

# Candy Claw Engineering



## ASSEMBLY VIDEO!

Scan this QR code to view a step-by-step assembly video and tips on how to build and use the candy claw machine.

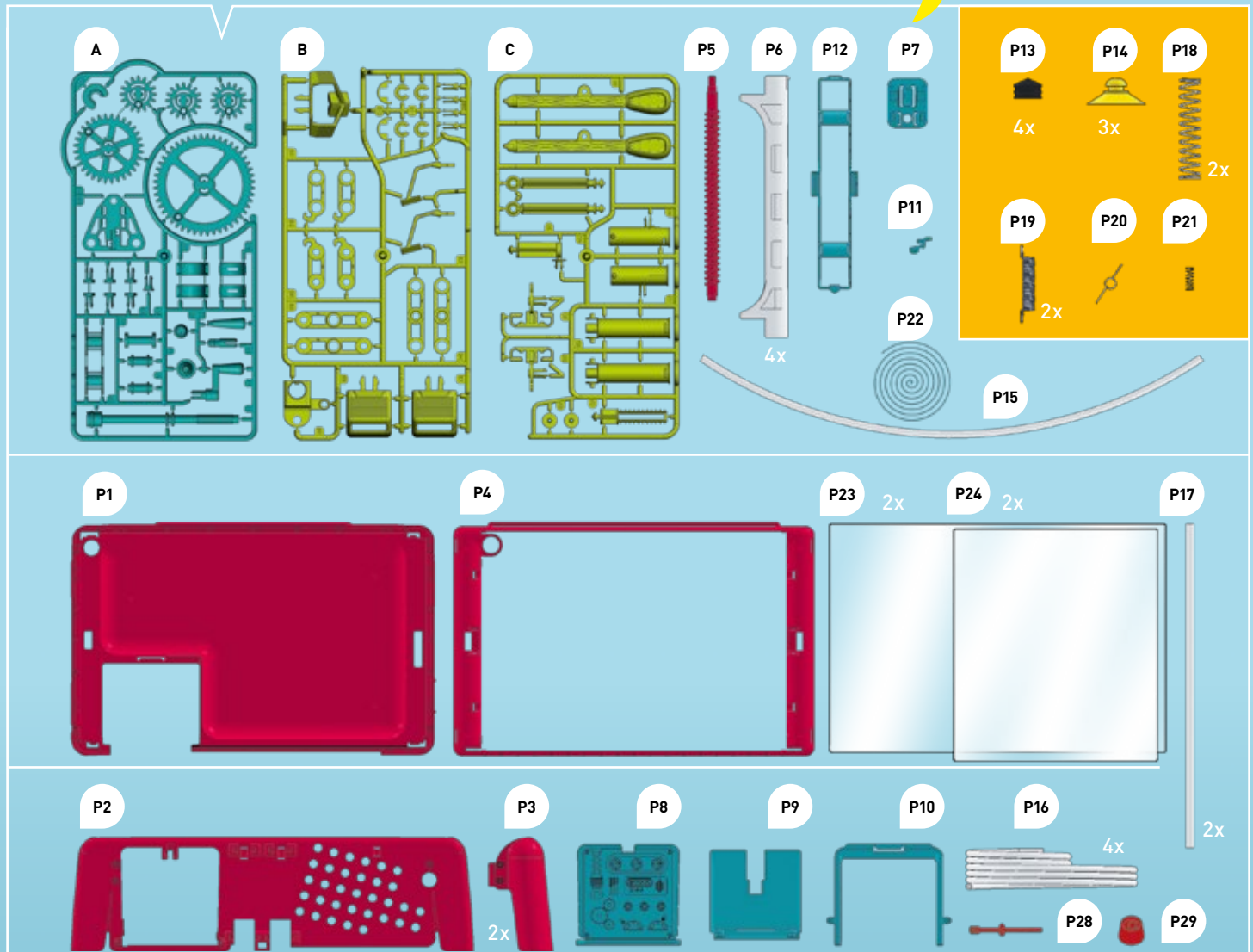


## KIT CONTENTS

*Good to know!*

Do you have any questions or are you missing any parts? Our tech support team will be happy to help you!  
support@thamesandkosmos.com  
or 1-800-587-2872

## What's inside your experiment kit:



## Checklist:

| ✓ No. | Description                     | Qty. |
|-------|---------------------------------|------|
| ○A    | Plastic frame A (Parts A1 –A18) | 1    |
| ○B    | Plastic frame B (Parts B1 –B12) | 1    |
| ○C    | Plastic frame C (Parts C1 –C10) | 1    |
| ○P1   | Base tray                       | 1    |
| ○P2   | Base front panel                | 1    |
| ○P3   | Back leg                        | 2    |
| ○P4   | Top frame                       | 1    |
| ○P5   | Worm screw                      | 1    |
| ○P6   | Column (2 A and 2 B)            | 4    |
| ○P7   | Mounting panel for crank        | 1    |
| ○P8   | Prize door                      | 1    |
| ○P9   | Prize ejector tray              | 1    |
| ○P10  | Prize chute frame               | 1    |
| ○P11  | Prize door latch                | 1    |
| ○P12  | Worm screw housing              | 1    |
| ○P13  | Piston seal                     | 4    |

| ✓ No. | Description                               | Qty. |
|-------|---|------|
| ○P14  | Suction cup                               | 3    |
| ○P15  | Flexible drive shaft, 480 mm              | 1    |
| ○P16  | Flexible tubing (3x 450 mm, and 1x 240mm) | 4    |
| ○P17  | Rail                                      | 2    |
| ○P18  | Large piston spring                       | 2    |
| ○P19  | Arm scissor spring                        | 2    |
| ○P20  | Prize door spring                         | 1    |
| ○P21  | Prize door latch spring                   | 1    |
| ○P22  | Belt                                      | 1    |
| ○P23  | Large clear plastic panel                 | 2    |
| ○P24  | Small clear plastic panel                 | 2    |
| ○P25  | Die-cut sheet with 3 prize boxes          | 1    |
| ○P26  | Sticker sheet                             | 1    |
| ○P27  | Lollipops*                                | 6    |
| ○P28  | Applicator stick                          | 1    |
| ○P29  | Well                                      | 1    |
| ○P30  | Lubricant packet                          | 1    |

\*Flavors and colors may vary.





## TABLE OF CONTENTS

|                         |                    |
|-------------------------|--------------------|
| Kit Contents .....      | Inside front cover |
| Table of Contents ..... | 1                  |
| Introduction .....      | 2                  |

## ASSEMBLY STARTS ON PAGE 3

|   |                   |
|---|-------------------|
| Candy Claw Machine Assembly .....       | 3                 |
| How to Use the Candy Claw Machine ..... | 13                |
| Experiments .....                       | 14                |
| How Hydraulics Work .....               | 15                |
| Handy-Dandy End Effectors .....         | 16                |
| About Gears and Levers .....            | Inside back cover |

## ★ TIPS

YOU WILL FIND ADDITIONAL INFO  
IN THE CHECK IT OUT SECTIONS ON  
PAGES 15, 16, AND THE INSIDE  
BACK COVER



## WARNING !!

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

Keep the packaging and instructions as they contain important information.

Refer to the packaging for the nutritional information and the ingredients list for the lollipops.

## Dear parents and adults,

Children as young as eight years of age can enjoy experimenting with the built candy claw machine, but most children under 12 years will need a lot of help building it. Regardless of their age, please support your child with advice and a helping hand, especially during tricky assembly steps. Before beginning, read the directions together and discuss the safety instructions.

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

When cutting the plastic parts out of the frames with the diagonal cutters 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 cutters or a nail file. Supervise your child when they are using the sharp tools until you trust that they can handle the tools independently.

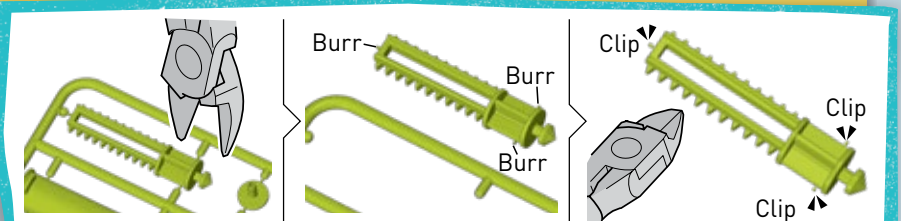
We hope you and your child have a lot of fun building and playing with Candy Claw Engineering!

## i YOU WILL ALSO NEED:

Diagonal cutters or scissors and nail file, cup of water, paper towel

## ! IMPORTANT TIPS

- You **must** carefully cut the plastic parts out of their frames with diagonal cutting pliers (diagonal cutters) or scissors. Take special care when cutting out the hydraulic cylinders, because they can crack if not removed carefully. See special note in red to the left.
- Remove the parts from the frames only when they are needed.
- Remove excess material (burrs) from the parts before assembling them. Normal scissors do not cut as precisely as diagonal cutters, so you may have to file some of the rough edges down with a nail file or sandpaper.
- Assemble everything in the order shown. Don't jump ahead!

