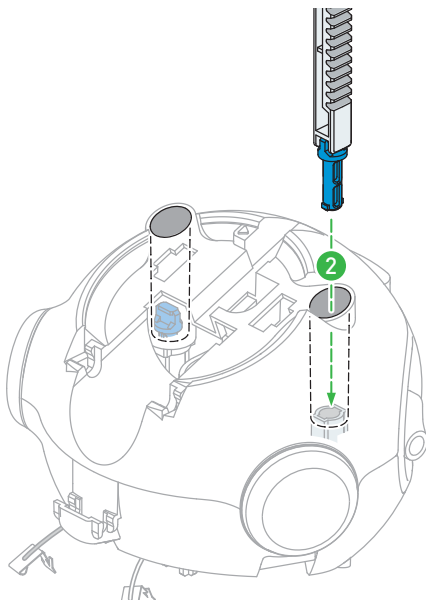
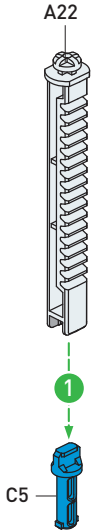
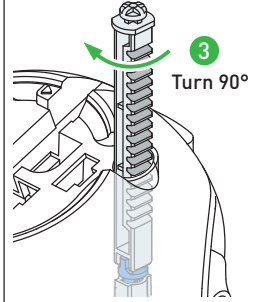
Right hip joint

7

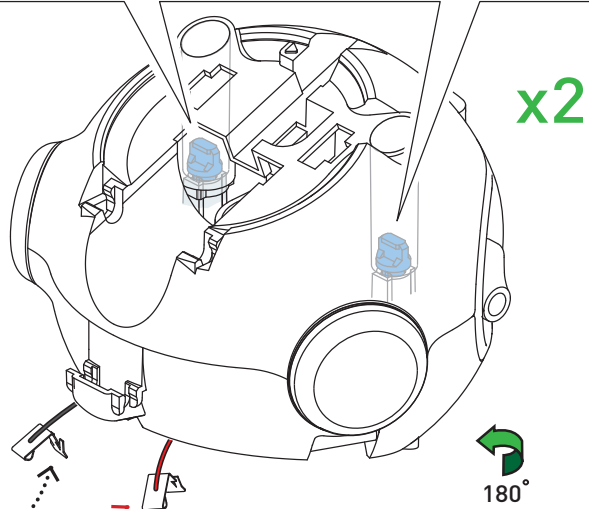




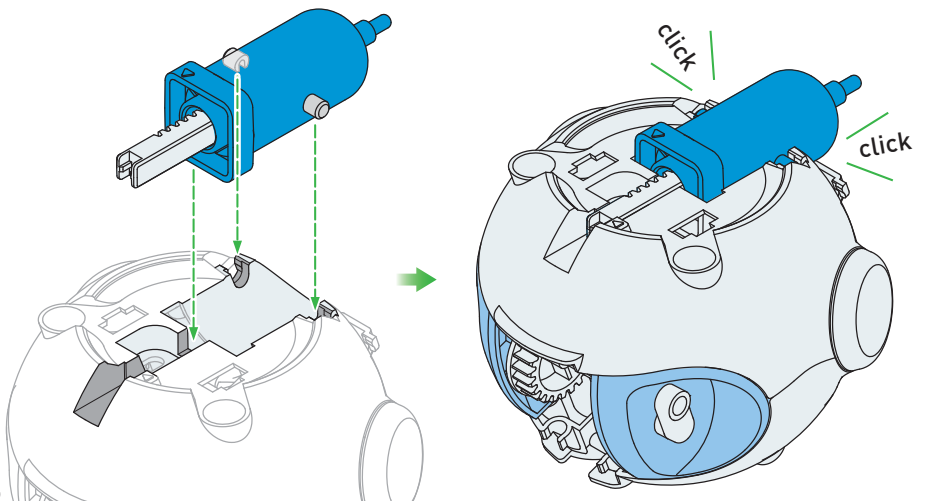
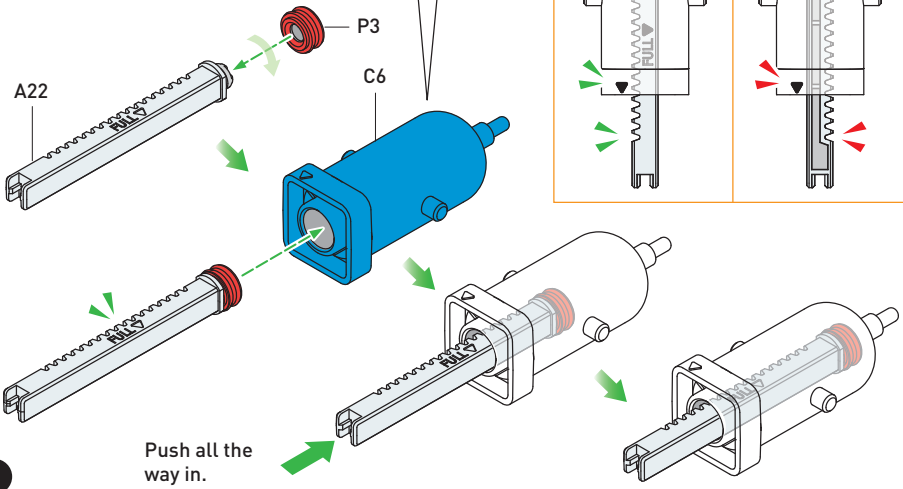
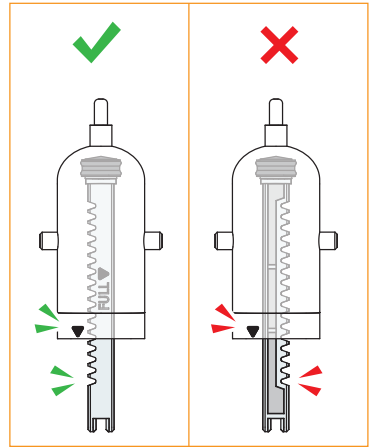
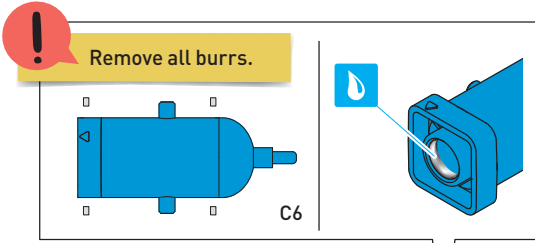
! Remove all burrs.



! Make sure that the wires protrude from the body of the robot. If they fall in, use the C2 tool to retrieve them. Clean C2 thoroughly with a paper towel before using it on the cables.

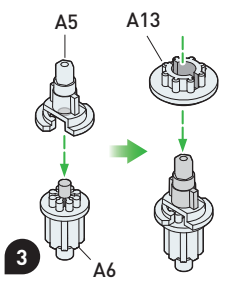
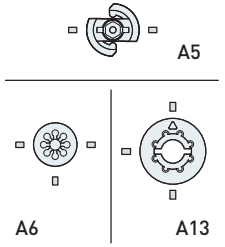


12

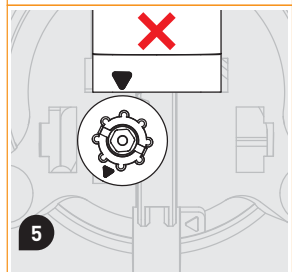
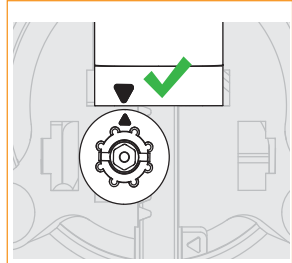




