

EXPERIMENT MANUAL

# Hydraulic Boxing Bots



*Let's  
Rumble!*

Scan this QR  
code for a full  
assembly video.

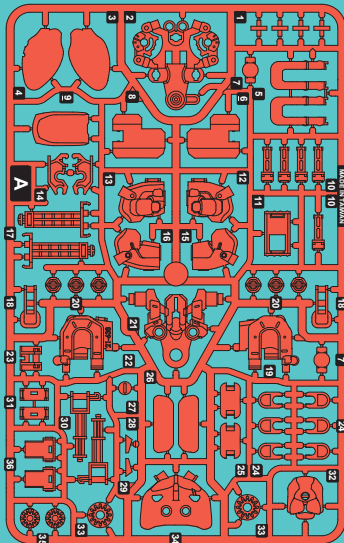


## KIT CONTENTS

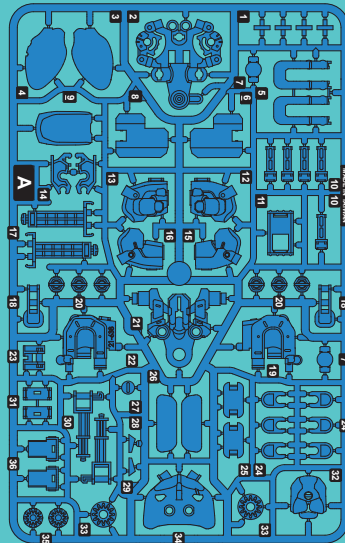
What's inside your experiment kit:

*Good to know!*

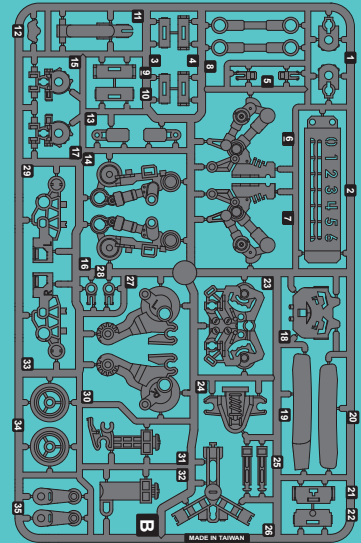
If you are missing any parts, please contact Thames & Kosmos customer service.



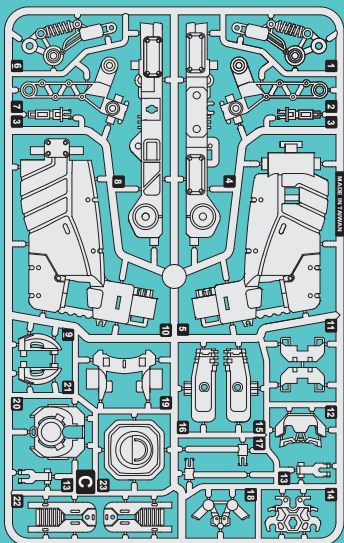
A



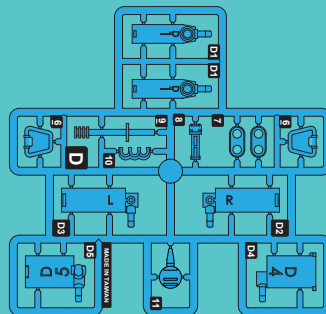
A



B 2x



C 2x



D 2x



### YOU WILL ALSO NEED:

Diagonal cutters or scissors and nail file,  
felt-tip marker,  
plastic cup or mug  
filled with tap water

*Wow!*

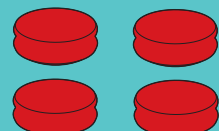
That's a lot of parts!



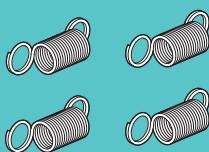
P1



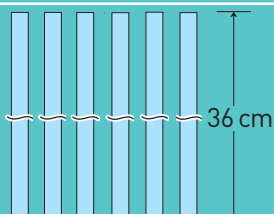
P2



P3



P4



P5



P6



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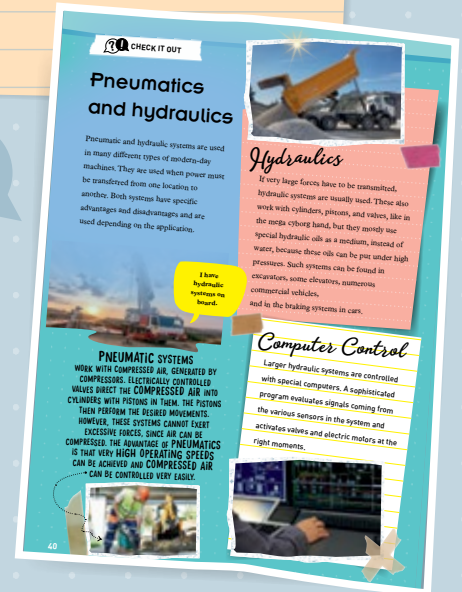


### TIPS

YOU WILL FIND ADDITIONAL INFO  
IN THE CHECK IT OUT SECTION ON  
PAGE 40.

## Checklist:

✓ No.	Description	Quantity	Item No.
○ P1	Cap, small	4	620505-1
○ P2	Cap, medium	4	620505-2
○ P3	Cap, large	4	620505-3
○ P4	Spring	4	620505-4
○ P5	Flexible tube	6	620505-5
○ P6	Lubricant packet	1	723607
○ A	Frame A with parts A1 – A36, orange	1	727793
○ A	Frame A with parts A1 – A36, blue	1	727797
○ B	Frame B with parts B1 – B35	2	727794
○ C	Frame C with parts C1 – C23	2	727795
○ D	Frame D with parts D1 – D11	2	727796



Yay!  
Let's begin!

## **WARNING!**

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

Only for use by children aged 10 years and older. Instructions for parents or other supervising adults are included and have to be observed.

Keep the packaging and instructions as they contain important information.

## **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.



## **Build and experiment**

Hydraulics and gears are exciting scientific topics that are easy to understand, especially with the help of hydraulic boxing bots! You can build two boxers and joysticks with the parts in this kit. You need patience to build them and set them up. To stay focused, it is advisable not to build the model all in one sitting, but rather to take breaks in between building sessions. Page 4 shows a summary of approximate build times, which can help you divide and plan your build sessions. Try to follow the instructions carefully and, if in doubt, ask an adult for help. We highly recommend having two people build the two boxing bots simultaneously. The printed manual includes instructions for the orange boxing bot only. The instructions for the blue boxing bot are identical, except for the color of frame A. For an online manual showing instructions for the blue boxing bot, turn to page 4.



## IMPORTANT INFORMATION

This experiment kit is  
only intended for children  
*over 10 years*  
of age.

## Dear Parents and Supervising Adults,

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.

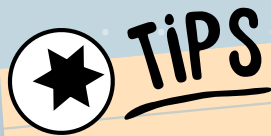
Support your child with advice and a helping hand, especially during tricky assembly steps or experiments.

To prevent damage to the work surface on which your child is building and experimenting, provide them with a mat or other surface protection. When experimenting with water, it is a good idea to have some paper towels ready to wipe up spills.

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.

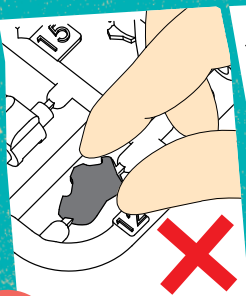
Supervise your child when they are using the sharp tools until you trust that they can handle the tools independently.

We hope you and your child have a lot of fun building and playing with the hydraulic boxing bots!

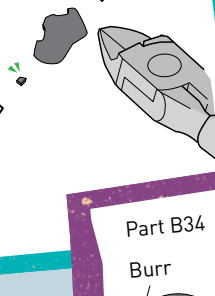
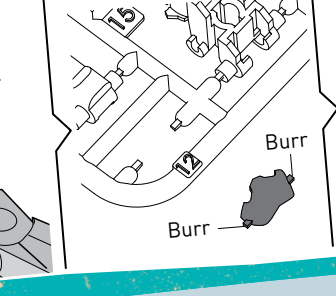
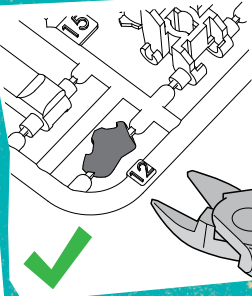


### IMPORTANT:

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 that all burrs are removed from the plastic parts before assembly so that your hydraulic boxing bots function properly.

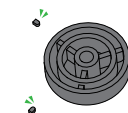
Part B34

Burr

Burr

Burr

Burr



Correct

# Assembling THE HYDRAULIC BOXING BOTS

Scan this QR  
code for a full  
assembly video.



Are you ready to build? Let's begin the construction of your hydraulic boxing bots. There are two separate bots to build (orange and blue). Each bot will take two to four hours of focused build time! We recommend that you get a friend, sibling, or caregiver to build one of the bots at the same time as you are building the other one. That way, your bots will be ready to battle faster!

Scoreboard and masks		10-20 min.
Right and left arms		15-30 min.
Right and left legs		15-30 min.
Body		20-40 min.
Joystick		15-30 min.
Hydraulic system		20-40 min.
Final assembly		30-60 min.
<b>Total build time for orange boxing bot</b>		<b>2-4 hours</b>

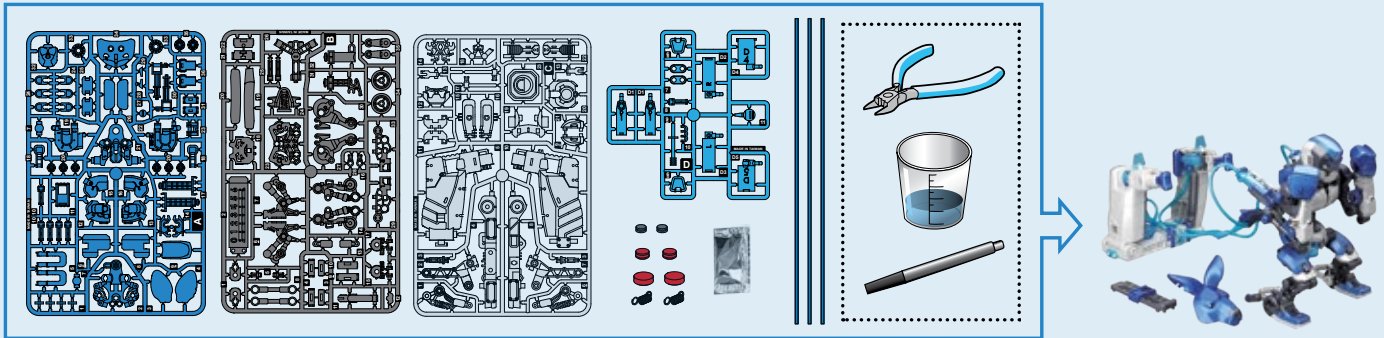
Scoreboard and masks		10-20 min.
Right and left arms		15-30 min.
Right and left legs		15-30 min.
Body		20-40 min.
Joystick		15-30 min.
Hydraulic system		20-40 min.
Final assembly		30-60 min.
<b>Total build time for blue boxing bot</b>		<b>2-4 hours</b>



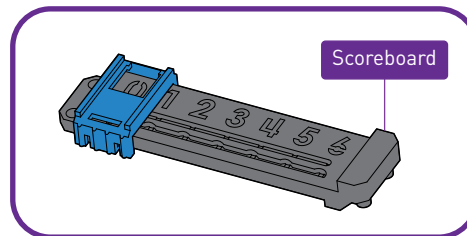
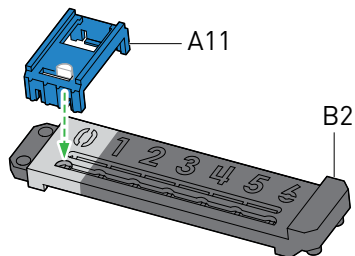
SCAN THIS QR CODE FOR AN ONLINE  
VERSION OF THE MANUAL THAT  
SHOWS THE INSTRUCTIONS FOR THE  
ORANGE BOXING BOT.



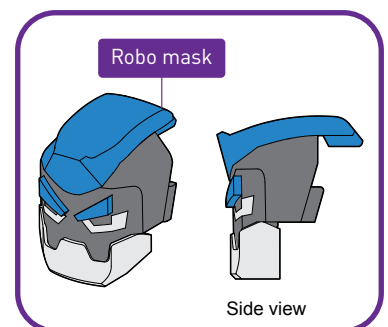
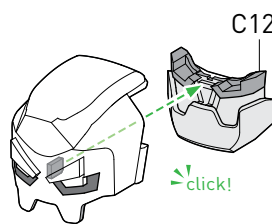
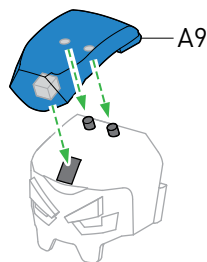
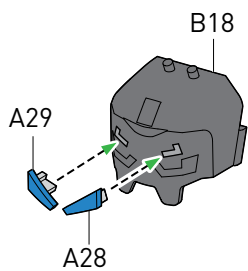
## You will need



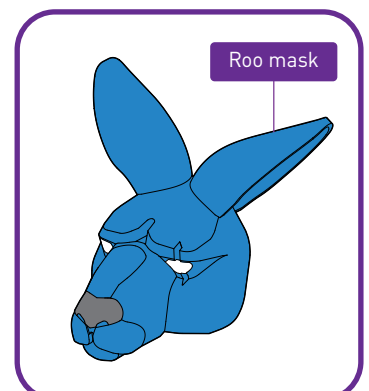
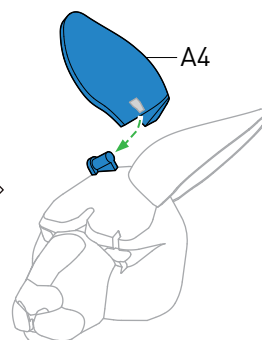
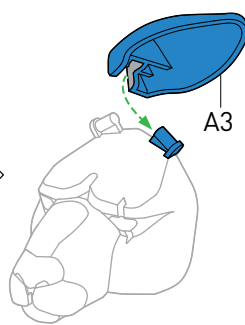
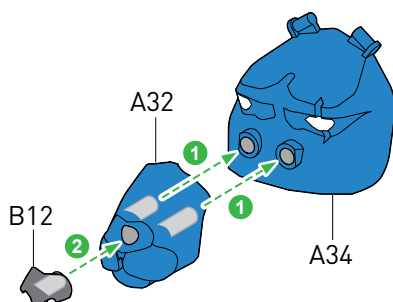
## ASSEMBLING THE SCOREBOARD



## ASSEMBLING THE ROBO MASK

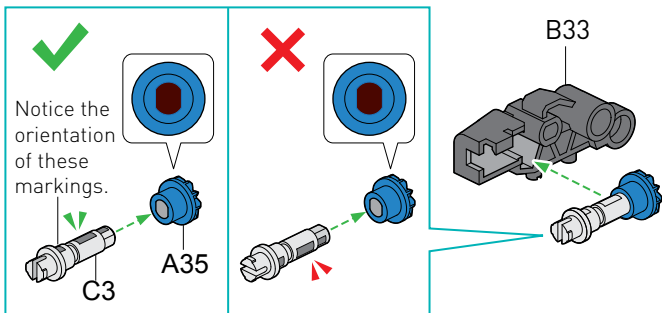


## ASSEMBLING THE ROO MASK

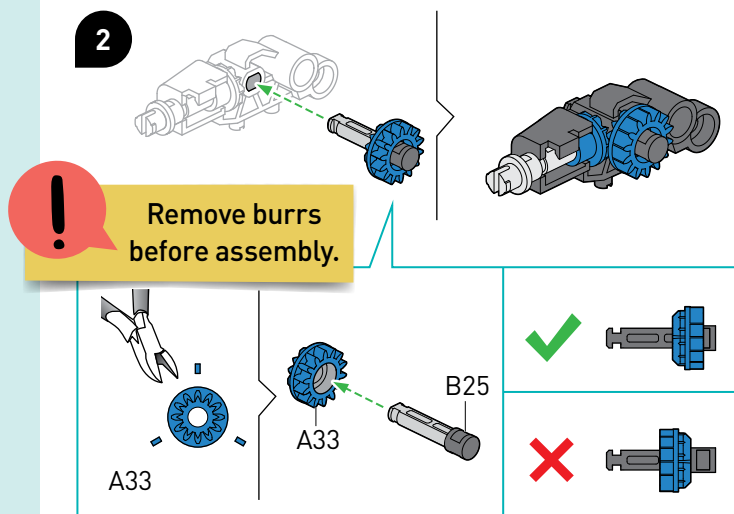


## ASSEMBLING THE RIGHT ARM

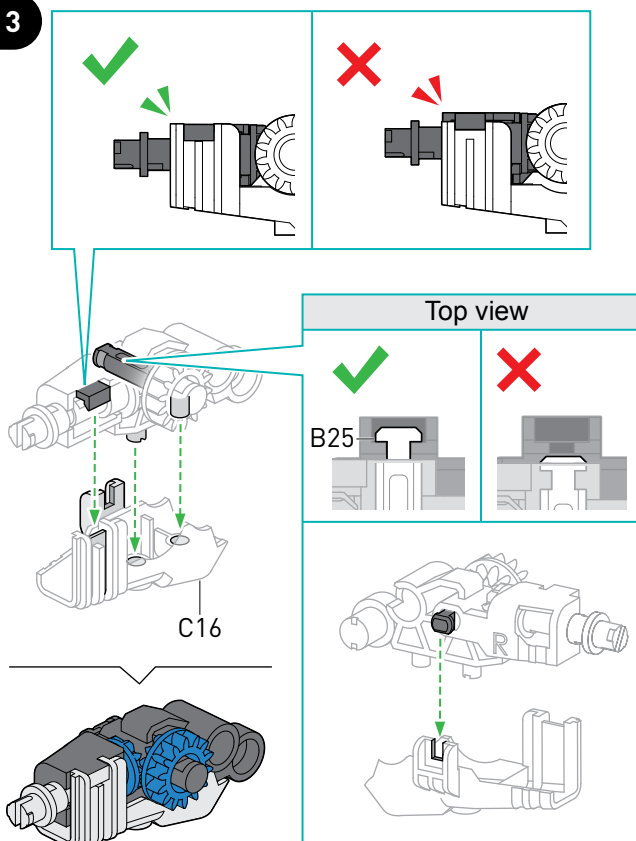
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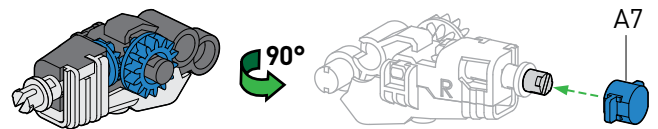
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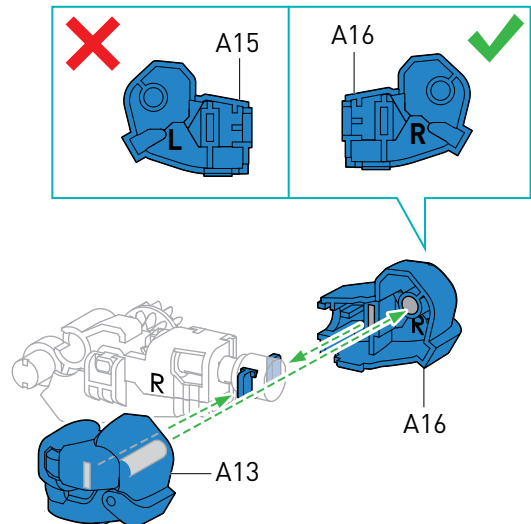
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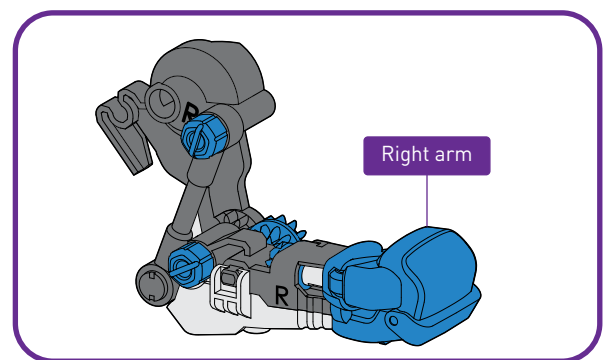
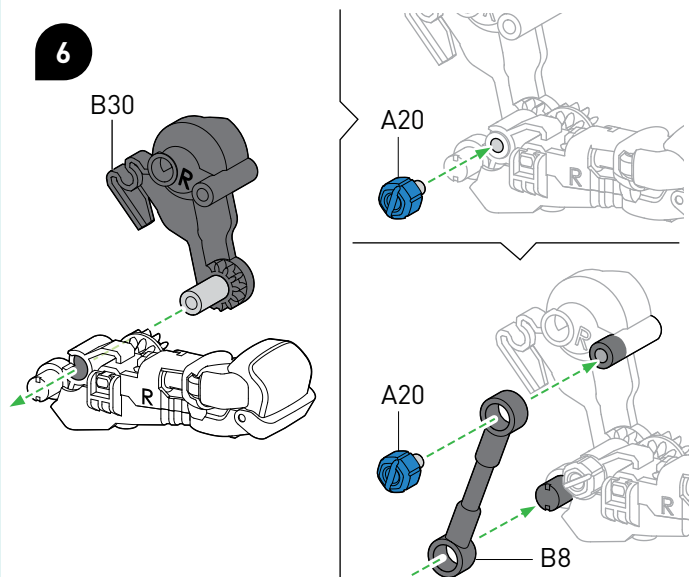
4



5



6

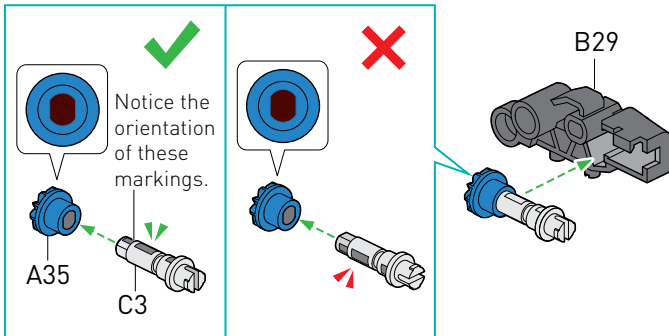




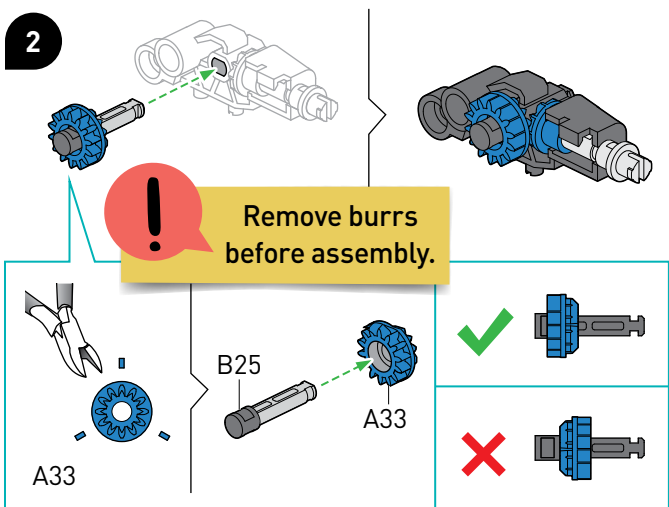


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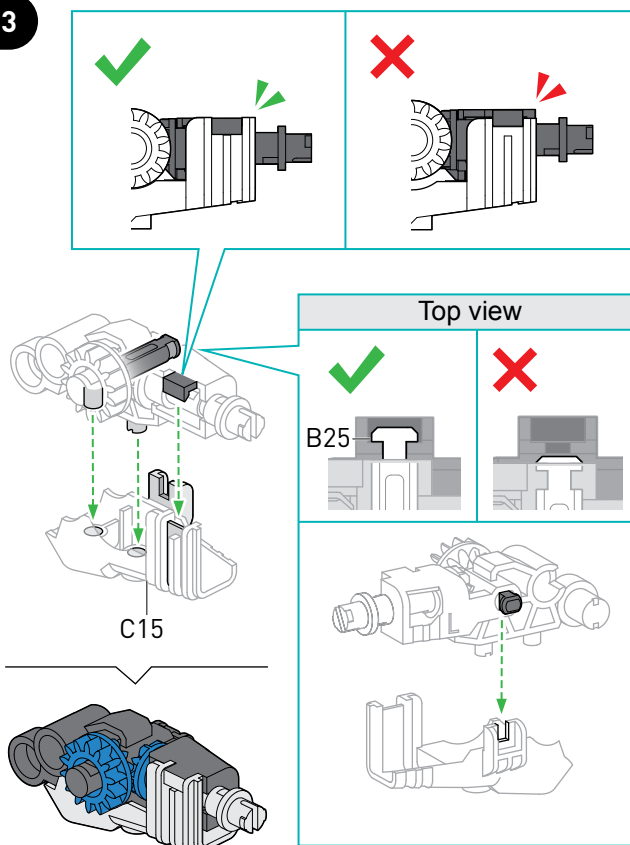
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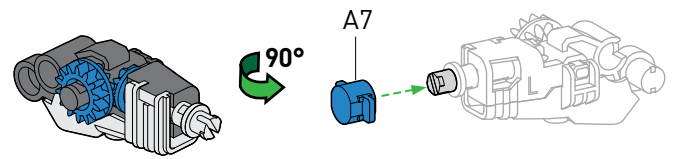
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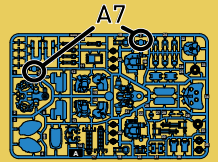
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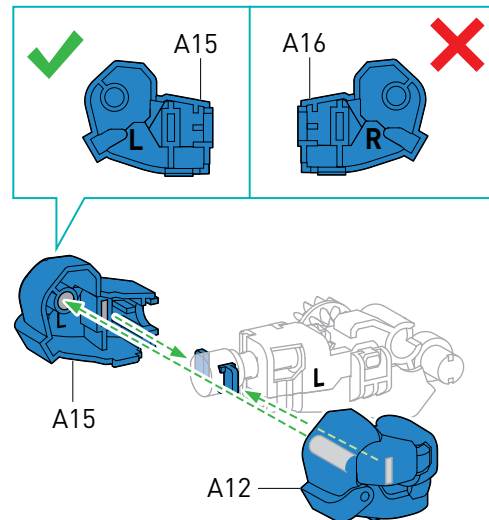
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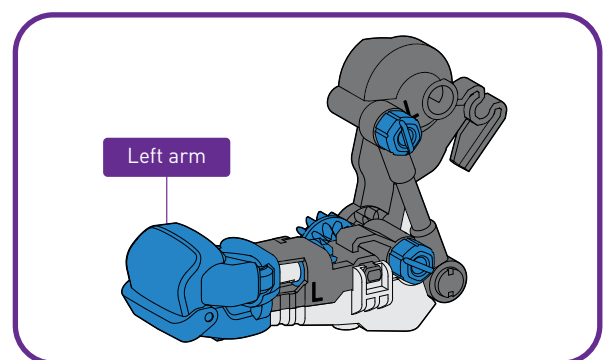
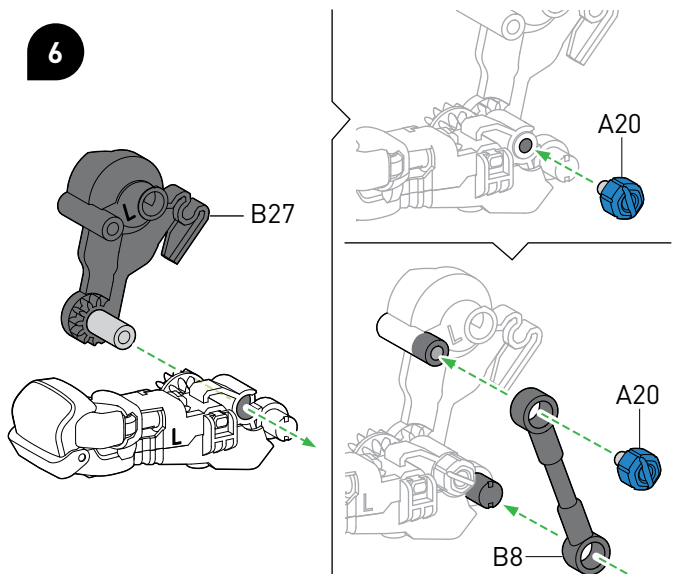
Some duplicate part numbers may not be next to each other on the plastic frame.



