EXPERIMENT MANUAL

Candy Claw Machine

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.

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Thames & Kosmos, 89 Ship St., Providence, RI, 02903, USA | 1-800-587-2872 | www.thamesandkosmos.com

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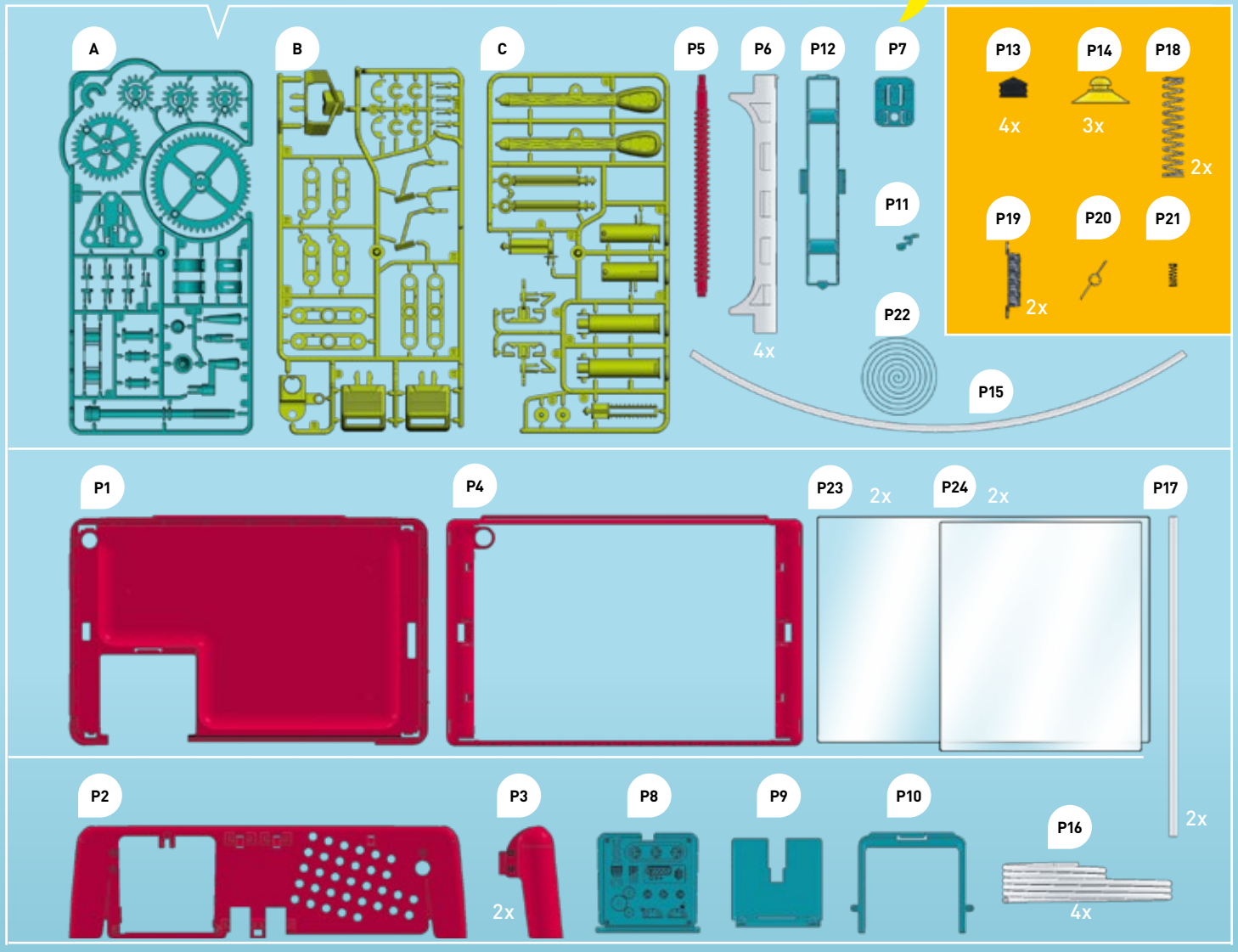
KIT CONTENTS

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:

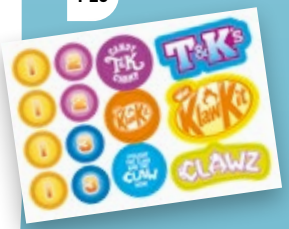
✓	No.	Description	Qty.
◯	A	Plastic frame A (Parts A1–A18)	1
◯	B	Plastic frame B (Parts B1–B12)	1
◯	C	Plastic frame C (Parts C1–C10)	1
◯	P1	Base tray	1
◯	P2	Base front panel	1
◯	P3	Back leg	2
◯	P4	Top frame	1
◯	P5	Worm screw	1
◯	P6	Column (2 A and 2 B)	4
◯	P7	Mounting panel for crank	1
◯	P8	Prize door	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

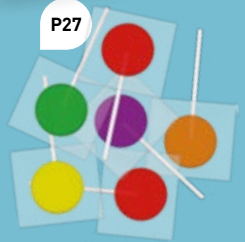
*Flavors and colors may vary.

P25

P26



P27



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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.

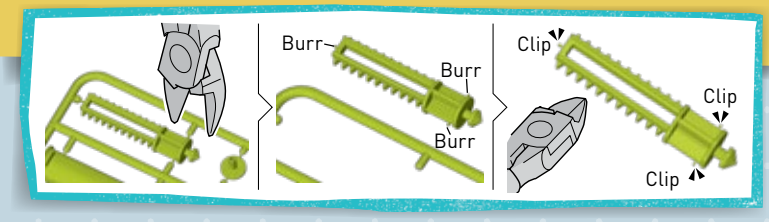
We hope you and your child have a lot of fun building and playing with the Candy Claw Machine!

YOU WILL ALSO NEED:

Diagonal cutters or scissors and nail file, vegetable oil, small bowl, cup of water

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!
- **You must properly lubricate the hydraulic cylinders by coating each piston seal (P13) with vegetable oil. See page 4.**



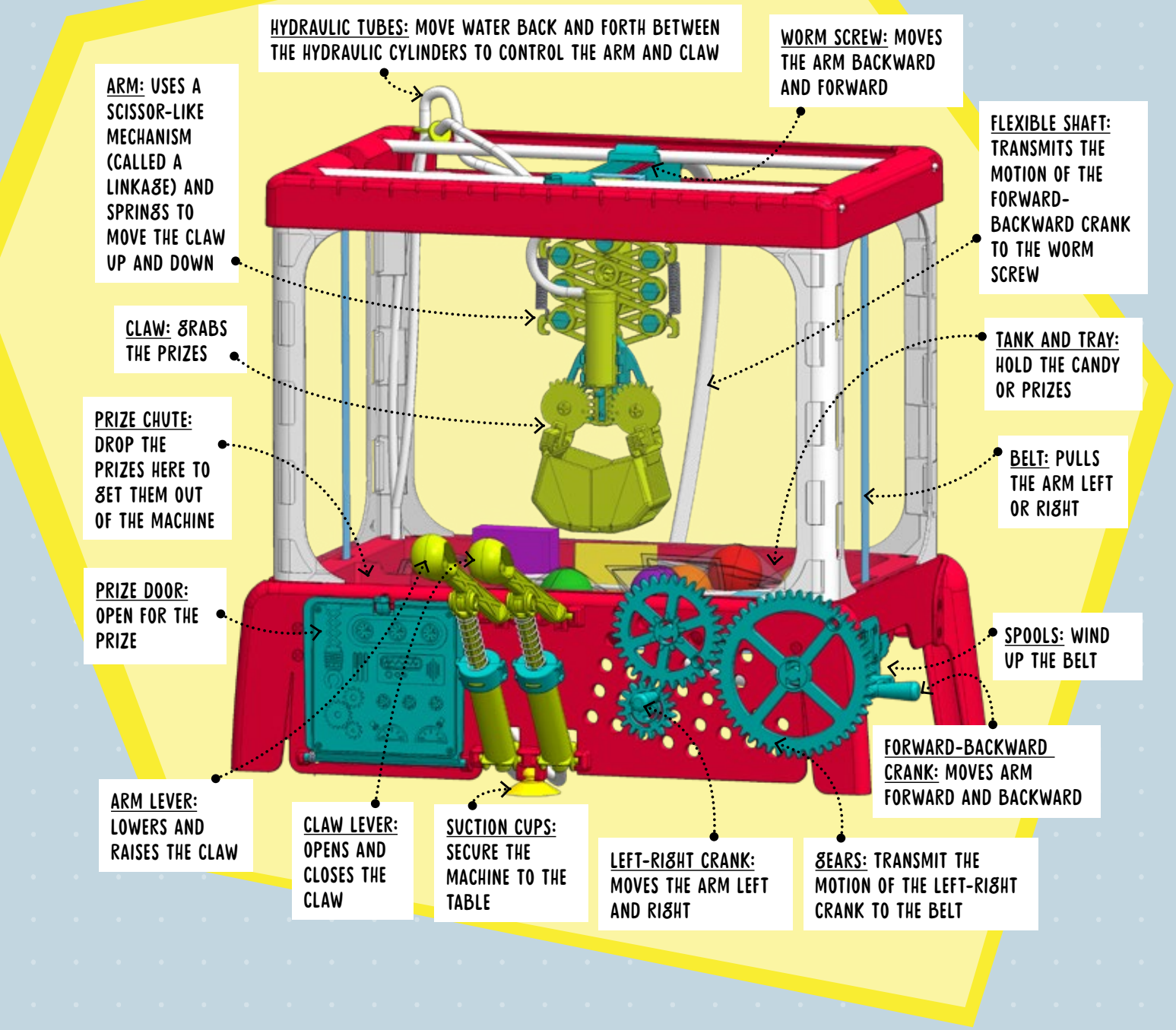
Take particular care when removing the tubes of the hydraulic cylinders (C4, C7, and C8) from the frame. Some of these are attached with thicker tabs of plastic.