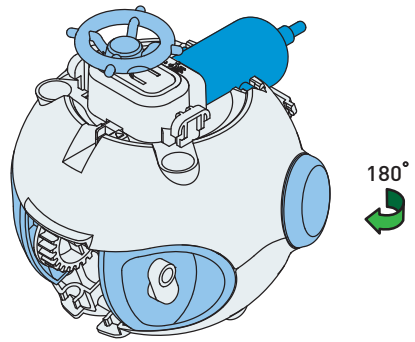
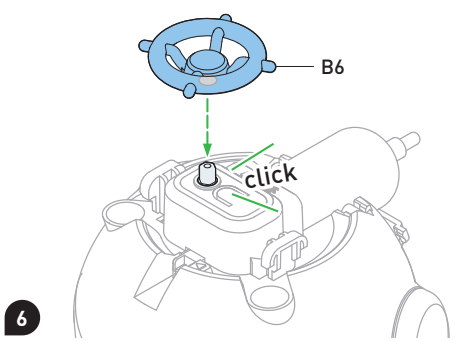
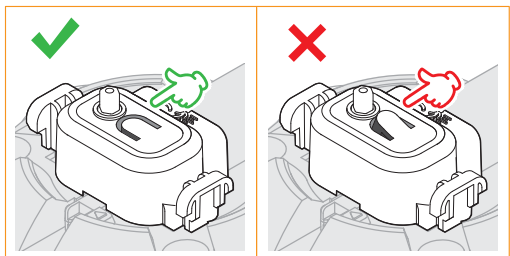
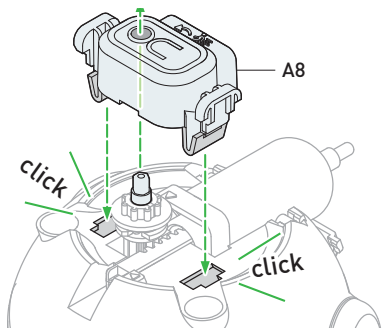
! Remove all burrs

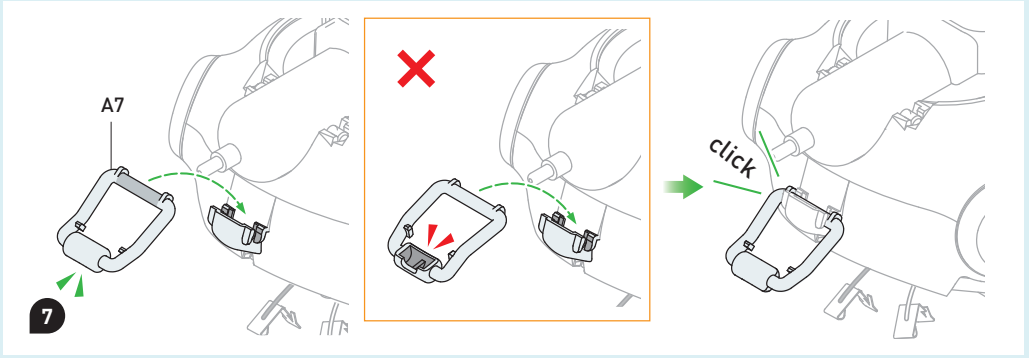


! Make sure that the arrows point to each other.

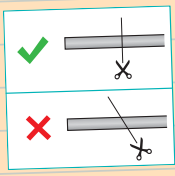
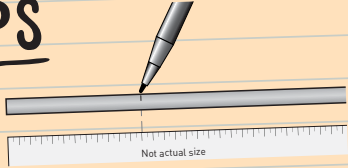


! If you have made a mistake, remove A8 and repeat step 5.

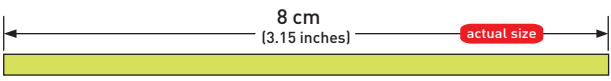




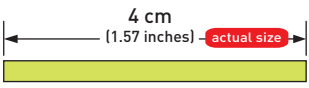
TIPS



MEASURE AND MARK BEFORE CUTTING. MAKE STRAIGHT CUTS WHEN CUTTING.

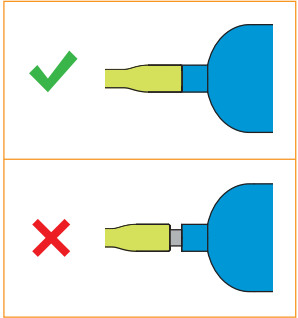
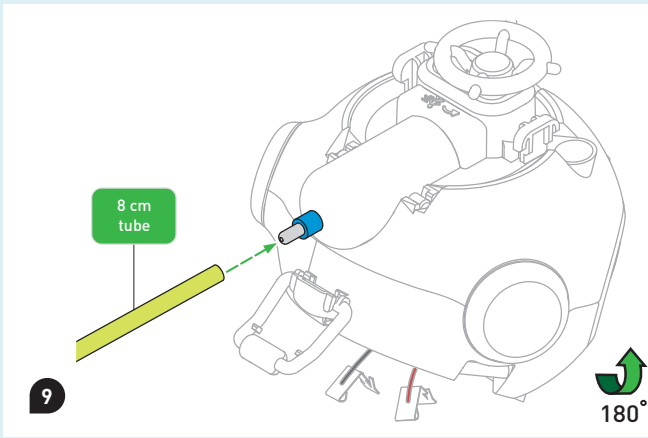


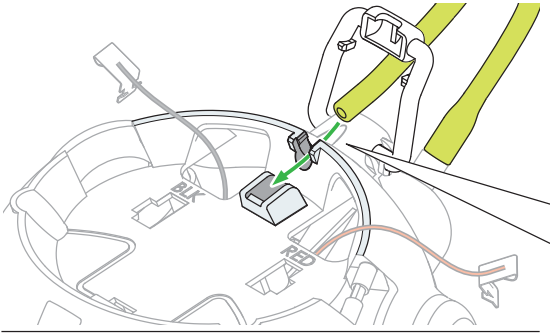
8 cm x1



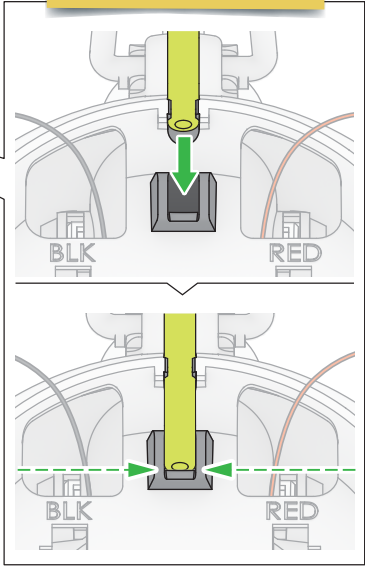
4 cm x2

! If you cut the tube incorrectly, the A10 connector can help (see p. 25).

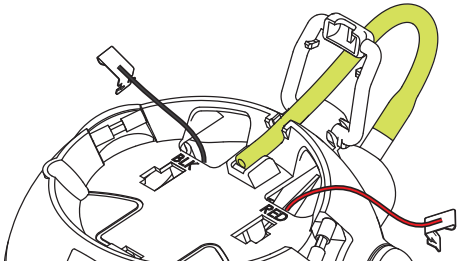




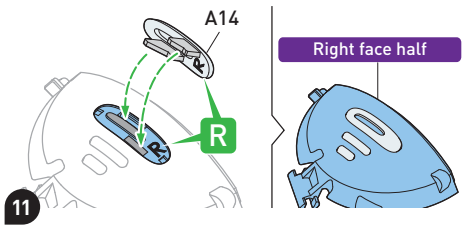
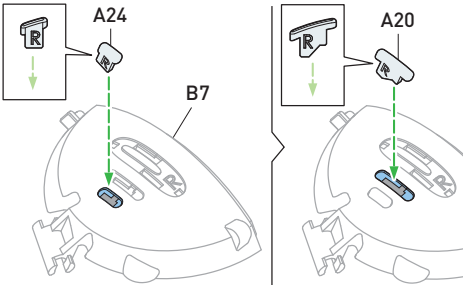
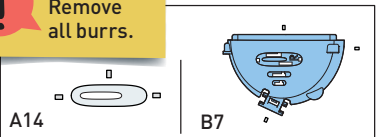
! Push the tube all the way through.