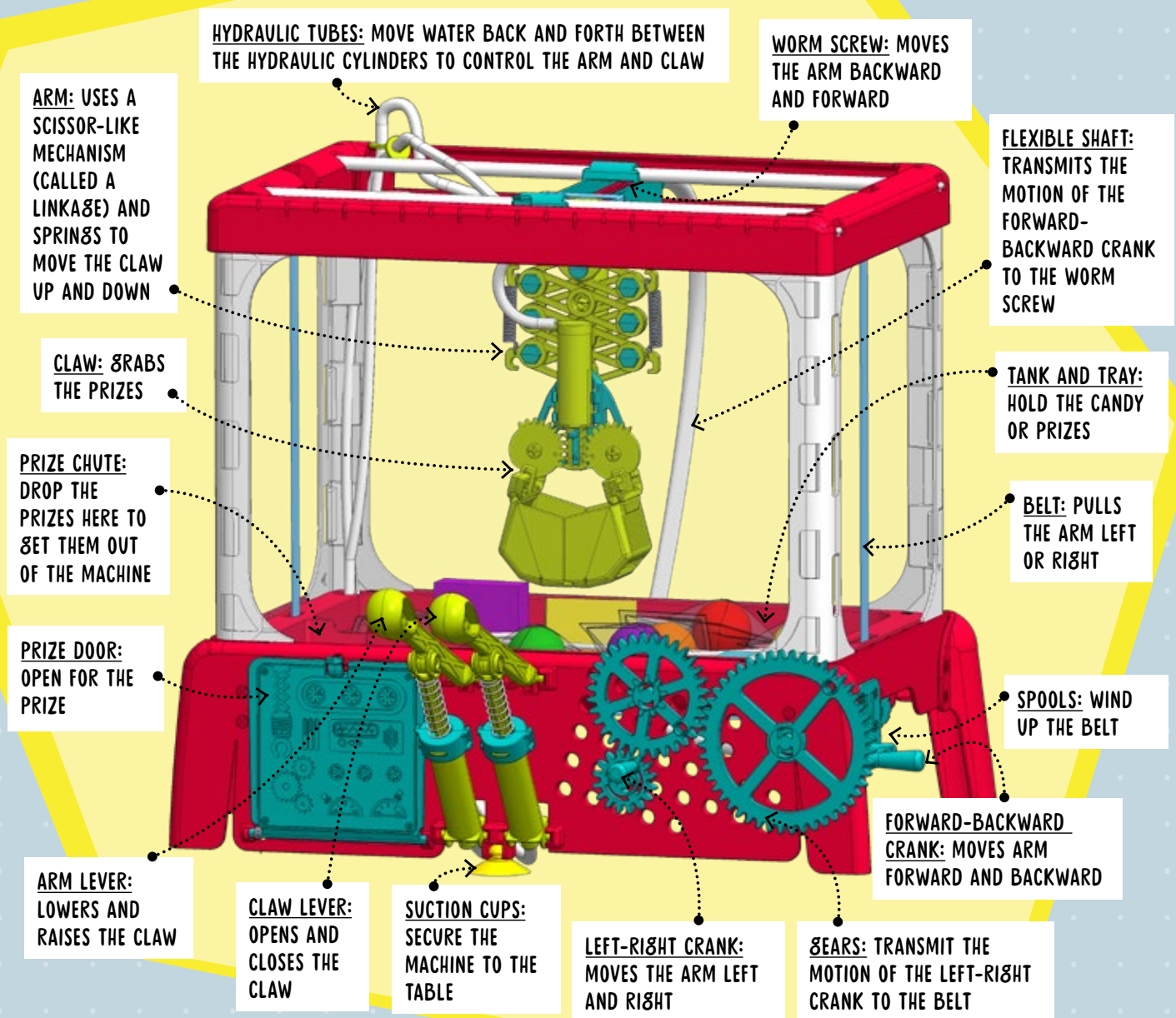


# The Amazing Candy Claw Machine

You have probably seen a **claw machine game** at a movie theater, video arcade, shopping mall, bowling alley, or other entertainment venue in your area. They go by many names including claw cranes, toy cranes, and skill cranes. They usually consist of a large, clear box filled with prizes like toys and stuffed animals. Inside the box is a claw that moves in **three dimensions**: forward and backward, left and right, and up and down. The player operates the claw with either push buttons or a joystick controller on the outside of

the machine. The player pays a fee to try their luck at moving the claw to the correct position and grabbing a prize. Then the claw returns to its starting position and drops the prize into a chute where the player can get it.

With this kit, you can build a **mechanical** claw machine. Your machine requires no electricity or electronics — just simple machines and the power of your hand. Here is an overview of the different parts of the candy claw machine:



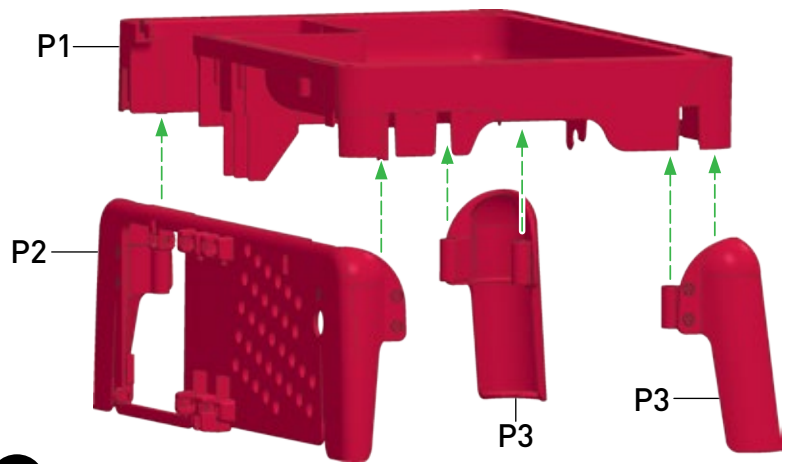
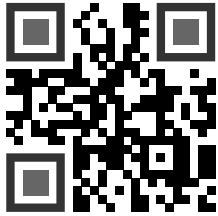


## CANDY CLAW MACHINE ASSEMBLY

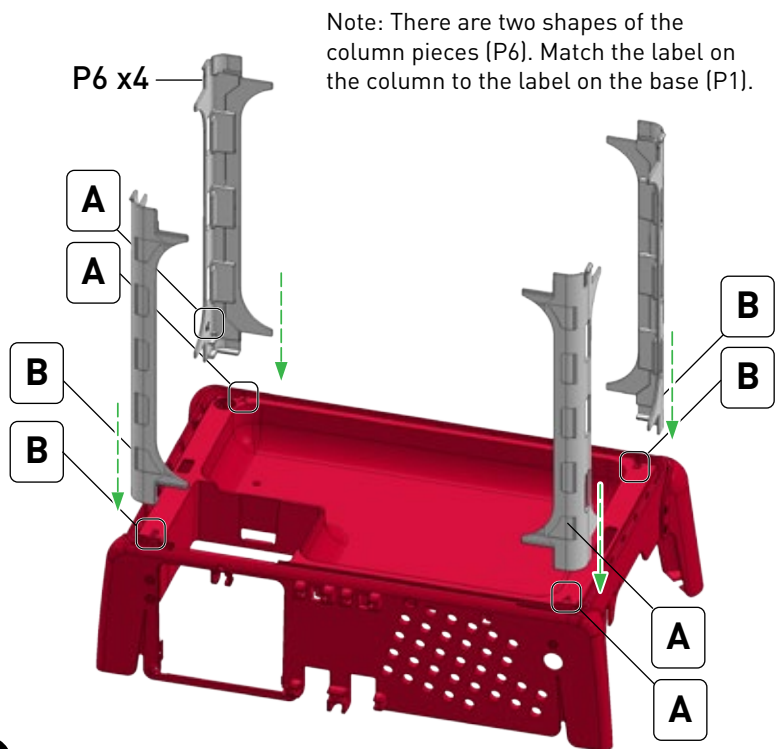


## ASSEMBLY VIDEO!

Scan this QR code to view a step-by-step assembly video and for more tips on building and using your candy claw machine.

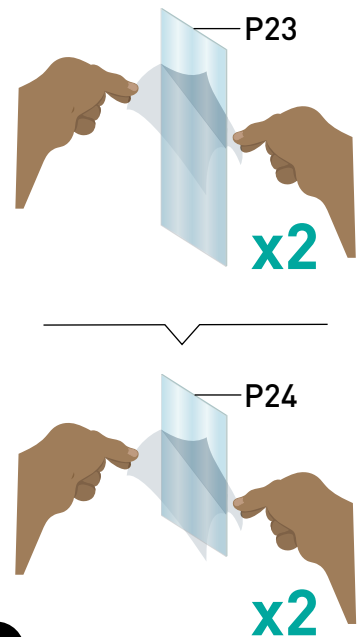


1

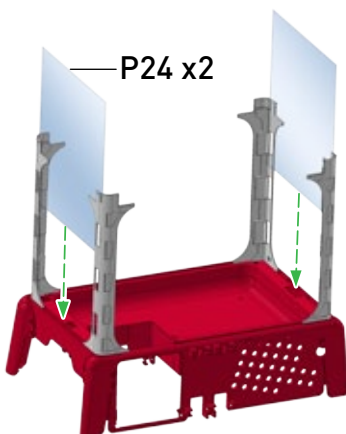


2

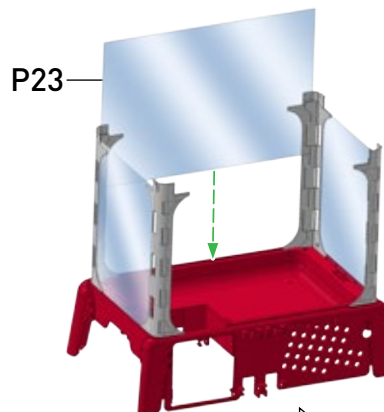
Peel the protective film off of **both sides** of the plastic panels.



3

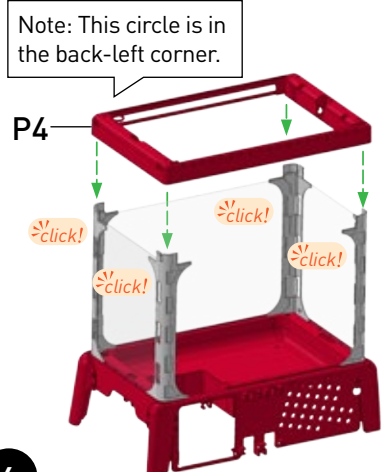


4



Note: Do not add the panel in the front of the machine yet.

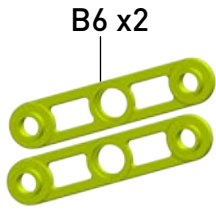
5



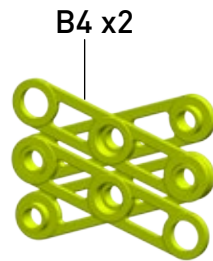
6



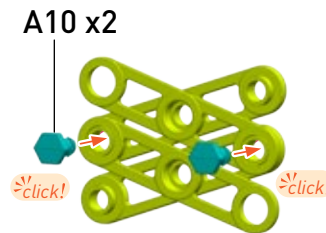
1. Lay the two B6 parts down on a table as shown. Pay attention to the orientation.



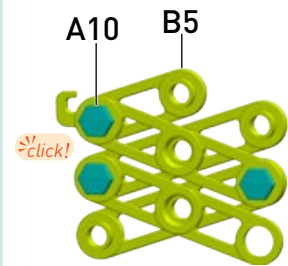
2. Add the two B4 parts in front.



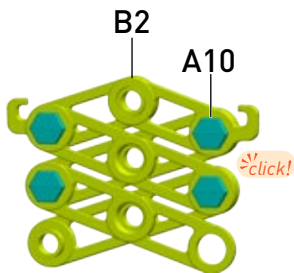
3. Carefully pick up the parts in your hands as you add the A10 pins.



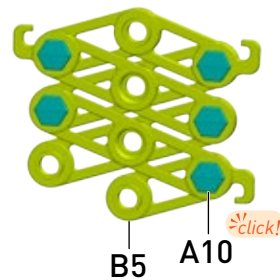
4. Add B5 behind, then add A10.



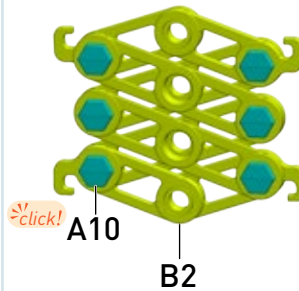
5. Add B2 in front, then add A10.



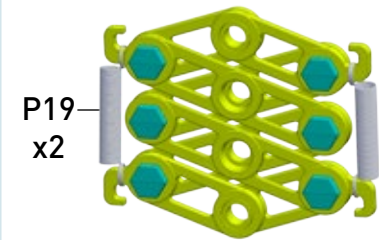
6. Add B5 behind, then add A10.