First, cut a few millimeters away from the tube. Then, carefully remove the excess material.

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!

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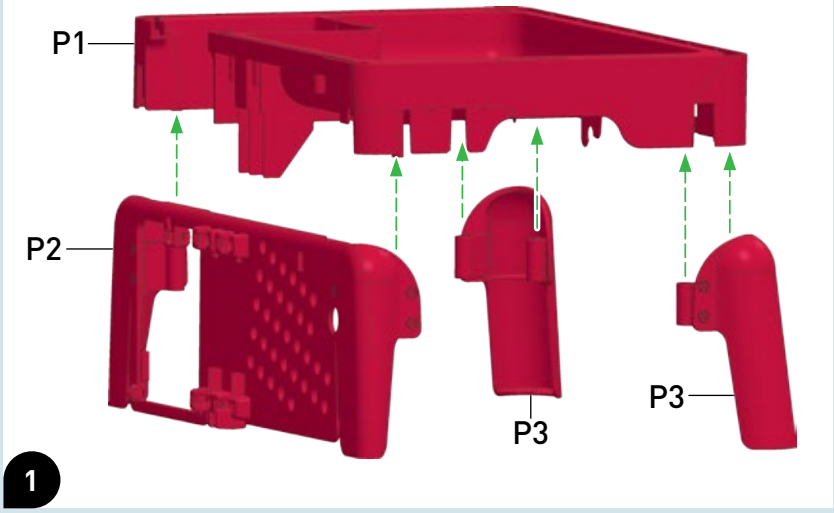
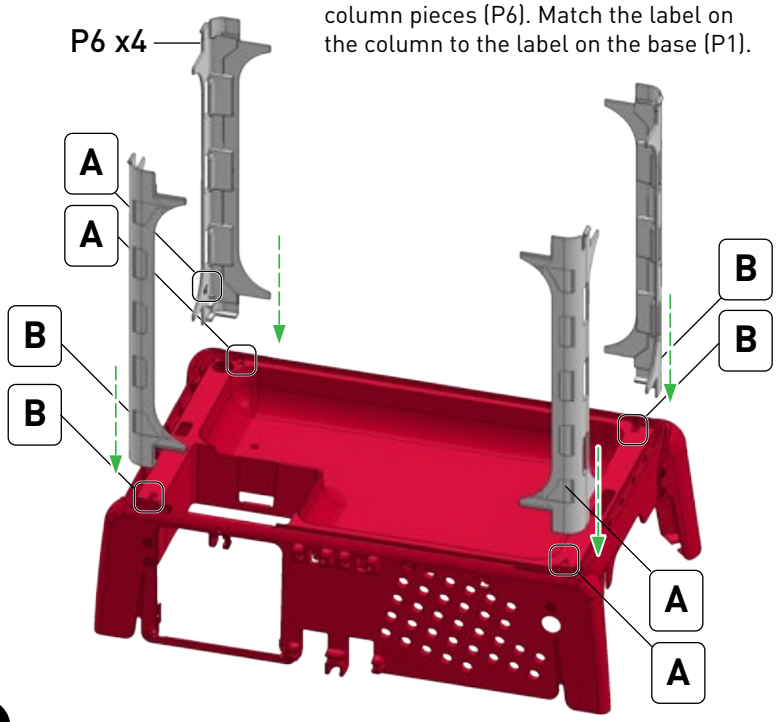


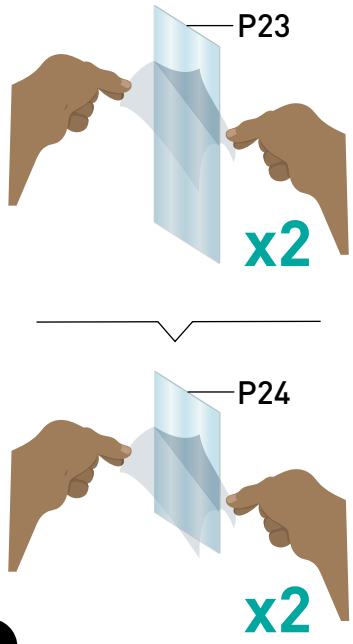
1



Note: There are two shapes of the column pieces (P6). Match the label on the column to the label on the base (P1).

2

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



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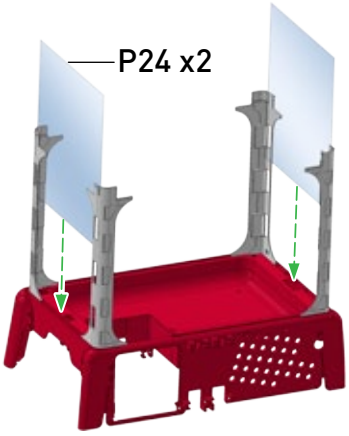

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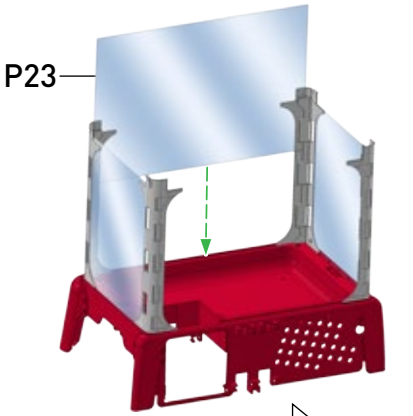
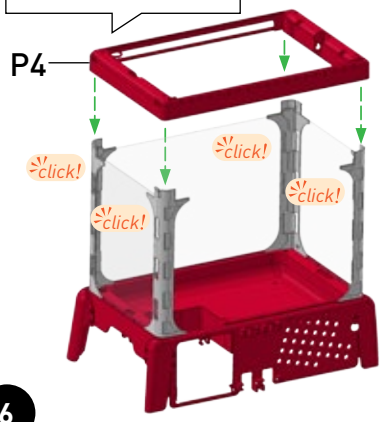


Note: Do not add the panel in the front of the machine yet.

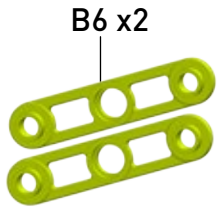
5

Note: This circle is in the back-left corner.

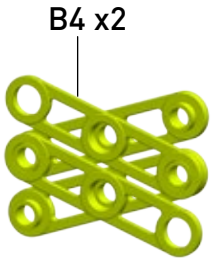


6

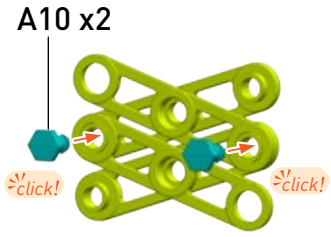
1. Lay the two B6 parts down on a table as shown. Pay attention to the orientation.



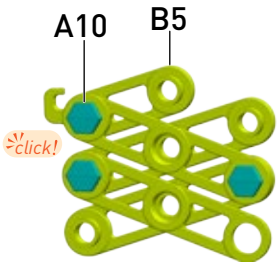
2. Add the two B4 parts in front.



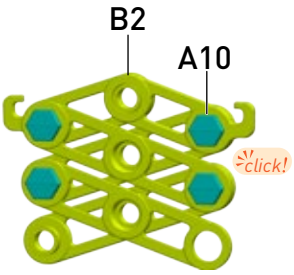
3. Carefully pick up the parts in your hands as you add the A10 pins.



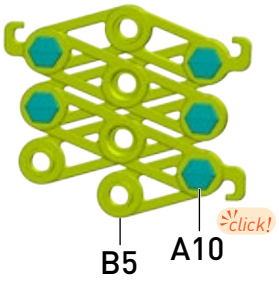
4. Add B5 behind, then add A10.