10

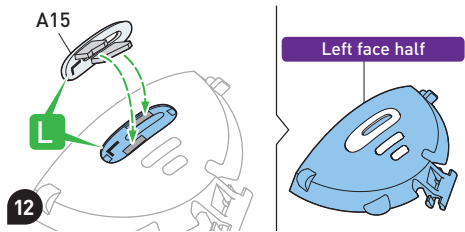
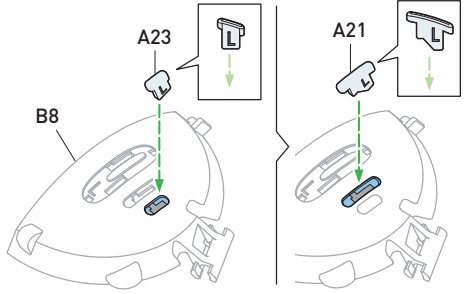
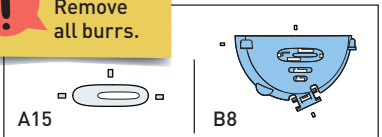


! Remove all burrs.

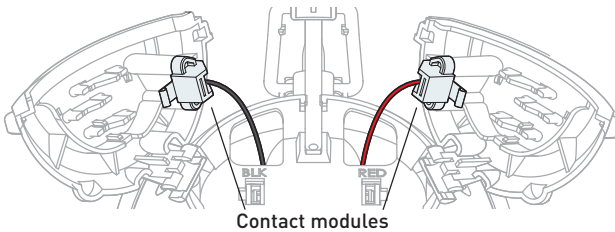
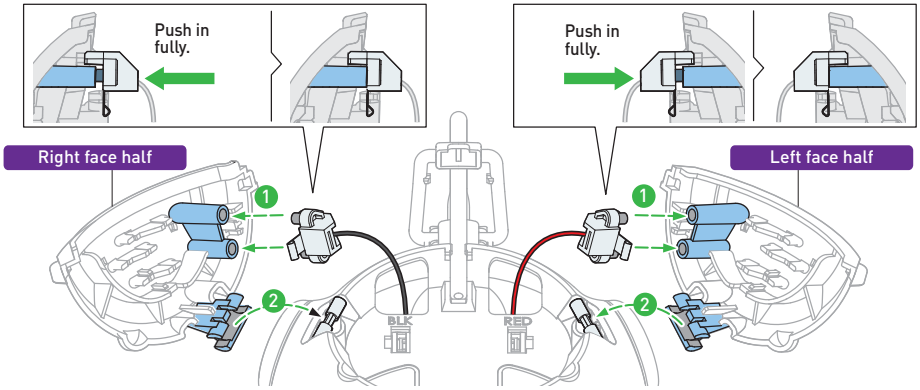
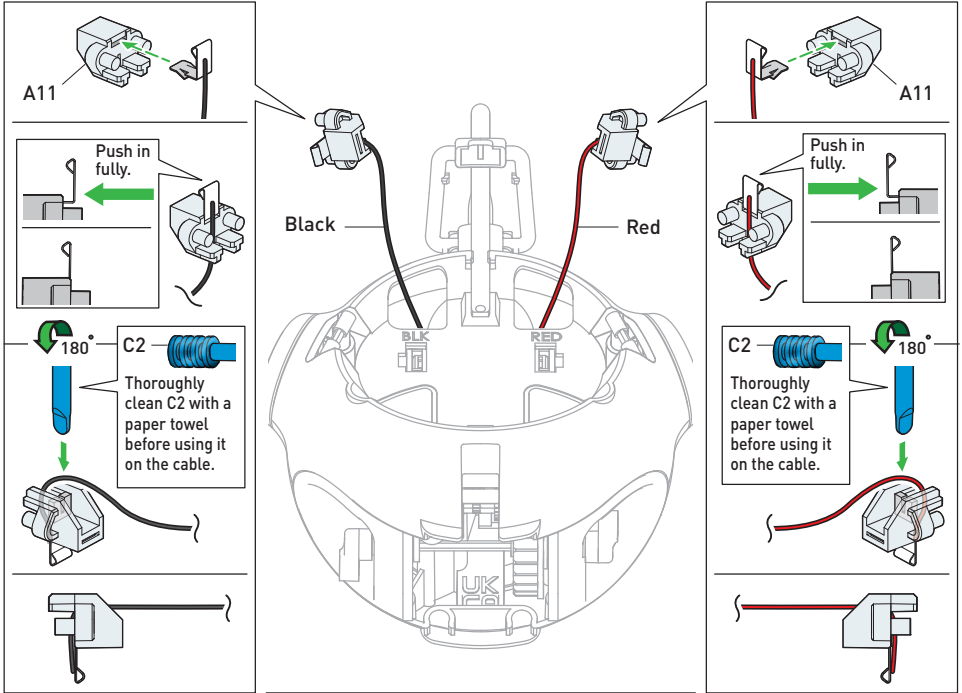


11

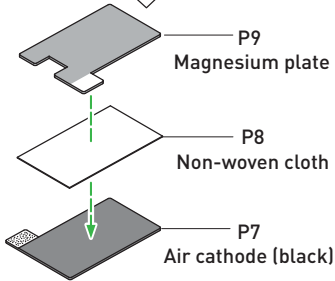
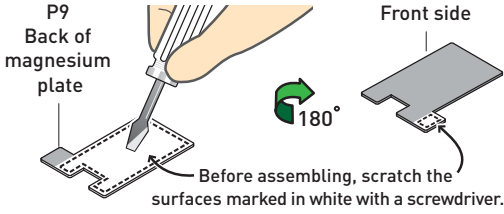
! Remove all burrs.



12



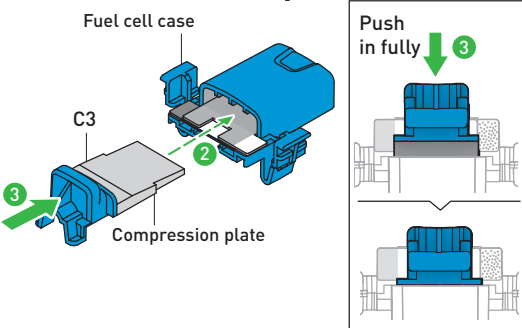
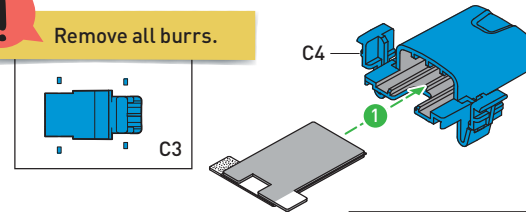
ASSEMBLING THE FUEL CELL



14

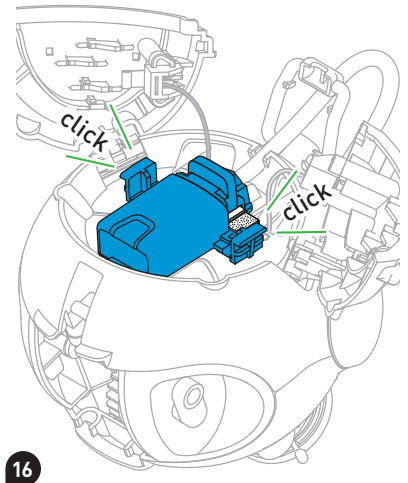
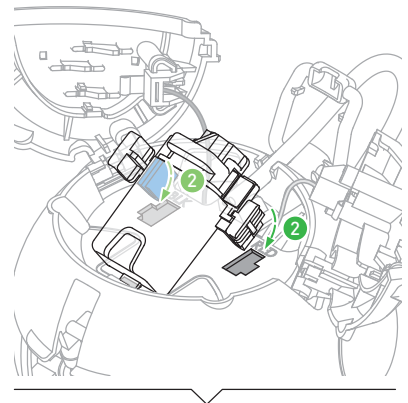
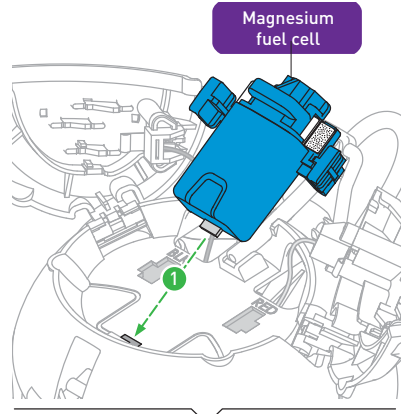
Make sure that P7, P8, & P9 are stacked in the correct order and orientation.