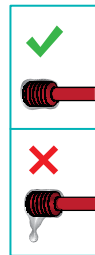
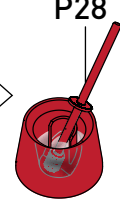
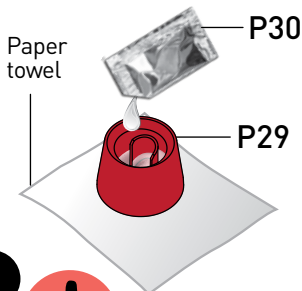
7. Add B2 in front, then add A10.



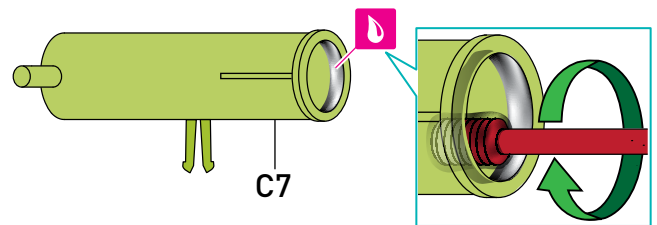
8. Hook the loops of the springs (P19) as shown.



Fill the well with oil.



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

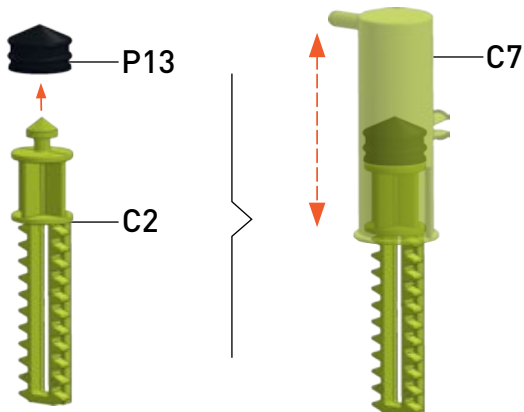


8



**You MUST oil the cylinders, or else the hydraulics will not work!**

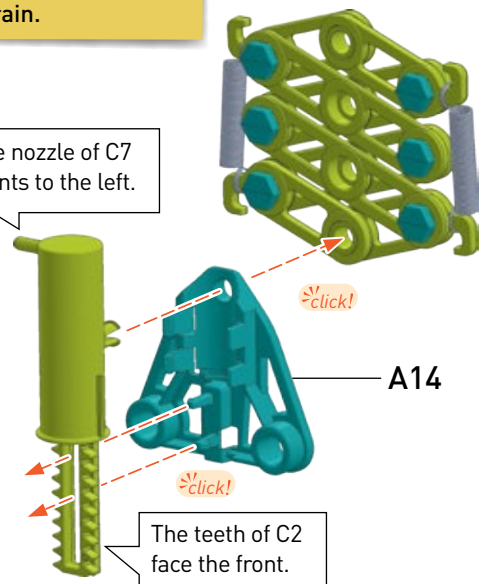
Oil only the area shaded in gray. Work carefully and do not touch the oil with your hands or get it into your eyes. Dispose of leftover oil in the household trash after assembly. Do not pour it down the drain.



Insert the piston seal into cylinder C7, and move it back and forth several times to coat the inside of the cylinder with oil. Repeat step 8 until the inside as necessary, until the piston seal slides freely.

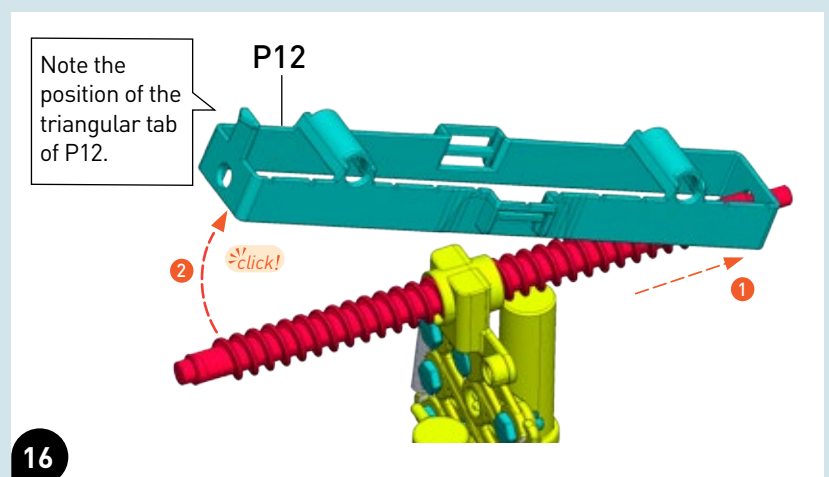
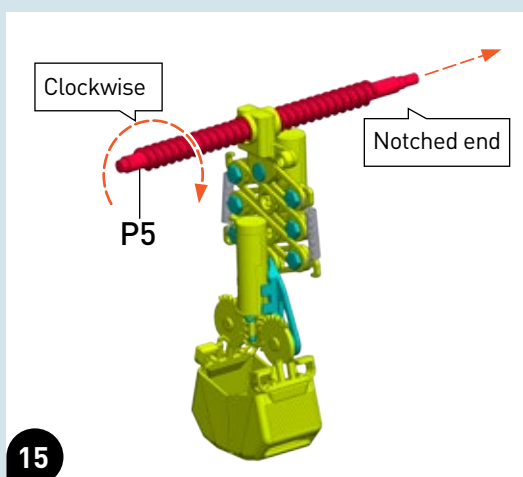
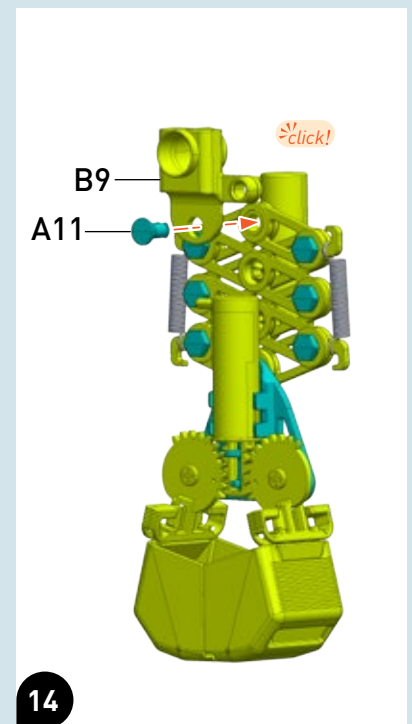
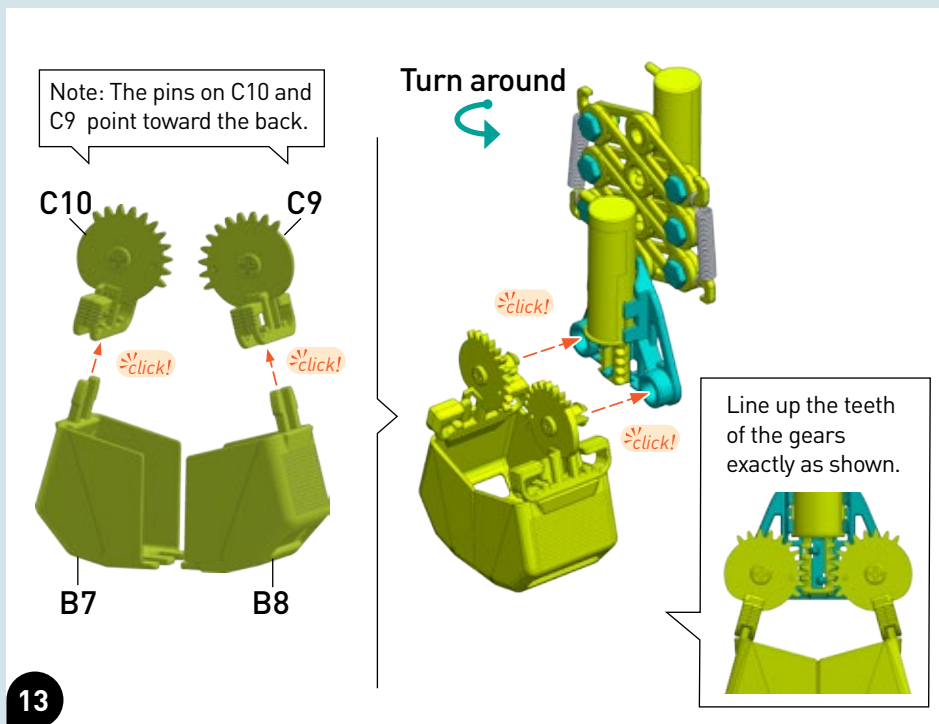
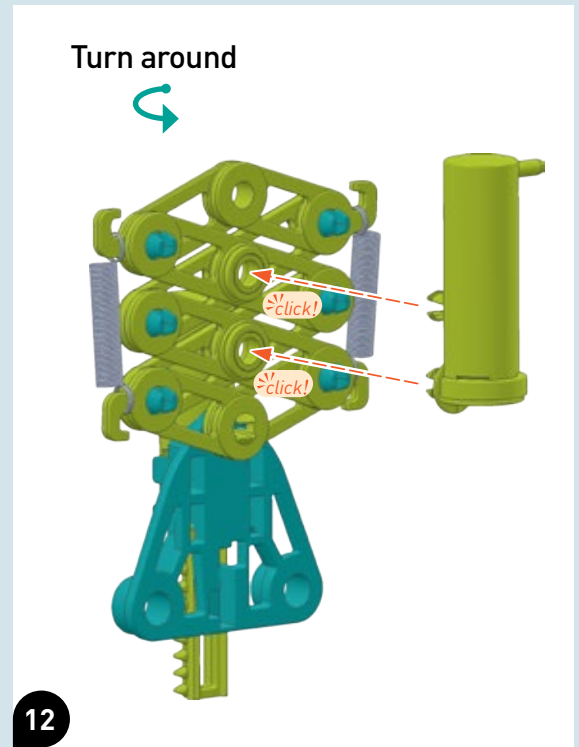
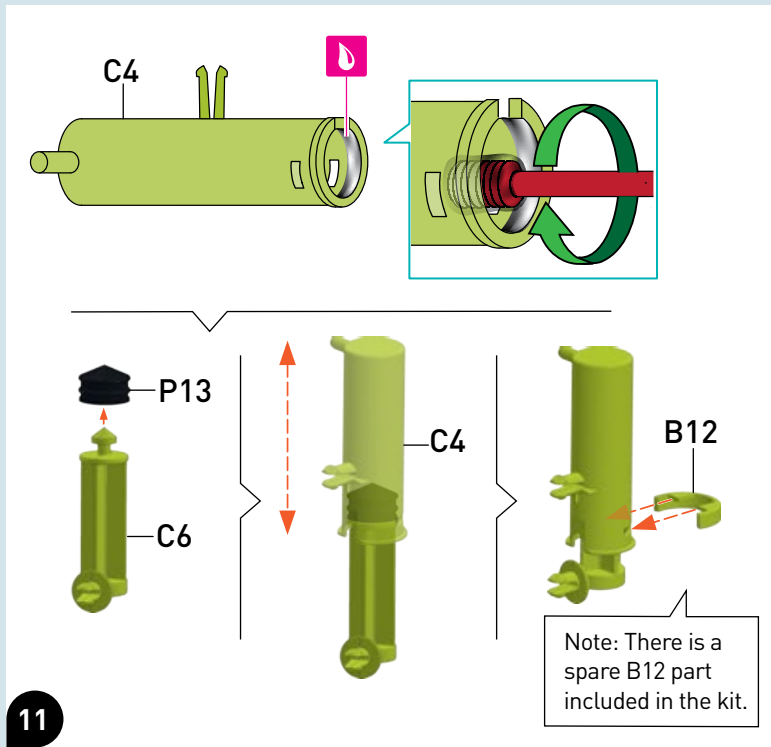
9

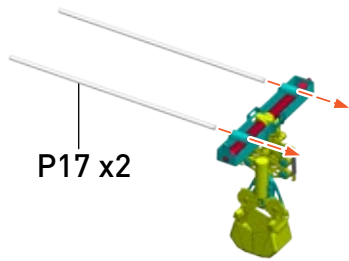
The nozzle of C7 points to the left.