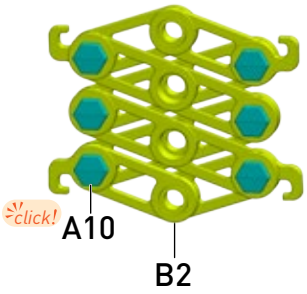
5. Add B2 in front, then add A10.



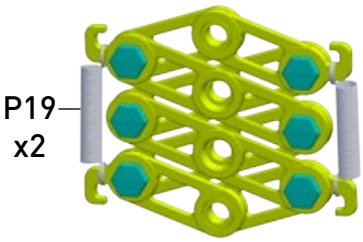
6. Add B5 behind, then add A10.



7. Add B2 in front, then add A10.

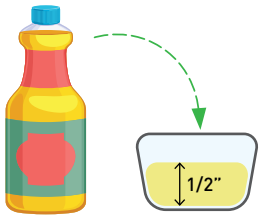


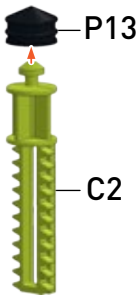
8. Hook the loops of the springs (P19) as shown.



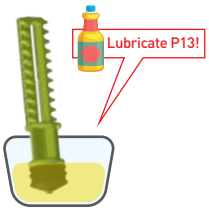
7

Pour vegetable oil into a small bowl. There should be about a half of an inch of oil in the bowl.

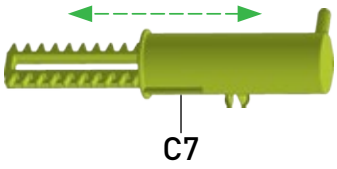




Dunk the piston seal (P13) into the oil, making sure to coat it completely.



Insert the piston seal into cylinder C7, and move it back and forth several times to coat the inside of the cylinder with oil. Reapply oil as necessary.



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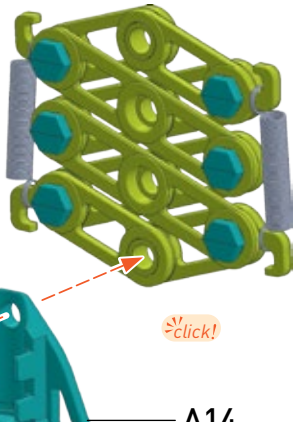

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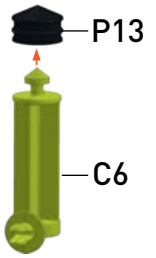
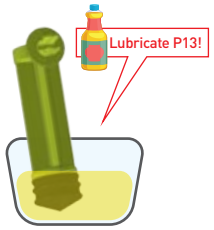
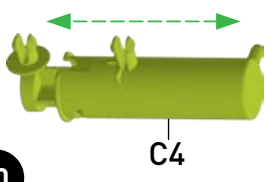
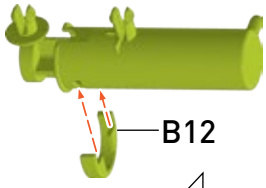




Insert the piston seal into cylinder C4, and move it back and forth several times to coat the inside with oil. Reapply oil as necessary.

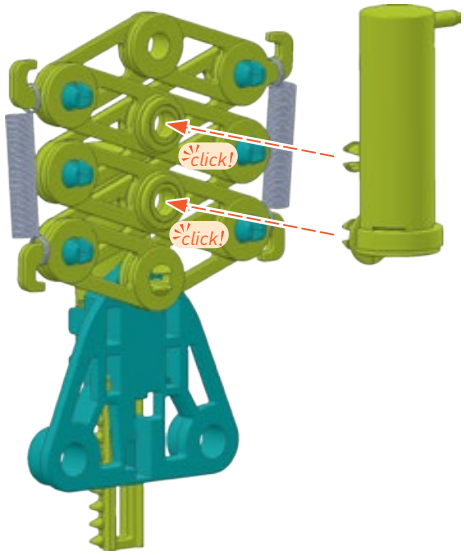




Note: There is a spare B12 part included in the kit.

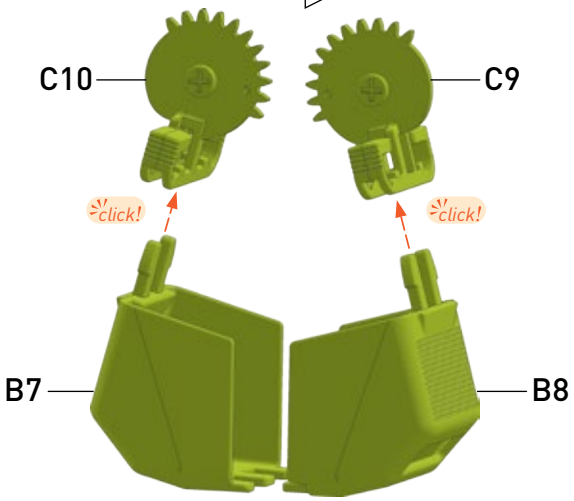
10

Turn around



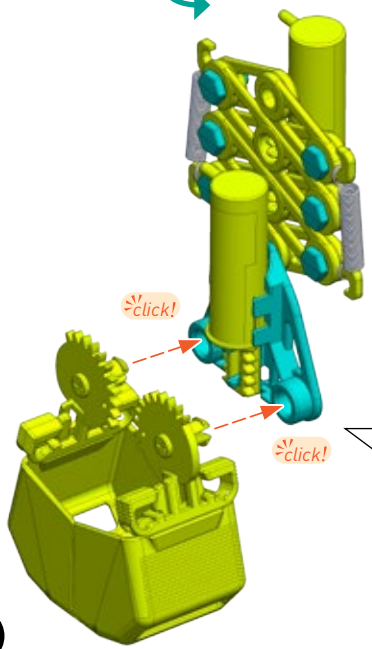
11

Note: The pins on C10 and C9 point toward the back.

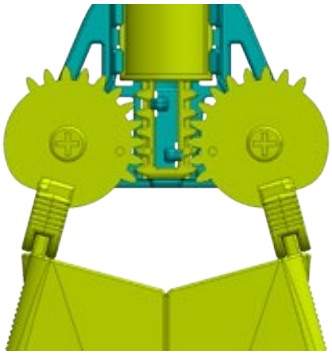


12

Turn around



Line up the teeth of the gears exactly as shown.



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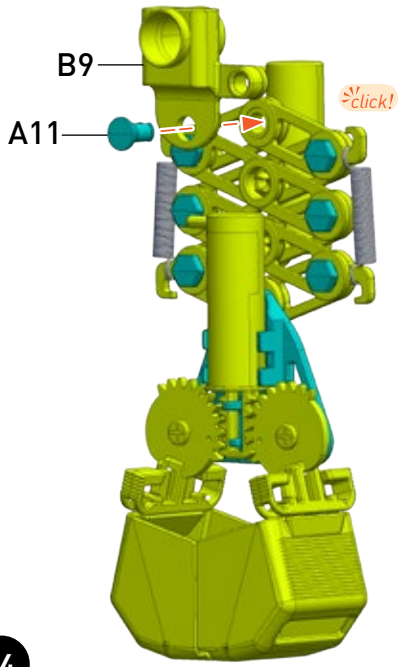

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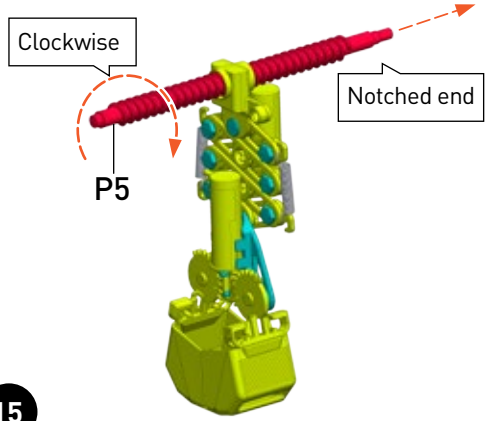
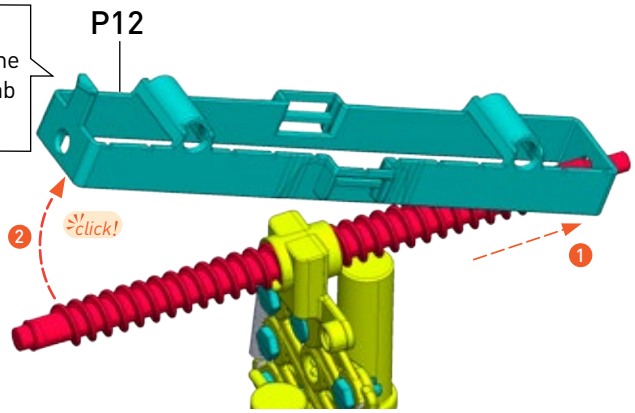


15

Note the position of the triangular tab of P12.