Remove all burrs.

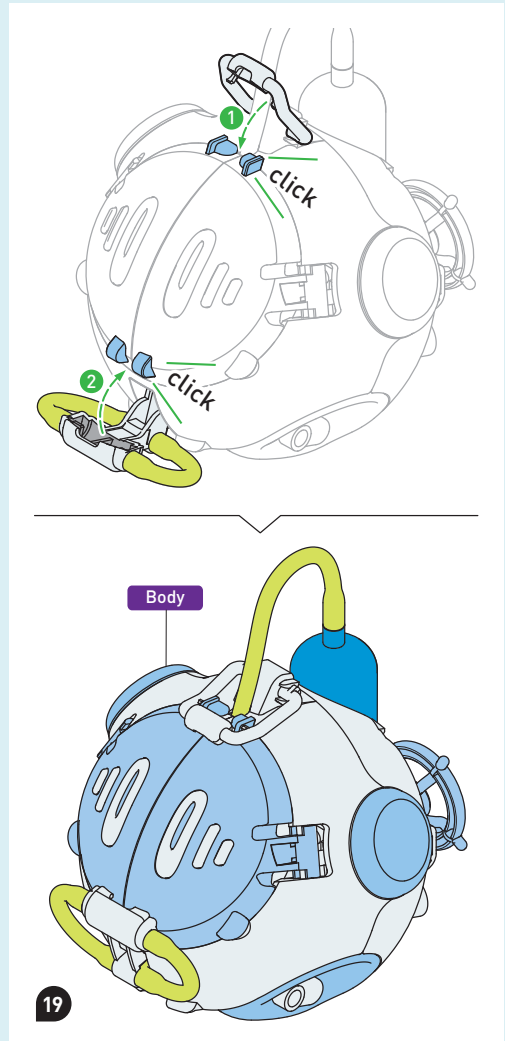
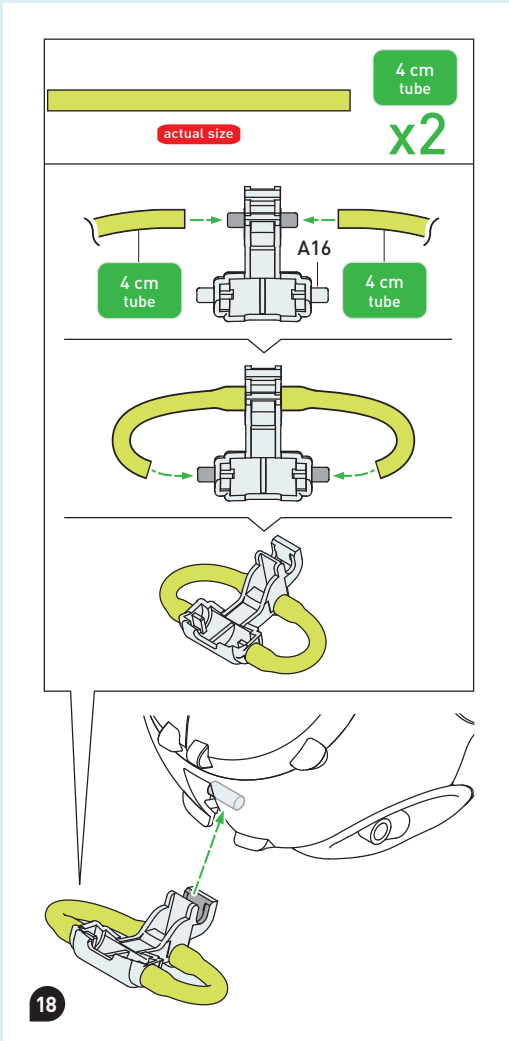
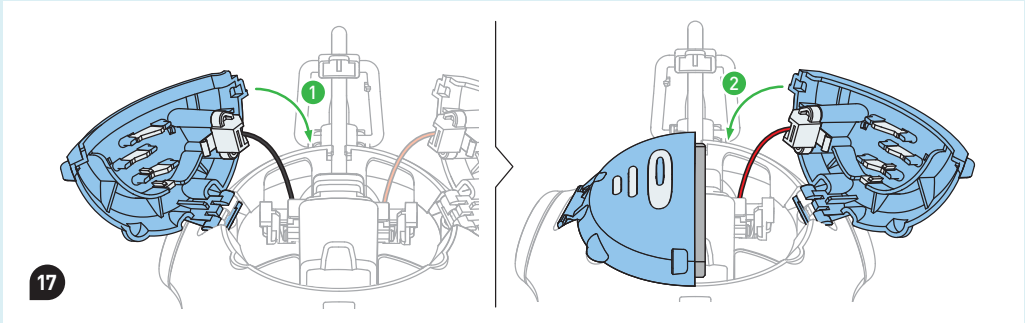


Magnesium fuel cell

15



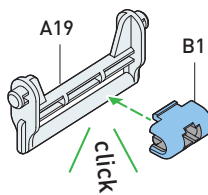
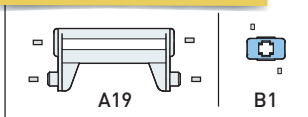
16



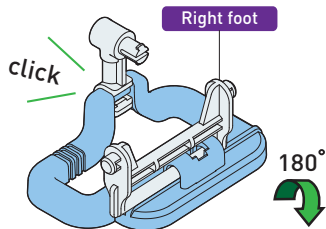
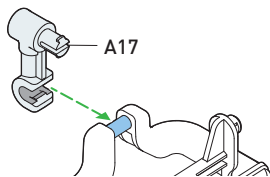
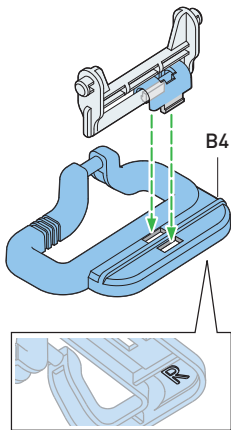
ASSEMBLING THE FEET



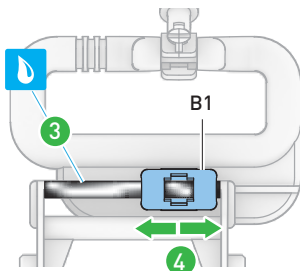
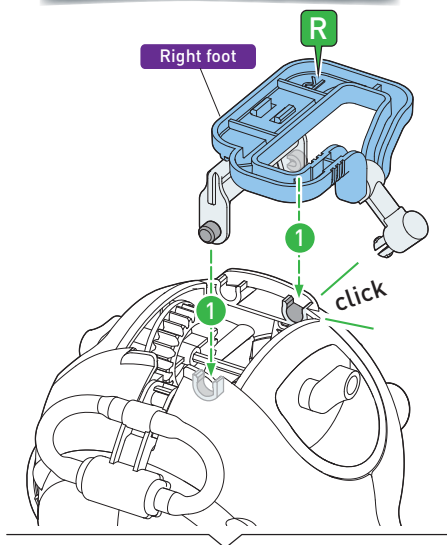
Remove all burrs.