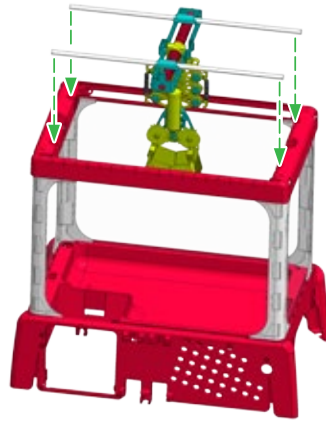
The teeth of C2 face the front.

10

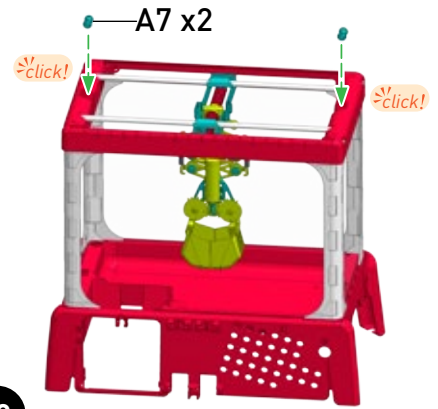




17

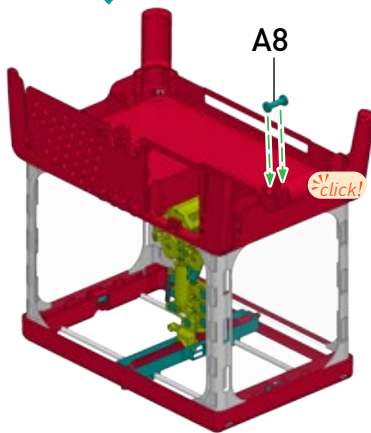


18



19

Flip over

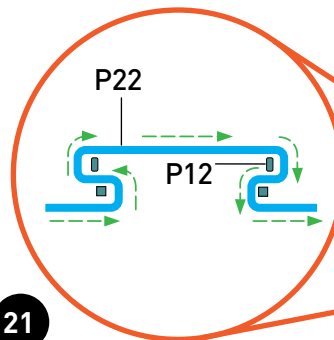


20

Turn right side up



Thread the belt (P22) through the slots of P12 as shown.



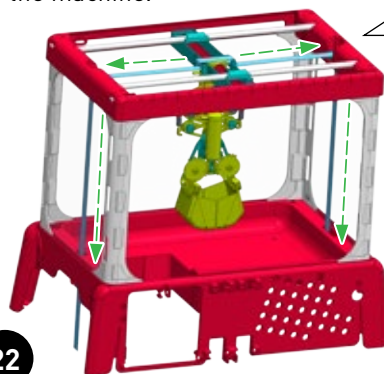
21

Adjust the belt so the end on the right is about 12 inches shorter than the end on the left.

12"



Thread the belt through the machine.

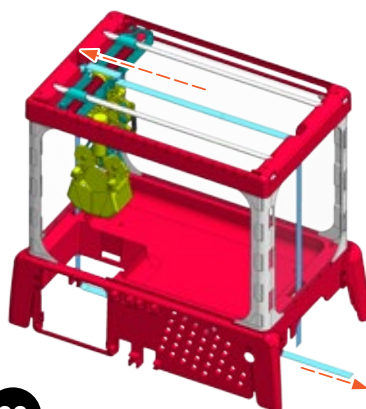


22



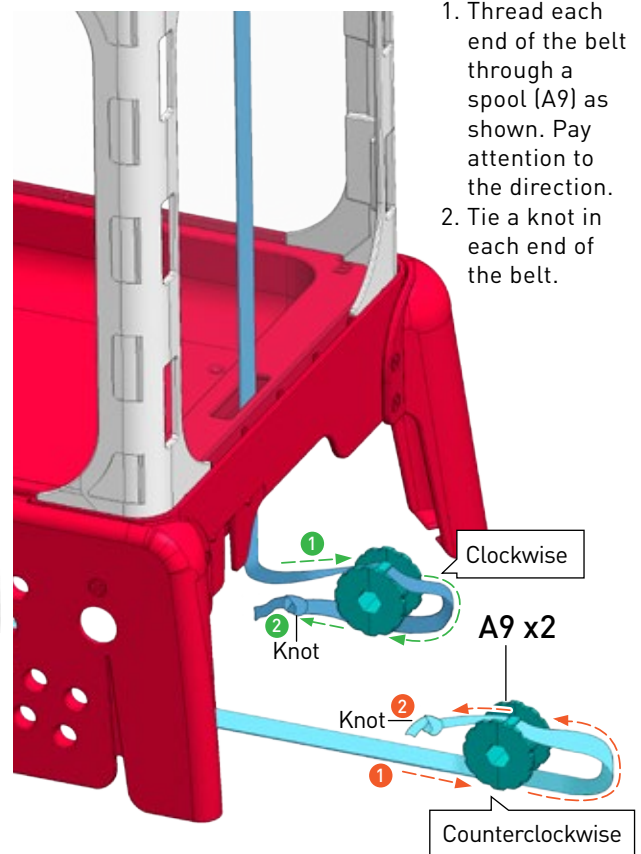
### INSTALLING THE BELT

Scan this QR for a step-by-step video showing how to install the belt.



23

Pull this end of the belt under the machine and to the right. This pulls the claw to the left.



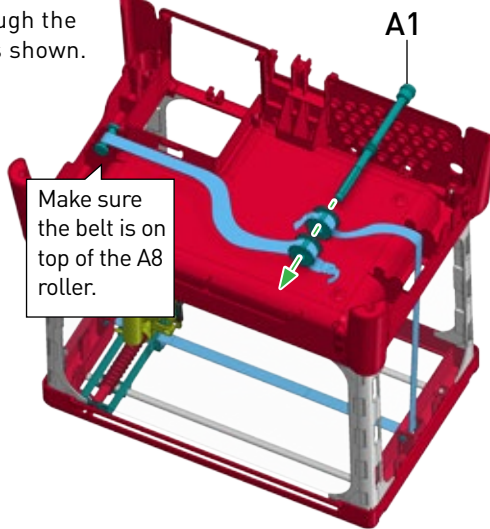
24





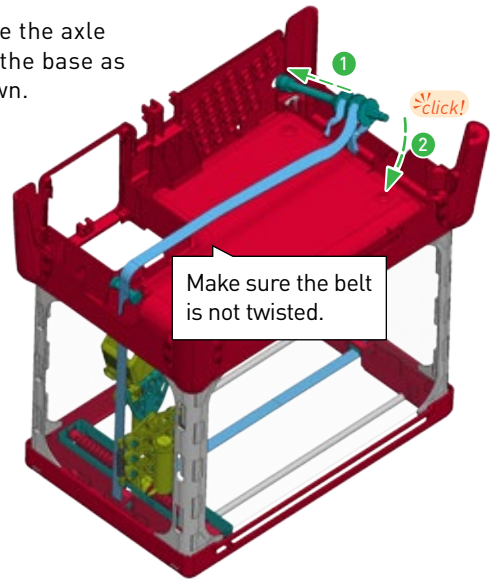
**Flip over** ↺

Insert the axle (A1) through the spools as shown.



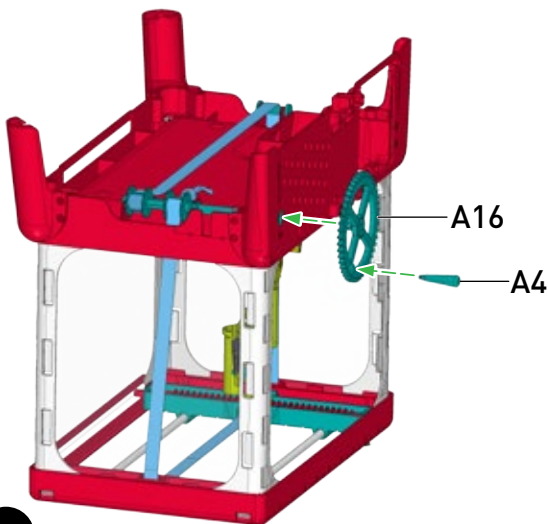
25

Place the axle into the base as shown.



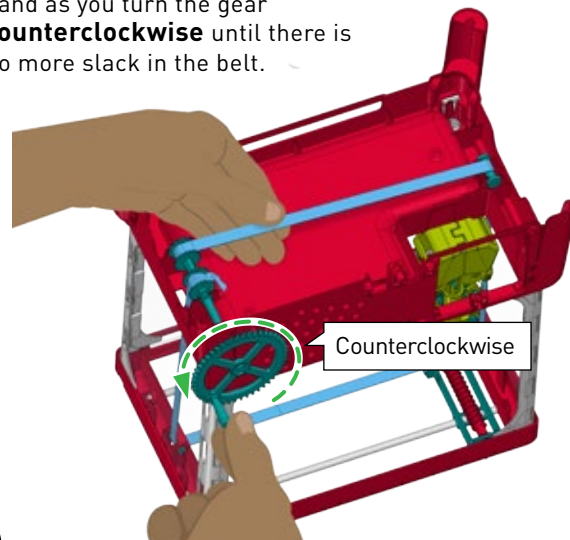
26

**Rotate 180°** ↺



27

Hold tension in the belt with one hand as you turn the gear **counterclockwise** until there is no more slack in the belt.