5

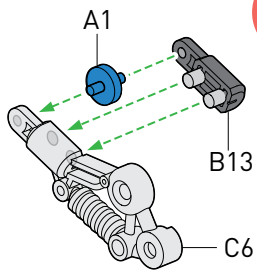


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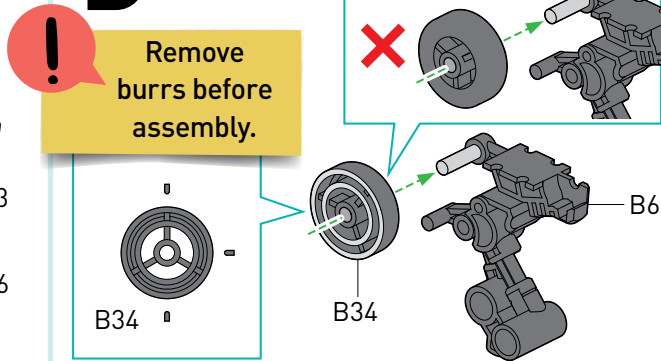


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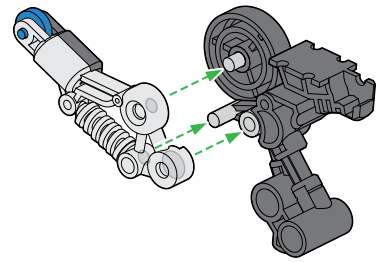
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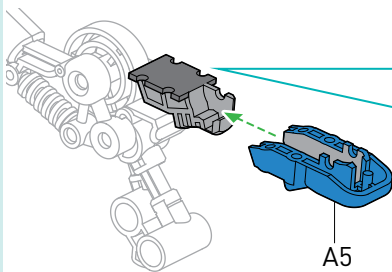
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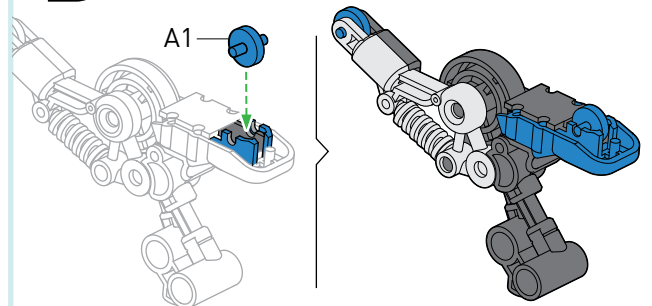
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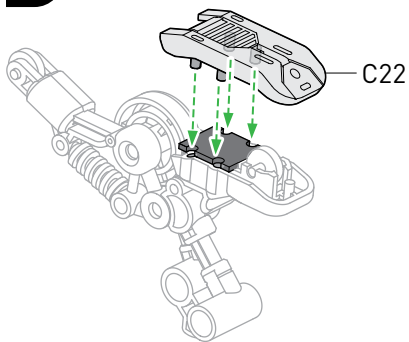
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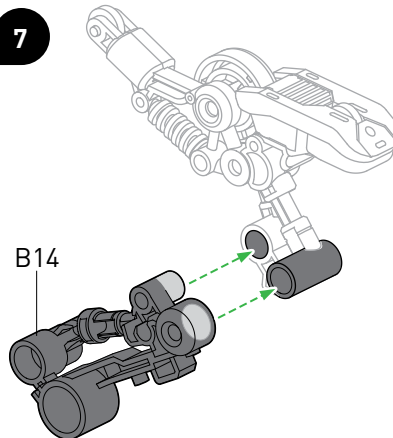
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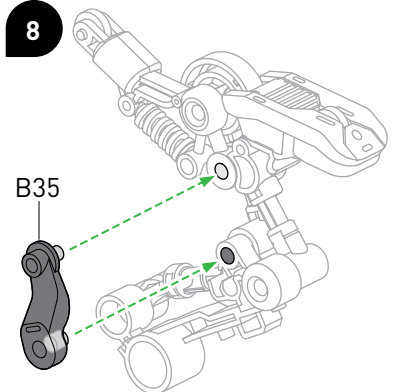
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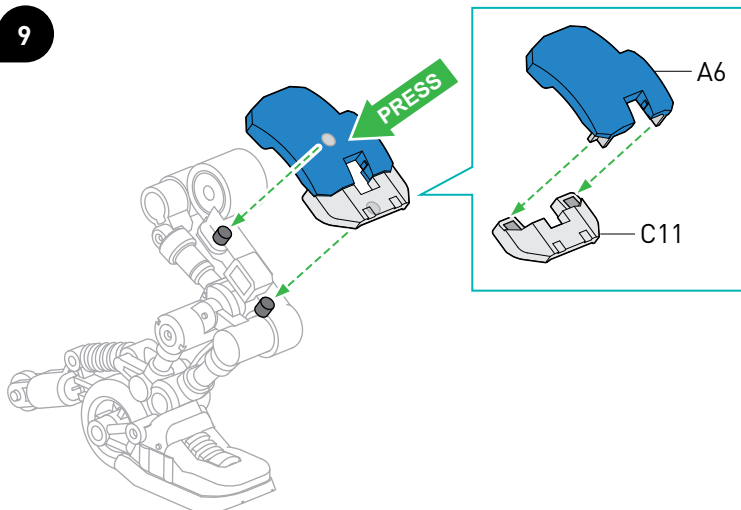
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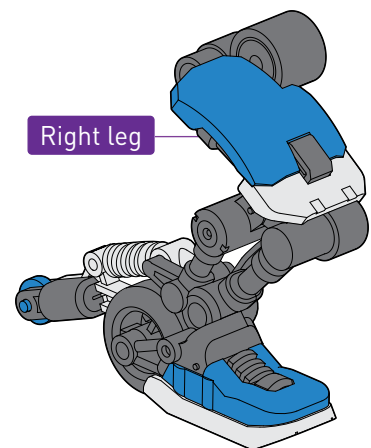
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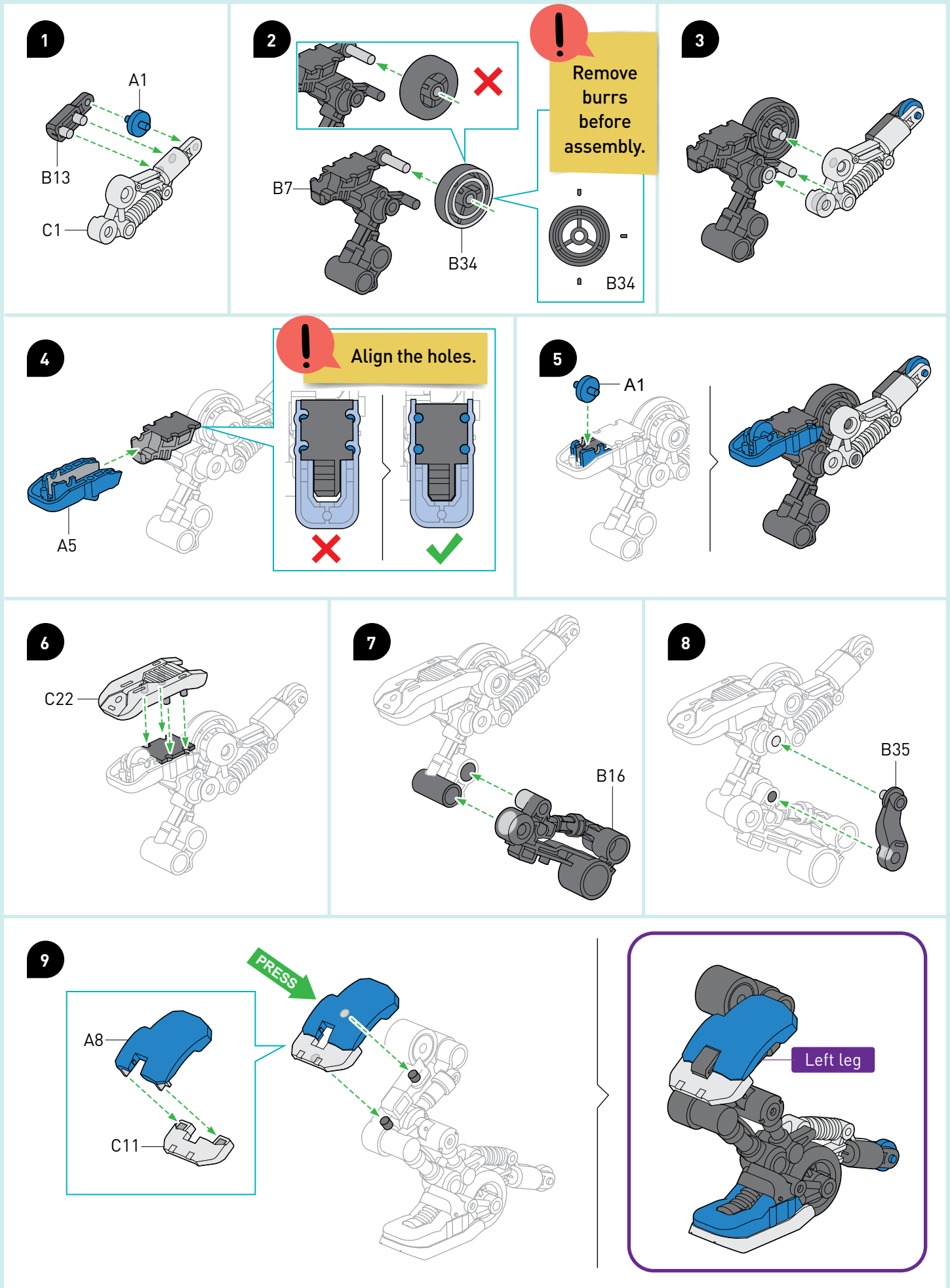
Right leg





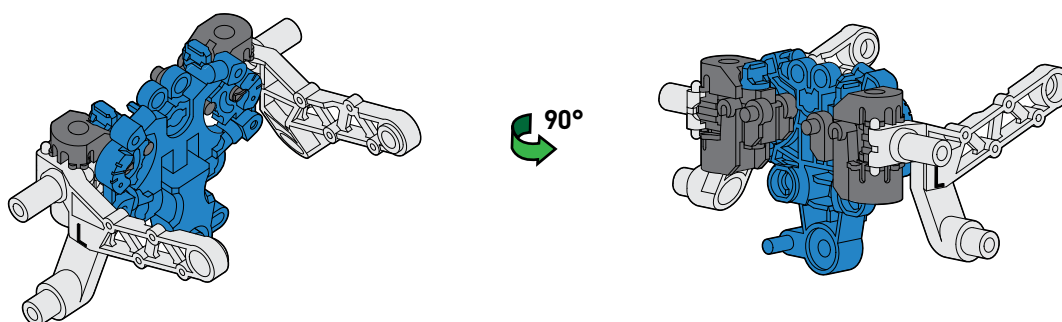
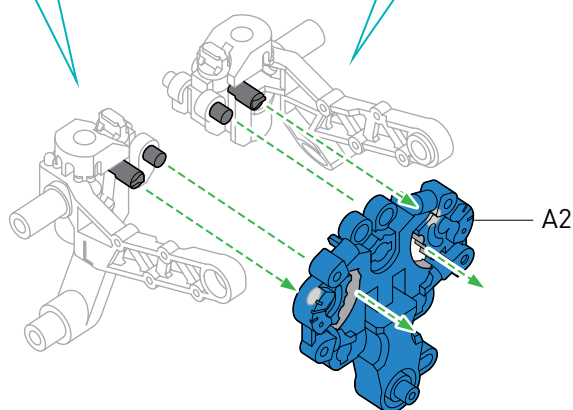
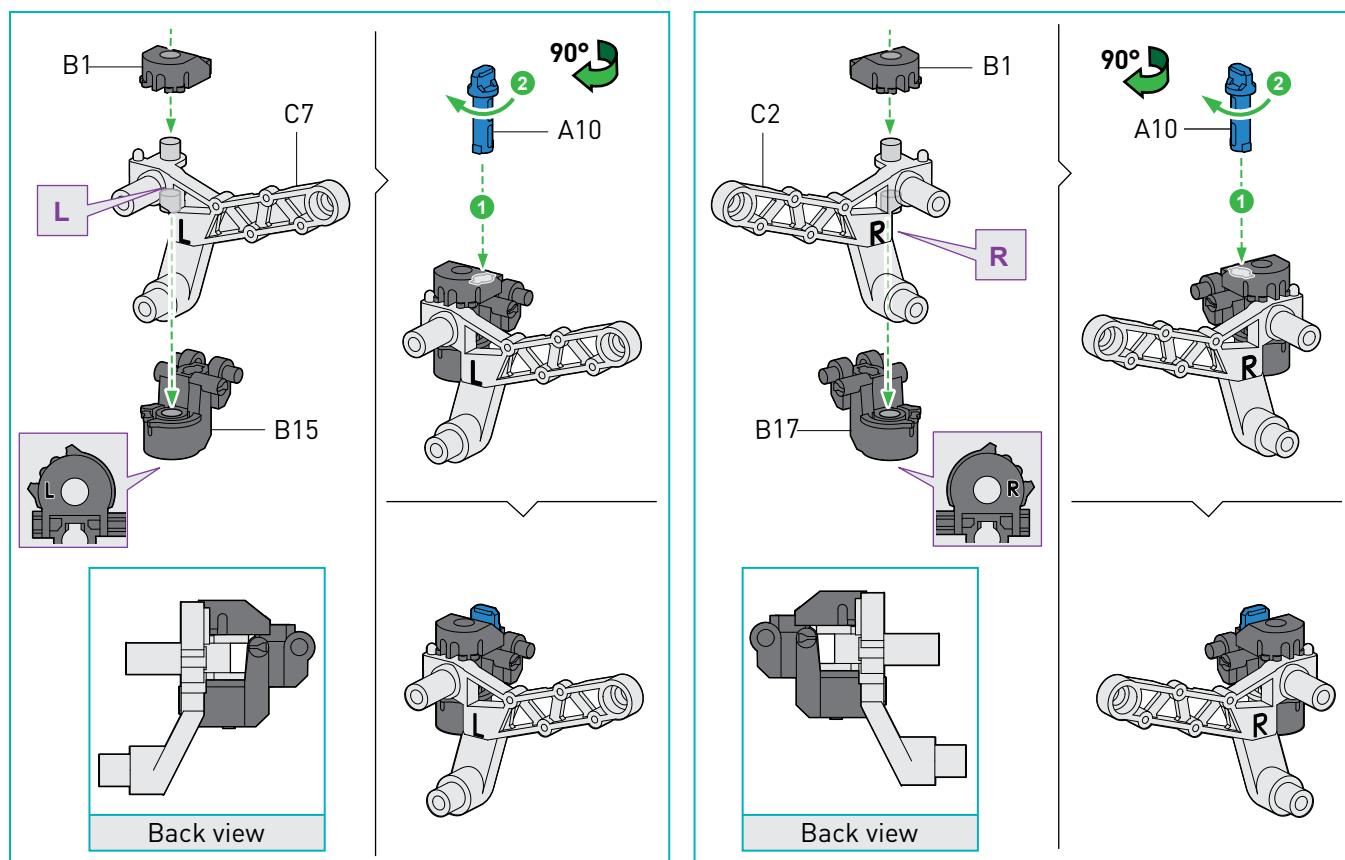


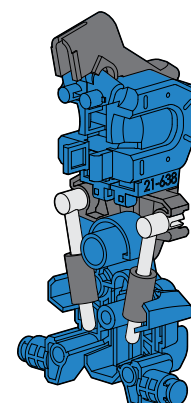
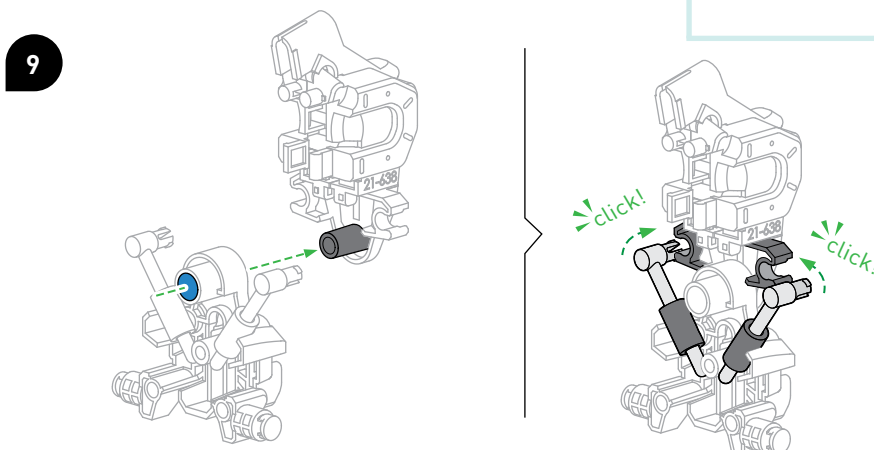
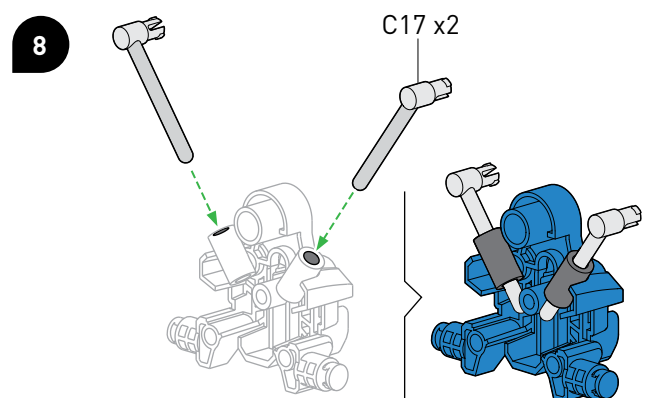
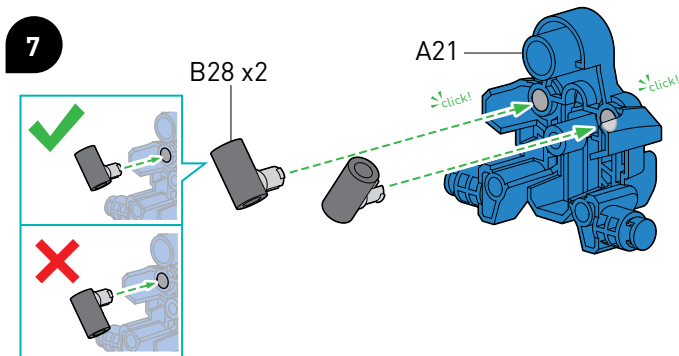
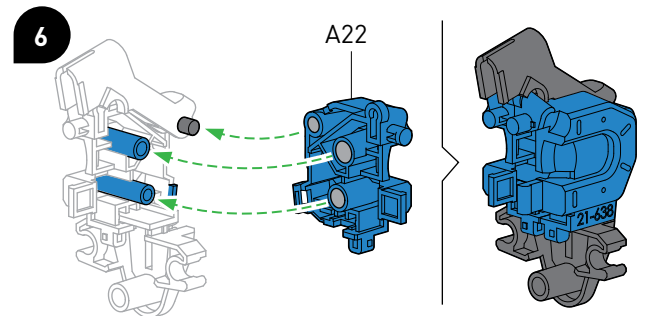
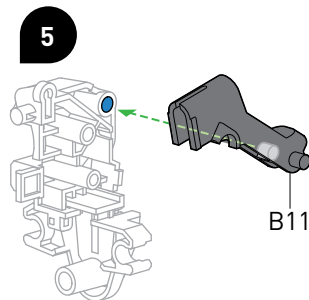
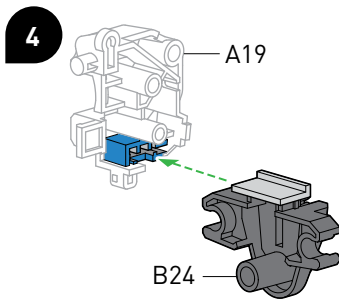
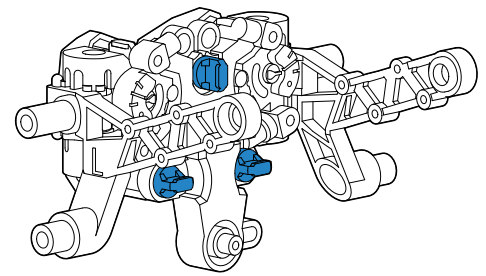
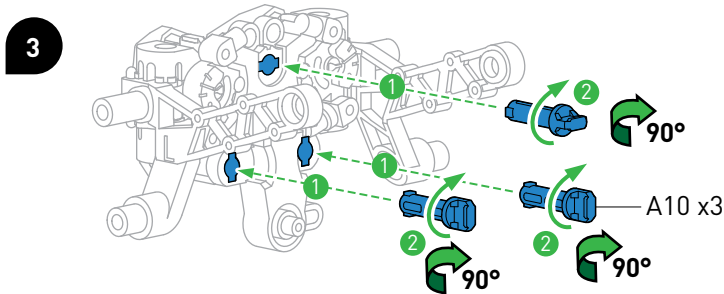
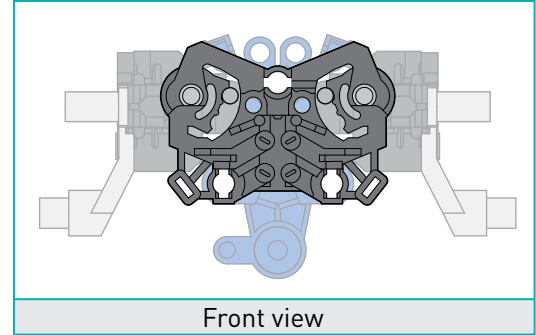
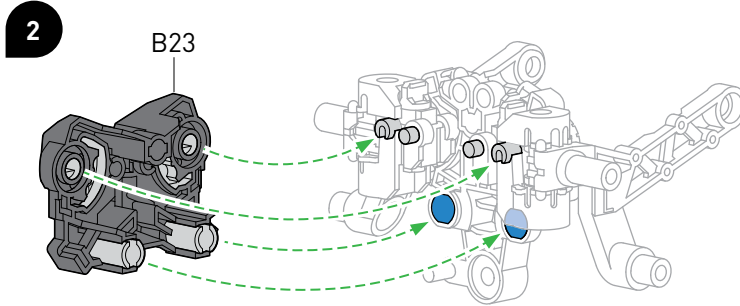
## ASSEMBLING THE LEFT LEG