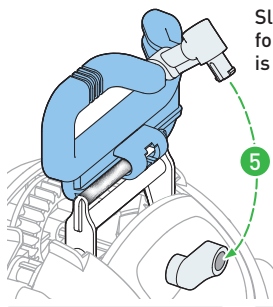
20



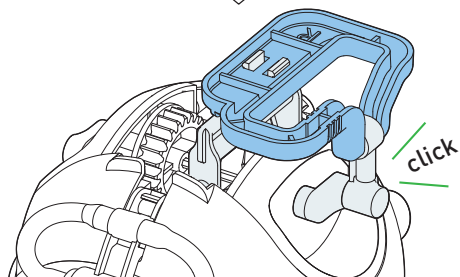
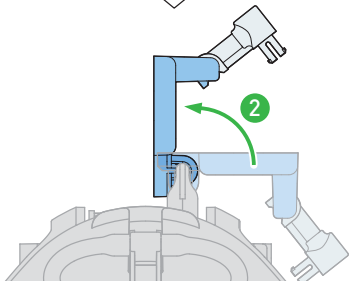
Ask an adult for help if you have any difficulties.



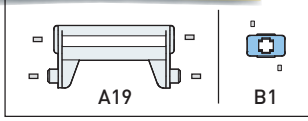
Slide B1 back and forth until the lubricant is evenly distributed.



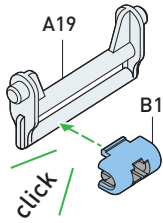
21



Remove all burrs.



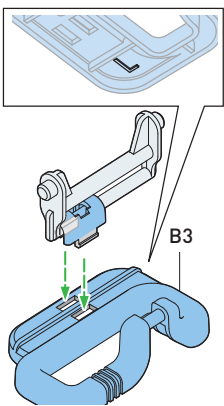
A19 B1



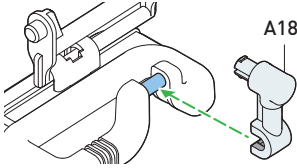
A19 B1

click

22



B3



A18

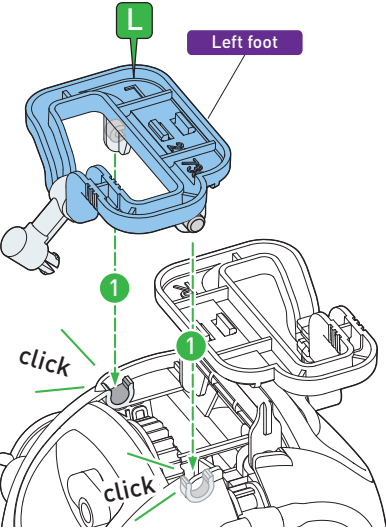
Left foot

click

180°

Ask an adult for help if you have any difficulties.

L Left foot

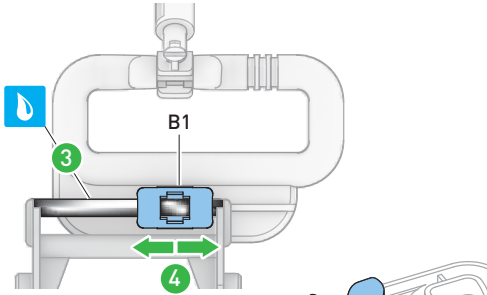


1

click

1

click



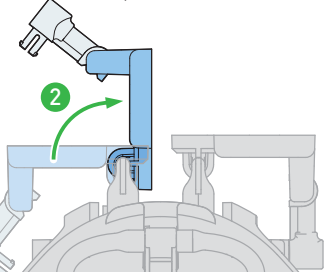
B1

3

4

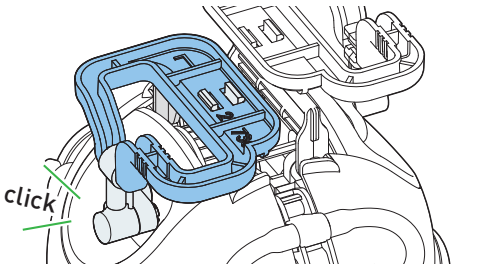
Slide B1 back and forth until the lubricant is evenly distributed.

5



2

23



click

Done!

Hi!
I'm Walter, the
Saltwater Fuel
Cell Robot!



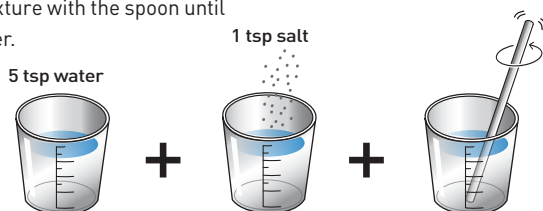
General Information

- Each magnesium plate has an operating time of about four hours. After this time, the surface of the plate will have dissolved to such an extent that you will have to replace it. The kit contains three magnesium plates.
- Dispose of used magnesium plates in the household trash.

1. Mix the saltwater solution


Prepare the saltwater solution by adding five teaspoons of water and one teaspoon of table salt to a plastic cup. Then stir the mixture with the spoon until the salt dissolves in the water.

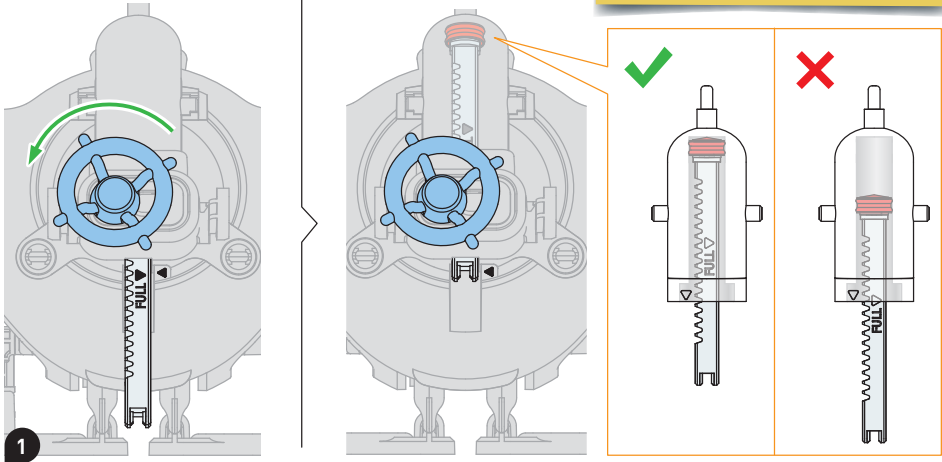
! Please read the following instructions carefully and follow the steps to successfully set Walter in motion.



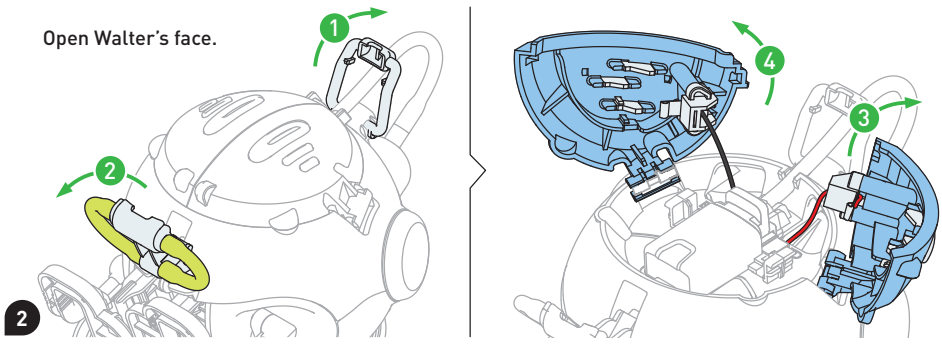
2. Fill Walter's tank

Turn the valve all the way counterclockwise.