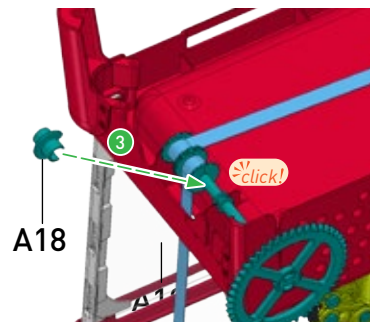
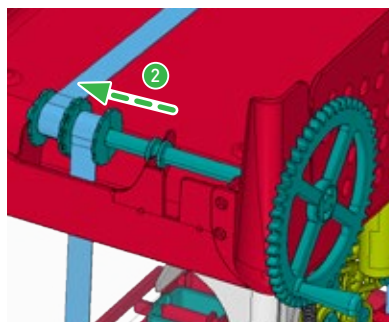
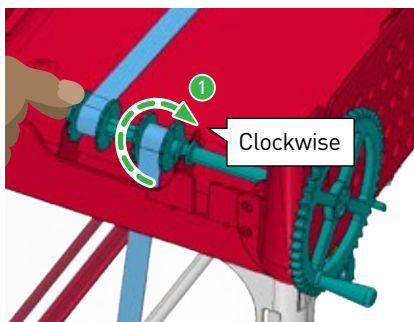


28

1. Move the right spool over to the right. Hold the left spool steady as you rotate the right spool with your fingers **clockwise** until it is tight.

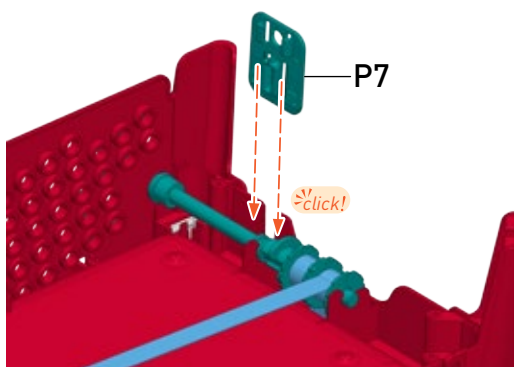
2. Keep the tension in the belt as you slide the right spool to the left.

3. Finally, add A18 to lock the belt spools in place. If the belt ever loosens, remove A18 and repeat this step.

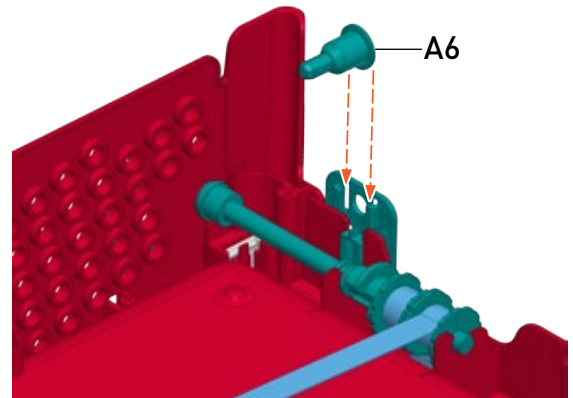


29

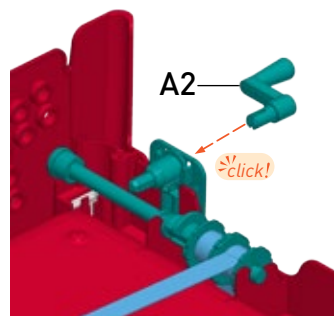
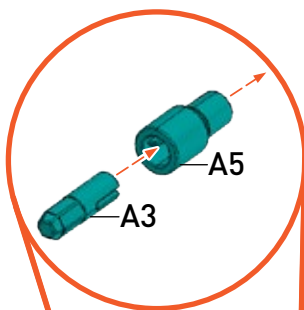
Rotate 180° ↺



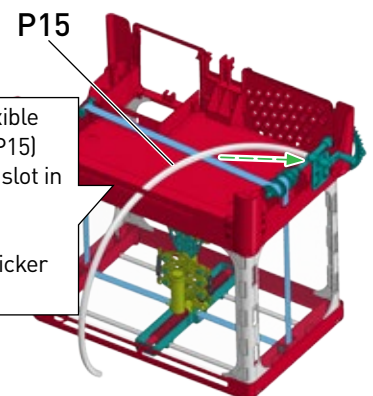
30



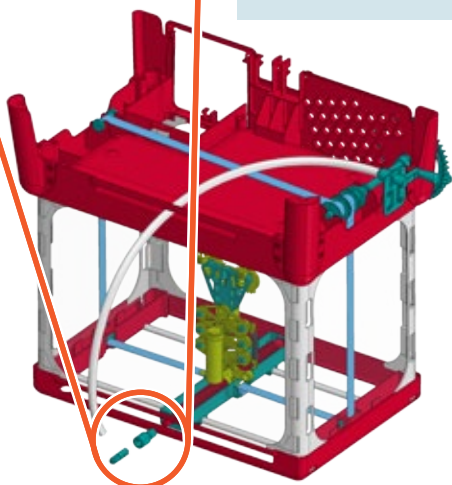
31



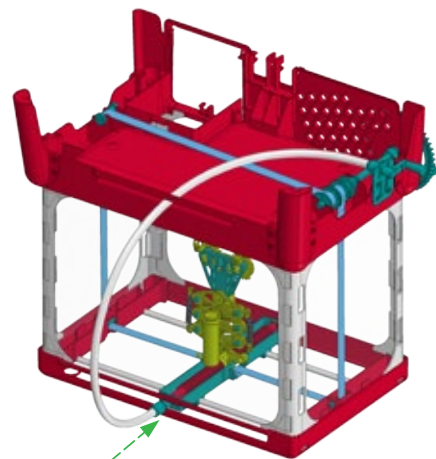
32



33



34

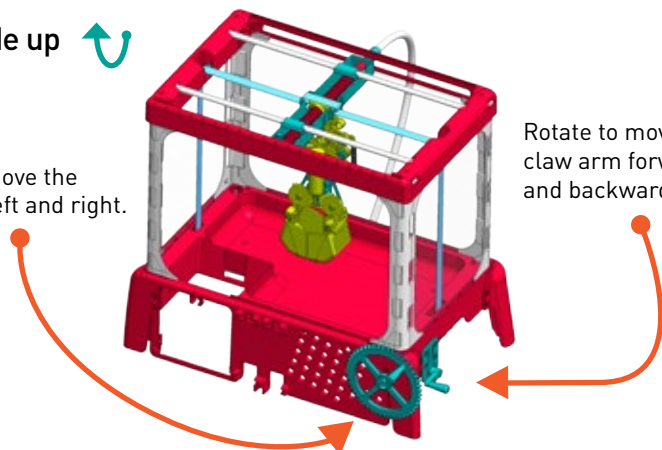


35

Turn right side up ↺

Rotate to move the claw arm left and right.

Rotate to move the claw arm forward and backward.



36

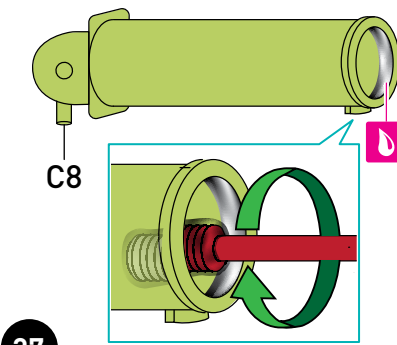
## TEST THE MOTION OF THE CLAW ARM

Now that you have installed the claw, flexible drive shaft, and belt, test out the motion of the claw arm. If you are having trouble, check out the assembly video:



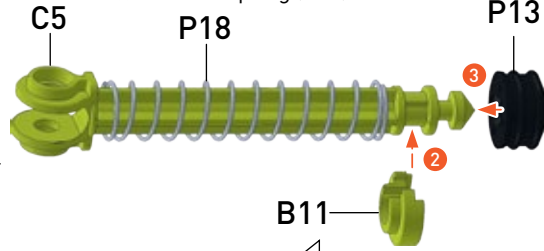


**!** Note: You will do steps 37 and 38 two times.

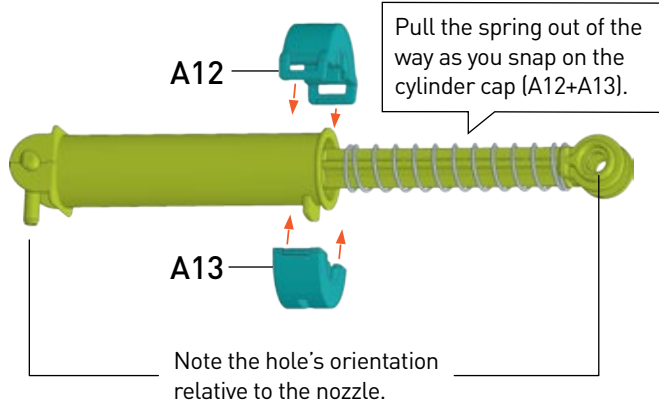
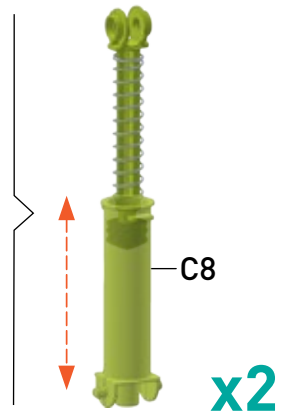


37

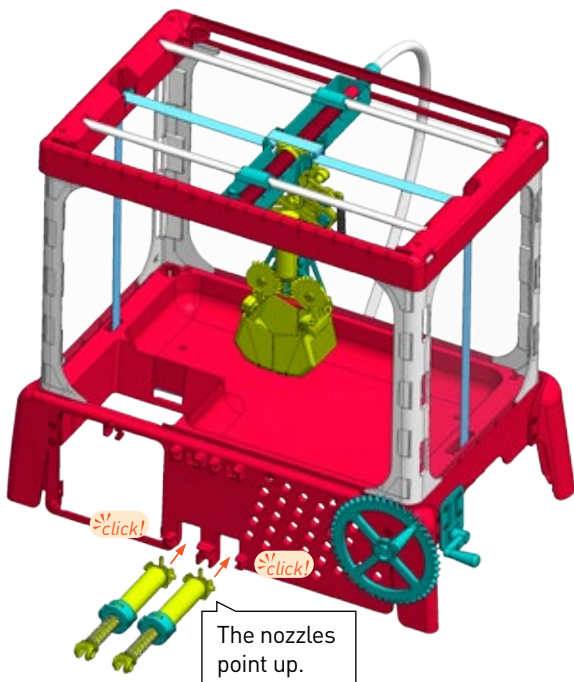
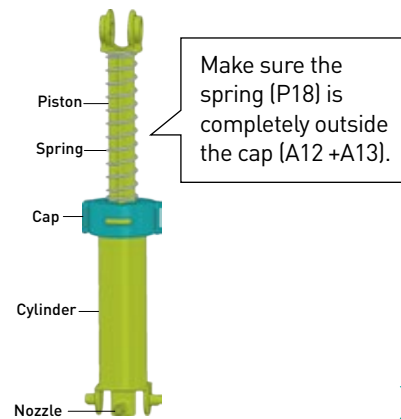
1 Add the spring (P18) to C5.