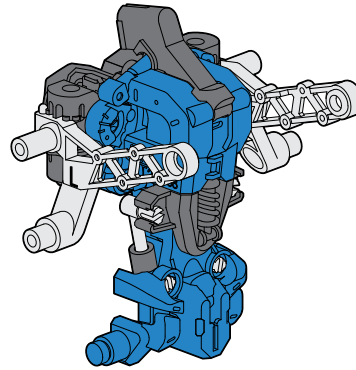
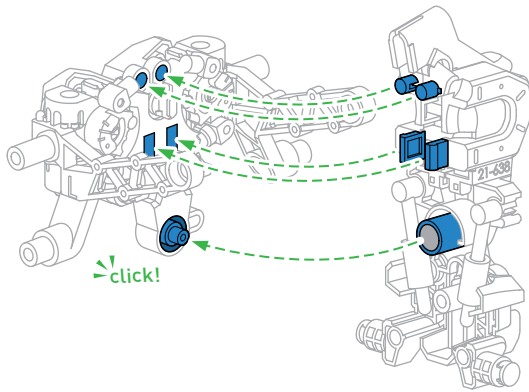
# ASSEMBLING THE BODY

1

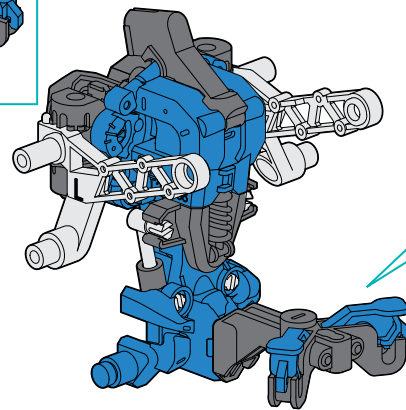
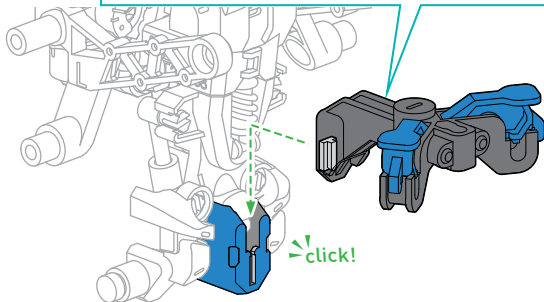
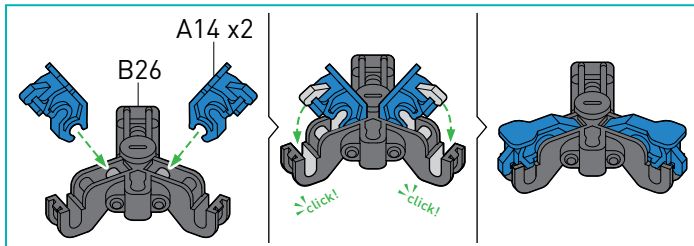




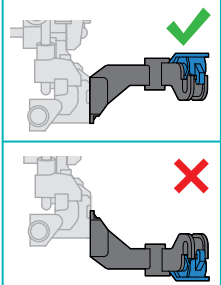
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11

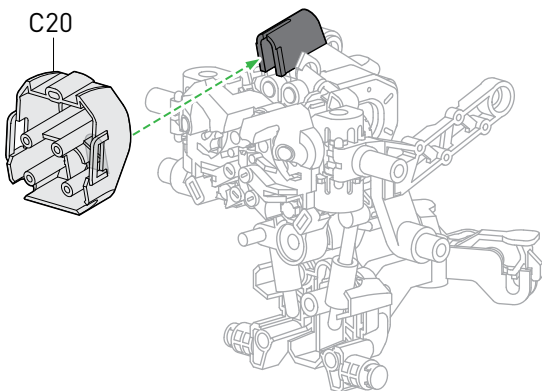


Side view

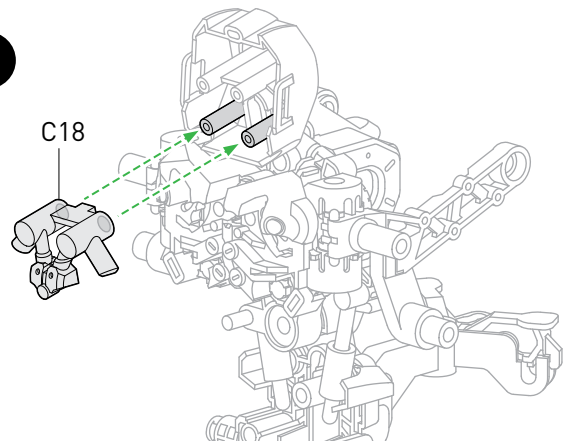


90°

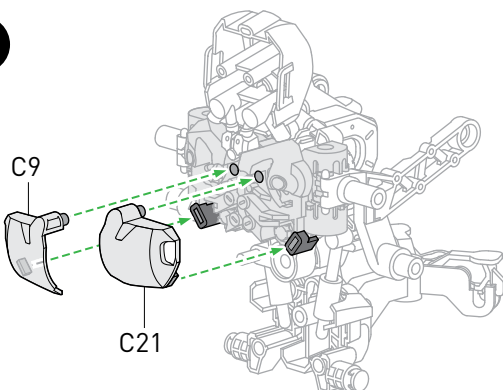
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13



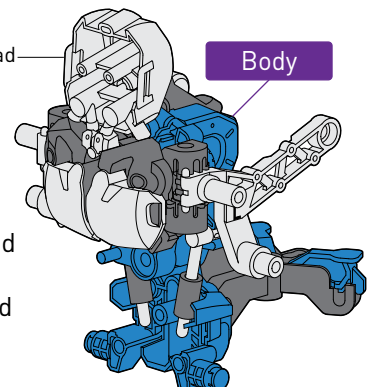
14



Head

Body

Note: The head will be able to move back and forward.

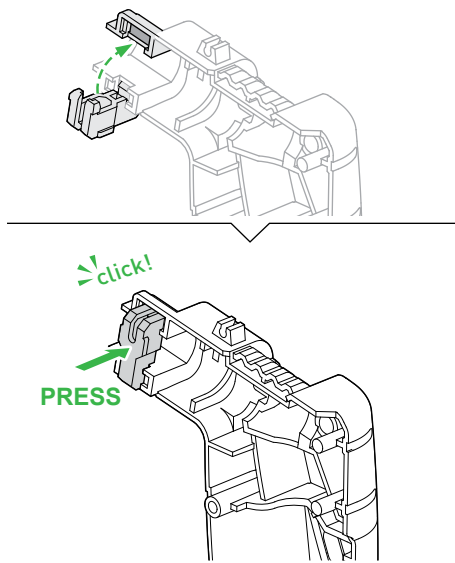
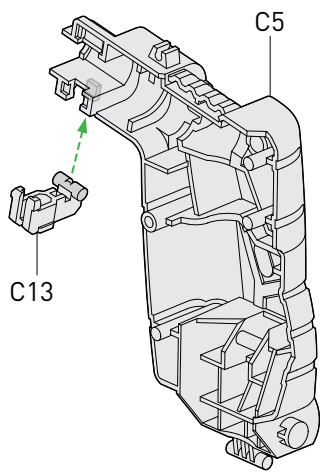




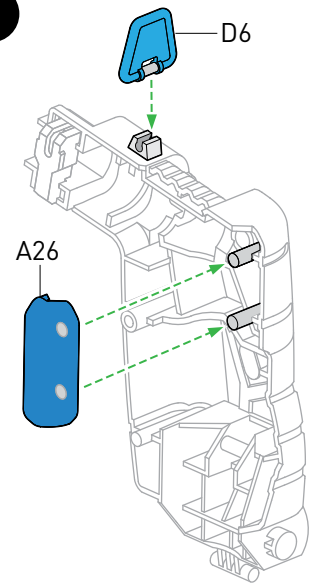


## ASSEMBLING THE JOYSTICK

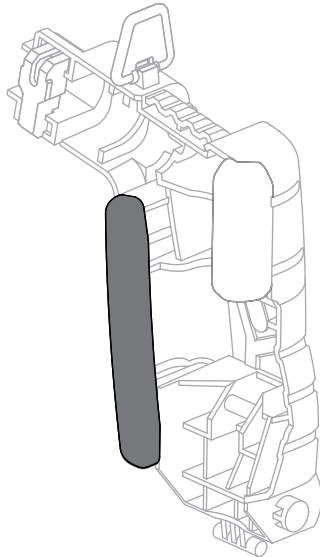
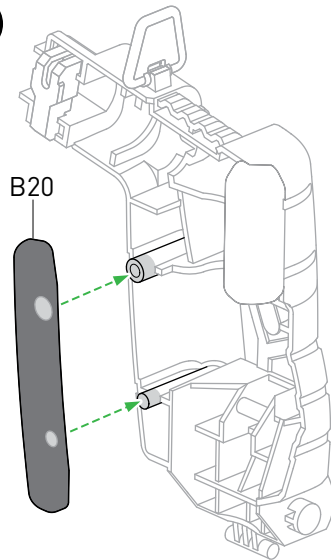
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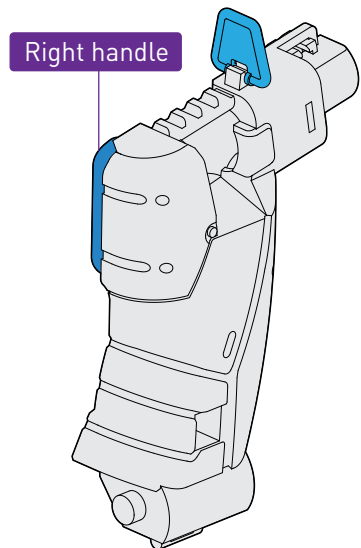
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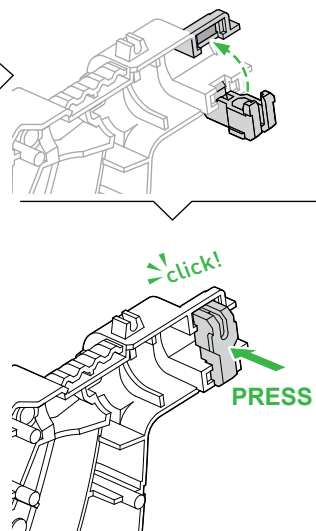
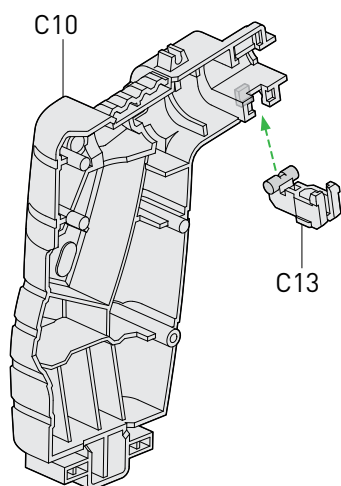
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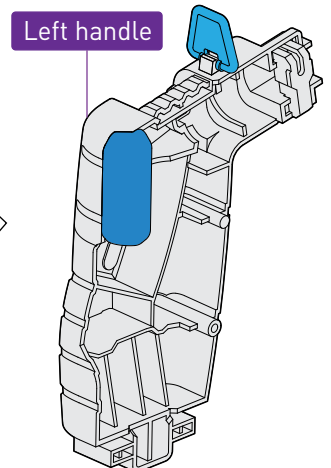
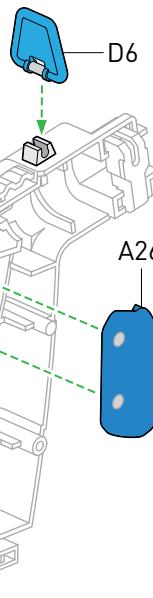
90°



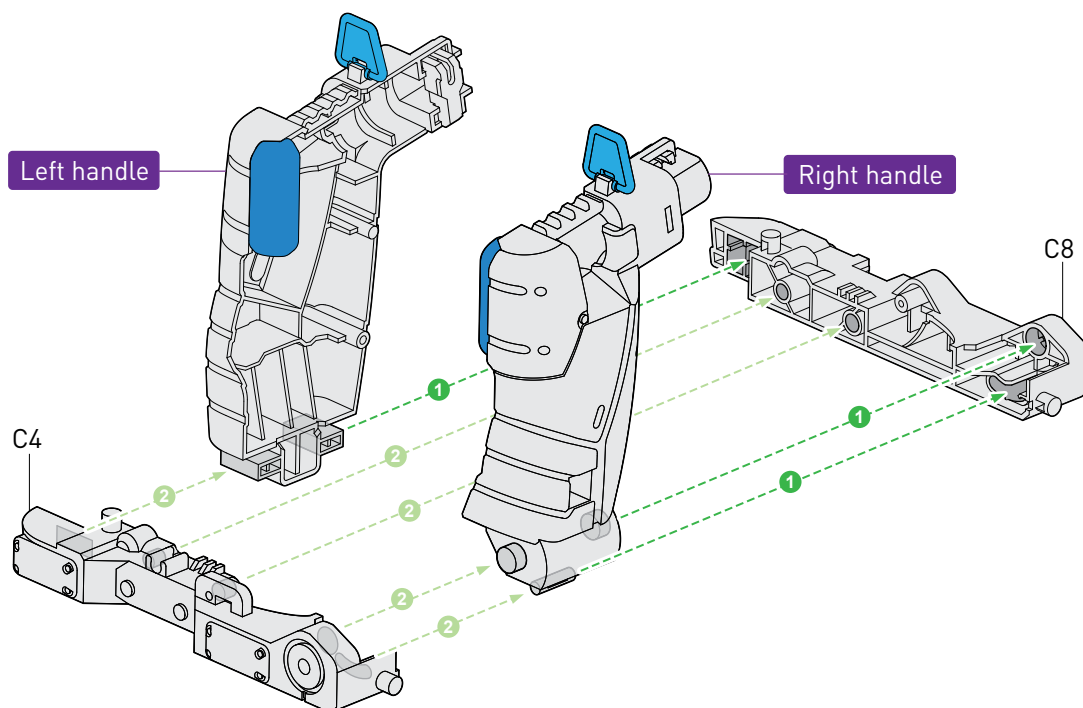
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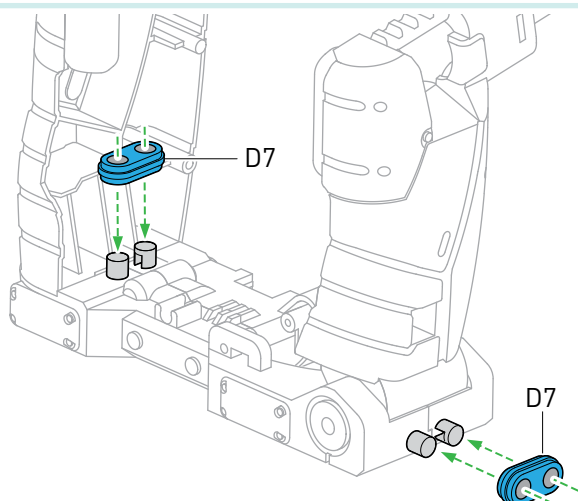
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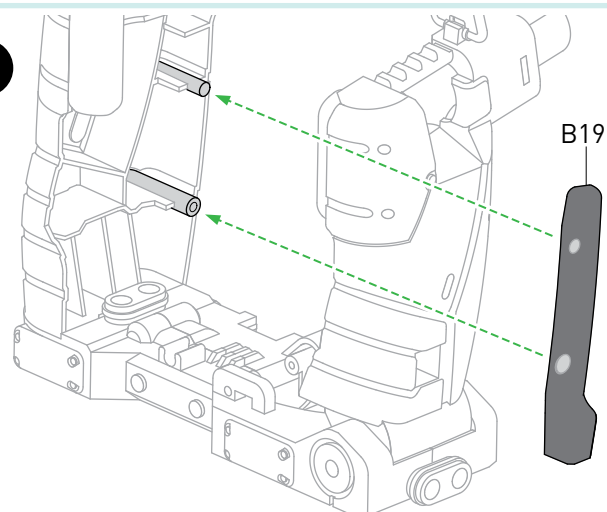
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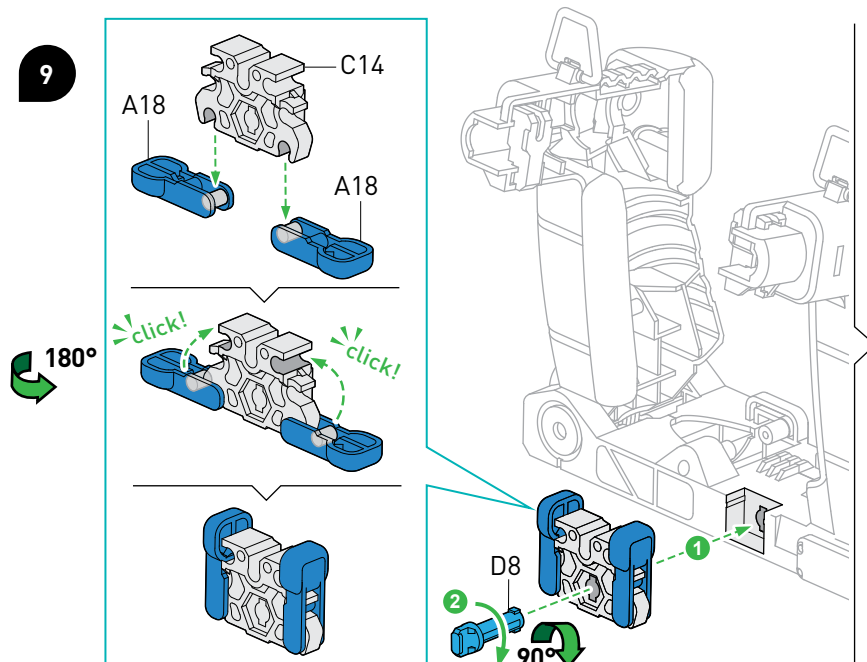
7



8



9



Right handle

Joystick

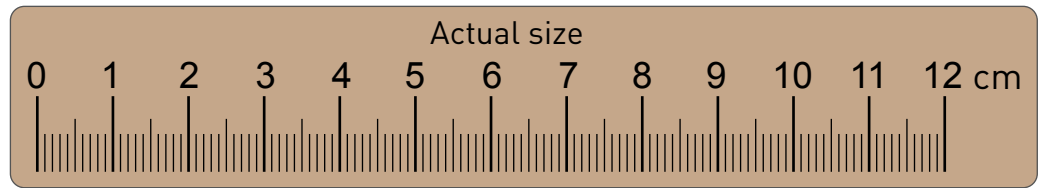
Note: The right handle will be able to move left and right.



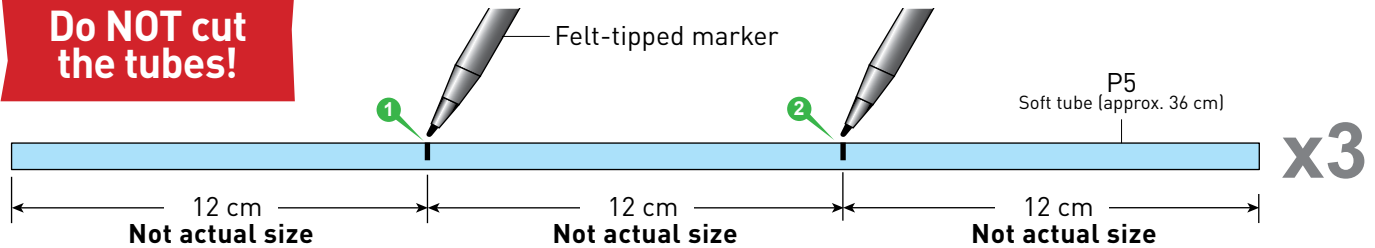
## ASSEMBLING THE HYDRAULIC SYSTEMS

### MEASURE AND MARK THE TUBES

This ruler is **actual size**. Use it to measure the tubes and mark every 12 cm, as shown in the diagram below.



**Do NOT cut the tubes!**

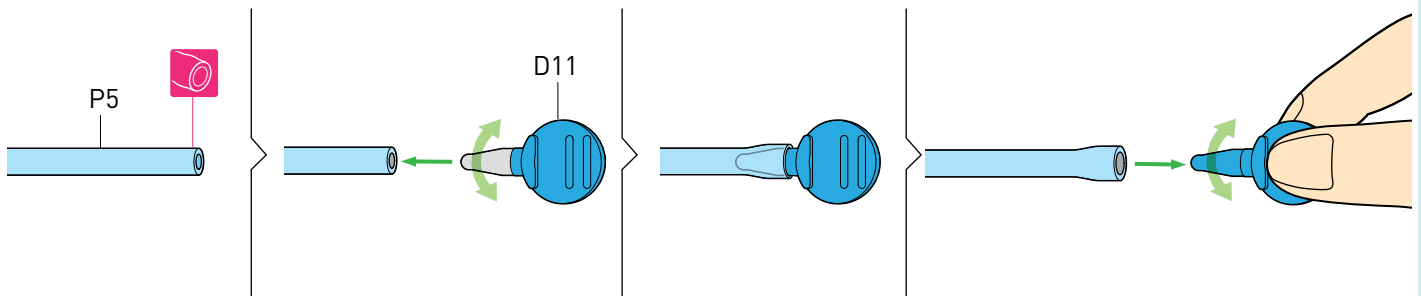


### HOW TO EXPAND THE TUBES



**= Expand the tube**

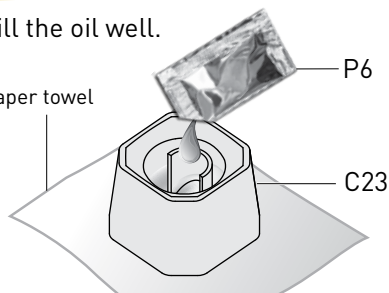
When you see this symbol in the instructions, expand the opening of the soft tube with part D11.



### HOW TO OIL THE CYLINDERS

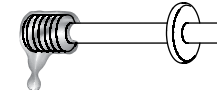
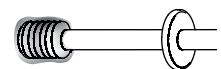
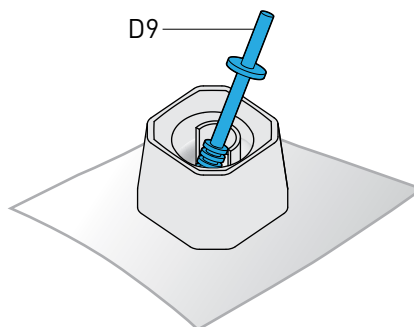
Fill the oil well.

Paper towel



Be careful not to spill oil from the C23 oil well.

D9

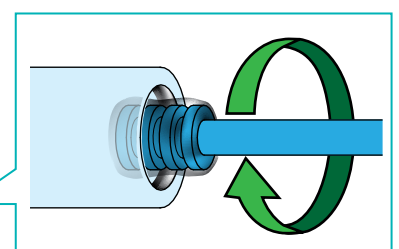


**= Oil**

When you see this symbol in the instructions, oil the component indicated.

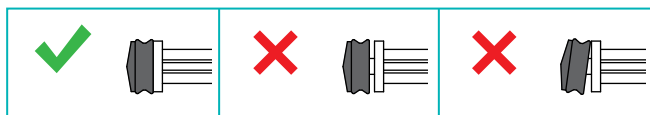
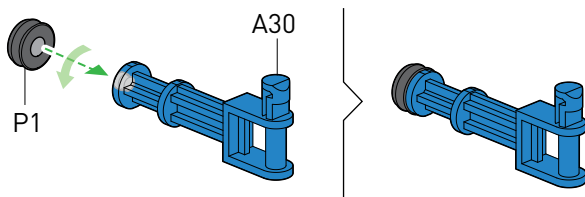
**You MUST oil the cylinders, or else the pistons might break!**

Oil only the area shaded in gray. Work carefully and do not touch the oil with your hands or get it into your eyes. Dispose of leftover oil in the household trash after assembly. Do not pour it down the drain.