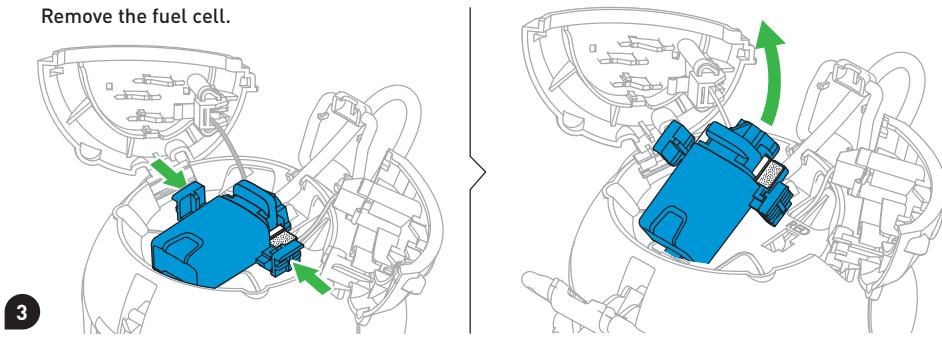
 Push the rack all the way in, otherwise air will enter the container when filling it.



Open Walter's face.

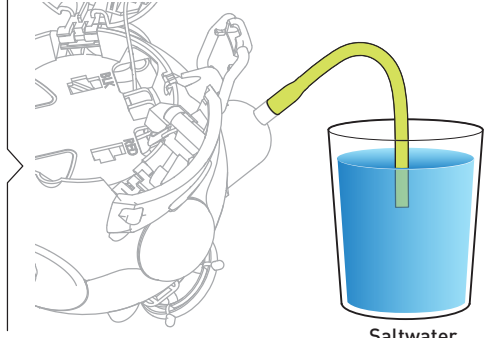
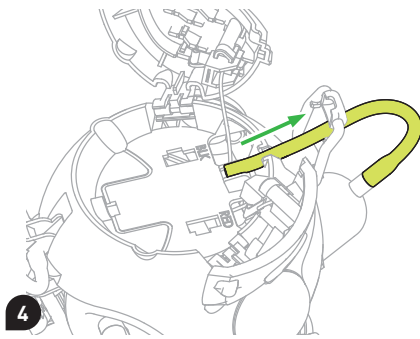


Remove the fuel cell.

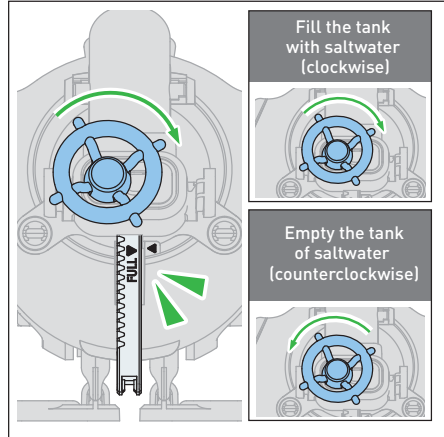
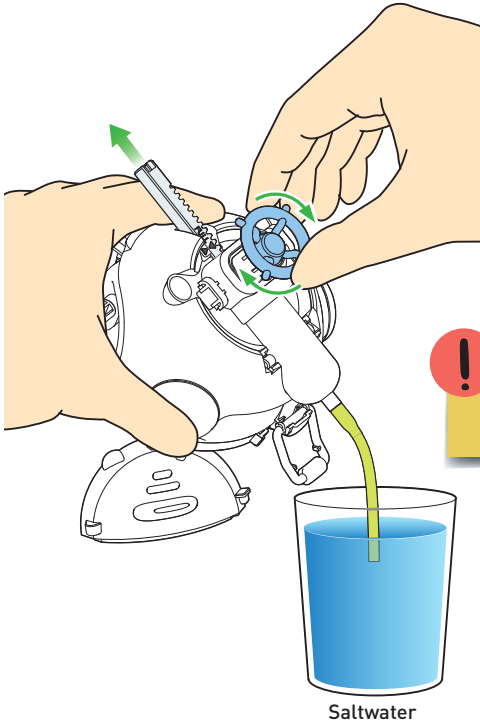




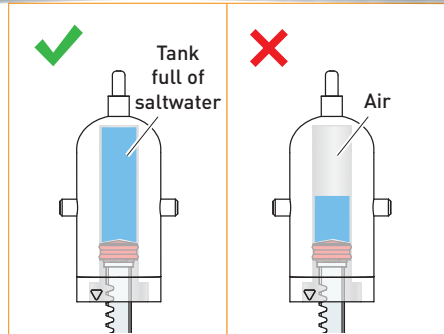
Pull the loose end of the hose out and place it in the saltwater.



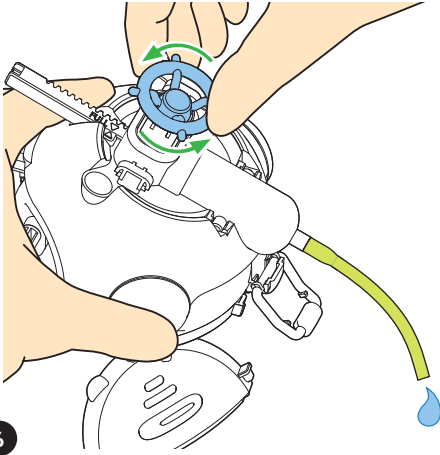
Turn the valve clockwise to draw in the saltwater.
Turn until the arrow on the rack lines up with the arrow on the body.



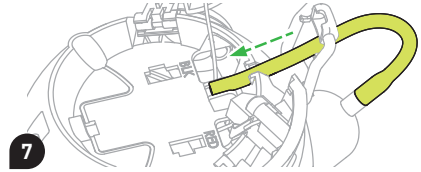
! If the rack is not pushed all the way in at the beginning, air can enter the tank and cause a problem when pushing the saltwater out (Page 19, Step 1).



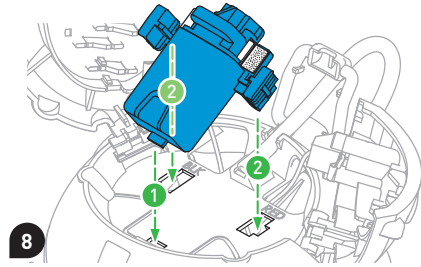
Test: Turn the valve one click counterclockwise to check if one drop of saltwater is dispensed. If yes, everything is functioning correctly.



Slide the tube back into place
(Refer to step 10 on page 12).

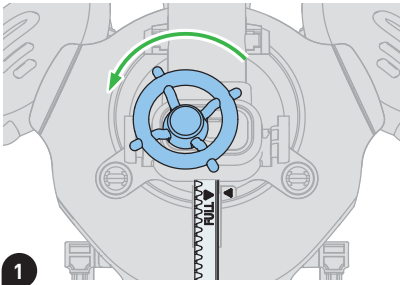


Put the fuel cell back into Walter.
(Refer to step 16 on page 14)



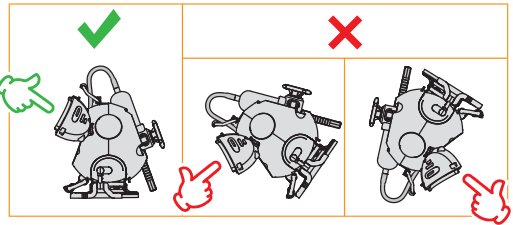
3. Release saltwater from the tank

Turn the valve one click counterclockwise to release a drop of saltwater into the fuel cell.



!

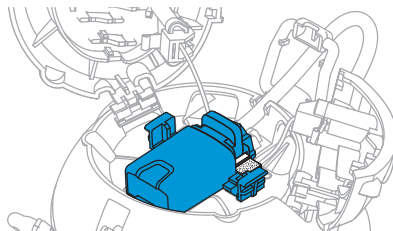
1. One click is enough. Avoid turning the valve for multiple clicks.
2. Make sure Walter is standing upright when turning the valve so that the saltwater can flow properly into the fuel cell.



Wait 10 seconds.