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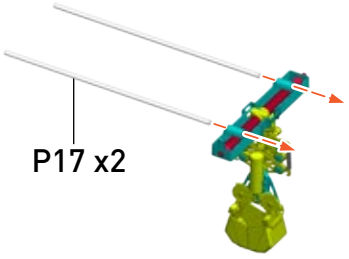

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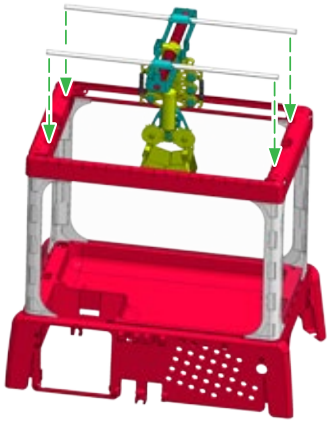

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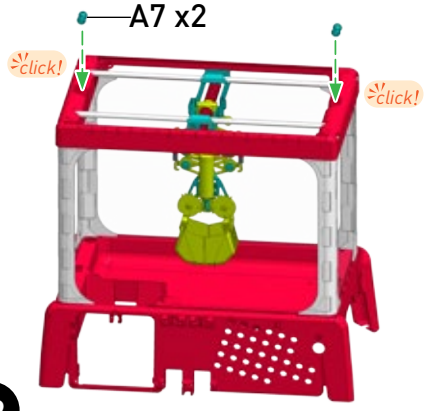
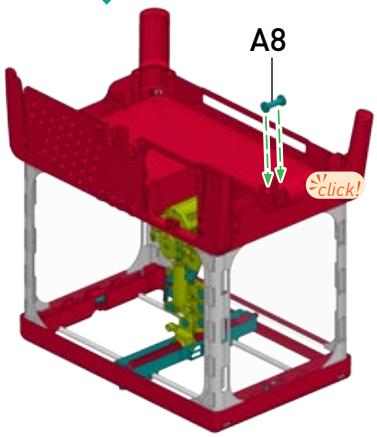


19

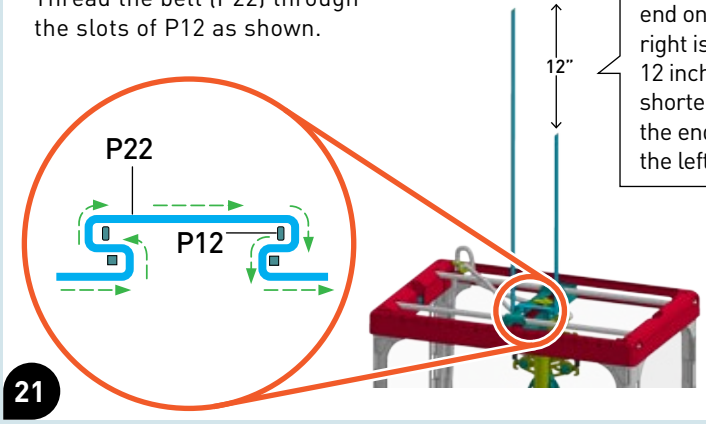
Flip over



20

Turn right side up

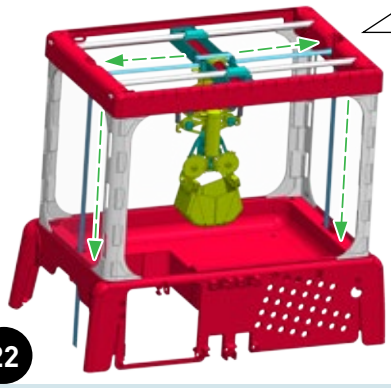
Thread the belt (P22) through the slots of P12 as shown.



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

21

Thread the belt through the machine.



The belt sits on top of the A7 rollers.

22

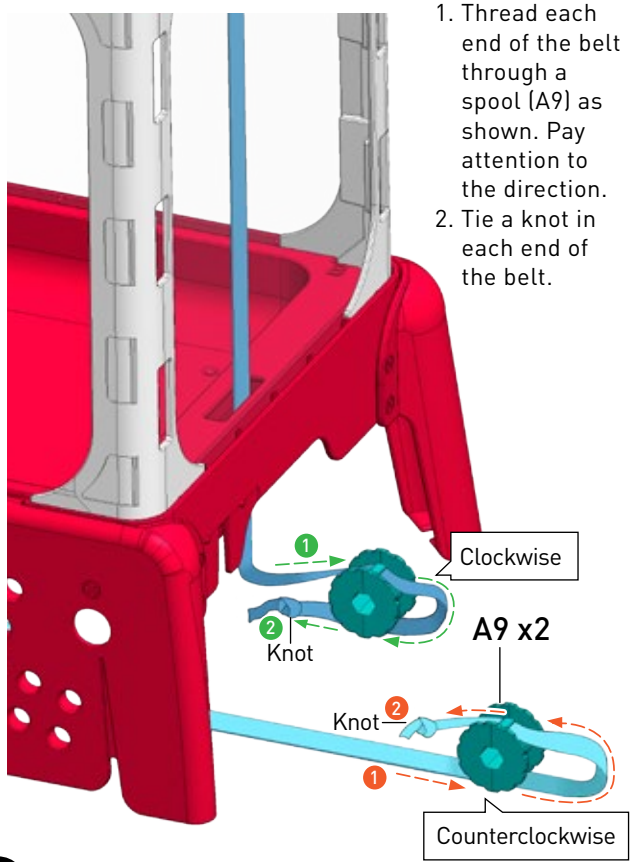
Pull this end of the belt under the machine and to the right. This pulls the claw to the left.

23

INSTALLING THE BELT

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

1. Thread each end of the belt through a spool (A9) as shown. Pay attention to the direction.
2. Tie a knot in each end of the belt.



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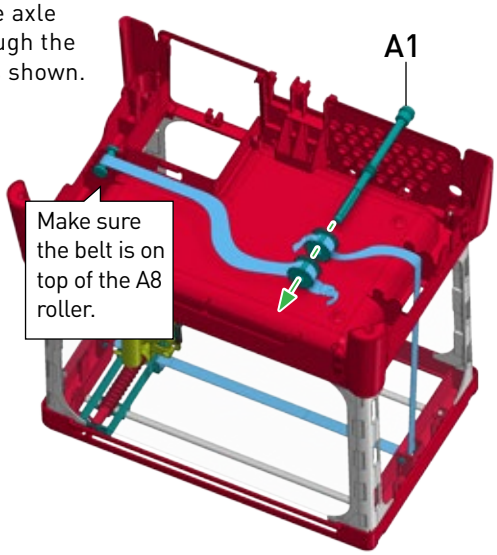
6

Flip over

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



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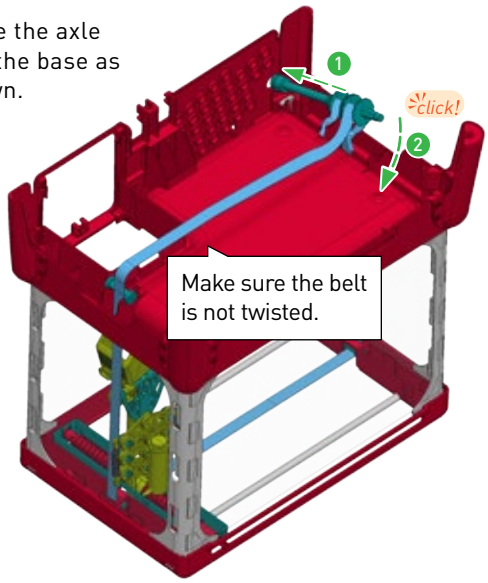
Place the axle into the base as shown.



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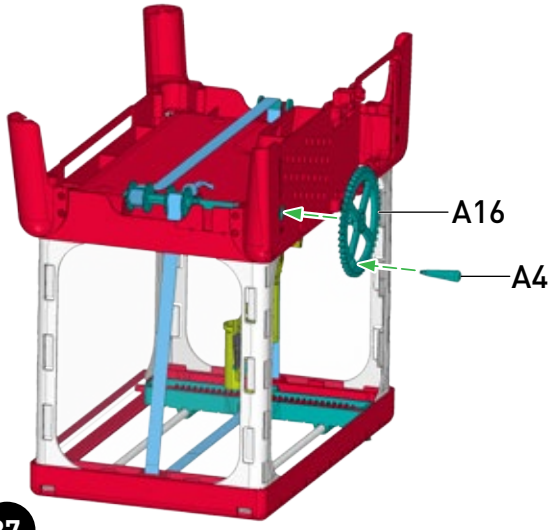
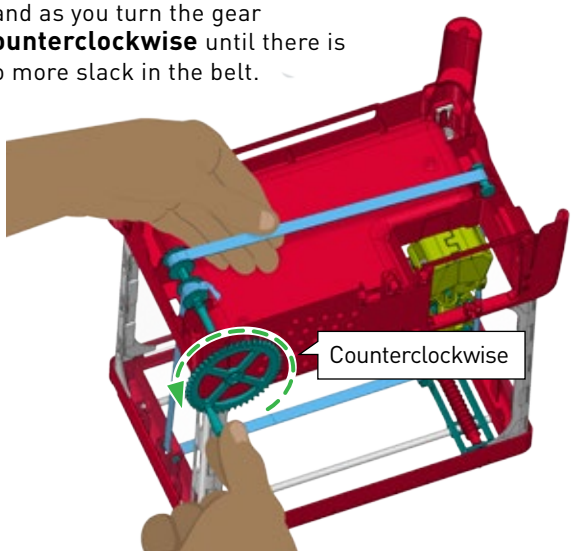
Rotate 180°