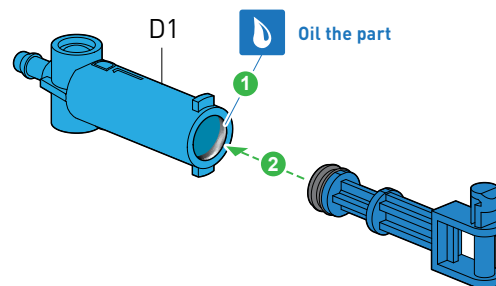


## ASSEMBLE D1 CYLINDER

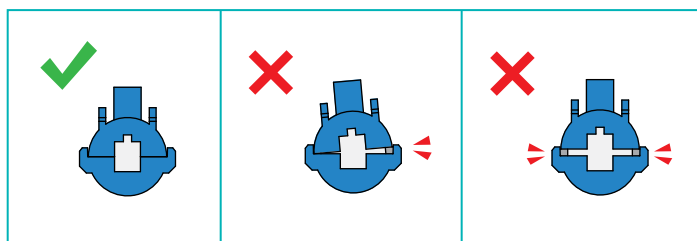
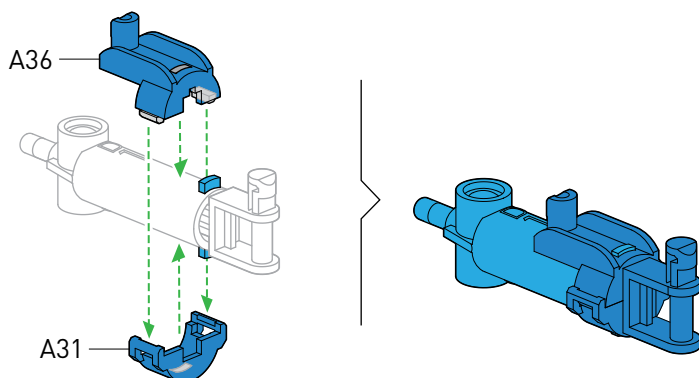
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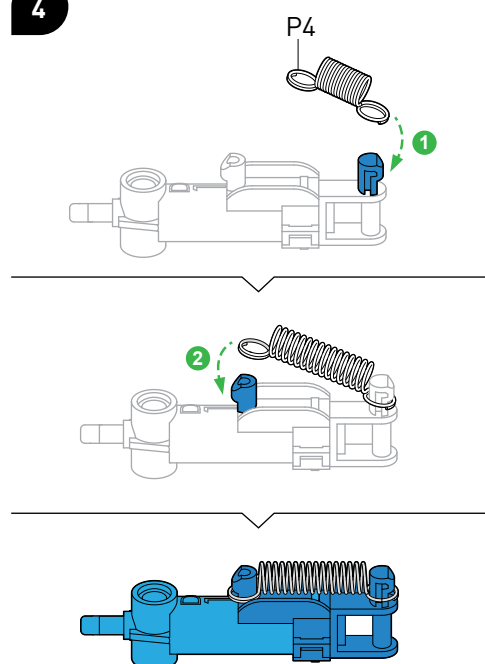
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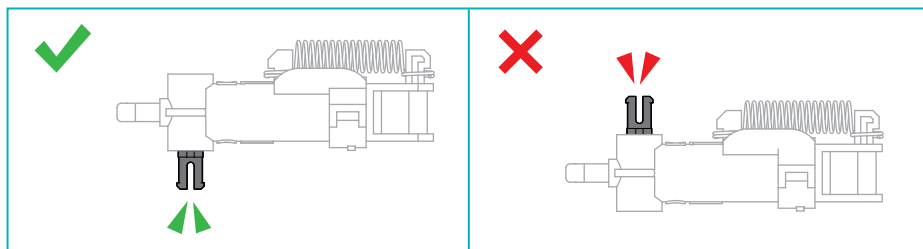
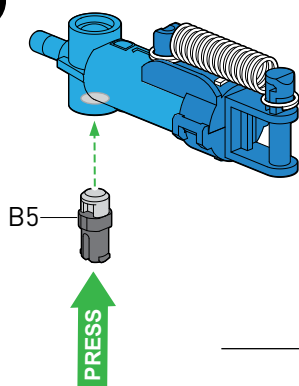
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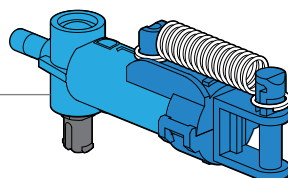
4



5



D1  
Cylinder

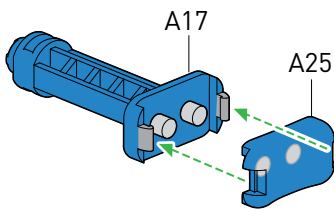


x2

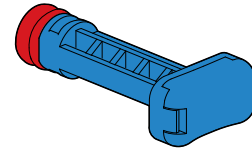




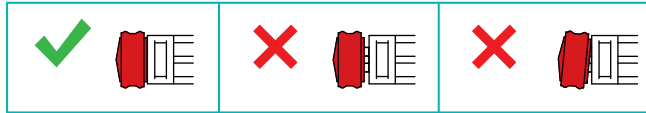
## ASSEMBLE PISTONS FOR D2 & D3



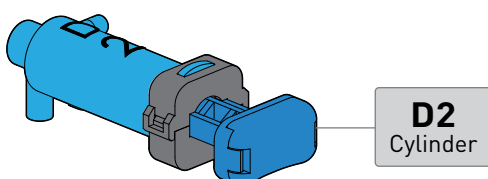
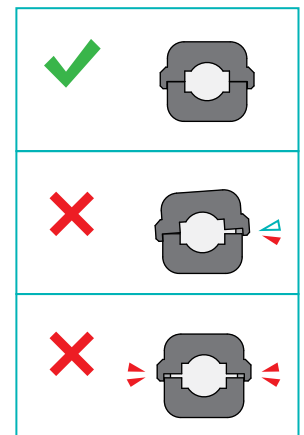
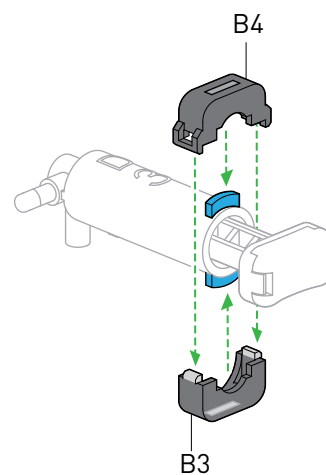
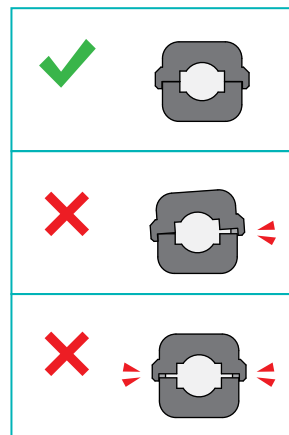
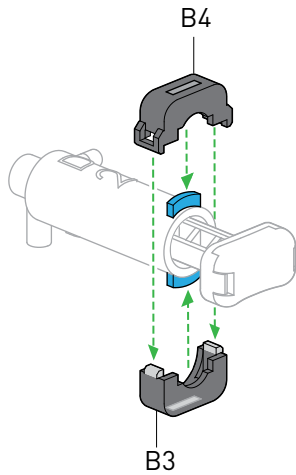
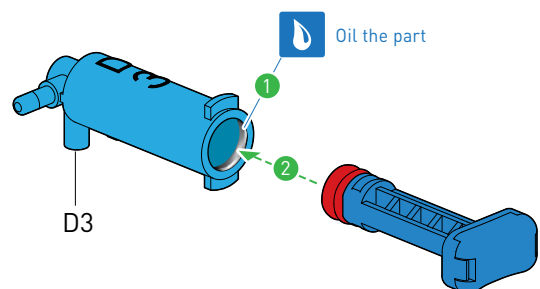
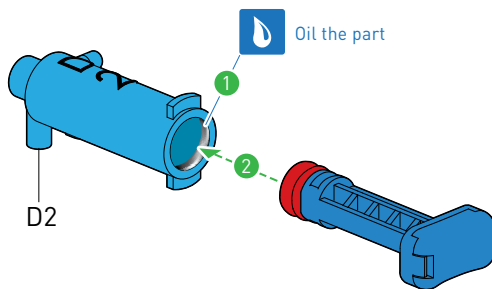
P2  
Medium cap



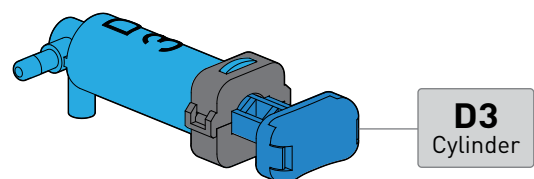
x2



## ASSEMBLE D2 CYLINDER

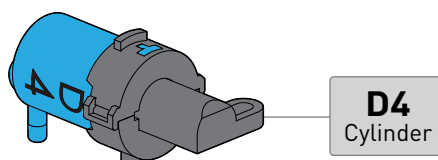
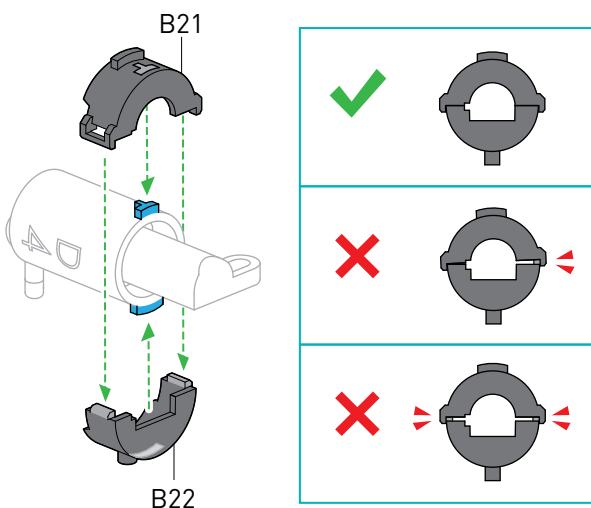
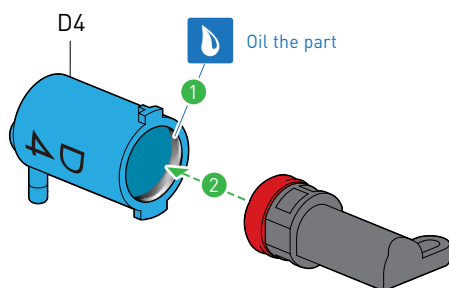
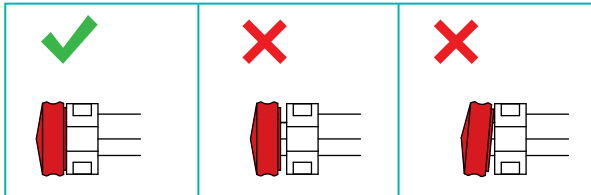
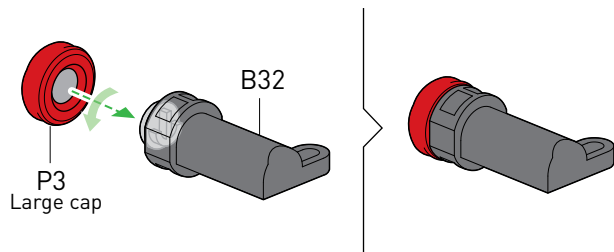


**D2**  
Cylinder

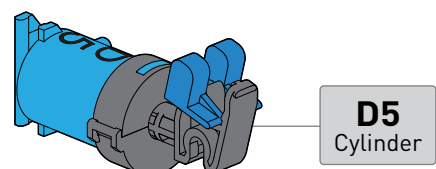
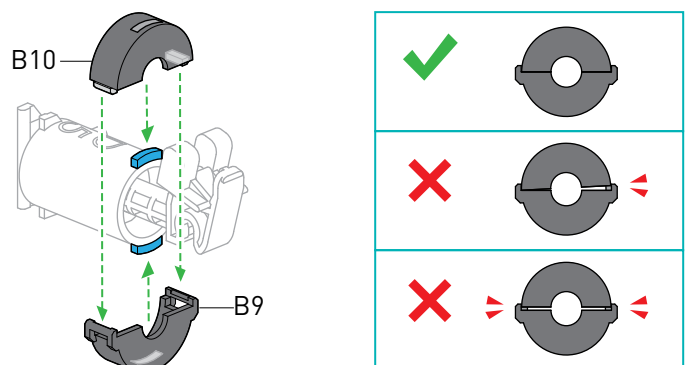
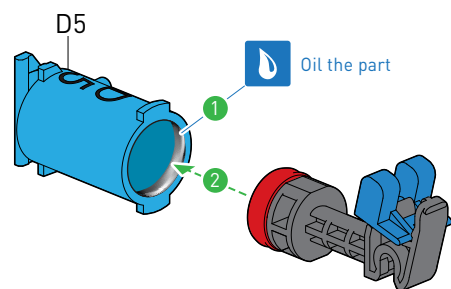
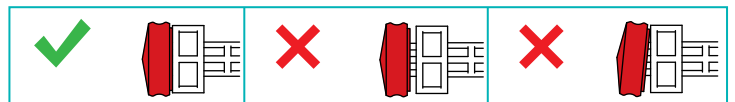
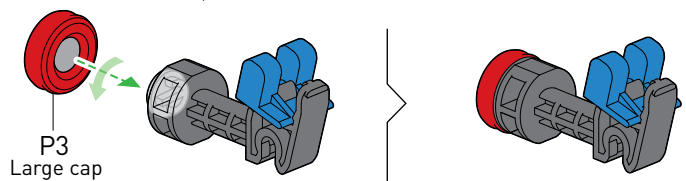
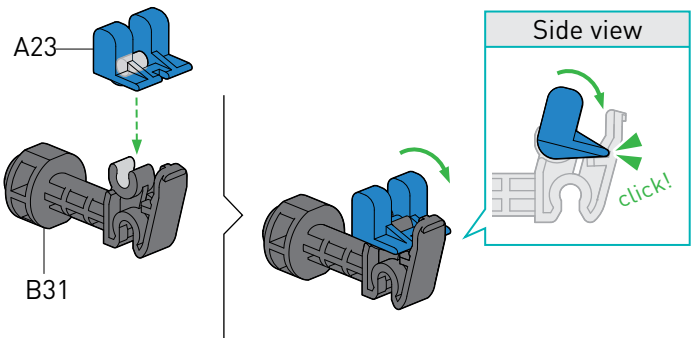


**D3**  
Cylinder

## ASSEMBLE D4 CYLINDER

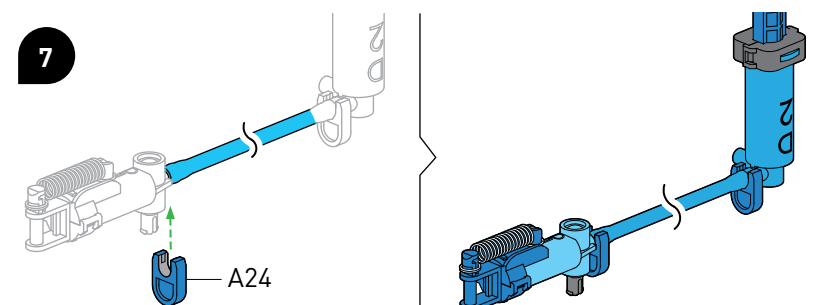
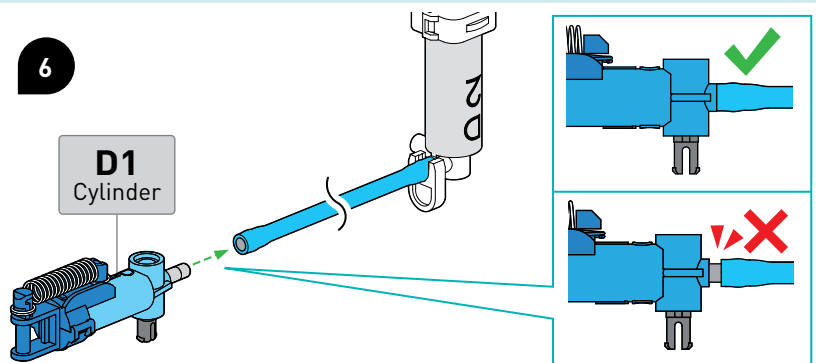
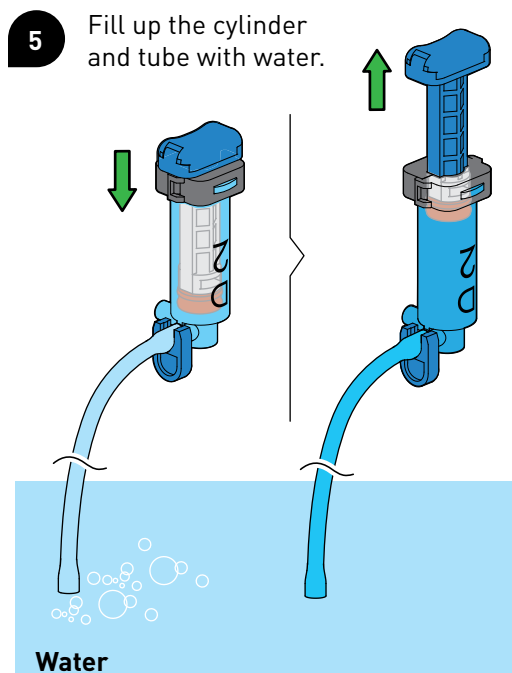
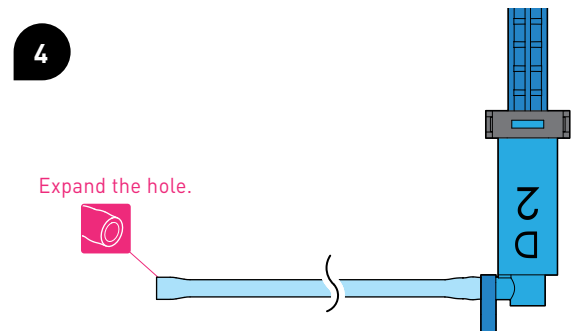
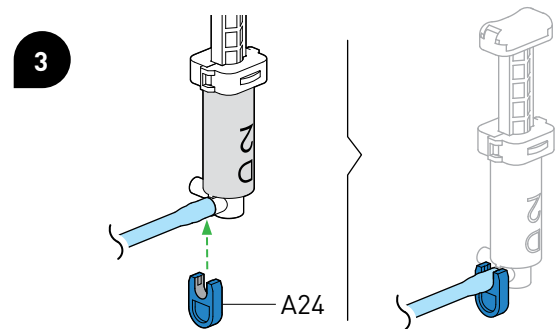
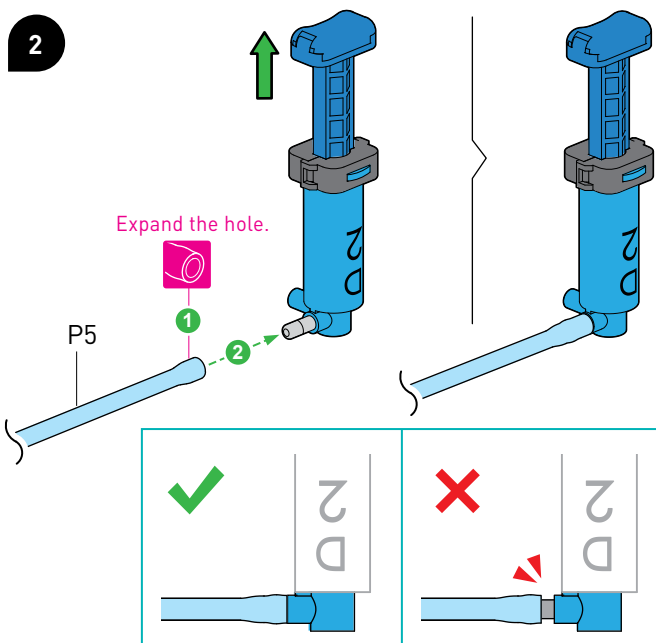
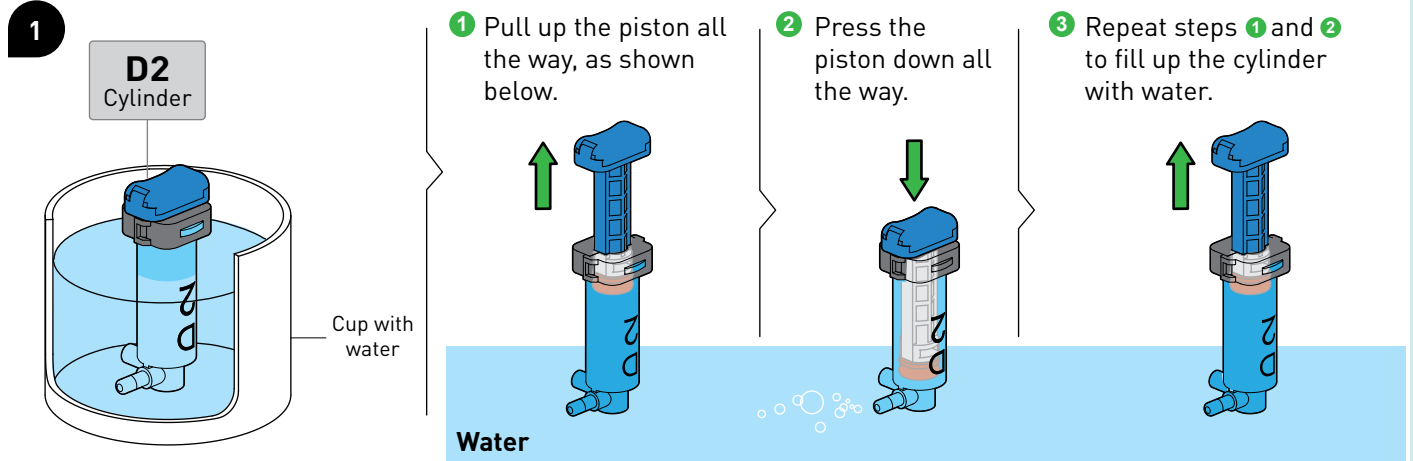


## ASSEMBLE D5 CYLINDER

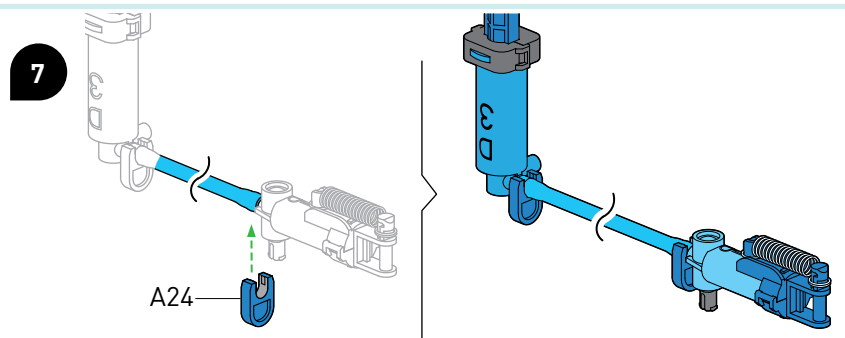
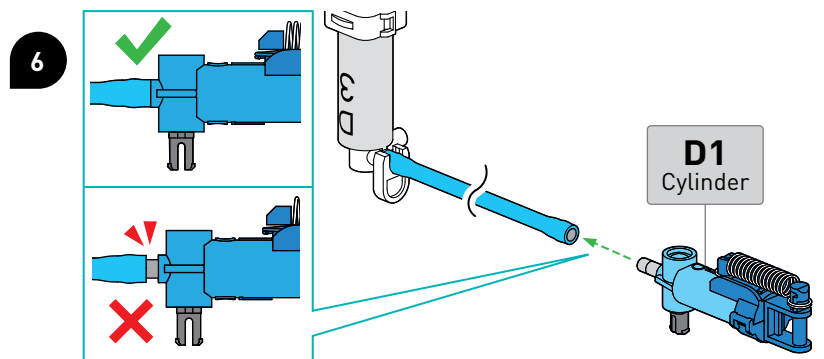
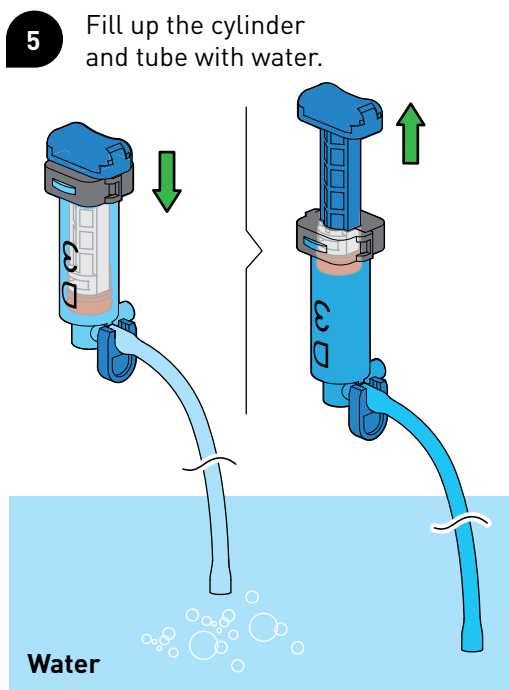
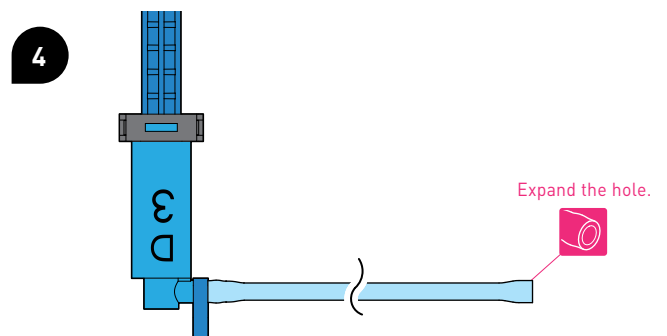
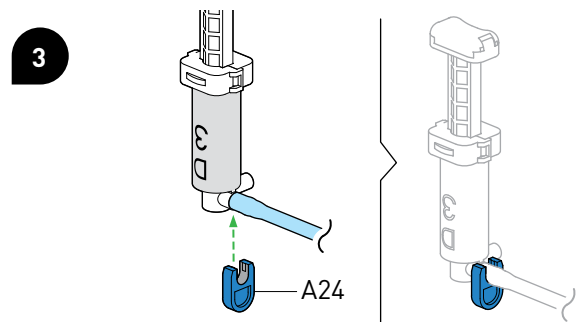
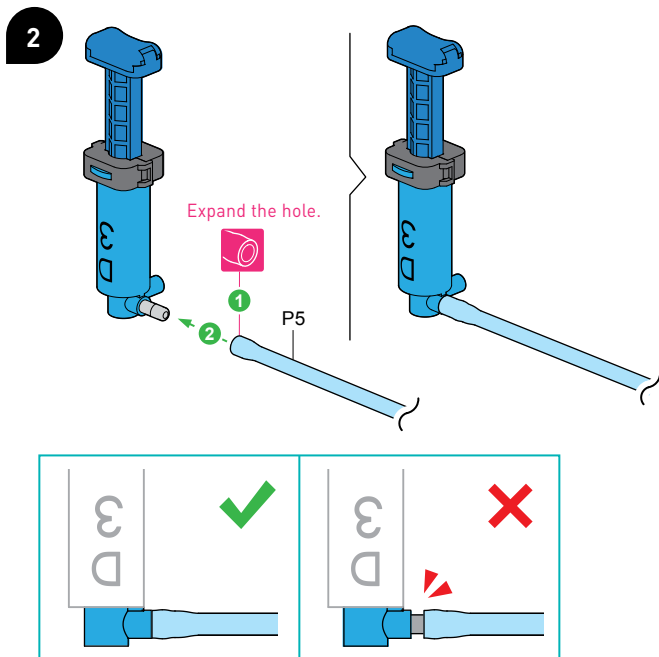
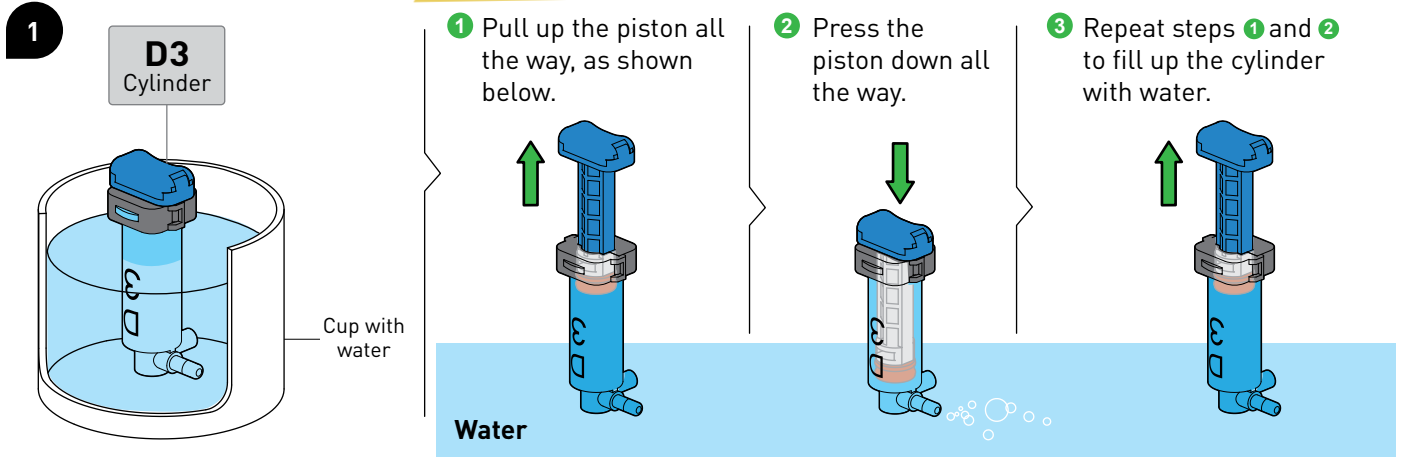