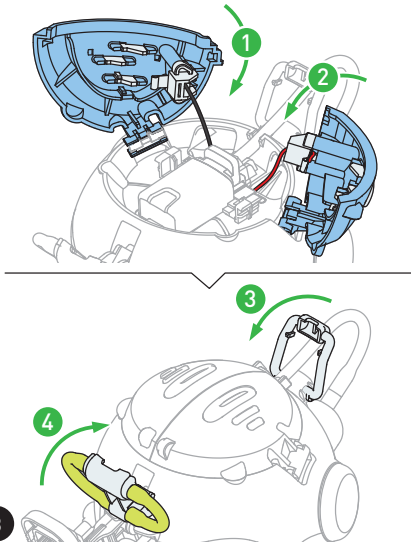


2

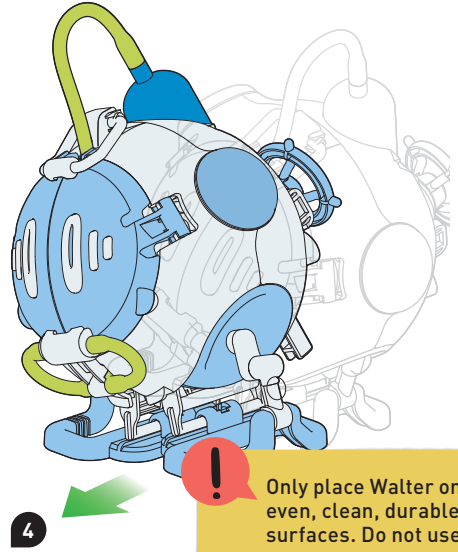




Close Walter's face, as well as the top and bottom clamps.

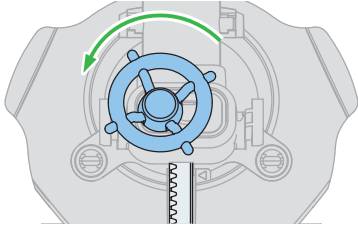


Walter starts walking!

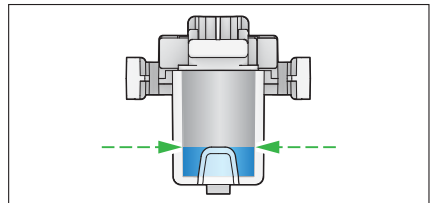


4. If Walter slows down ...

... add another drop of saltwater by turning the valve one click counterclockwise.

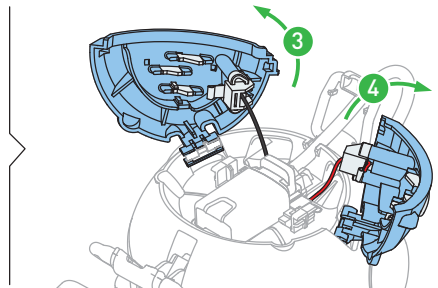
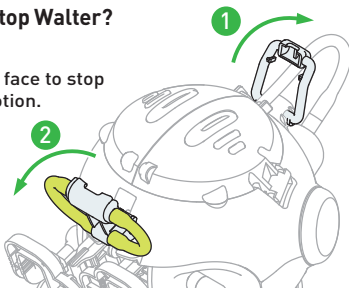


Make sure that the saltwater level stays below the indicated line in the fuel cell.




5. How do I stop Walter?

Open Walter's face to stop the robot's motion.




6. Cleaning and maintaining the magnesium fuel cell

The fuel cell must be cleaned after each use.



Air cathode

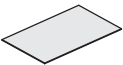


Air cathode

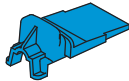
1 Carefully rinse the air cathode under tap water. To avoid damaging the air cathode, do not rub the surface when cleaning.

Clean the parts shown below by gently rubbing the surface with your hand under running water. Make sure that there is no salt residue left. Lay out all parts to dry separately.

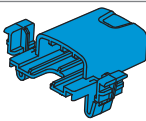




1. Non-woven fabric




2. Compression plate



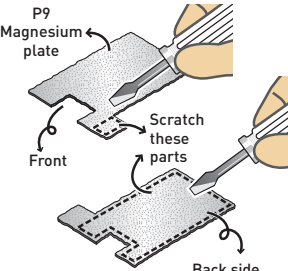
3. Fuel cell case

Clean the magnesium plate and scratch off oxidized parts as shown below.




Magnesium plate

Gently rinse the magnesium plate.



Scratch oxidized areas off of the magnesium plate.



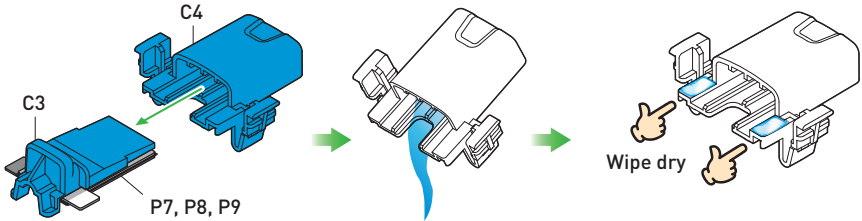
Magnesium plate

Carefully rinse off the magnesium plate and let it dry.

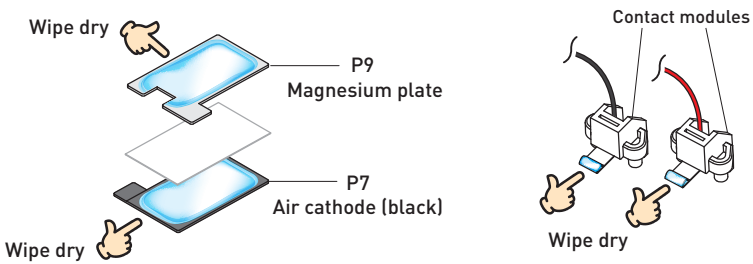
TROUBLESHOOTING

Double check the following steps if Walter does not walk correctly.

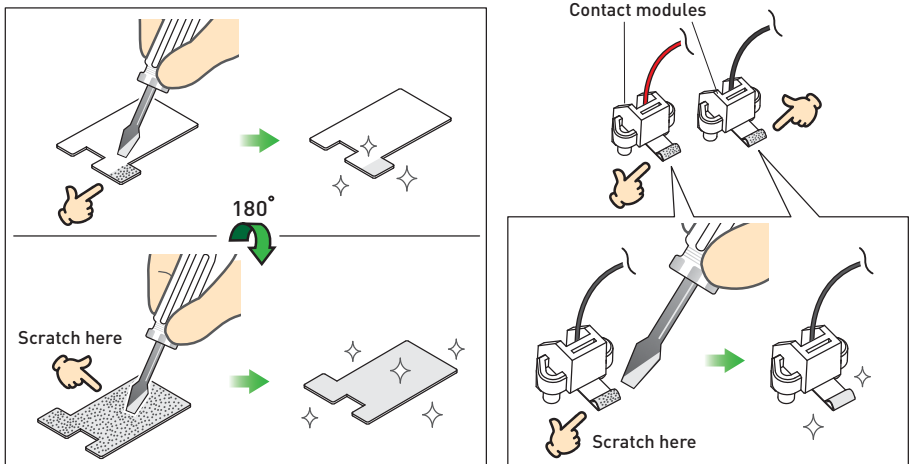
- A1** Disassemble the fuel cell. Pour out excess saltwater and wipe the areas indicated dry.



- A2** Be sure that the magnesium plate, air cathode, and contacts are dry. Wipe away any saltwater.

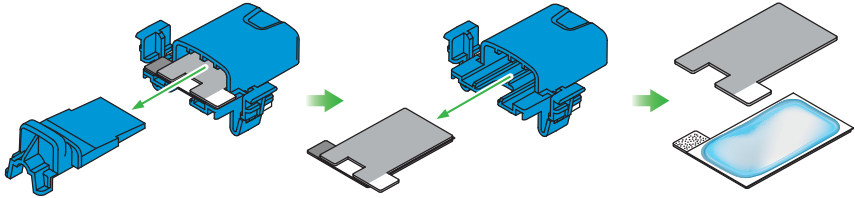


- A3** If the magnesium plate and/or contacts are oxidized, clean them as shown:



B Check that the tube, contact modules, and fuel cell are correctly assembled (see pages 12 to 14).

C Open the fuel cell and check to make sure the non-woven fabric is wet.