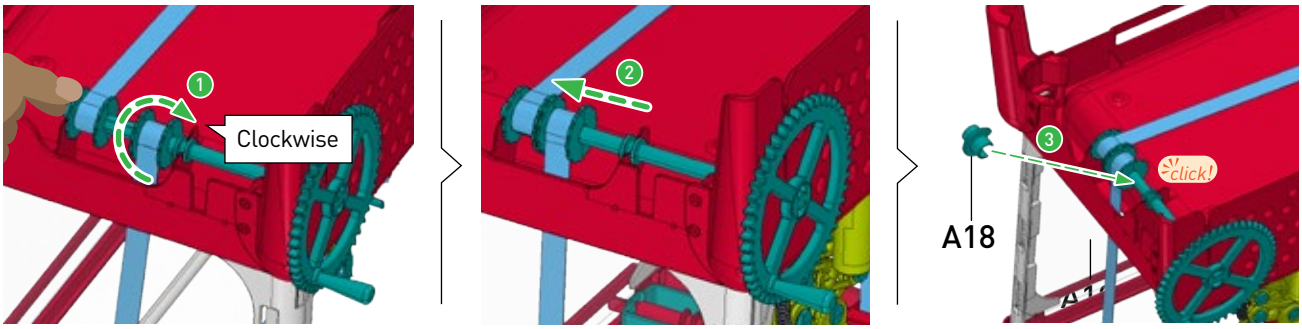
27

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



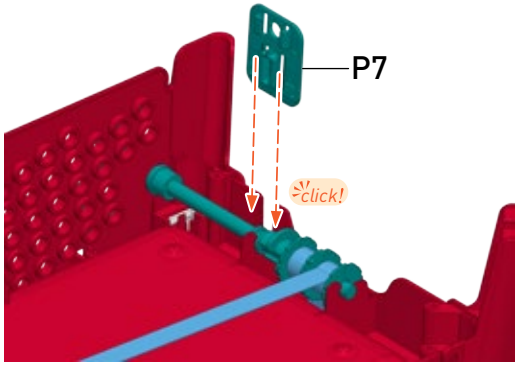
28

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°



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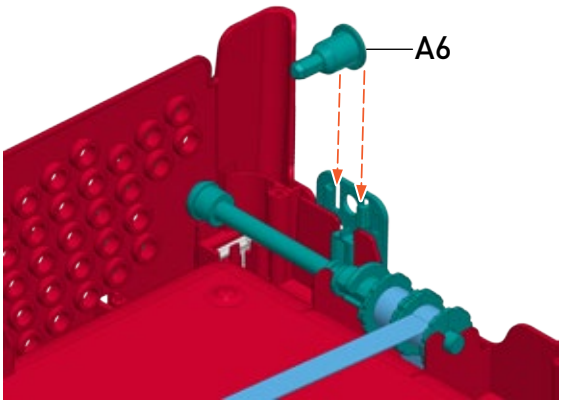

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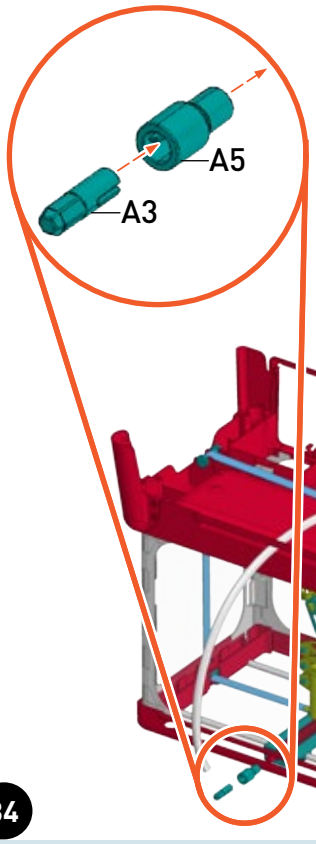
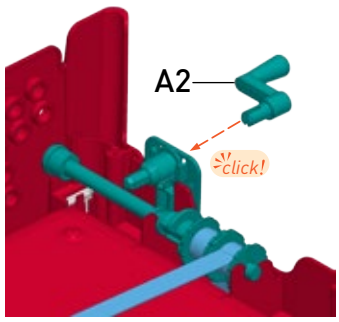
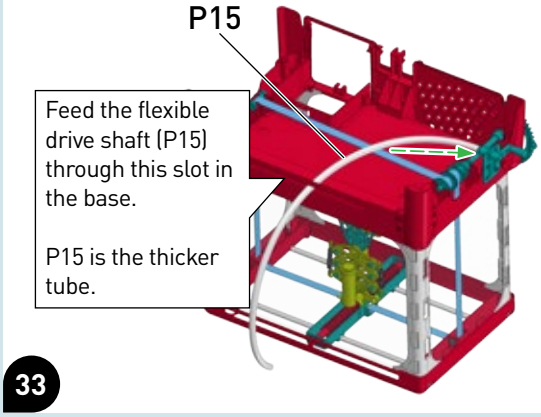




32



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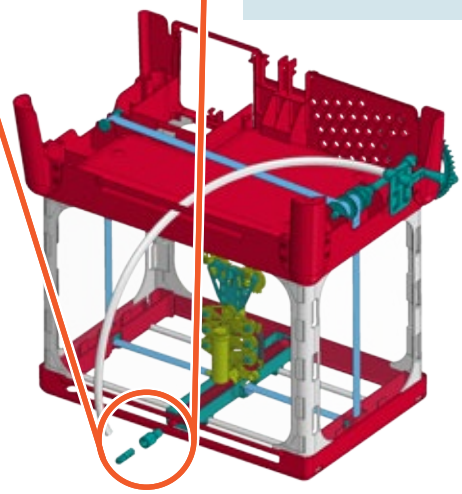

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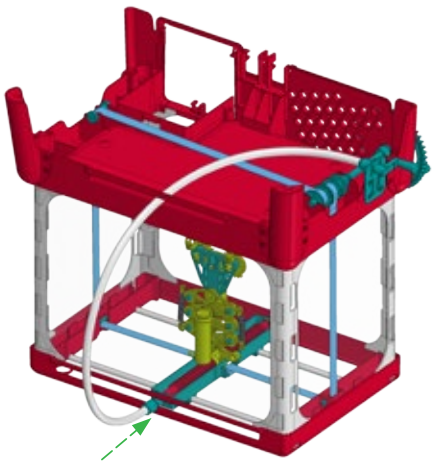
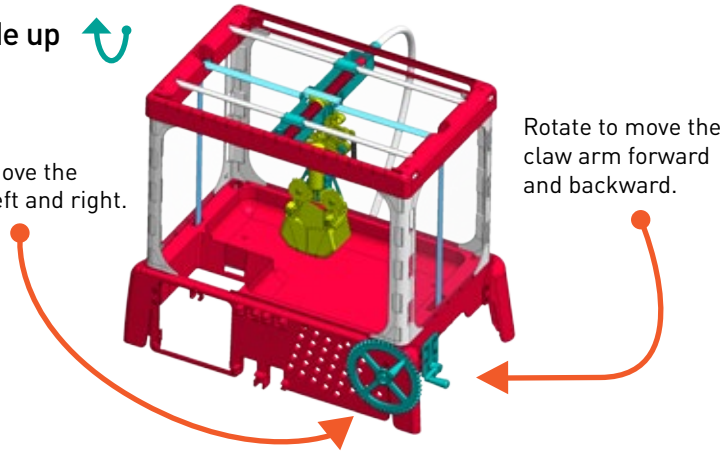


35

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:

Turn right side up

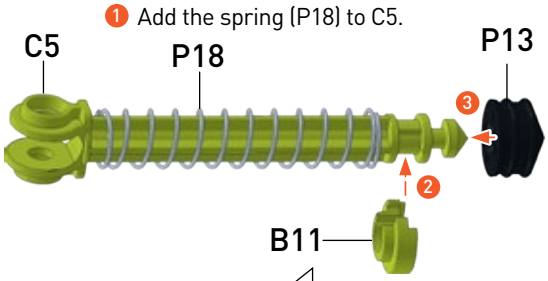


36

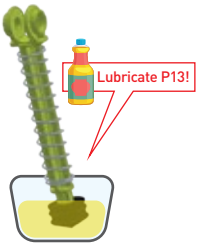
Note: You will do steps 37 and 38 two times.