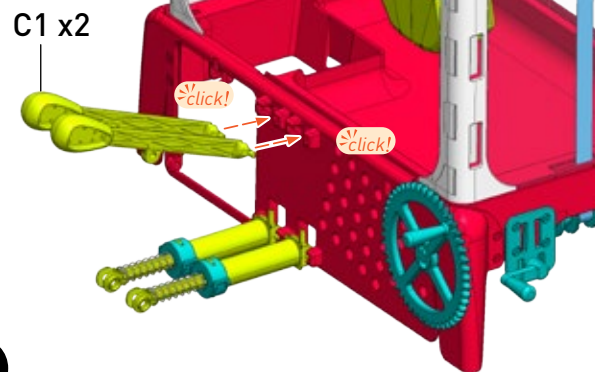
Note: There are two spare B11 parts included in the kit.



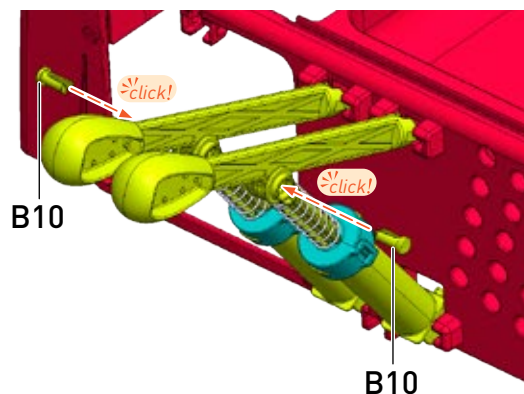
38



39



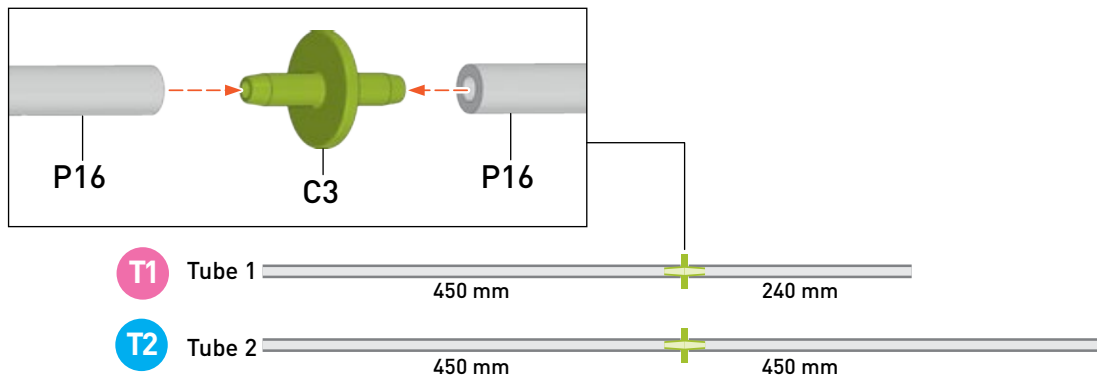
40



41

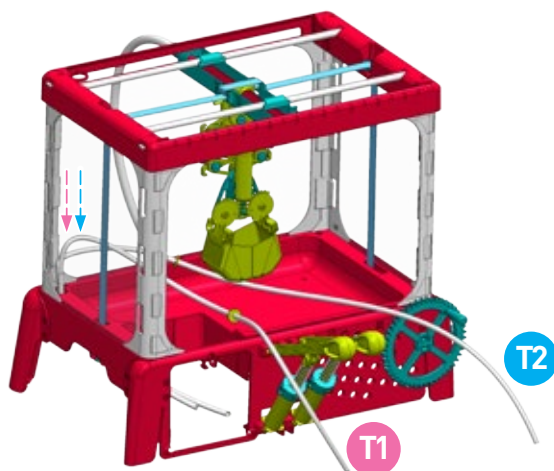


**Tube assembly:** There are three 450-mm tubes and one 240-mm tube. Connect them as shown here.



42

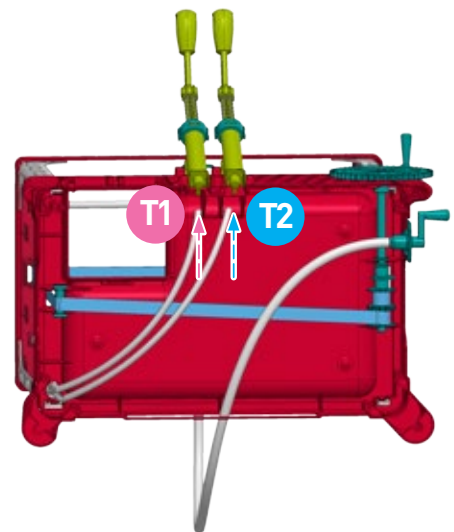
Feed the long ends of T1 and T2 into the hole in the back-left corner of the base.



43

**Flip over** ↺

Connect the ends of tubes T1 and T2 that you fed through the hole to the hydraulic nozzles.



44

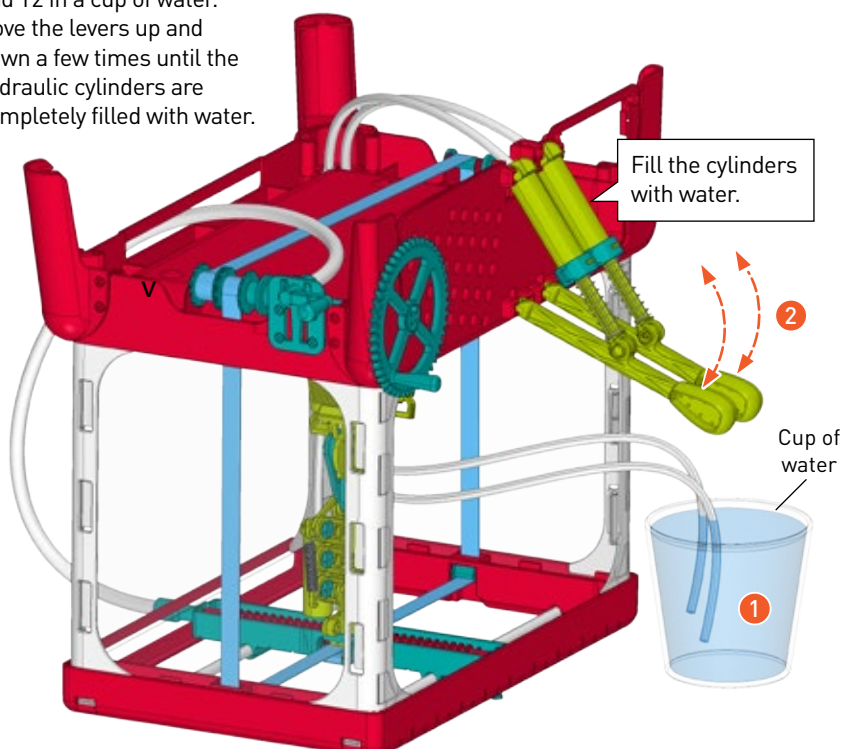
## REFILLING THE HYDRAULICS

In the course of playing with your candy claw machine, it is normal for the hydraulics to lose a little water. When you need to refill the hydraulics, return to step 45.

Here's a video showing how to refill the hydraulics after the machine has been assembled:



1. Place the loose ends of T1 and T2 in a cup of water.
2. Move the levers up and down a few times until the hydraulic cylinders are completely filled with water.

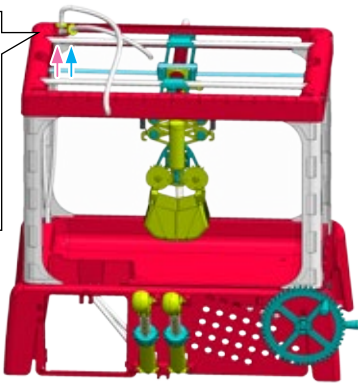


45

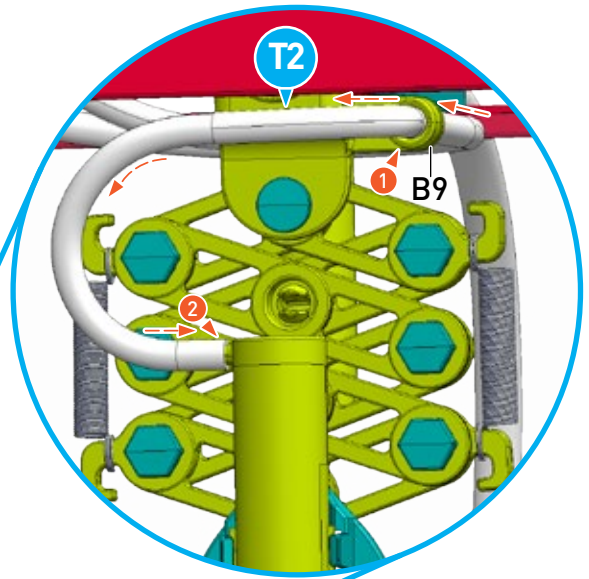


Turn right side up ↻

Feed the T1 and T2 tube connectors up through the hole in the top frame.



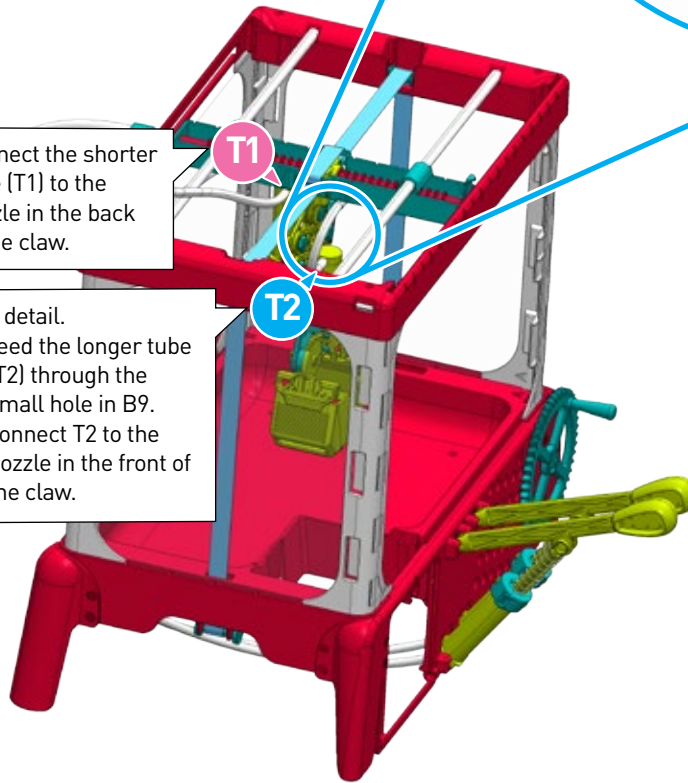
46



Connect the shorter tube (T1) to the nozzle in the back of the claw.