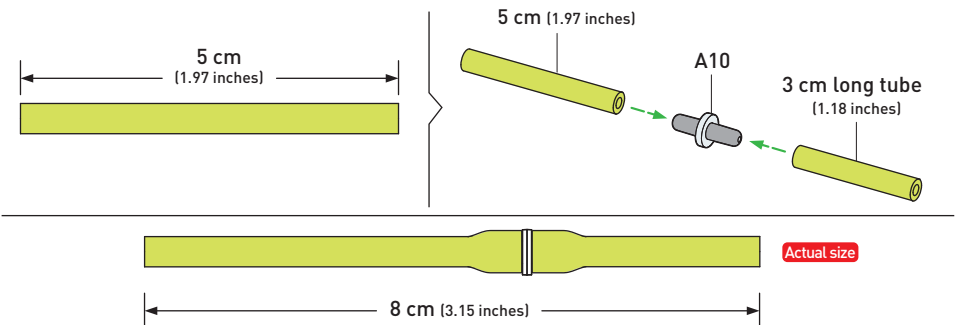
D Replace the magnesium plate if it is corroded.



E Check that the feet are correctly assembled (see pages 16 to 17).

F Make sure that the gear box is assembled correctly (see pages 4 to 7).

G If the 8 cm tube has accidentally been cut shorter than 6 cm (for example to 5 cm), use the A10 connector to extend it back to 8 cm.





How does Walter Work?

Walter waddles forward thanks to a magnesium-air fuel cell. Magnesium is an element that can change rapidly during chemical reaction. As soon as you put a drop of saltwater into the magnesium-air fuel cell, the magnesium oxidizes, forming a rust-like layer. This releases negatively charged particles (electrons), which then travel through the black cable to the built-in motor and then through the red cable to the carbon air cathode. There, the cathode's surface pulls oxygen out of the air to absorb the electrons.



The non-woven fabric that is located between the magnesium plate and the air cathode in the fuel cell absorbs the drop of saltwater and acts as an electrolyte, carrying charged particles across the fuel cells and completing the electrical circuit. The salt accelerates the reaction between the water and the magnesium plate.

In your robot, magnesium is the fuel source, reacting with oxygen from the saltwater to form magnesium hydroxide and charged particles that power Walter's motor. The magnesium plate is consumed in the process, as you can see by the black spots or holes that appear over time.

WALTER'S WALK

Walter is a **legged robot** that moves forward using its two legs. Legged robots have a special significance in robotics because their movements have to be planned with great precision. The robot must always be stable so that it does not tip to the side and fall over. There are various approaches to how this can work. Robots with four or more legs usually have at least three feet firmly on the ground at all times. The body's center of gravity is distributed across the three feet so that the robot can stand stably. They move "statically". Robots with fewer than three legs like Walter, on the other hand, move "dynamically". The robot's center of gravity shifts as the robot moves.



Fuel Cells

Cars that run on gasoline or diesel produce CO_2 , which is harmful to the climate. Due to climate change, more and more thought is being given to alternative means of propulsion. This includes the increasing popularity of electric vehicles. Electric vehicles are powered by batteries or fuel cells.

Unlike Walter, fuel cells in cars do not use magnesium, but instead combine hydrogen and oxygen. This process creates water and, at the same time, generates electricity to power the car. The basic principle is the same, however. Here, too, electrons move from one electrode to the other. These electrodes are also connected to one another by an external circuit, which contains the car's motor.

A single fuel cell does not generate enough electricity to power an entire car, so electric cars with fuel cell drives often have up to 400 fuel cells connected in series called a **fuel cell stack**.



One advantage of cars with a fuel cell is that the hydrogen required can be easily refueled, just like a car with a gasoline engine!



Battery-powered cars, on the other hand, need more time to charge up. However, they also have many advantages.





BATTERIES vs FUEL CELLS

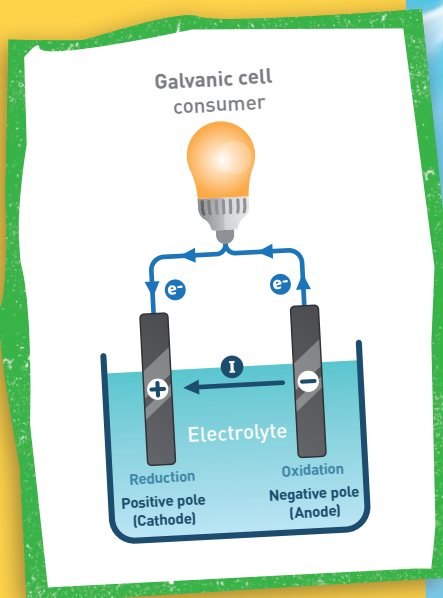
While all types of fuel cells are energy **converters**, batteries are energy **storage devices**.

To be more precise: in fuel cells, chemical energy (the fuel) is constantly supplied and replenished. Batteries, on the other hand, store chemical energy, which is then converted into electrical energy through reactions.

However, fuel cells and batteries have one thing in common: both work using a **galvanic cell**. This consists of two electrodes (an **anode** and a **cathode**) and a conductive liquid (an **electrolyte**).

A **redox** reaction takes place in the galvanic cell. The locations of the two partial reactions, **reduction** and **oxidation**, are separated from each other. They are connected via an electrically conductive wire that transfers the electrons from the negative pole (anode) to the positive pole (cathode).

If you add an electrical consumer to the electrically conductive wire, it will be supplied with electricity. For example, a light bulb can light up or Walter's motor can rotate, moving its gears.



© 2025 Franckh-Kosmos Verlags-GmbH & Co. KG • Pfizerstrasse 5-7 • 70184 Stuttgart, DE

This work, including all its parts, is copyright protected. Any use outside the specific limits of the copyright law is prohibited and punishable by law without the consent of the publisher. This applies specifically to reproductions, translations, microfilming, and storage and processing in electronic systems and networks. We do not guarantee that all material in this work is free from other copyright or other protection.

Text: Sven Nam Karsten

Project manager: Jonathan Felder

Technical product development: Deryl Tjahja, CIC Components Industries Co., Ltd., Taiwan

English language editing: Ava Tessitore, Hannah Mintz

Manual design concept: Atelier Bea Klenk, Berlin

Manual layout: Olaf Peters, Freitag van Geigk, Hannover

Illustration, material images: CIC Components Industries Co., Ltd., Taiwan

Manual photos: Jamie Duplass (all adhesive strips); Danuta Hyniewska, p. 26 mr; Urbanscape, p. 26 tr;

Kirill Gorlov, p. 27 bl; VectorMine, p. 28 mr; Kenishirotie, p. 28 bl; Aleksandra Konoplya, p. 26 - 28

background (all previous © Adobe Stock); asharkyu, p. 27 tl (© Shutterstock);

Rick Govic, p. 27 br (© Unsplash)

Design concept & packaging design: Peter Schmidt Group, Hamburg

Packaging layout: Dan Freitas

3D images for packaging: CIC Components Industries Co.

The publisher has made every effort to identify the owners of the rights to all photos used. If there is any instance in which the owners of the rights to any pictures have not been acknowledged, they are asked to inform the publisher about their copyright ownership so that they may receive the customary image fee.

1st English Edition © 2025 Thames & Kosmos, LLC, Providence, RI, USA

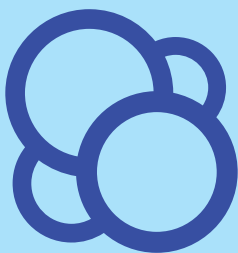
Thames & Kosmos © is a registered trademark of Thames & Kosmos, LLC.

Distributed in North America by Thames & Kosmos, LLC, Providence, RI 02903

Phone: 800-587-2872; Web: www.thamesandkosmos.com

We reserve the right to make technical changes.

Printed in Taiwan/Imprimé en Taïwan



Do you have any questions?

Our technical support team would be glad to help you!

Thames & Kosmos US
Email: support@thamesandkosmos.com
Phone: 1-800-587-2872