## CONNECT D1 & D2



## CONNECT D1 & D3





## EXPERIMENT 1

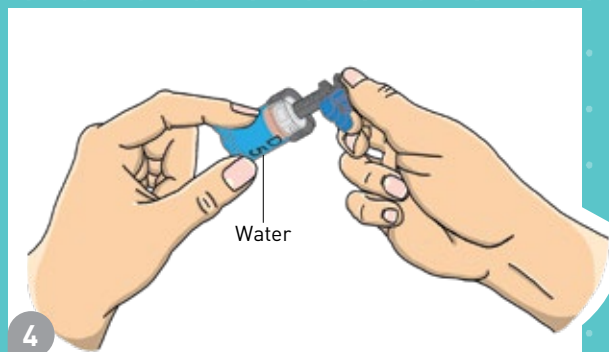
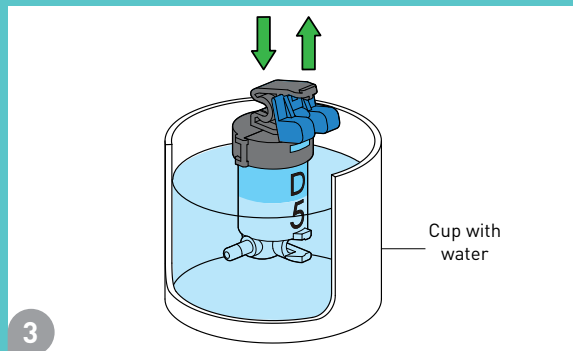
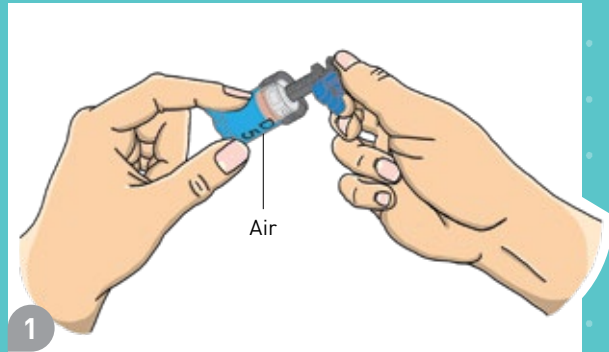
# The power of air and water

## You will need

- D5 hydraulic cylinder
- Cup of water

## Here's how

1. Pull the piston of the D5 cylinder outward and then seal the opening of the tube connection nozzle with your finger.
2. Now push the piston in. It will slide in about a centimeter or two, but will spring back when released.
3. Now, fill the D5 cylinder completely with water. To do this, dip the opening of the tube connection nozzle into a cup filled with water, push the piston all the way in, and then pull it out again.
4. Again, seal the opening of the tube connection nozzle with your finger and push the piston in. You will hardly be able to move it in at all, and you will not feel the same springy, elastic feeling you felt when the cylinder was filled with air.



## WHAT'S HAPPENING?

Air is elastic. Air-filled balls used in sports take advantage of this scientific fact. The elastic air in bicycle and car tires absorbs vibrations and shocks while the vehicles are moving.

Unlike air, water can hardly be squeezed. This applies generally to all liquids, including oil. Under the influence of pressure, the density of all real substances changes, but especially with gases. This is much less the case with liquids and solids than with air. The amount by which a substance can be compressed is referred to as its **compressibility**.

## EXPERIMENT 2

# Hydraulic transmission

### You will need

– D1 & D3 hydraulic system

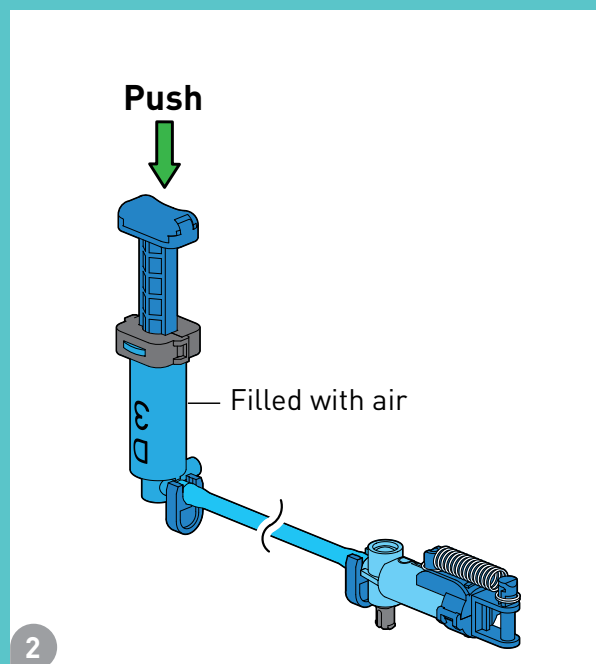
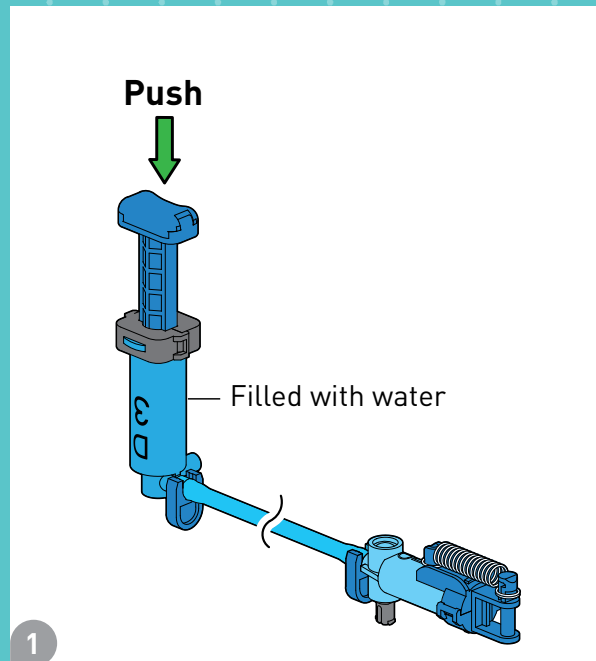
### Here's how

1. Push the piston of D3 inward, and the piston of D1 will move outward accordingly. Try to block this outward movement: You will feel the force you exert on one piston transmitted to the other piston.
2. Empty the water from the cylinders and repeat the experiment with air. Can you move the D1 piston by pushing on the D3 piston? Is it the same or different?
3. Go back to step 1 on page 20 to refill the hydraulic system with water, then continue on with assembly.



### WHAT'S HAPPENING?

The force with which you push in on the piston of the G1 cylinder is transmitted from the water or air to the piston of the G3 cylinder. However, some of the force is lost in the air-filled system because the air compresses. Since the **compressibility** of water is lower, the hydraulic cylinders in your hydraulic boxing bots are filled with water to make it more powerful.



### KEYWORDS

#### DID YOU KNOW ...

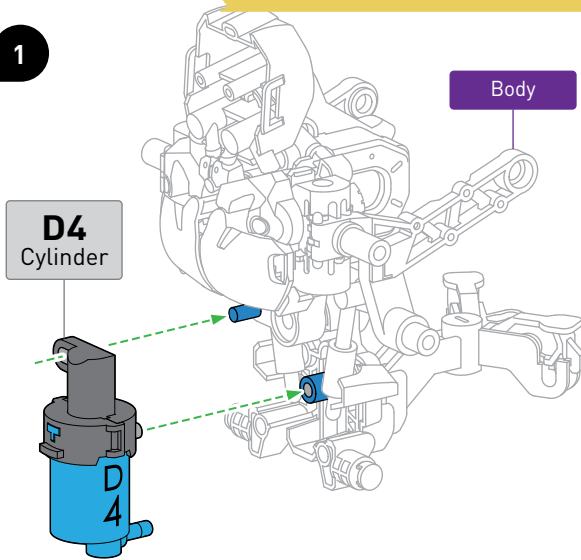
... that this method of power transmission is widely used in engineering? Devices that work with compressed air are called **pneumatic**; those with liquids such as water or (much more often) special oils are called **hydraulic**. You can find out more about this on page 40.



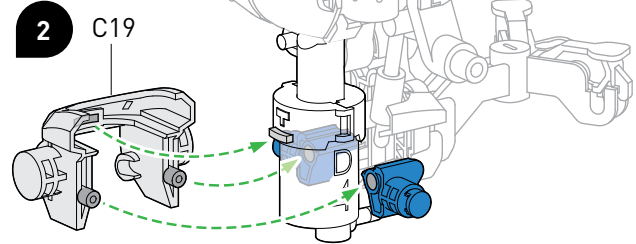
## INSTALLING THE HYDRAULIC SYSTEMS

### INSTALL D4 & D5 (UPPER BODY MOVEMENT)

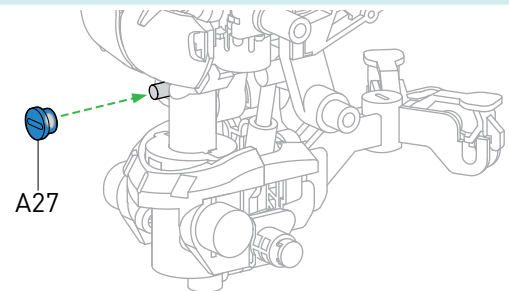
1



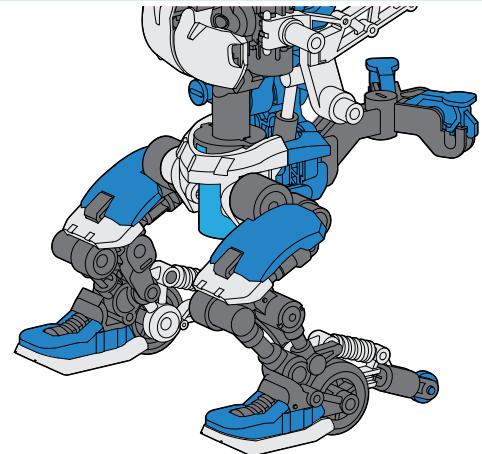
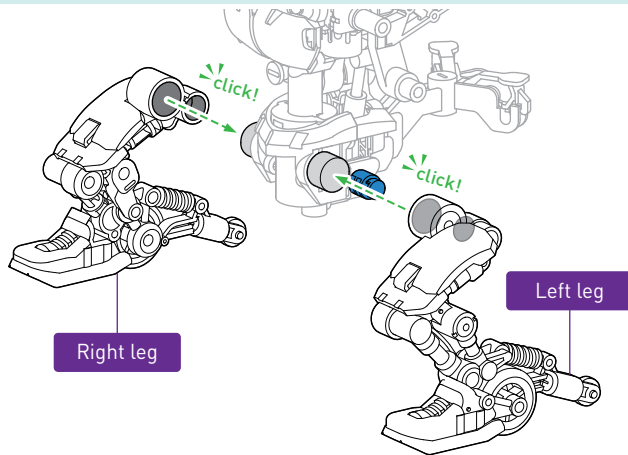
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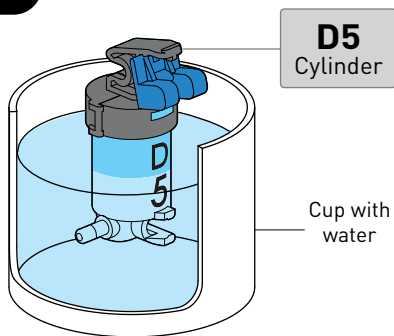
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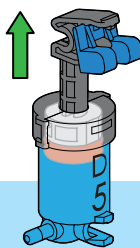
4



5



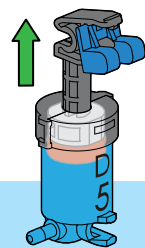
1 Pull up the piston all the way, as shown below.



2 Press the piston down all the way.



3 Repeat steps 1 and 2 to fill up the cylinder with water.

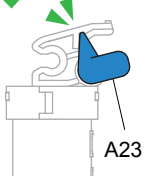


Water

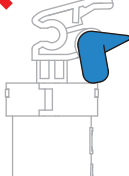
!

Make sure A23 is installed correctly.

✓



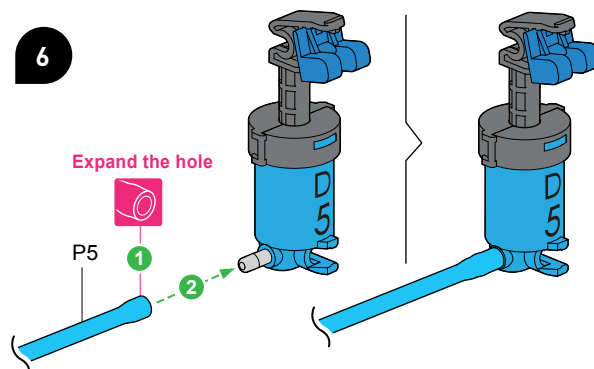
✗



6

Expand the hole

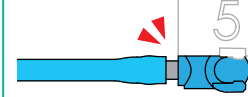
P5



✓

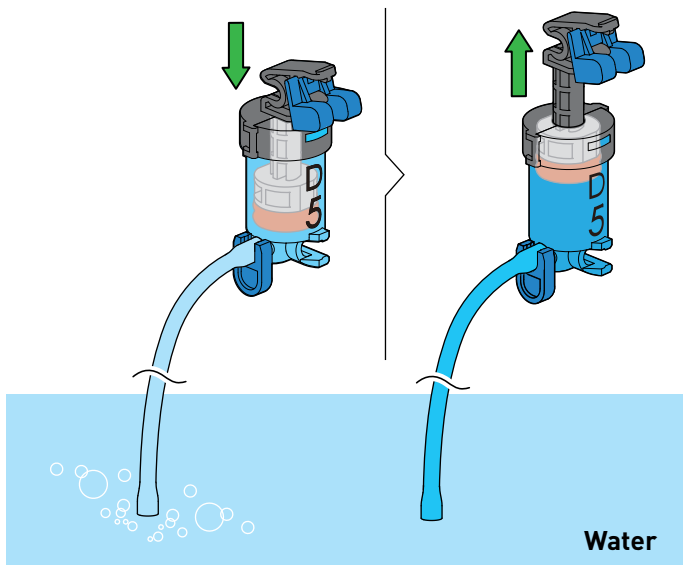


✗





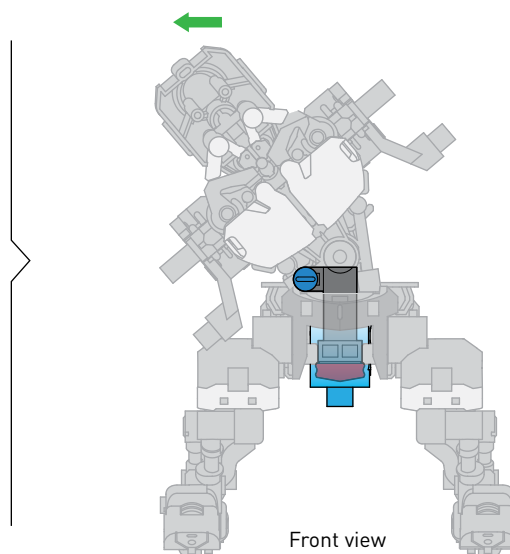
Fill up the cylinder and tube with water.



Press Down



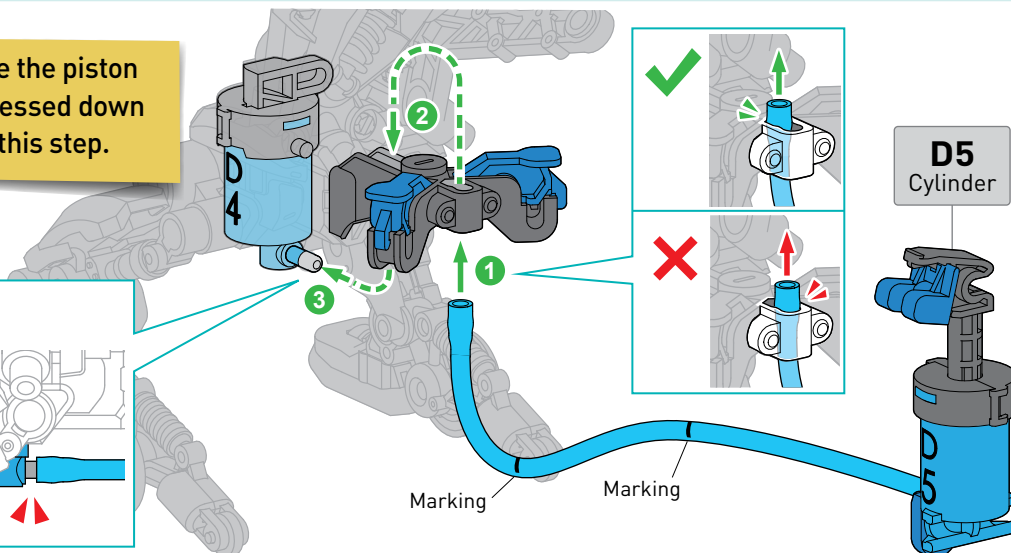
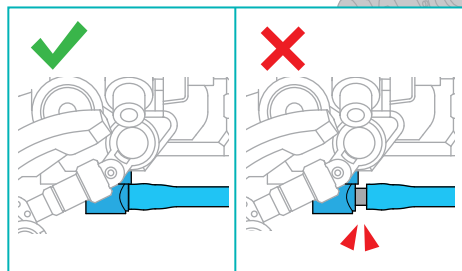
Press Down



Front view



**Make sure the piston of D4 is pressed down during this step.**



**D5**  
Cylinder

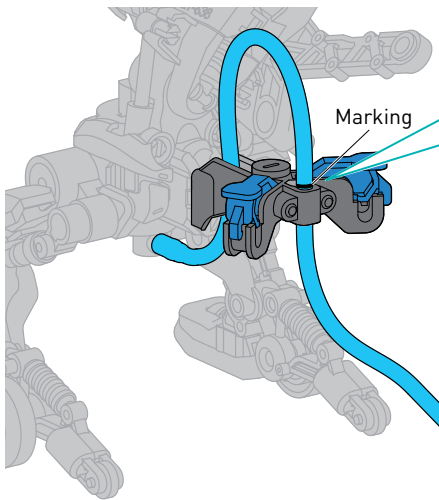
### Marking

Marking

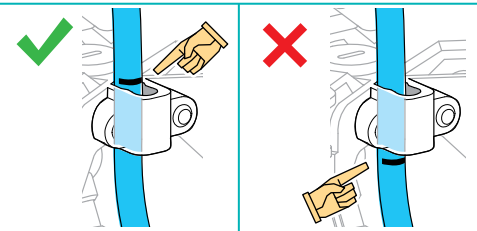




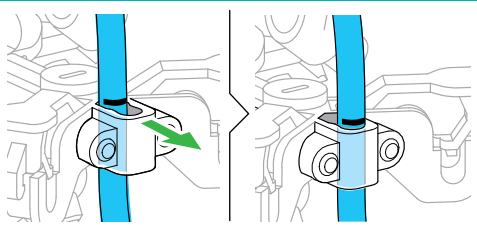
12



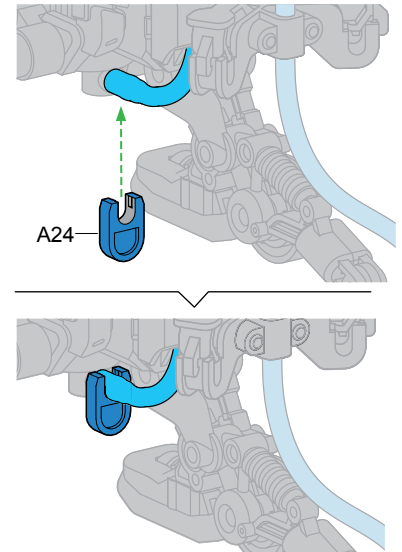
1. Line up the marking as shown below.



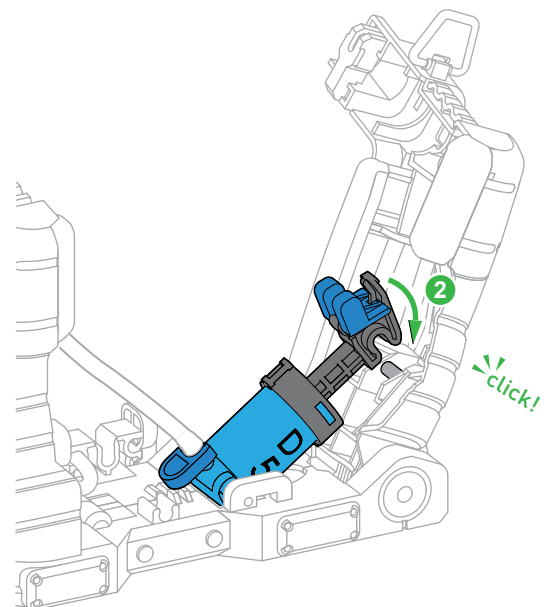
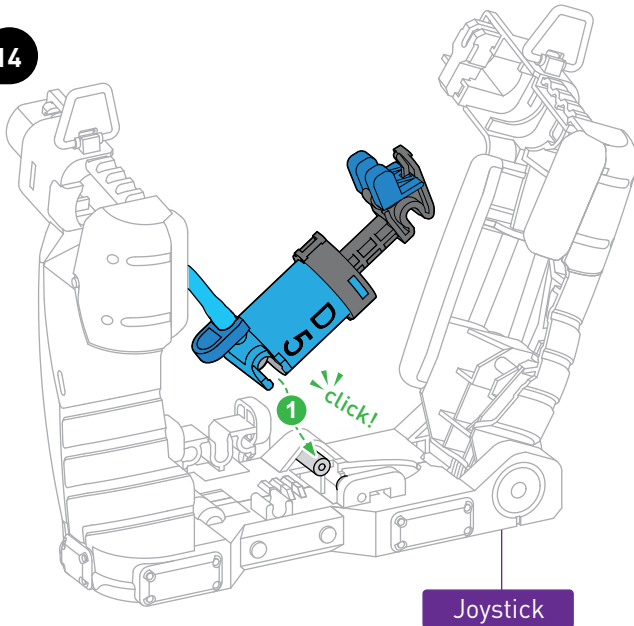
2. Push the hydraulic tube forward.