37

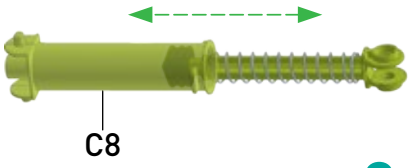
1. Add the spring (P18) to C5.



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

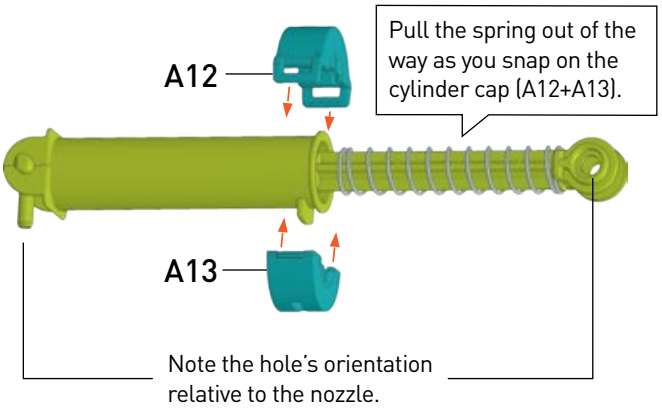


Insert the piston seal into cylinder C8, and move it back and forth several times to coat the inside with oil. Reapply oil as necessary.



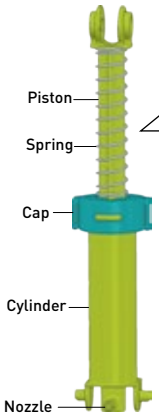
x2

38



Pull the spring out of the way as you snap on the cylinder cap (A12+A13).

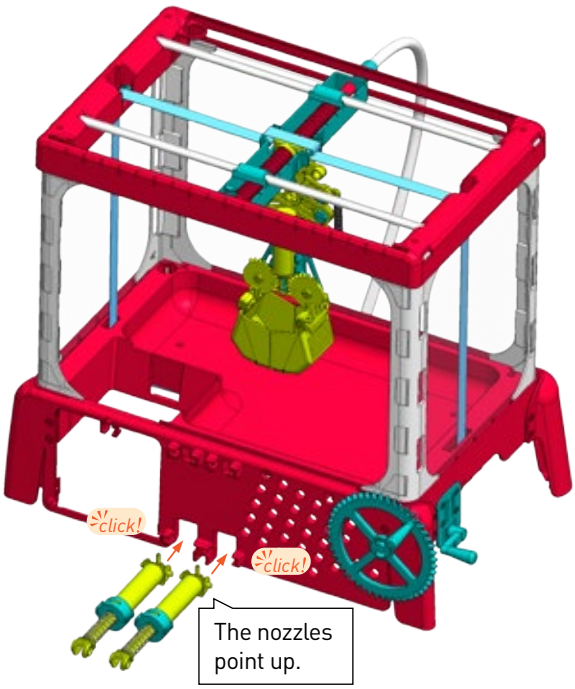
Note the hole's orientation relative to the nozzle.



Make sure the spring (P18) is completely outside the cap (A12 +A13).

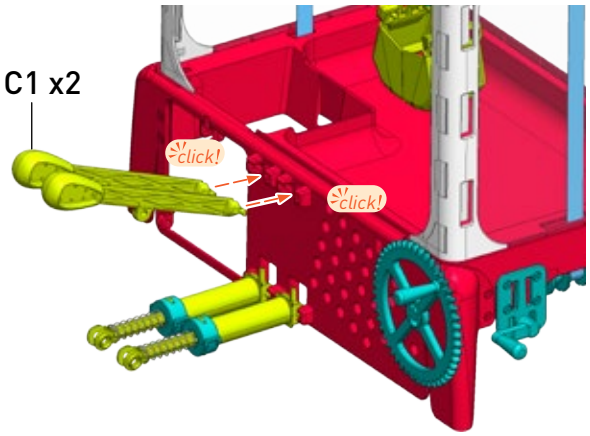
x2

39

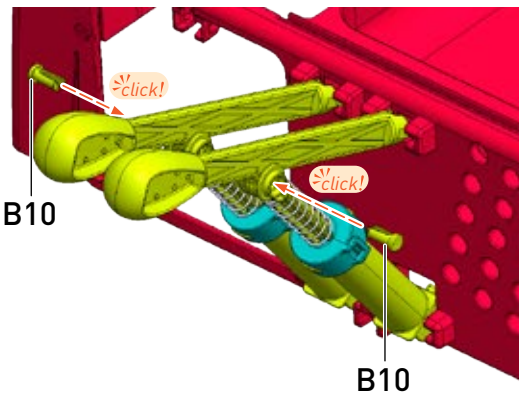


The nozzles point up.

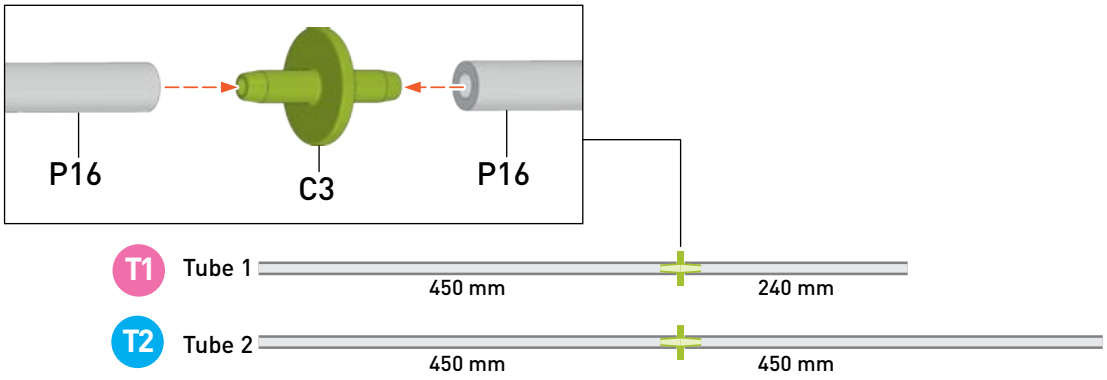
40



41

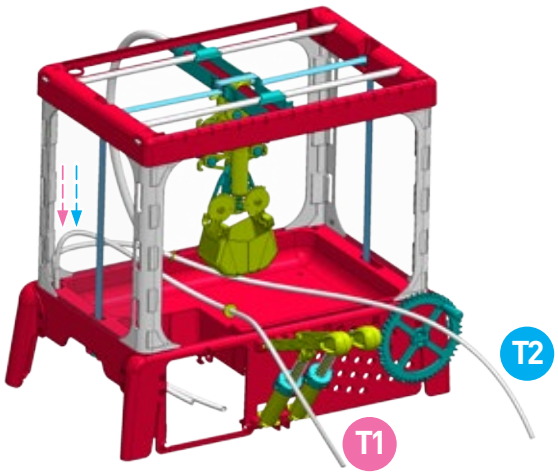


Tube assembly: There are three 450-mm tubes and one 240-mm tube. Connect them as shown here.



42

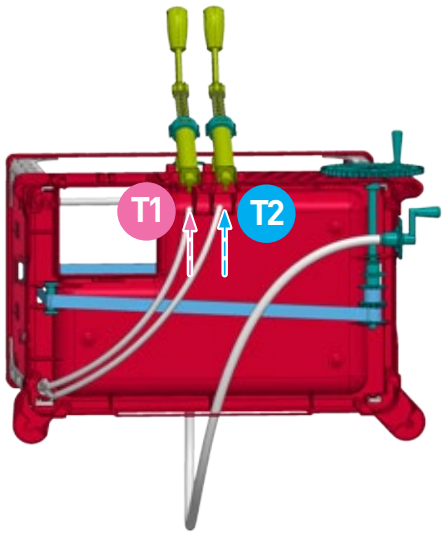
Feed the long ends of T1 and T2 into the hole in the back-left corner of the base.