See detail.

1. Feed the longer tube (T2) through the small hole in B9.
2. Connect T2 to the nozzle in the front of the claw.



47

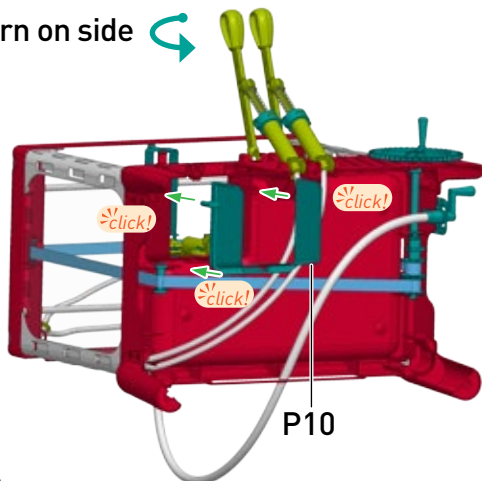
## ! TEST THE HYDRAULICS

**After** connecting T1 and T2 to the nozzles, move the levers up and down to test the motion of the claw. The lever on the left moves the claw up and down; the lever on the right opens and closes the claw. It is normal for a little water to leak.

If your hydraulics are not functioning properly, scan this QR code for help with troubleshooting the hydraulics:

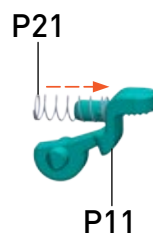


Turn on side ↻

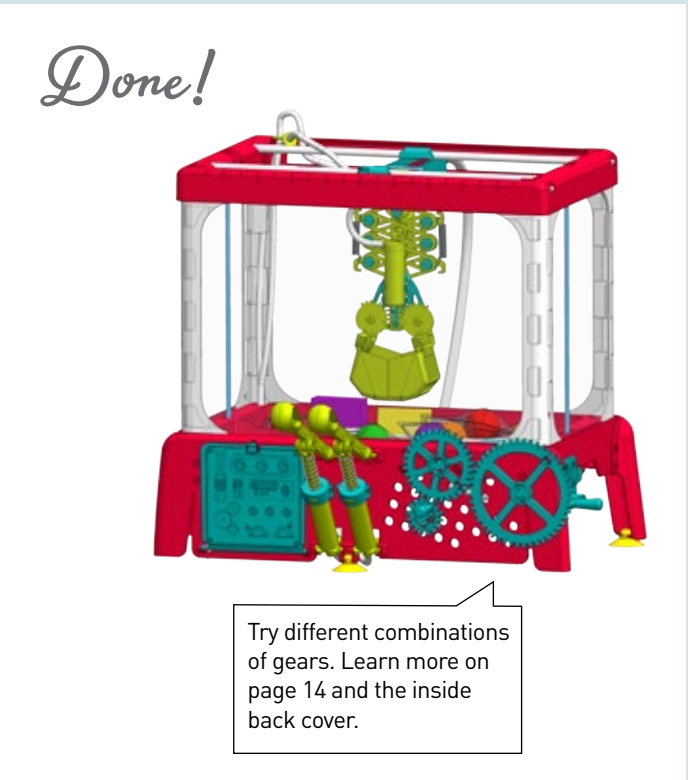
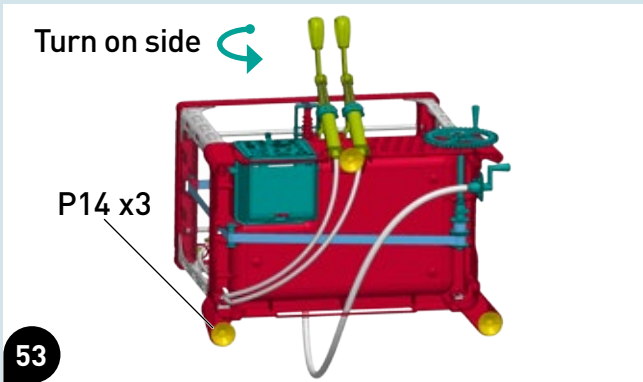
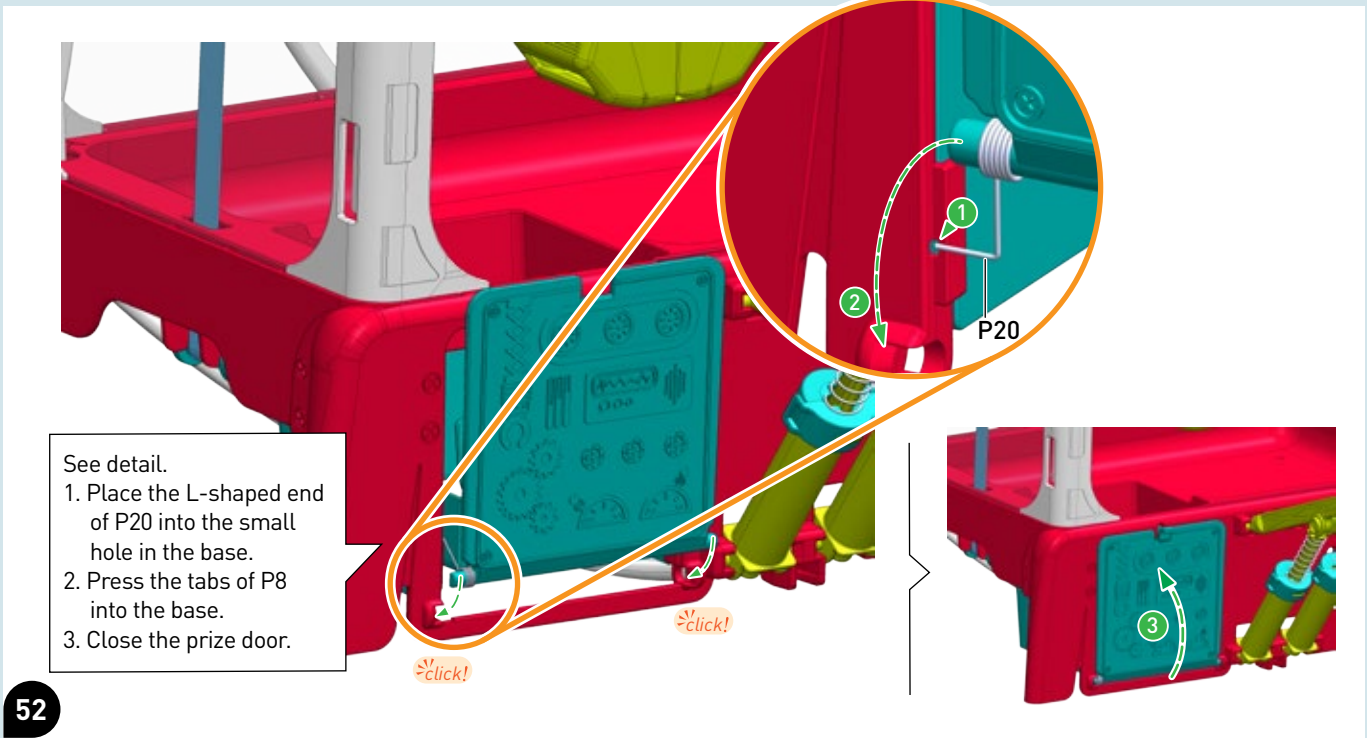
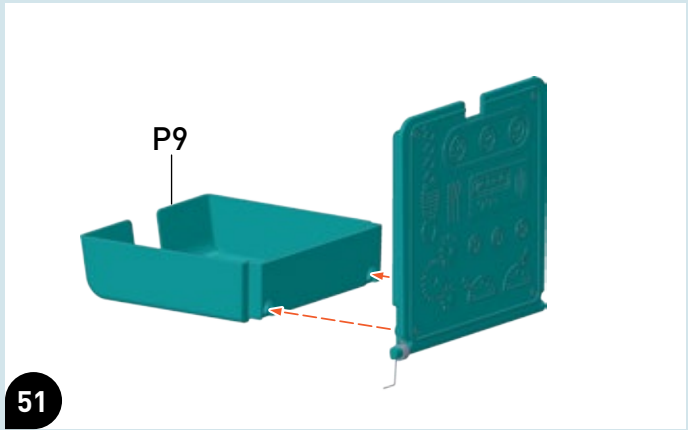
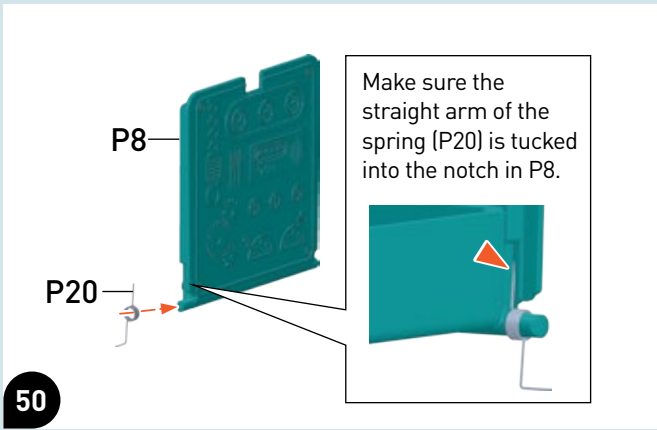


48

Turn right side up ↻



49





## HOW TO USE THE CANDY CLAW MACHINE

# Can you GRAB IT?



- 1** Fold up the small prize boxes and put them, along with the lollipops and any other prizes of your own, into the tray. Stick the number stickers onto your prizes to indicate different point values for each prize.
- 2** Decide which prize you want to try to grab. Turn the left-right crank to move the claw arm left or right toward the prize.
- 3** Turn the forward-backward crank to move the claw arm directly above the prize.
- 4** Push the arm lever down to extend the claw onto the prize.
- 5** Holding the arm lever down, open the claw by pushing down on the claw lever. Pull it back up when you have grabbed a prize. Then release the arm lever to raise the arm.
- 6** Holding the claw lever up, move the claw to the prize chute with the left-right and forward and backward cranks. Once the prize is over the chute, release the claw lever.
- 7** The prize drops into the prize chute. Open the door by pressing the prize door latch, and enjoy your prize!



## TROUBLESHOOTING!

If any part of your claw machine is not working properly, scan this QR code to view troubleshooting videos.