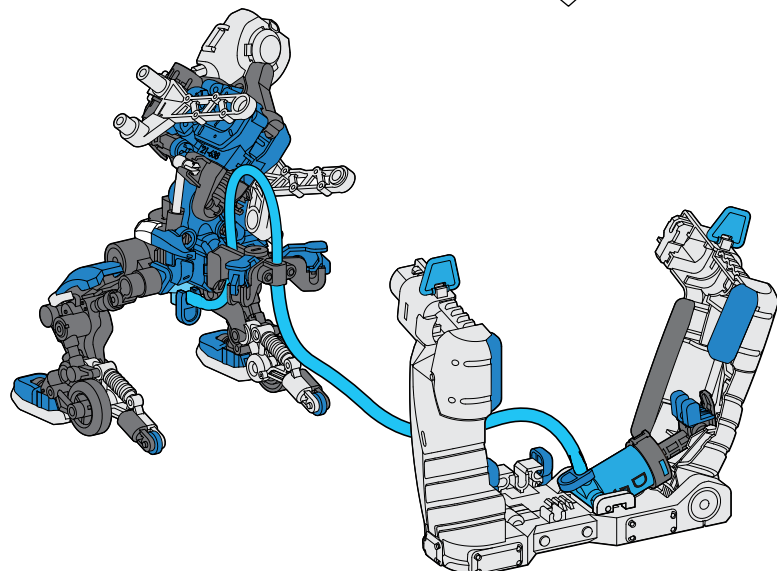
13



14

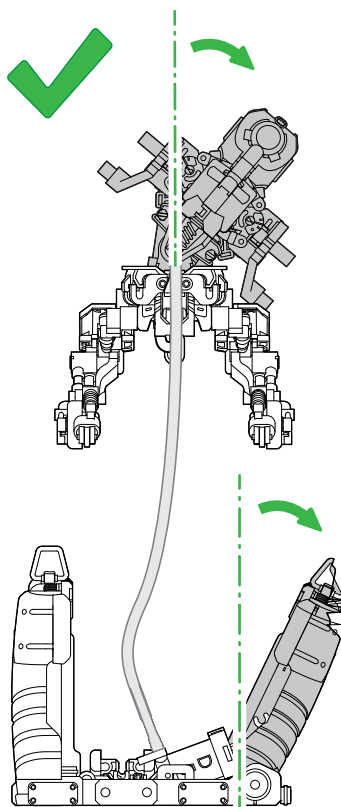


**!** Check the functionality of the D4 and D5 hydraulic system on the following page.

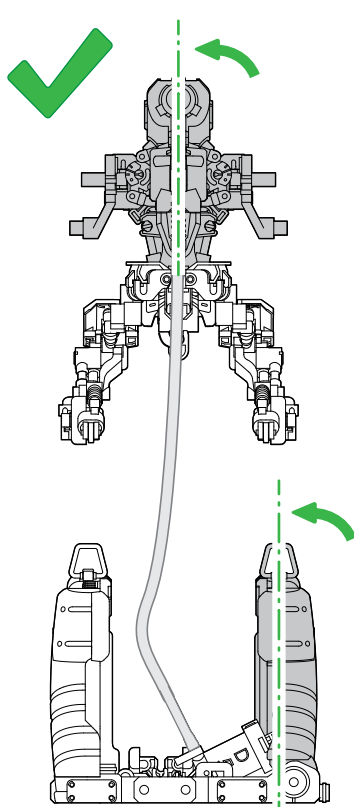


## CHECK UPPER BODY MOVEMENT

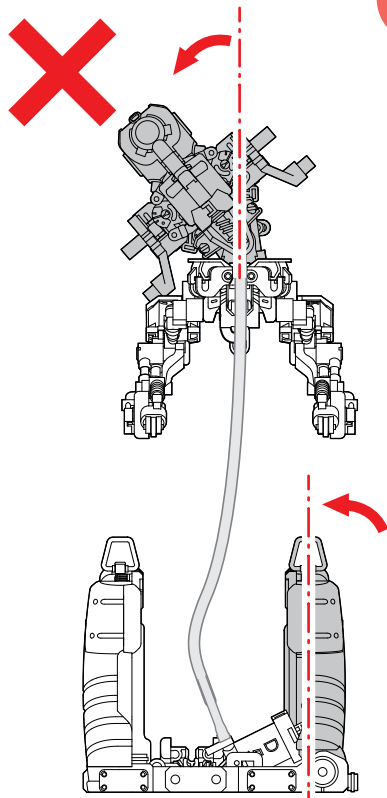
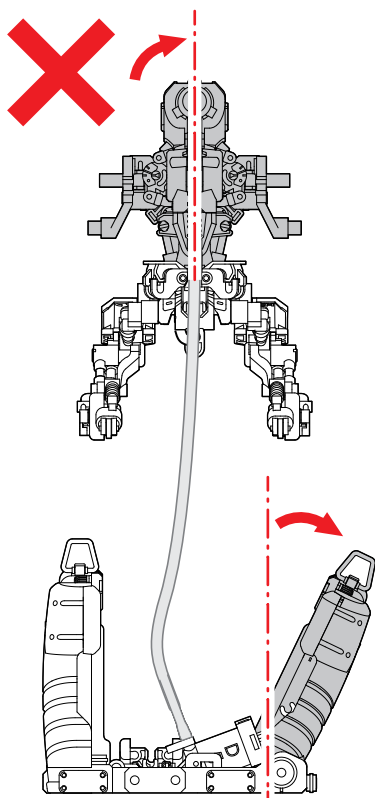
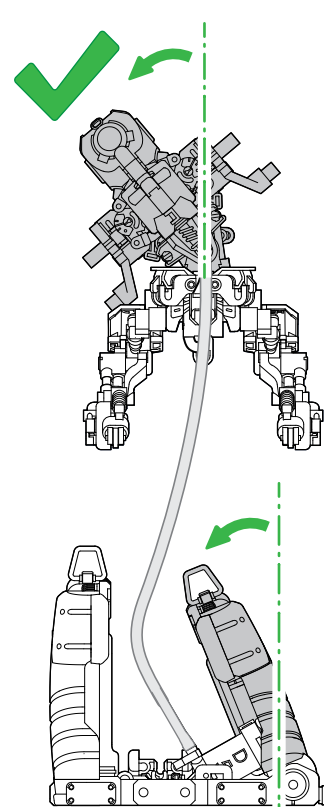
When the right handle of the joystick is pulled to the right, the boxer's upper body should tilt to the right.



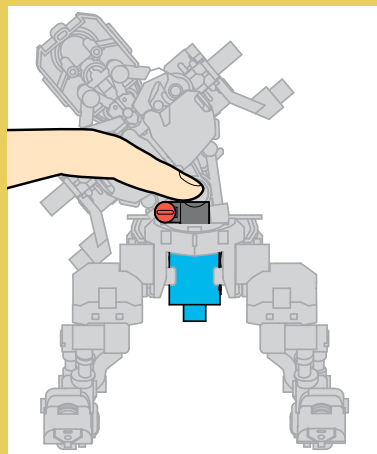
When the right handle of the joystick is in the center, the boxer's upper body should be centered.



When the right handle of the joystick is pushed to the left, the boxer's upper body should tilt to the left.



**!** If the boxer is not moving side to side with the full range of motion, go back to step 10 on page 24, and make sure the D4 piston is pressed all the way down while the tube is being connected.

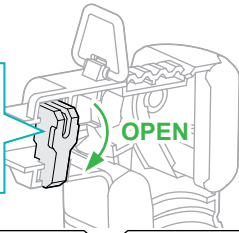




## INSTALL D1 & D2 (RIGHT ARM MOVEMENT)

1

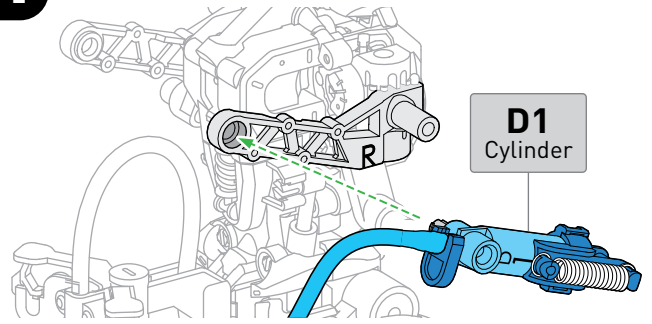
Squeeze the tabs and pull to release.



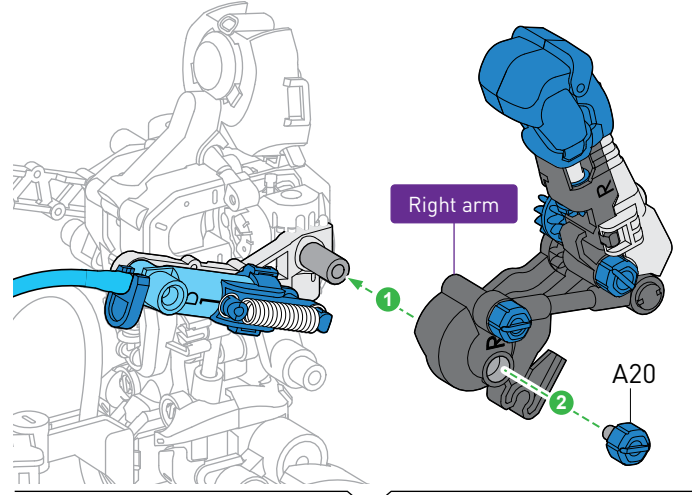
Right handle

OPEN

2

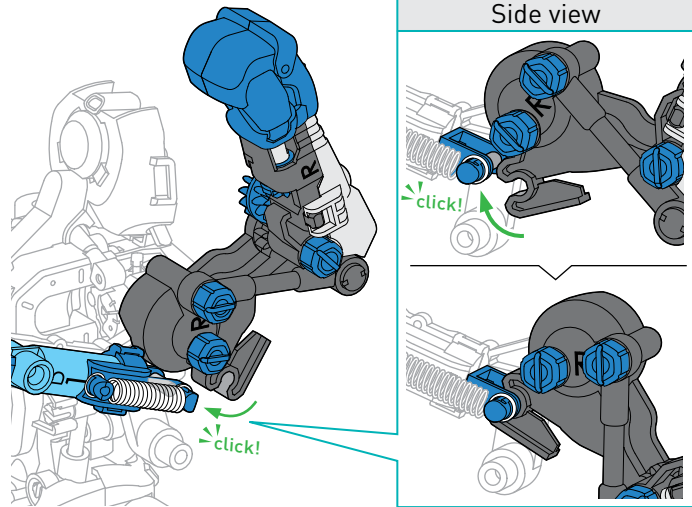


D1  
Cylinder



Right arm

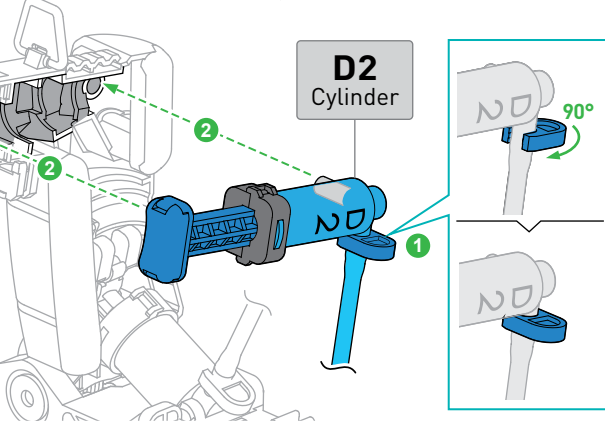
A20



Side view

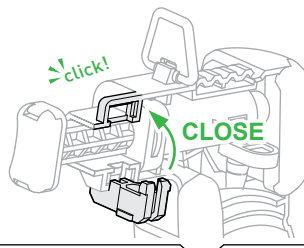
click!

click!



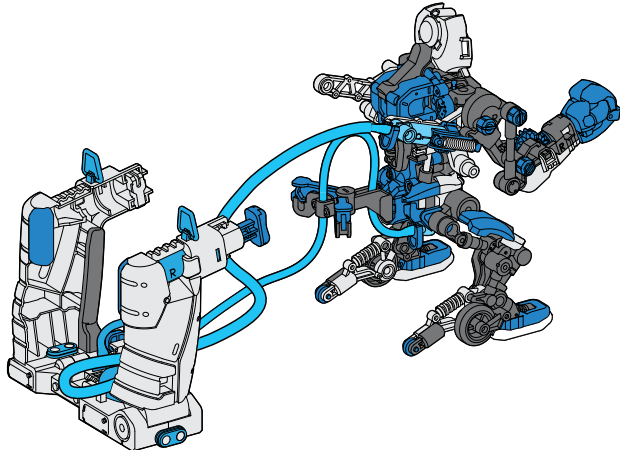
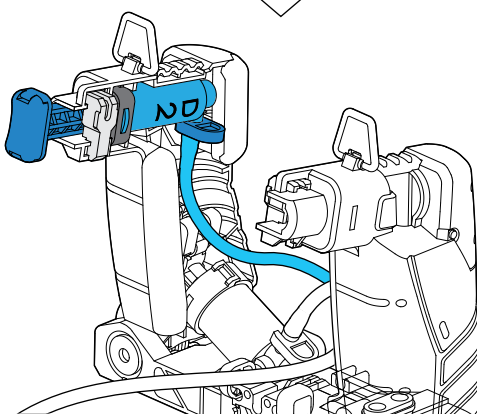
D2  
Cylinder

90°



click!

CLOSE



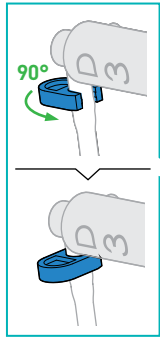
## INSTALL D1 & D3 (LEFT ARM MOVEMENT)

1

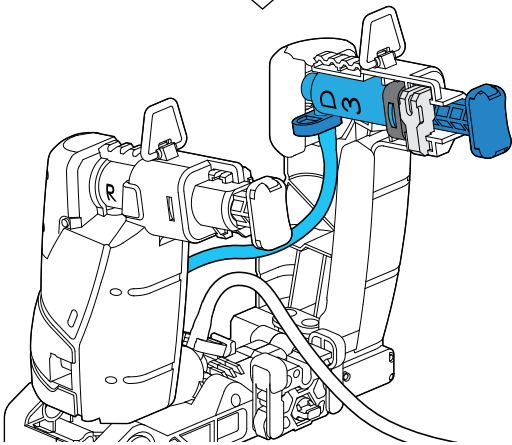
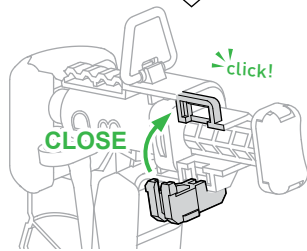
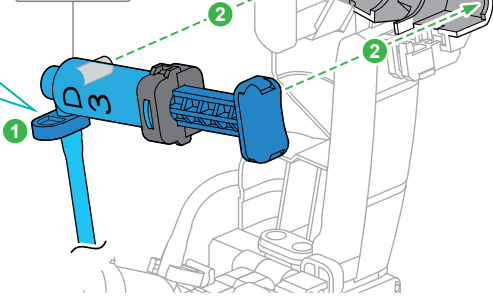
Left handle

OPEN

Squeeze the tabs and pull to release.

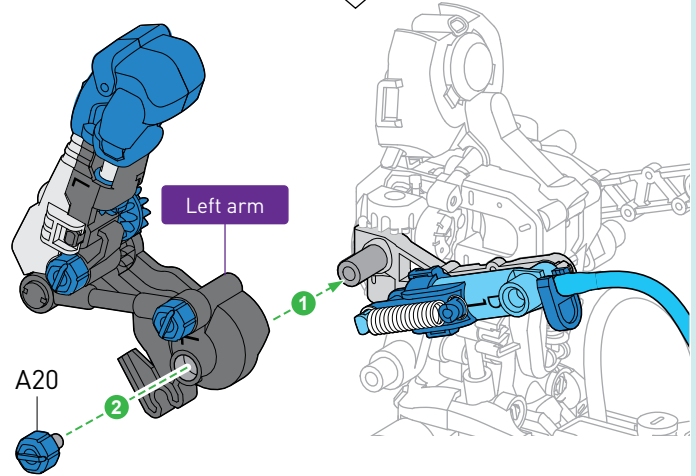
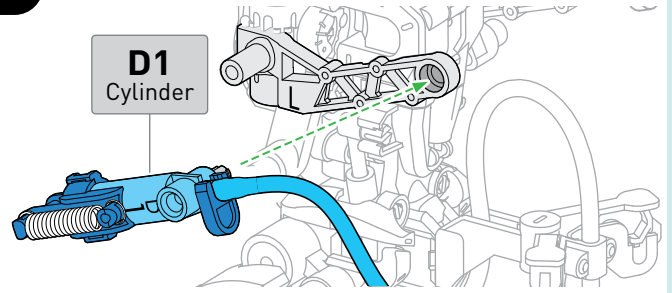


D3 Cylinder

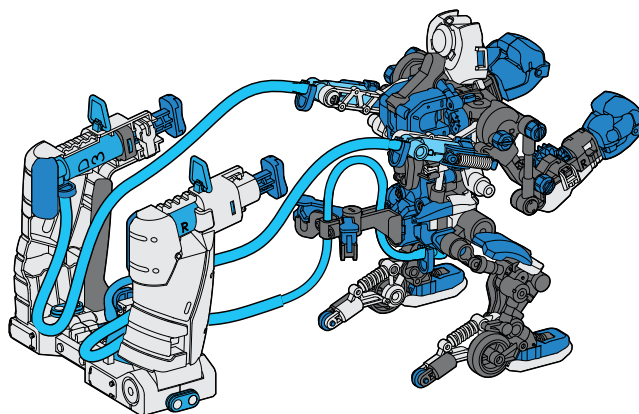
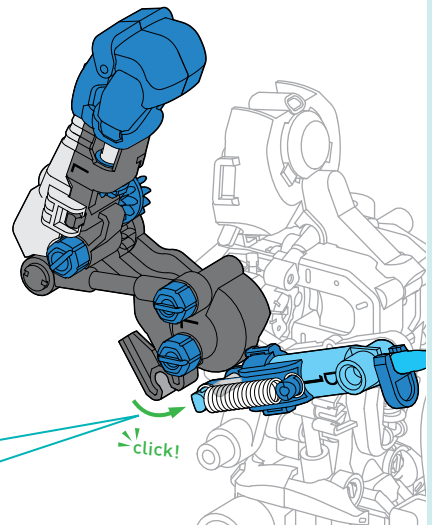
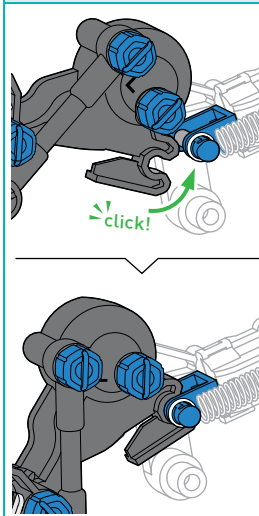


2

D1 Cylinder



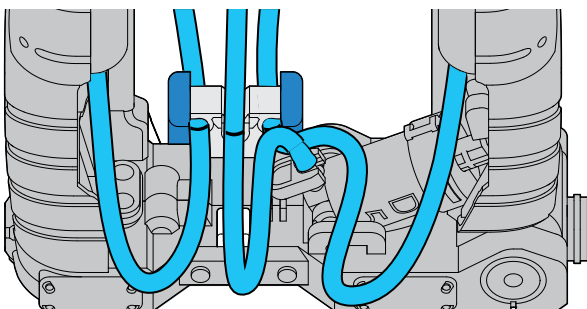
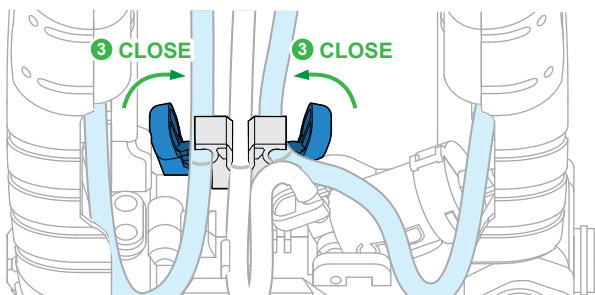
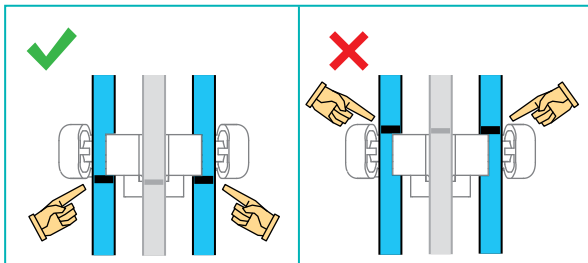
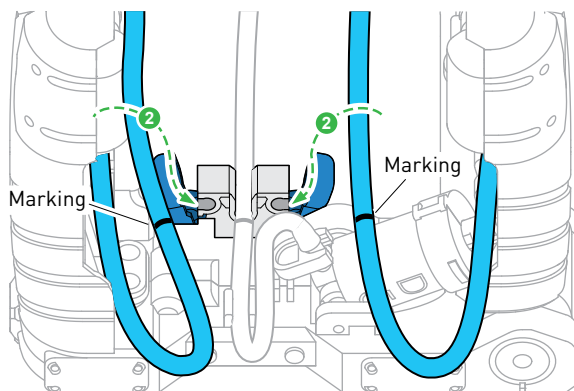
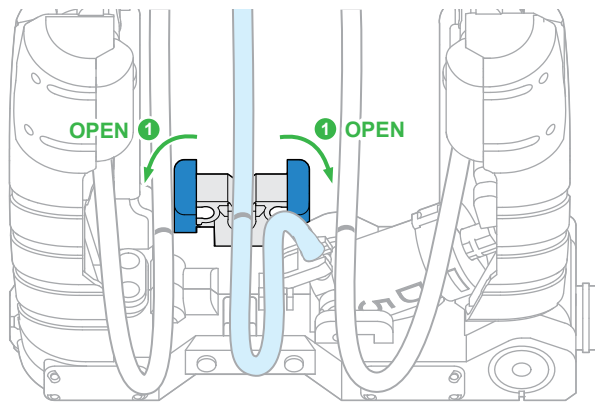
Side view



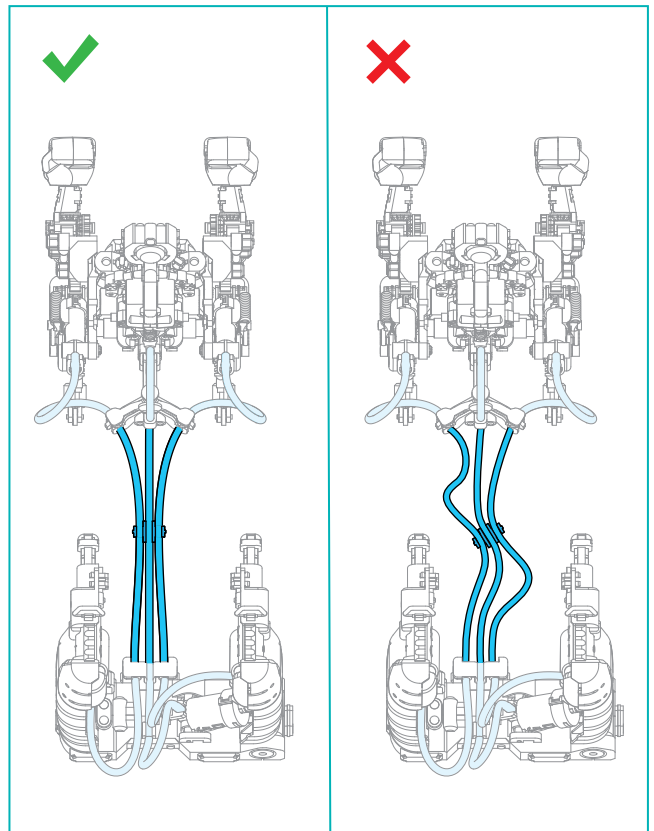
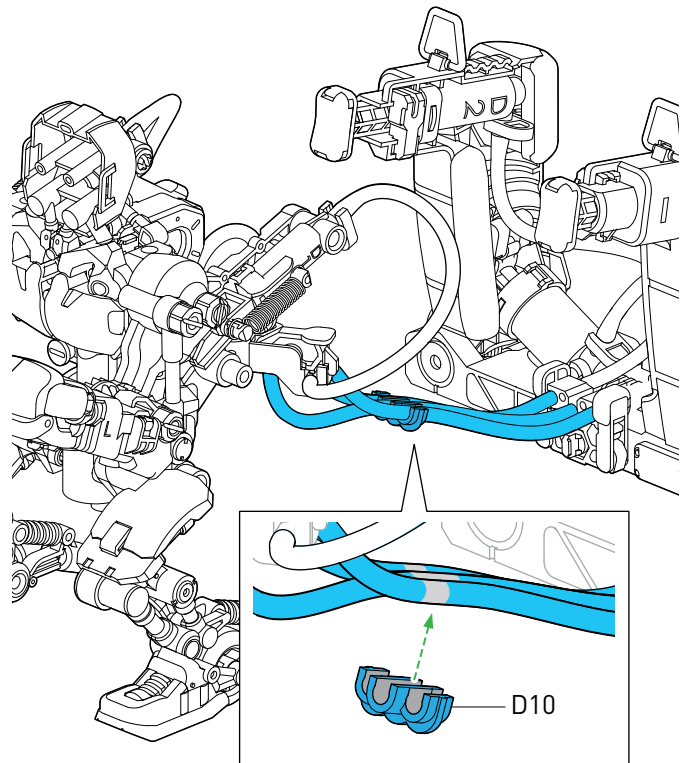