43

Flip over

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



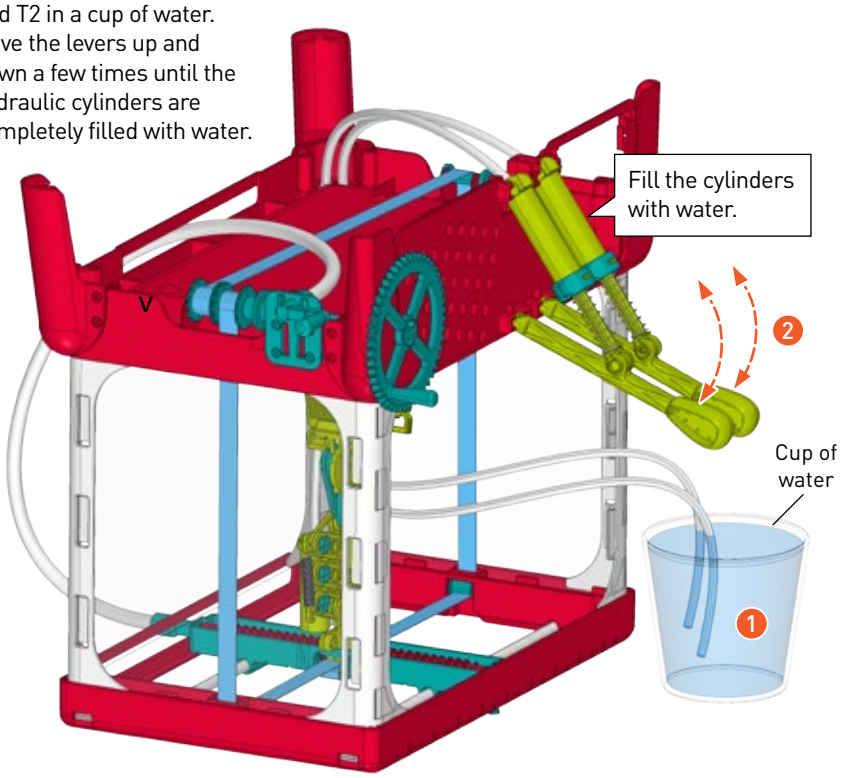
44

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:

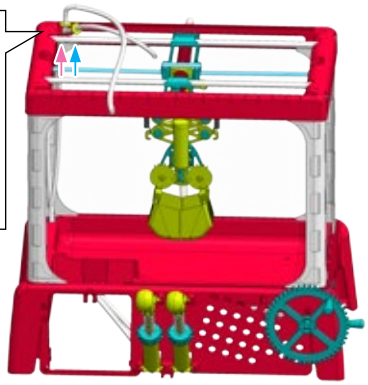
1. Place the loose ends of T1 and T2 in a cup of water.
2. Move the levers up and down a few times until the hydraulic cylinders are completely filled with water.



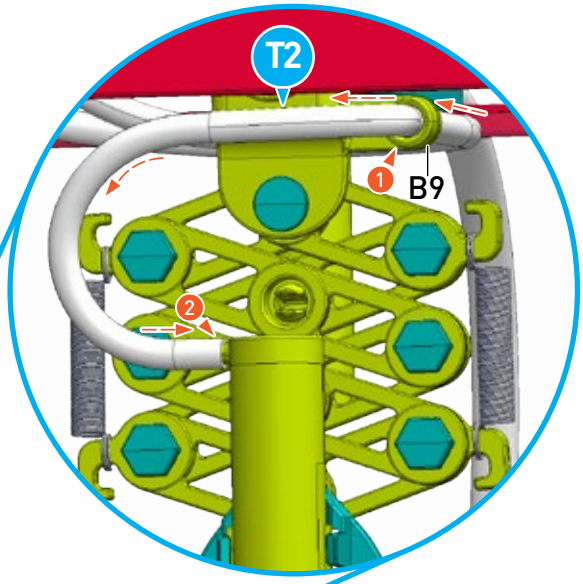
45

Turn right side up

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

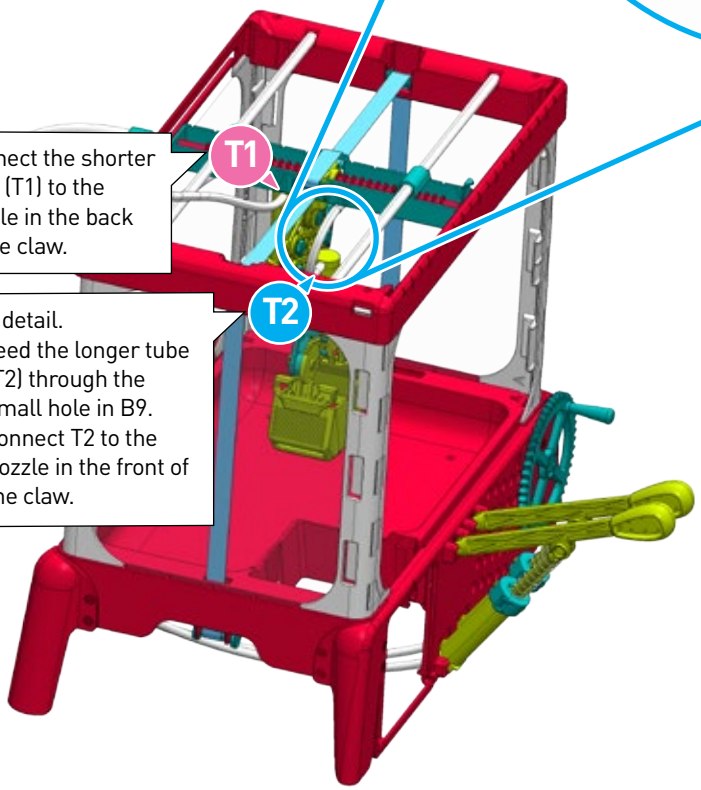


46



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.



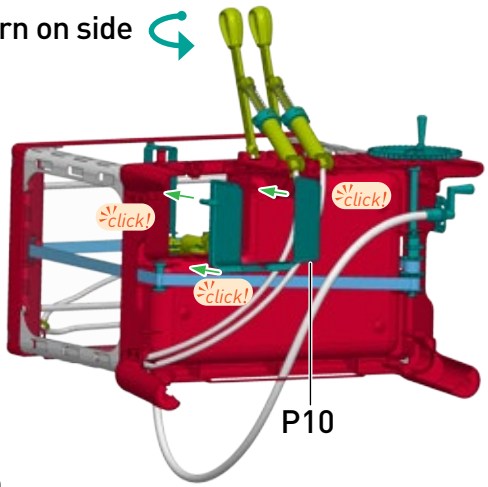
TEST THE HYDRAULICS

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, but if your hydraulics are not holding water, there may be a crack in one of the cylinders, or a fault in the piston seal. In that case, contact tech support: support@thamesandkosmos.com