**CAN YOU MASTER THE CANDY CLAW MACHINE AND GET A PRIZE EVERY TIME!?**

## EXPERIMENTS

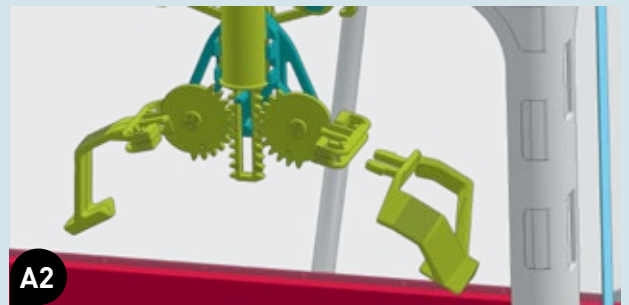
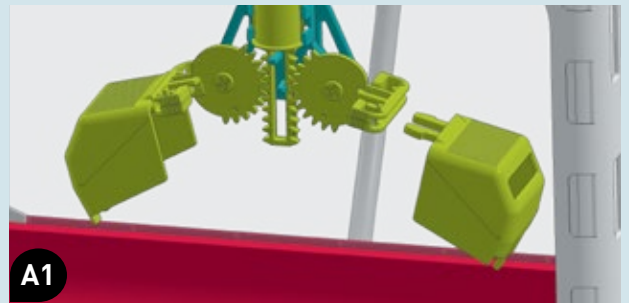
### A. Change the claws

1. Lift up the front plastic panel. Press the tabs on C9 and C10 toward each other to release the current claw piece.
2. Snap the new claw pieces into C9 and C10.  
Experiment to see which claws work best for picking up a variety of different objects!



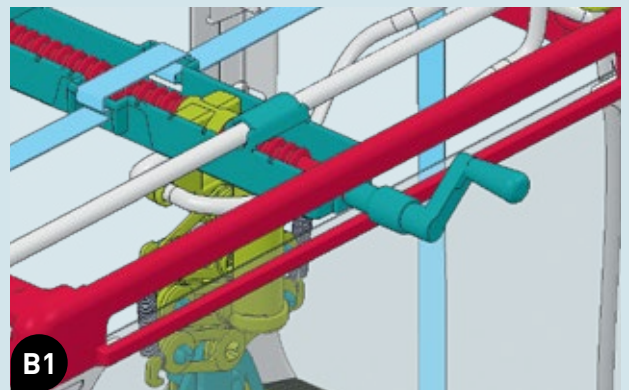
#### SEE THE EXPERIMENTS

Here's a video showing  
how to set up the  
different experiments:



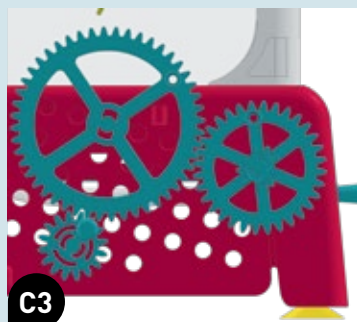
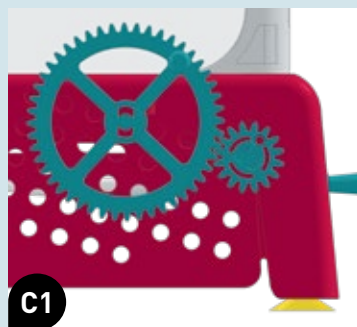
### B. More direct control

1. Remove the flexible shaft and the small shaft A3.
2. Connect the crank A2 directly to the connector A5. Observe the differences in how the worm screw operates with this configuration.

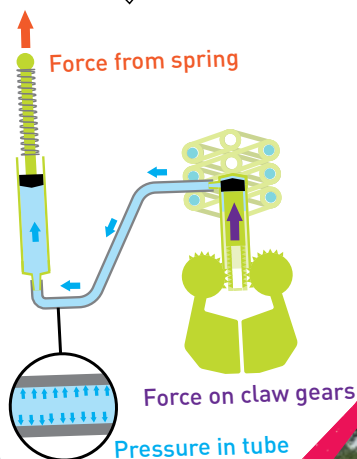
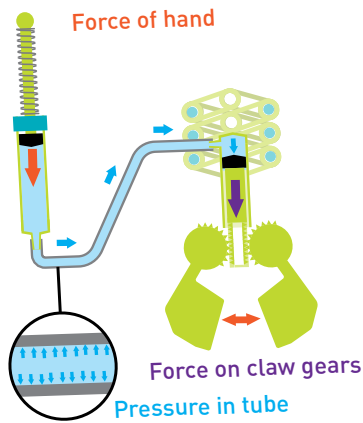


### C. Gears, gears, gears

- 1–4. Try all of the different gear train combinations below, and invent your own!
- v5. Which one moves the arm the fastest? Which one is the easiest to turn? Note which direction each gear turns in each setup.







# HOW HYDRAULICS WORK

In the claw machine, you saw how you could use the piston of one hydraulic cylinder to move another cylinder's piston, and thereby transfer force, when the two of them are connected by a tube and the system is filled with water. This is partly due to the fact that **water cannot be compressed**. It is also because the pressure applied to a **liquid** like water is transmitted through it with equal strength in all directions, because the molecules of a liquid can be easily moved.

The metal **springs** on the cylinders apply forces to the pistons to keep them pushed out. This sets the default state of the claw as closed and the arm as raised.

The transfer of force through cylinders and pistons is called **hydraulics** (Greek for "water tube"). Hydraulic technology is used in industrial machines and many technical applications. Hydraulics allow the transmission of forces from one place to another through a flexible tube and also the conversion of small forces into larger forces.

Special hydraulic oils are often used as a medium instead of water because they can be put under higher pressures. Hydraulic systems can be found in excavators, elevators, numerous construction vehicles, and in the braking systems in cars.







CHECK IT OUT

## Handy-Dandy *End Effectors*

The device at the end of a robotic arm is called the **end effector**. You can think of it like a human hand, but the variety of different end effectors and their capabilities goes far beyond what a human hand can do on its own. In this kit, there are three interchangeable end effectors: scoop, three-point gripper, and two-point gripper. They are all good at picking up different objects. End effectors are designed to interact with and manipulate objects in their environments to perform specialized tasks.



## WHAT CAN END EFFECTORS DO?

There are two main categories of end effectors: grippers and tools. Here are examples of each.

### Grippers

Mechanical (fingers)  
Suction, vacuum  
Magnetic  
Adhesive

### Tools

Welding torch  
Spray painting  
Measuring, sensing  
Drilling, cutting



## Degrees of Freedom

Unlike a human arm, a robotic arm has a lot more freedom to move through space in different ways. The term **“degrees of freedom”** is used to describe the movement of a robotic arm through space. The position and orientation of an object in space is described by three **coordinates** in the **x, y, and z directions**, and three directions of rotation around those axes.

The area defined by all of the positions in space that the end of the robotic arm can reach is known as the **workspace**. If the object that the robotic arm needs to pick up is not in the workspace, the robot cannot pick it up! The workspace depends on the degrees of freedom, limitations of the joints, lengths of the linkages, and the angles at which the object must be picked up.

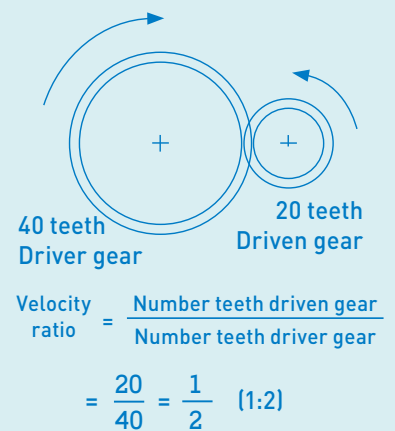


CHECK IT OUT

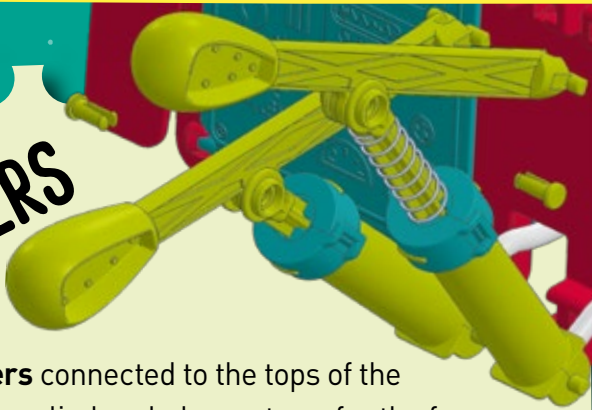
# GEARS AND GEAR RATIOS

**Gears** are actually just **wheels** with teeth on them. The teeth allow the wheels to mesh together and turn each other. In other words, they allow **forces to be transmitted** from one wheel to another.

The mechanical advantage of a gear is evident when a large gear meshes with a small gear. One full turn of the large gear will produce, say, three full turns of the small gear. Because of this, the smaller gear always turns faster than the larger. On the other hand, the larger gear turns with greater force than the smaller one. So, in this way, gears can be used to make slow turning motion into rapid turning motion, or to convert small forces into large forces. Multiple gears meshing with each other are called **gear trains**, or **transmissions**.



## LEVERS



The **levers** connected to the tops of the hydraulic cylinders help you transfer the force from your hand to move the pistons inside the cylinders. Levers are rigid bars that pivot on a point called the **fulcrum**. A **weight (or load)** at one point on the bar can be moved by applying a **force (the effort)** to another point on the bar. If the distance from the fulcrum to the effort (**the effort arm**) is greater than the distance from the fulcrum to the load (**the load arm**), then a smaller force can move a larger load. This is how the lever makes work easier.

Your claw machine has a gear train controlling the left-right motion of the arm. The gear connected to the crank (or any input force) is called the **driver gear**. The gear that is turned by the driver gear is called the **driven gear**. Gears of different sizes are used to increase or decrease the speed or the force of rotary motion, called **torque**. The relationship between the number of teeth on meshing gears is called the **gear ratio**. The gear ratio indicates the change in speed or torque from one gear to the other.





6th Edition ©2023 Thames & Kosmos, LLC, Providence, RI, USA  
Thames & Kosmos® is a registered trademark of Thames & Kosmos, LLC.

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.

Invented by David Yakos, Streamline Design LLC

Text and editing: Hannah Mintz and Ted McGuire

Package design template: Atelier Bea Klenk, Klenk/Riedinger

Package design: Dan Freitas

Photos: p. 15 (digger) Medien Kommunikation, Unna; p. 15 (truck) Dreamsquare © shutterstock.com; p. 16 (glass suction cup robotic arm) Oliver Sved, ©fotolia.com; p. 16 (robotic arm on assembly line) Sasint ©Adobe Stock; p. 16 (robotic arm over chassis) wellphoto ©Adobe Stock; All others, Thames & Kosmos.

The publisher has made every effort to locate the holders of image rights for all of the photos used. If in any individual cases any holders of image rights have not been acknowledged, they are asked to provide evidence to the publisher of their image rights so that they may be paid an image fee in line with the industry standard.

Distributed in North America by Thames & Kosmos, LLC. Providence, RI 02903  
Phone: 800-587-2872; Web: [www.thamesandkosmos.com](http://www.thamesandkosmos.com)

We reserve the right to make technical changes.

Printed in China / Imprimé en Chine

**Do you have any  
questions?**

Our technical support  
team will be glad to  
help you!

Thames & Kosmos US  
Email: [support@thamesandkosmos.com](mailto:support@thamesandkosmos.com)  
Web: [thamesandkosmos.com](http://thamesandkosmos.com)  
Phone: 1-800-587-2872

550103-03-161023