3



4



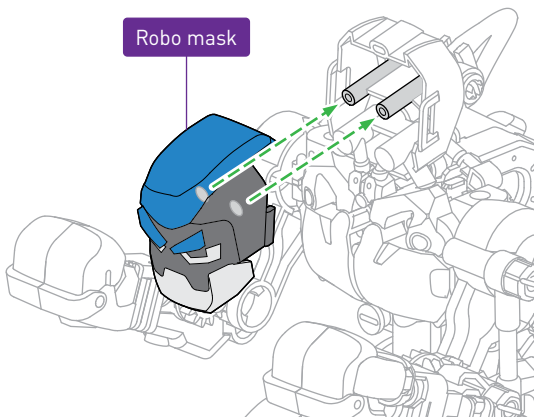
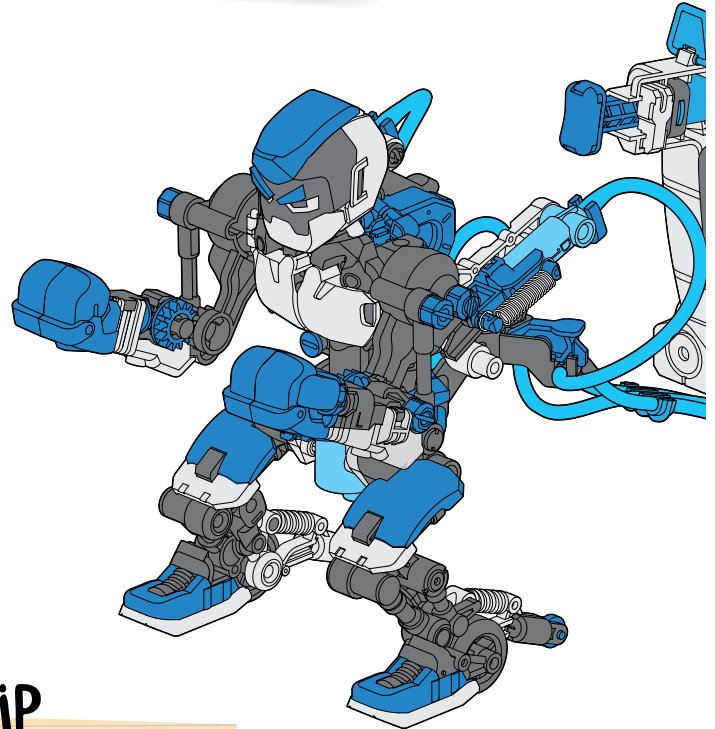
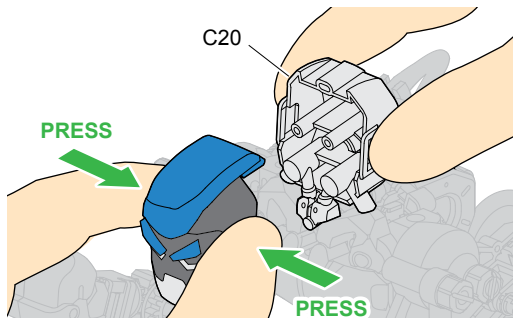


## CUSTOMIZING YOUR BOXING BOT

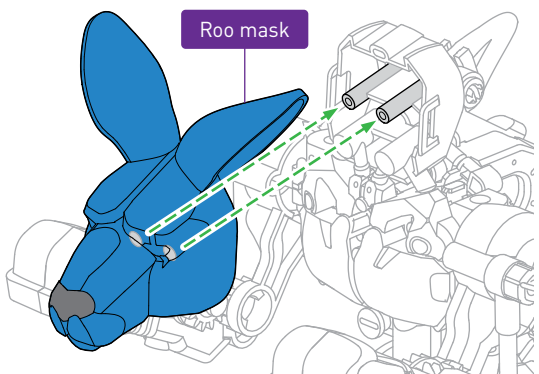
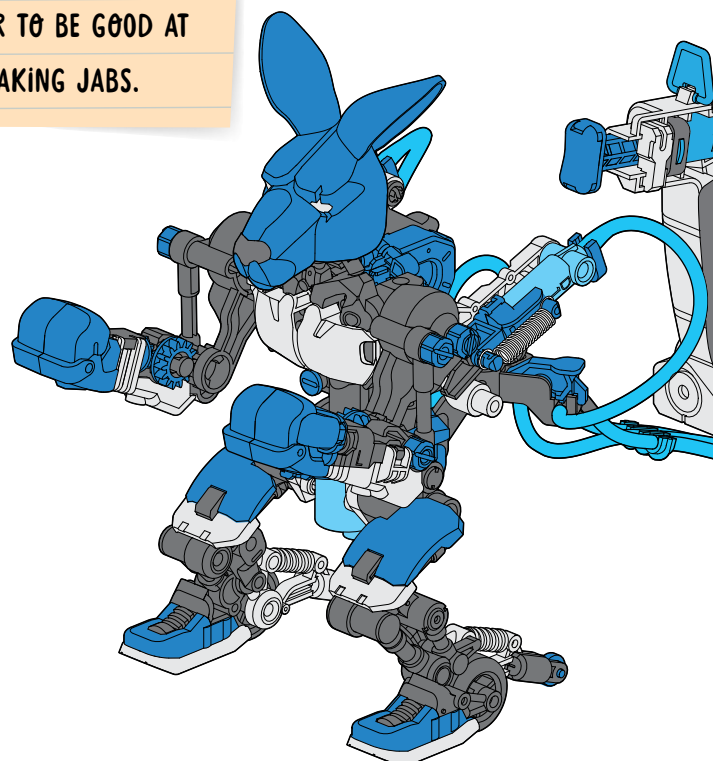
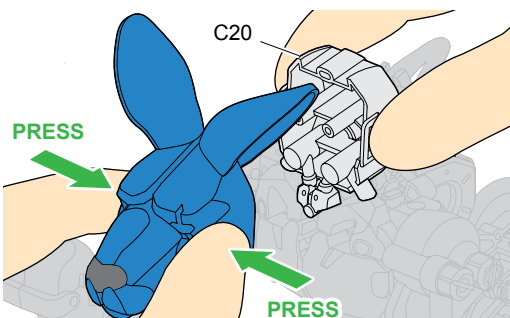
## 1. CHOOSE YOUR MASK

**TIP**

CHOOSE THE ROBO MASK

IF YOU WANT YOUR BOXER TO BE  
GOOD AT TAKING UPPERCUT PUNCHES.**Disassembly****Tip:** Gently press the sides of the mask with one hand while holding C20 steady with your other hand.**TIP**

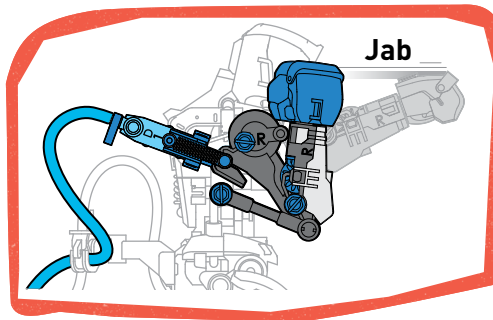
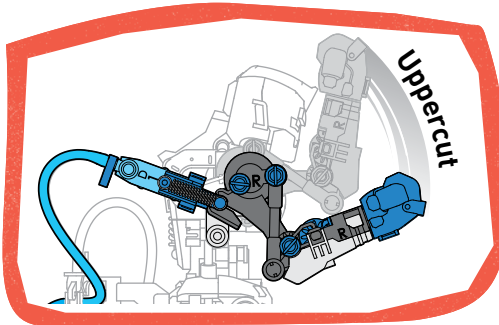
CHOOSE THE ROO MASK

IF YOU WANT YOUR  
BOXER TO BE GOOD AT  
TAKING JABS.**Disassembly****Tip:** Gently press the sides of the mask with one hand while holding C20 steady with your other hand.



## 2. CHOOSE YOUR PUNCHES

*The two types of punches:*



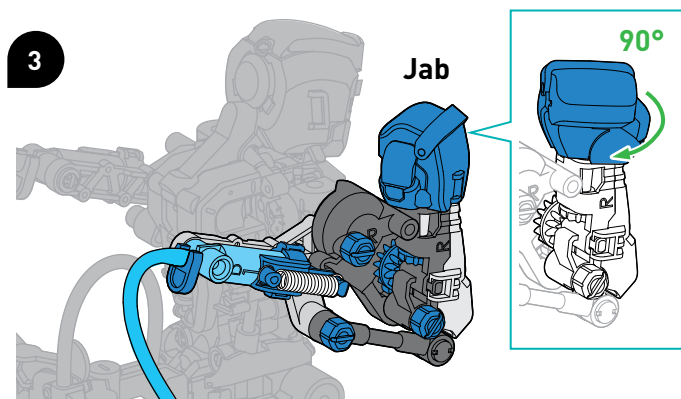
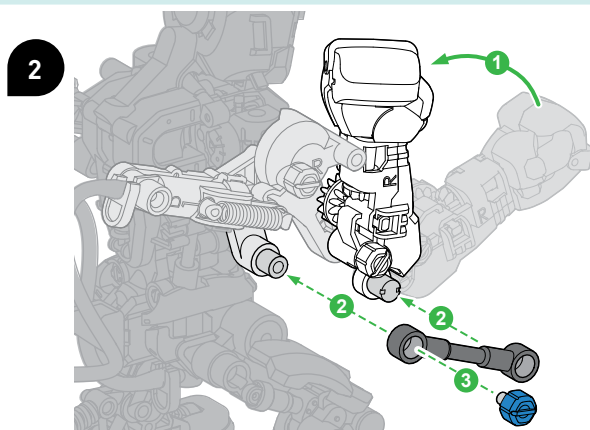
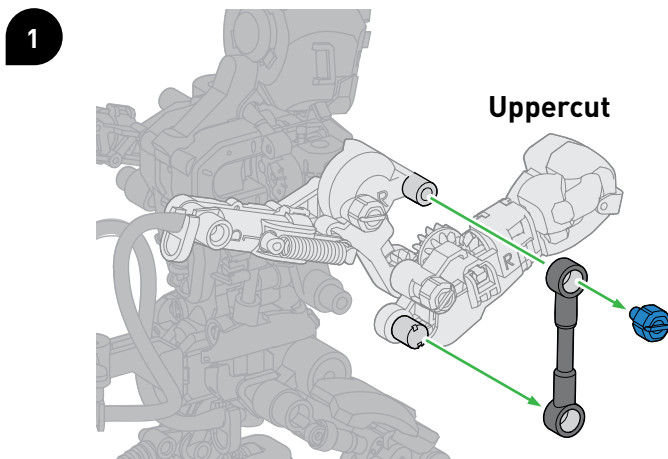
Both arms of your boxing bot are originally configured in the uppercut position. You can change one or both arms to jabs. Experiment with different configurations!



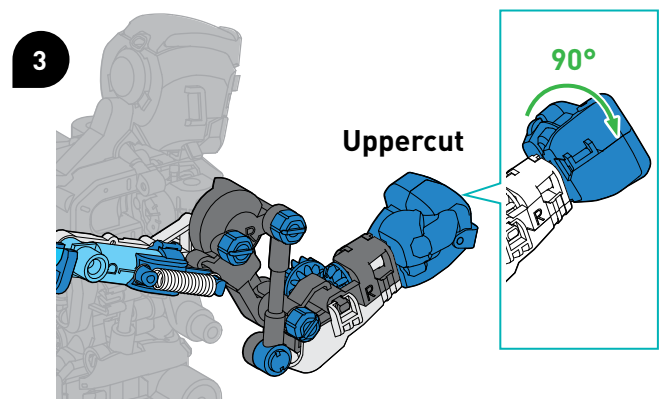
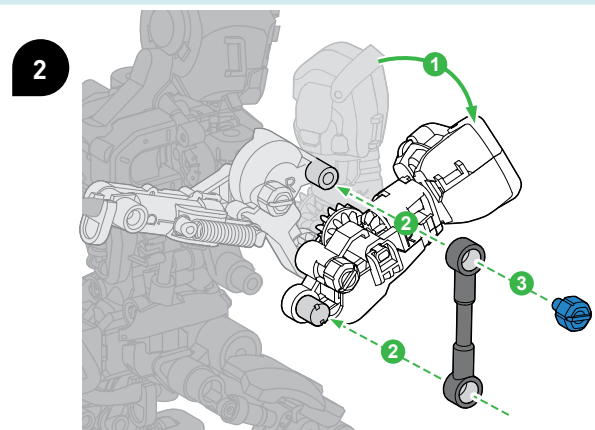
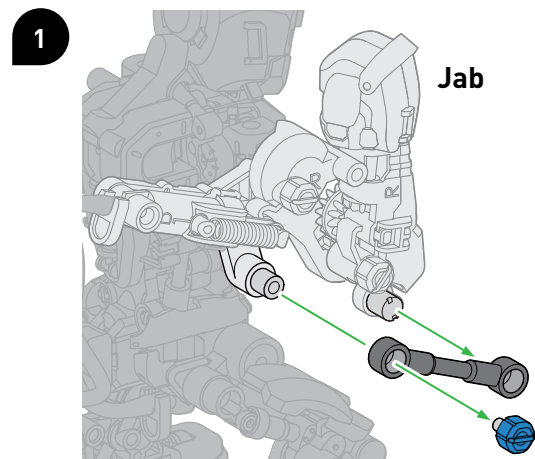
Scan this QR code for a video showing how to change the punch.



### HOW TO CHANGE UPPERCUT TO JAB



### HOW TO CHANGE JAB TO UPPERCUT

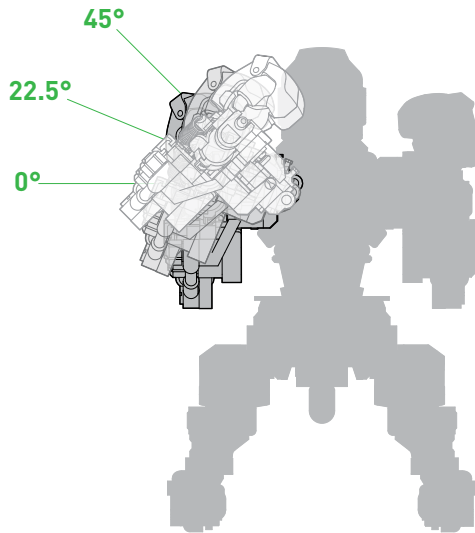




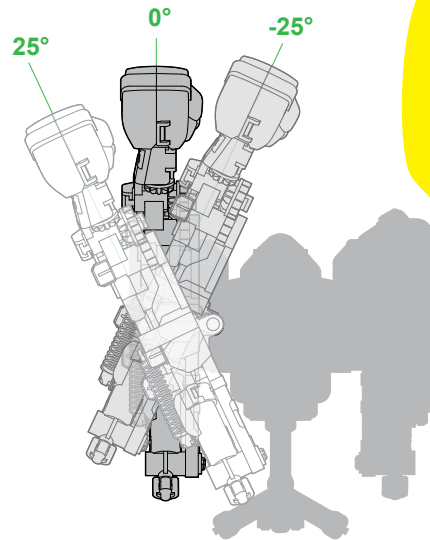


### 3. CHOOSE YOUR SHOULDER POSITIONS

*The two ways to change the shoulder angle:*



Back view

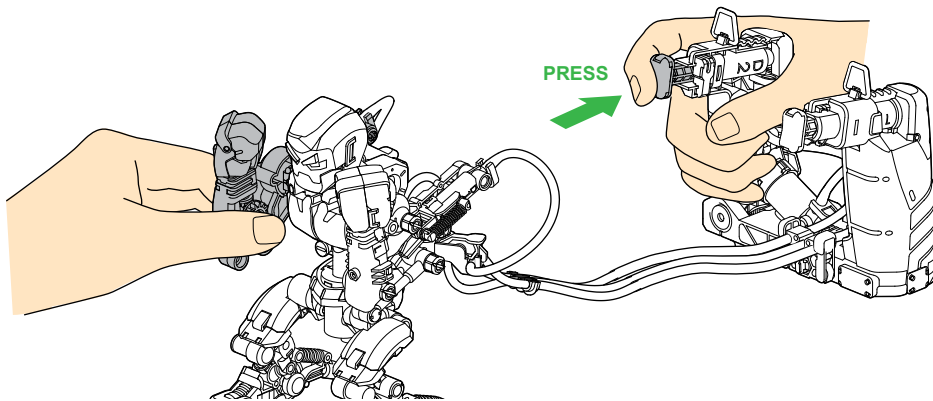


Top view

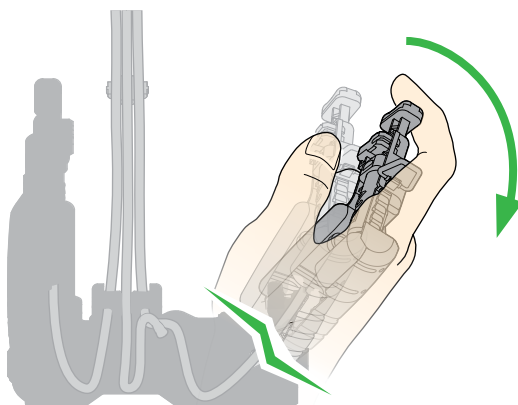
The left and right shoulders are configurable in two different degrees of motion. Experiment to see what works best for your boxing bot.

### IMPORTANT WARNINGS

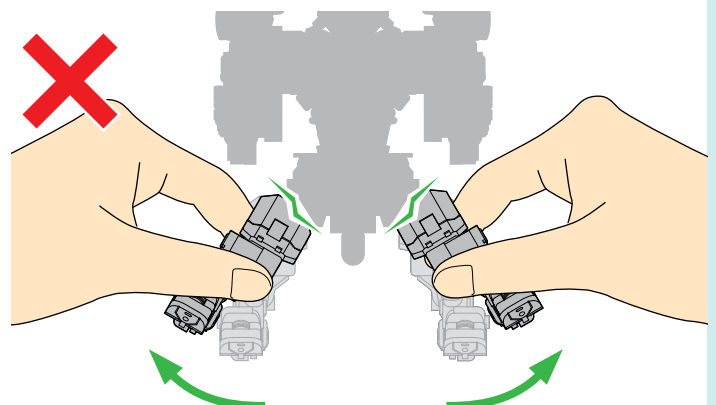
1. Do not hold the robot while pressing the hydraulic pistons.



2. Do not over-bend the handles.

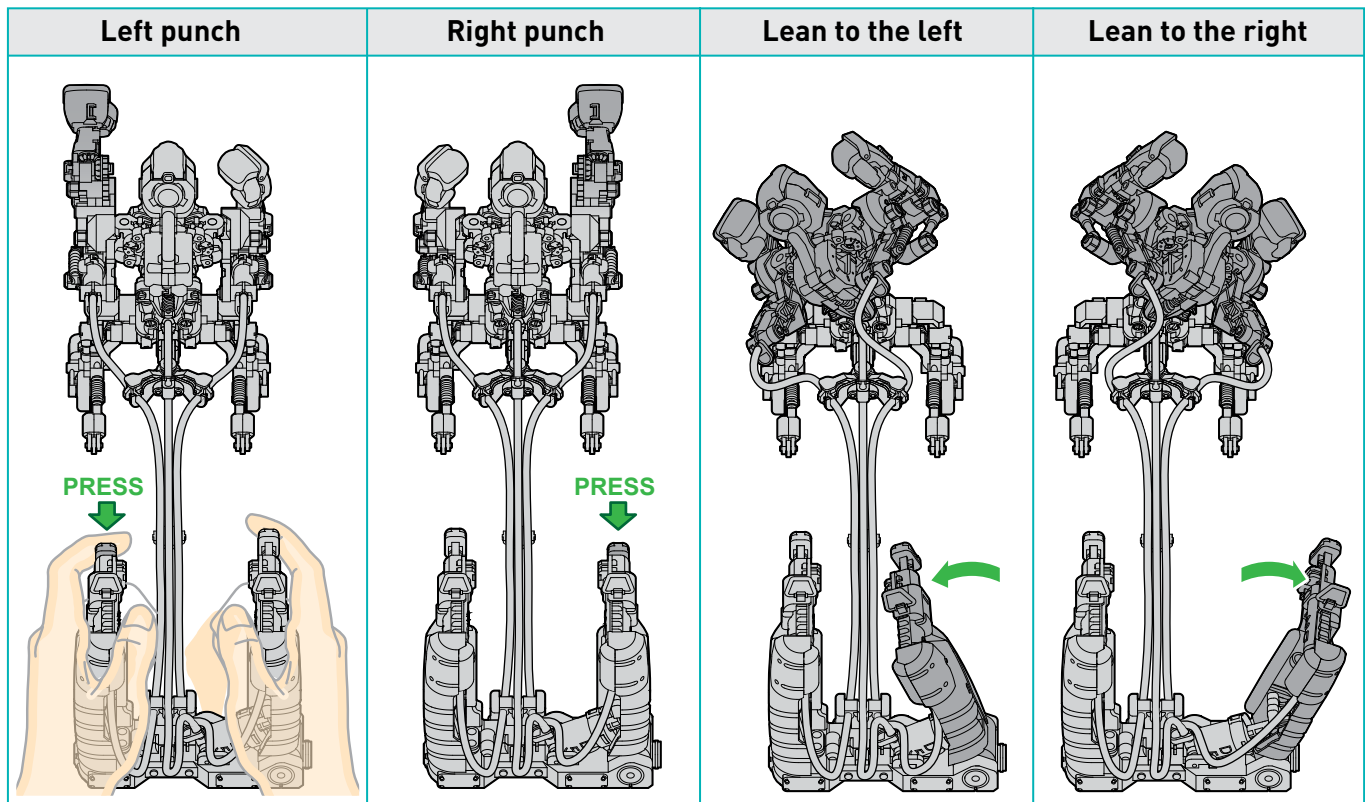


3. Do not pull the robot's legs.

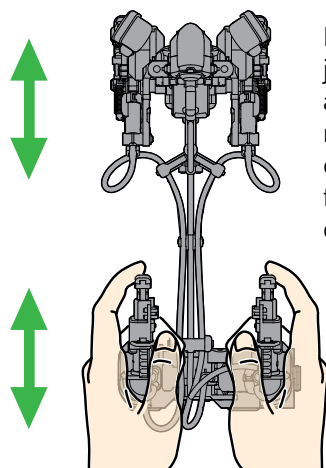


## OPERATING INSTRUCTIONS

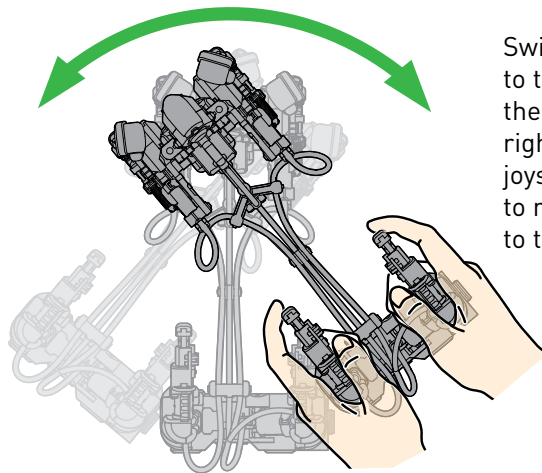
### HOW TO CONTROL THE HYDRAULIC SYSTEMS



### HOW TO MOVE THE BOXER



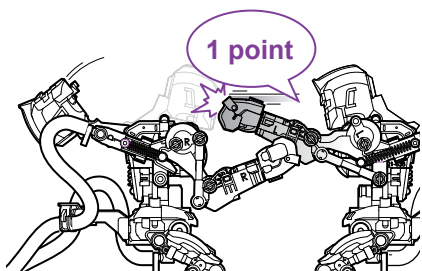
Move the joystick forward and backward to move the boxer closer to or farther from its opponent.



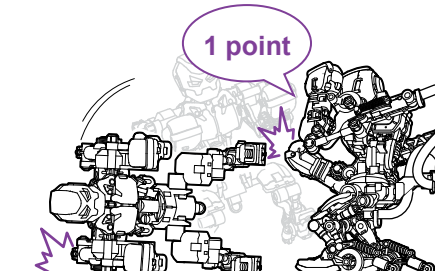
Swing the joystick to the left to rotate the boxer to the right; swing the joystick to the right to rotate the boxer to the left.

### HOW TO SCORE

#### Two ways to score

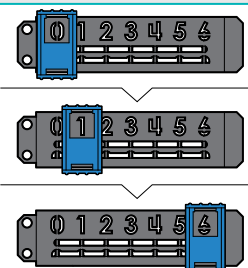


Knock back your opponent's head.



Knock down your opponent's body.

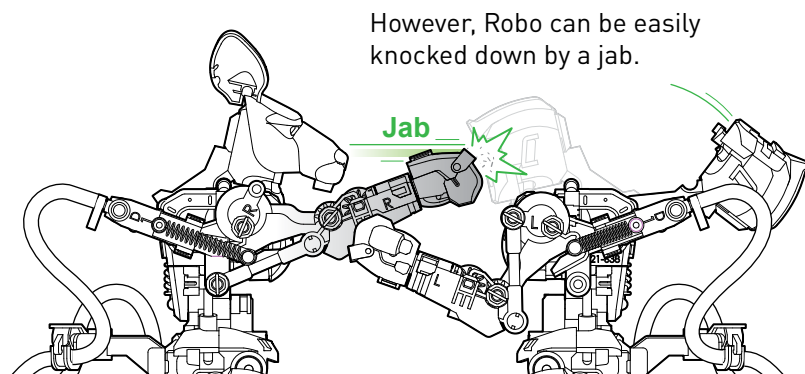
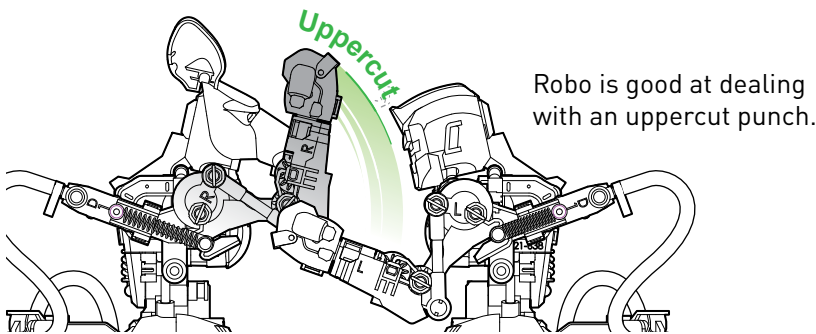
#### Keeping score



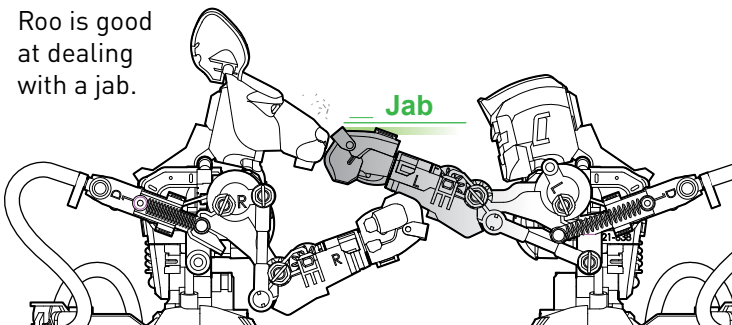
The first boxer to win six rounds wins the match.