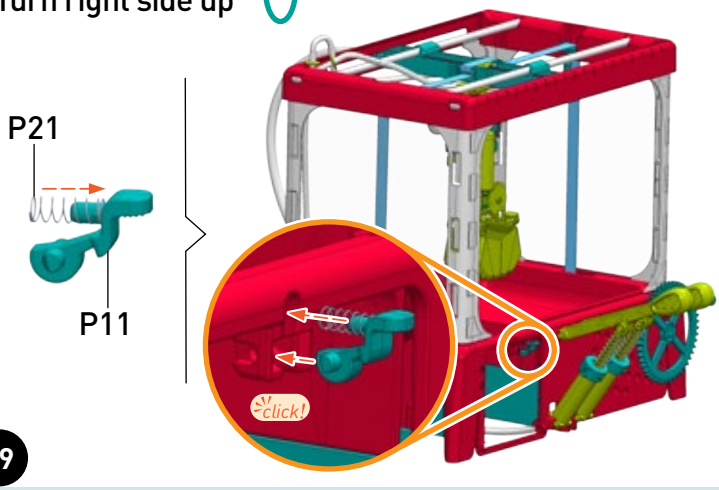
47

Turn on side

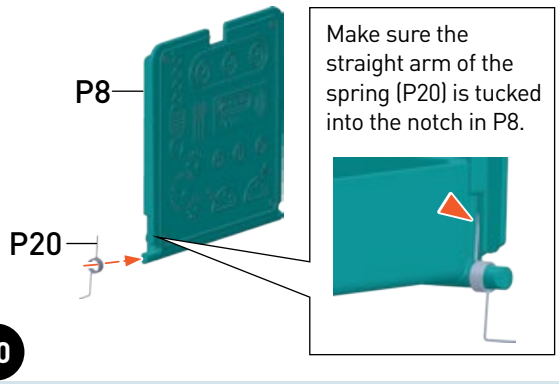


48

Turn right side up

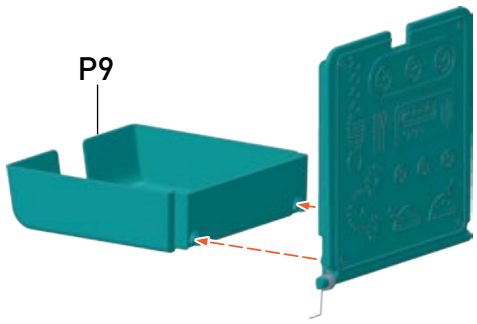


49

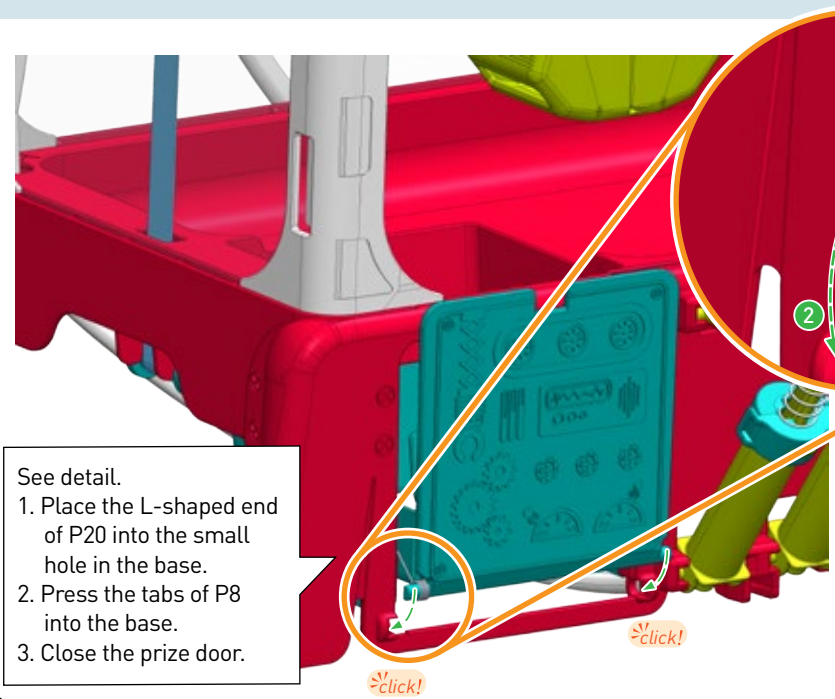


Make sure the straight arm of the spring (P20) is tucked into the notch in P8.

50



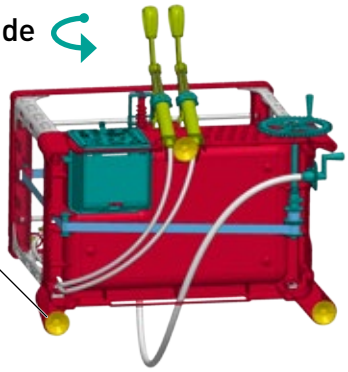
51



See detail.
1. Place the L-shaped end of P20 into the small hole in the base.
2. Press the tabs of P8 into the base.
3. Close the prize door.

52

Turn on side



53

Turn right side up

Add the prizes and the front panel.

54

Done!

Try different combinations of gears. Learn more on page 14 and the inside back cover.

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!

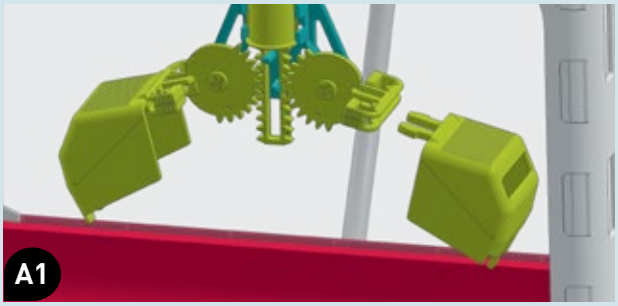
TROUBLESHOOTING!

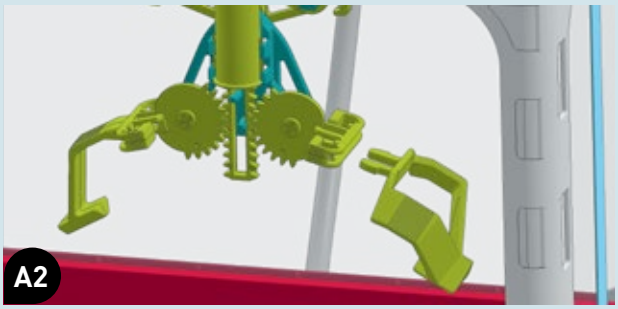
If any part of your claw machine is not working properly, scan this QR code to view troubleshooting videos.

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

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!



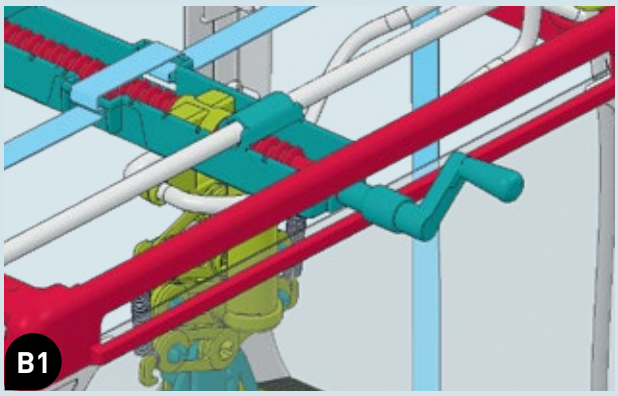


SEE THE EXPERIMENTS

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

B. More direct control

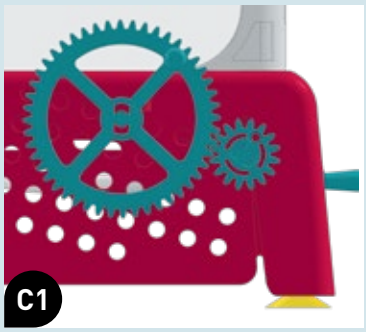
1. Remove the flexible shaft and the small shaft A3.
2. Connect the crank A2 directly to the connector A5. Observe the differences in how the worm screw operates with this configuration.

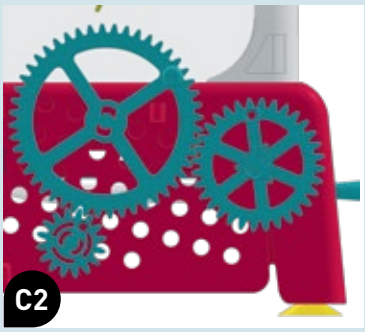


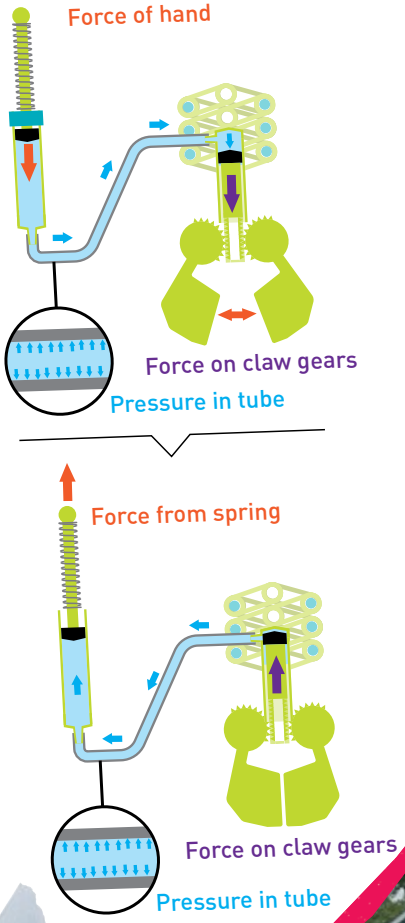
C. Gears, gears, gears

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 once 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	Tools
Mechanical (fingers)	Welding torch
Suction, vacuum	Spray painting
Magnetic	Measuring, sensing
Adhesive	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.

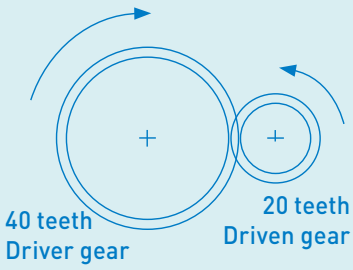
The area defined by all of the positions in space that the end of the robotic arm can reach is known as the **workspace**. If the object that the robotic arm needs to pick up is not in the workspace, the robot cannot pick it up! The workspace depends on the degrees of freedom, limitations of the joints,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

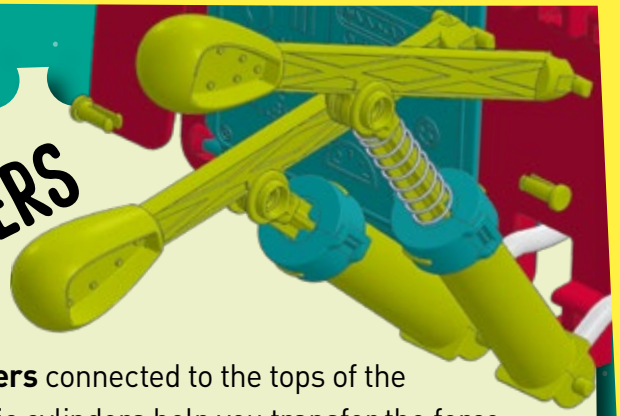
The mechanical advantage of a gear is evident when a large gear meshes with a small gear. One full turn of the large gear will produce, say, three full turns of the small gear. Because of this, the smaller gear always turns faster than the larger. On the other hand, the larger gear turns with greater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



$$\text{Velocity ratio} = \frac{\text{Number teeth driven gear}}{\text{Number teeth driver gear}}$$

$$= \frac{20}{40} = \frac{1}{2} \quad (1:2)$$

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.

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