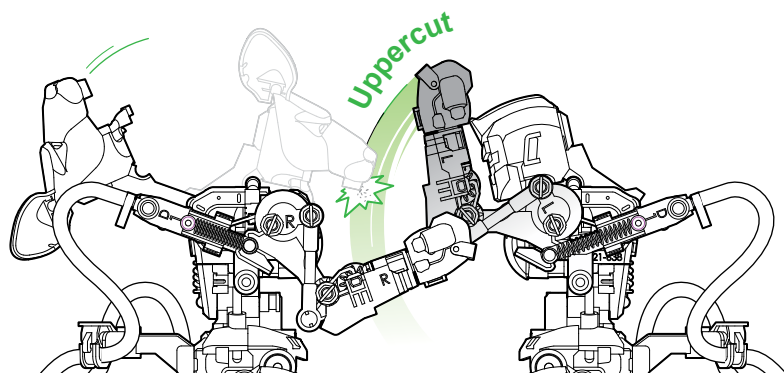
### Boxing tips



Roo is good at dealing with a jab.

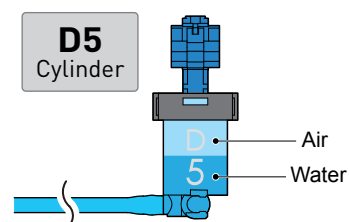
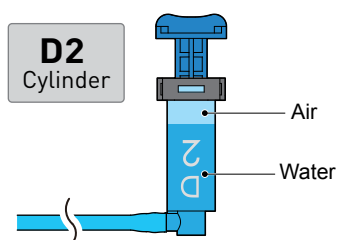


However, Roo can easily get knocked down by an uppercut punch.



### Troubleshooting tips

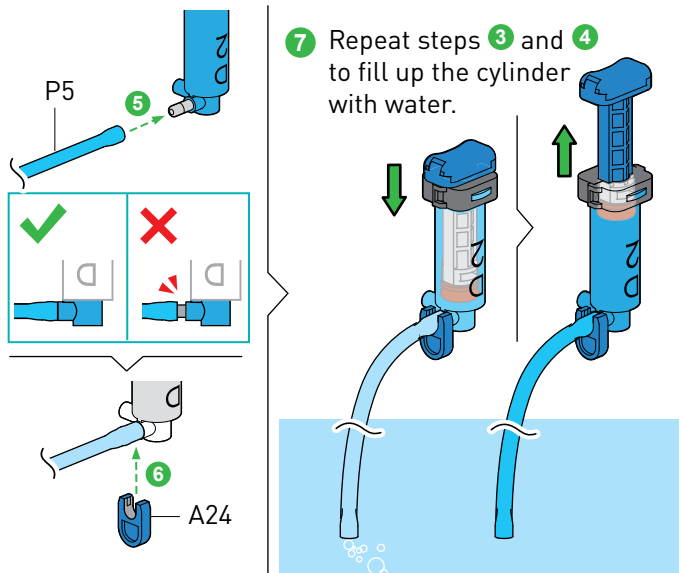
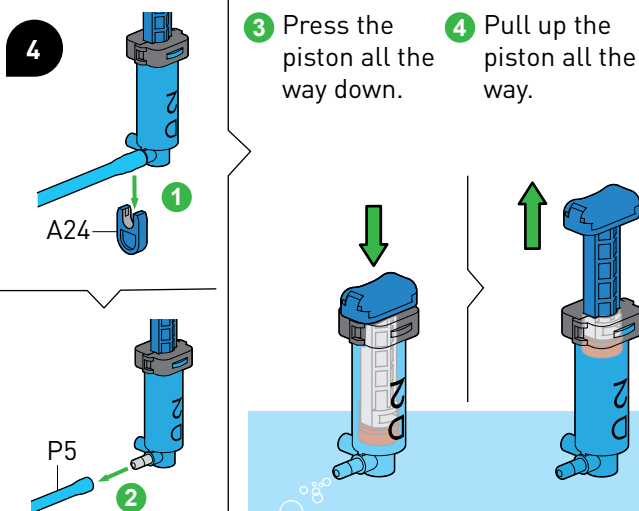
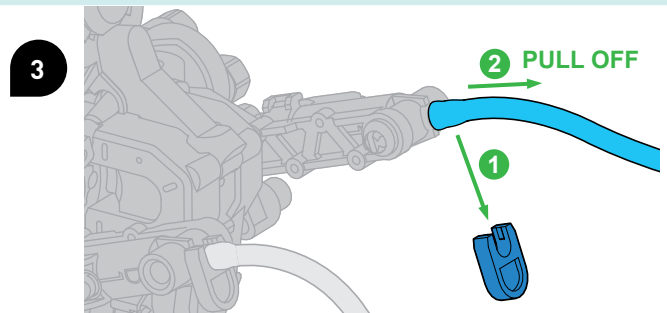
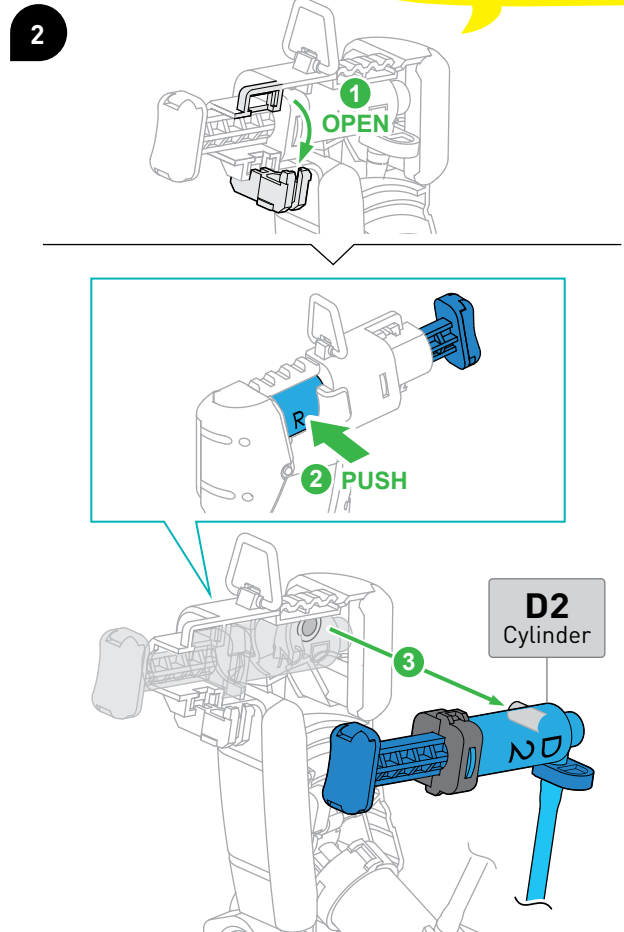
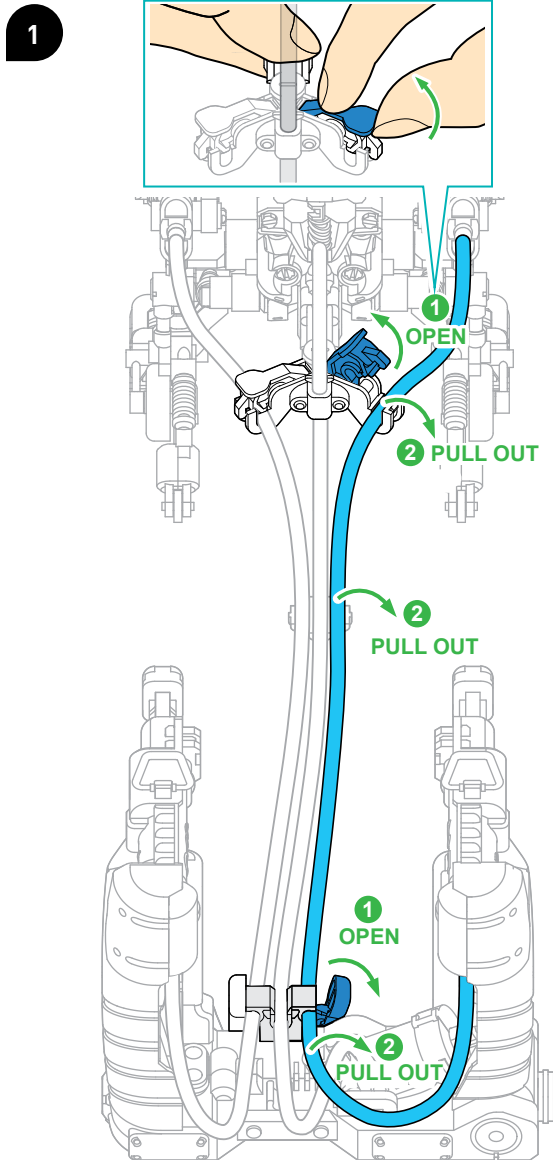
If your boxer moves abnormally or there are air bubbles in the hydraulic systems, please follow the steps on pages 36–39 to refill the hydraulics.



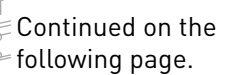
## REFILLING THE HYDRAULICS

### REFILLING THE D2 CYLINDER

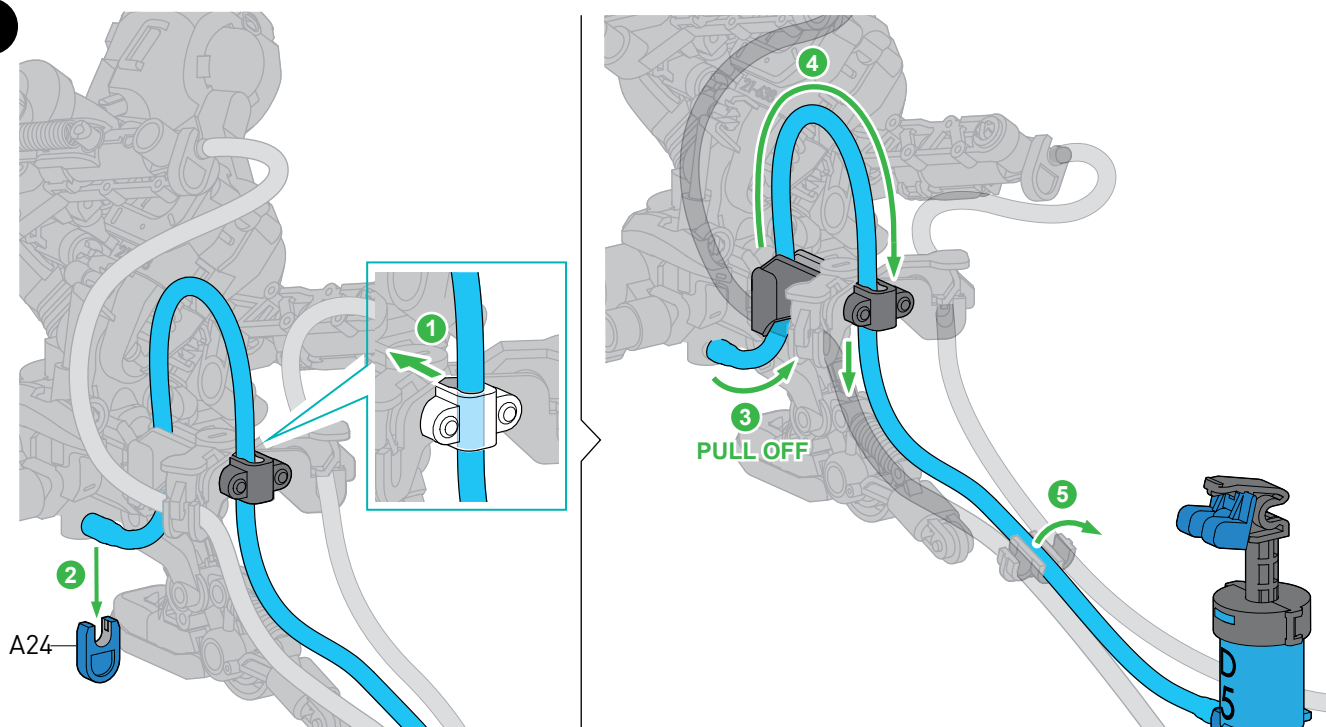
Follow the same steps to refill the D3 cylinder.



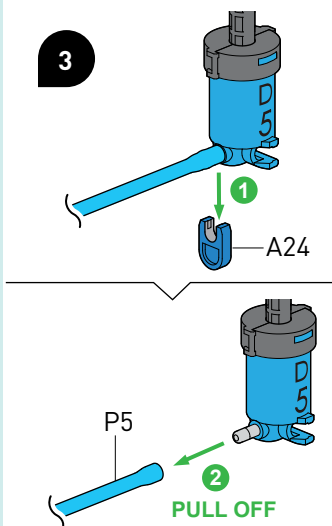




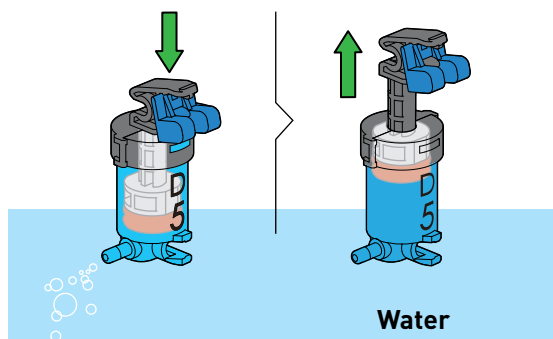
2



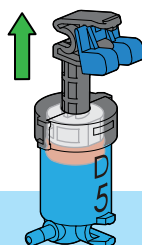
3



3 Press the piston all the way down, then pull it up.

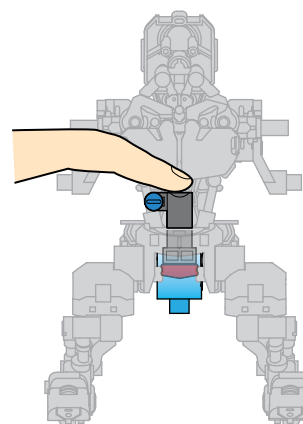


4 Repeat step 3 to fill up the cylinder with water.

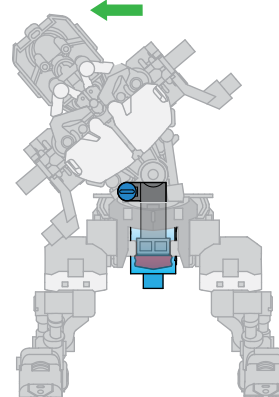
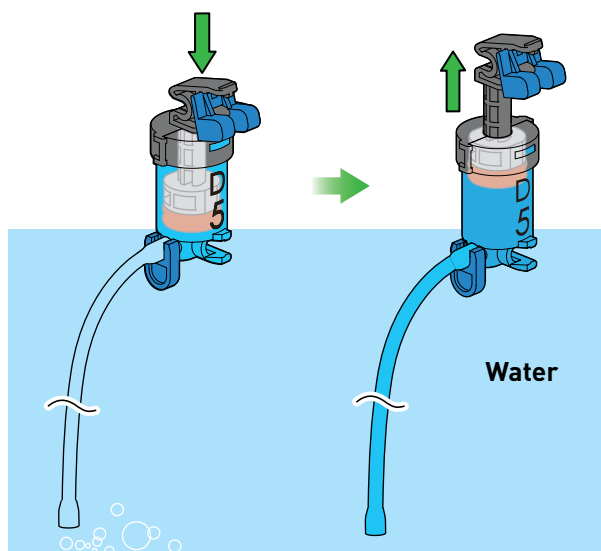


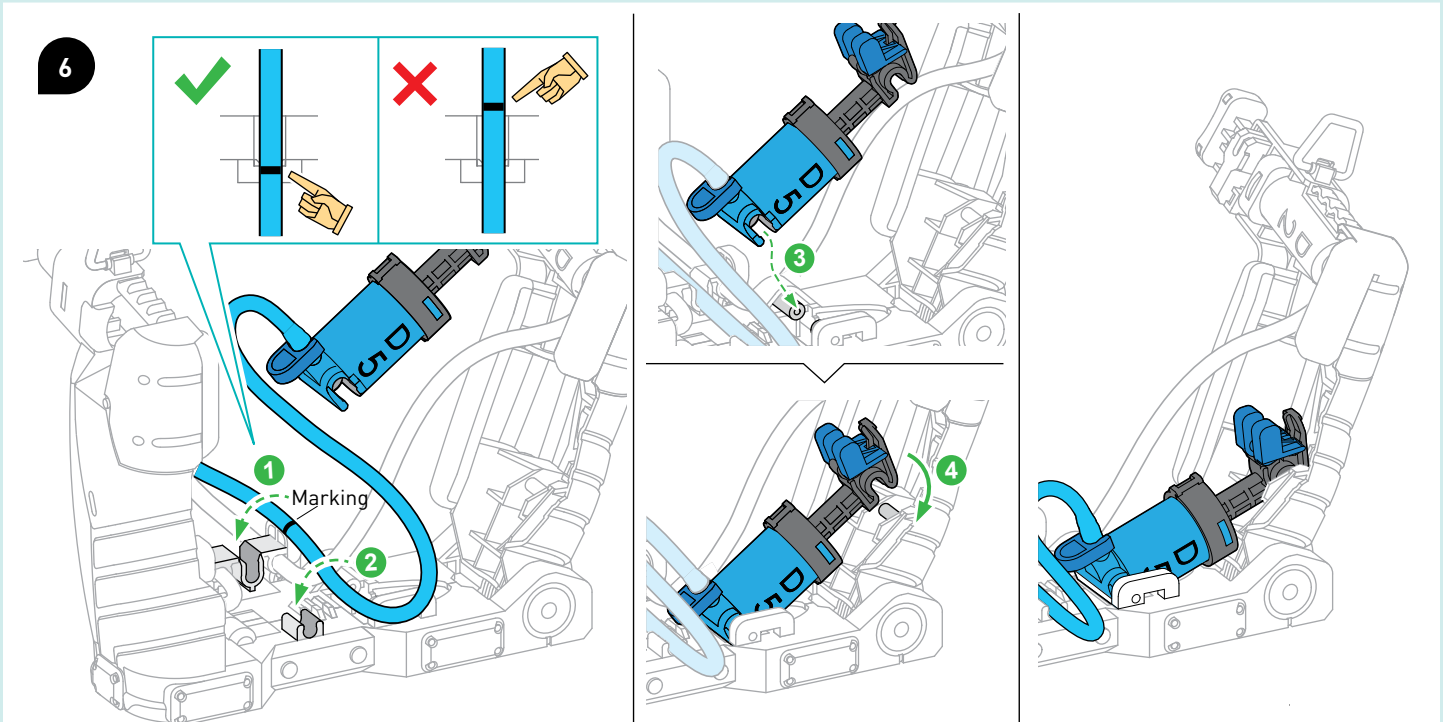
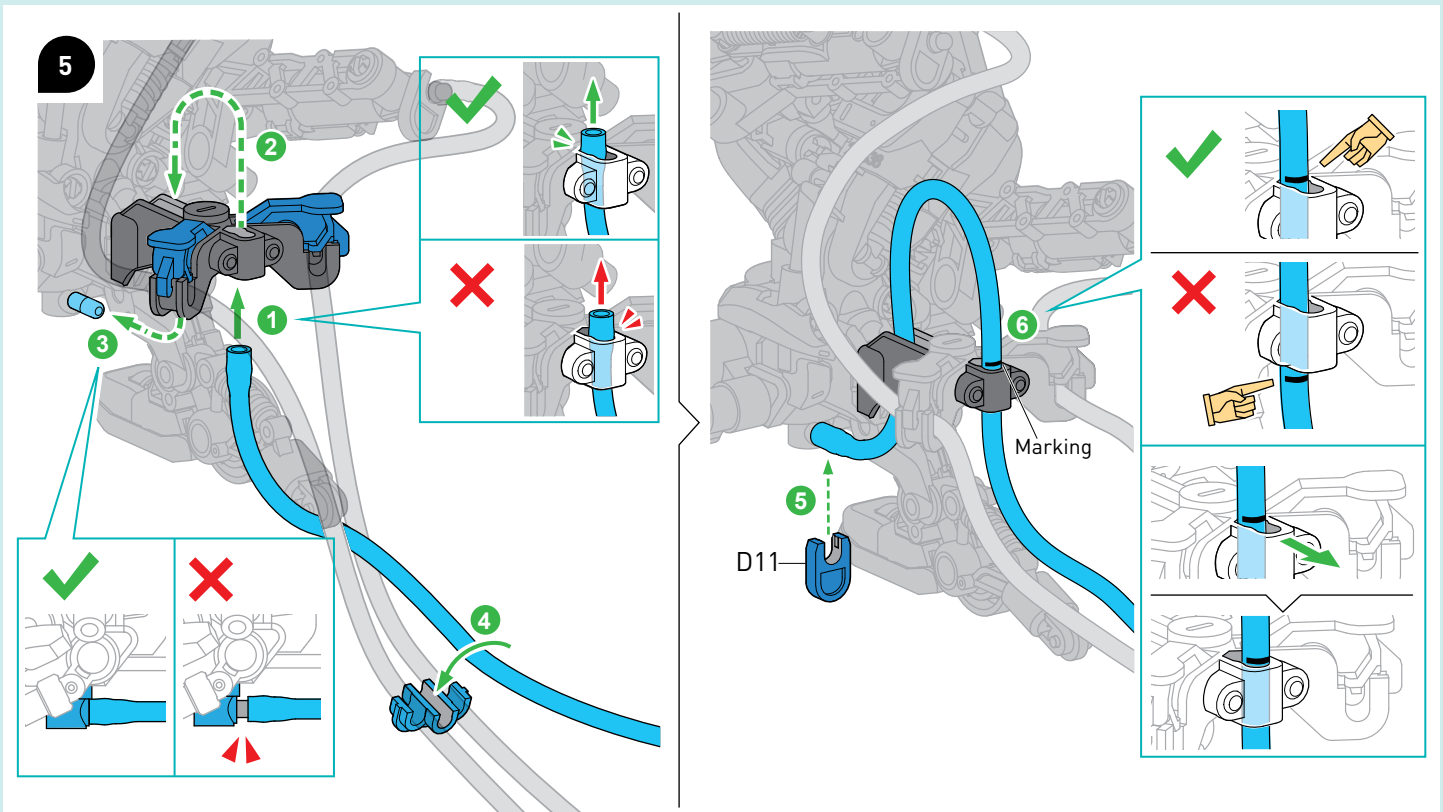
4

Press down the piston of D4 during this step.



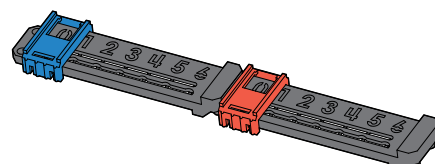
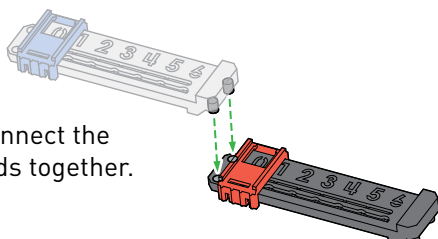
7 Fill up the cylinder and tube with water.





### ONE FINAL TIP

You can connect the scoreboards together.





# Pneumatics and hydraulics

Pneumatic and hydraulic systems are used in many different types of modern-day machines. They are used when power must be transferred from one location to another. Both systems have specific advantages and disadvantages and are used depending on the application.



I have hydraulic systems on board.

## PNEUMATIC SYSTEMS

WORK WITH COMPRESSED AIR, GENERATED BY COMPRESSORS. ELECTRICALLY CONTROLLED VALVES DIRECT THE COMPRESSED AIR INTO CYLINDERS WITH PISTONS IN THEM. THE PISTONS THEN PERFORM THE DESIRED MOVEMENTS. HOWEVER, THESE SYSTEMS CANNOT EXERT EXCESSIVE FORCES, SINCE AIR CAN BE COMPRESSED. THE ADVANTAGE OF PNEUMATICS IS THAT VERY HIGH OPERATING SPEEDS CAN BE ACHIEVED AND COMPRESSED AIR CAN BE CONTROLLED VERY EASILY.



## Hydraulics

If very large forces have to be transmitted, hydraulic systems are usually used. These also work with cylinders, pistons, and valves, like in the hydraulic boxing bots, but they mostly use special hydraulic oils as a medium, instead of water, because these oils can be put under high pressures. Such systems can be found in excavators, some elevators, numerous commercial vehicles, and in the braking systems in cars.

## Computer Control

Larger hydraulic systems are controlled with special computers. A sophisticated program evaluates signals coming from the various sensors in the system and activates valves and electric motors at the right moments.





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