

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.

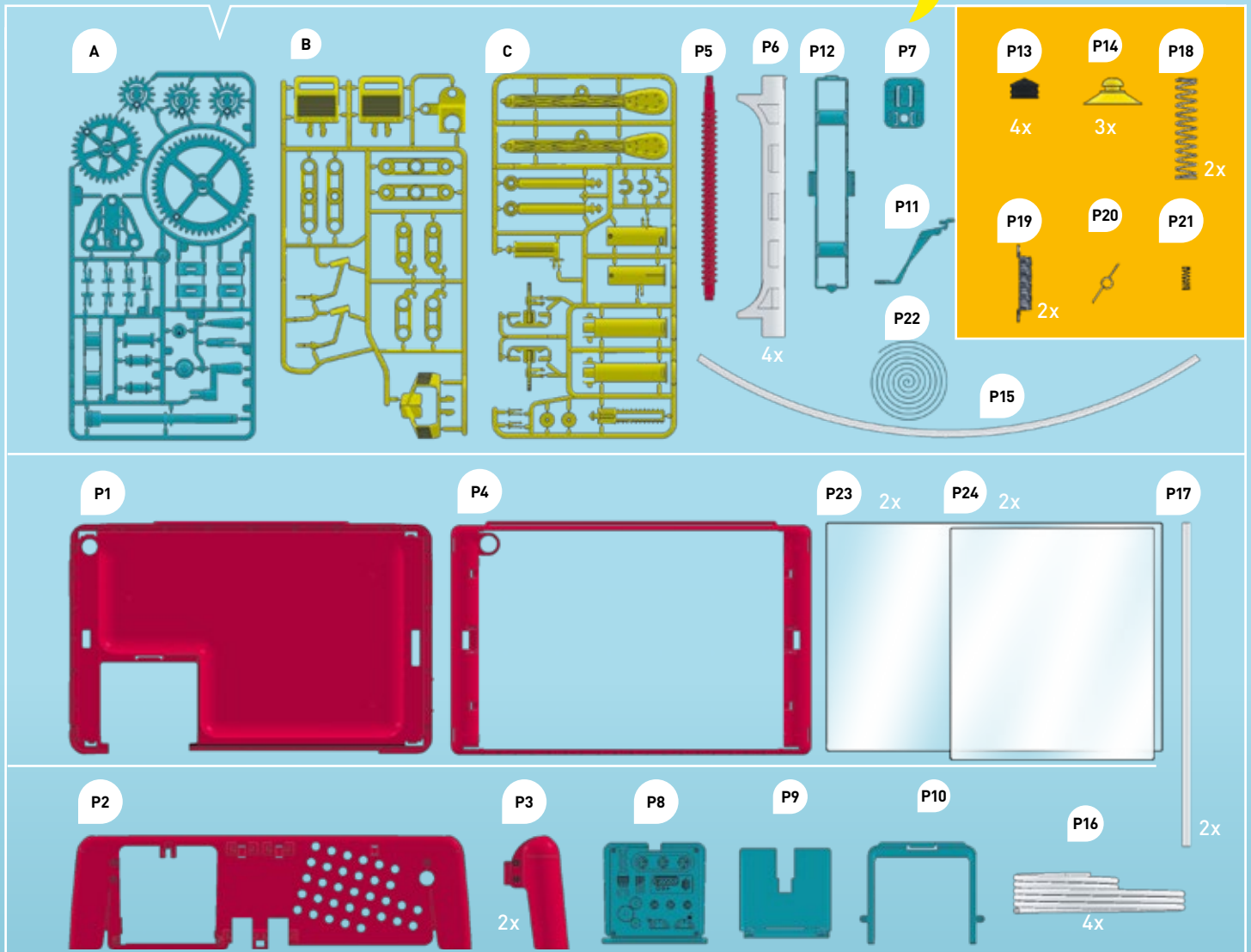


KIT CONTENTS

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.	✓ No.	Description	Qty.
○A	Plastic frame A (Parts A1 –A17)	1	○P14	Suction cup	3
○B	Plastic frame B (Parts B1 –B9)	1	○P15	Flexible drive shaft, 480 mm	1
○C	Plastic frame C (Parts C1 –C13)	1	○P16	Flexible tubing (3x 450 mm, and 1x 240mm)	4
○P1	Base tray	1	○P17	Rail	2
○P2	Base front panel	1	○P18	Large piston spring	2
○P3	Back leg	2	○P19	Arm scissor spring	2
○P4	Top frame	1	○P20	Prize door spring	1
○P5	Worm screw	1	○P21	Prize trigger spring	1
○P6	Column (2 left and 2 right)	4	○P22	Belt	1
○P7	Mounting panel for crank	1	○P23	Large clear plastic panel	2
○P8	Prize door	1	○P24	Small clear plastic panel	2
○P9	Prize ejector tray	1	○P25	Die-cut sheet with 3 prize boxes	1
○P10	Prize chute frame	1	○P26	Sticker sheet	1
○P11	Prize trigger	1	○P27	Lollipops*	6
○P12	Worm screw housing	1			
○P13	Piston seal	4			

*Flavors and colors may vary.

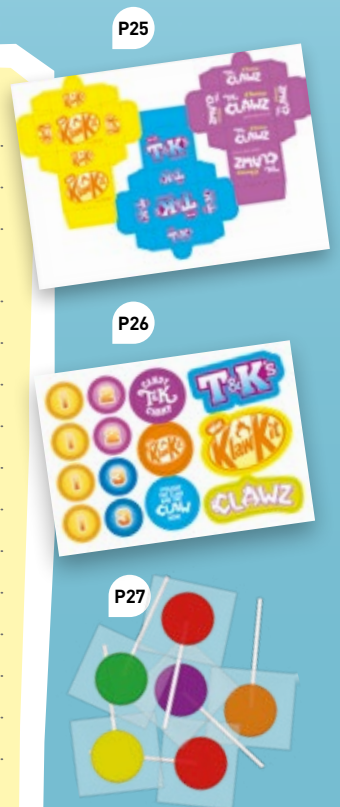


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TIPS

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:

Scissors, diagonal cutters, nail file, basin of water, vegetable oil

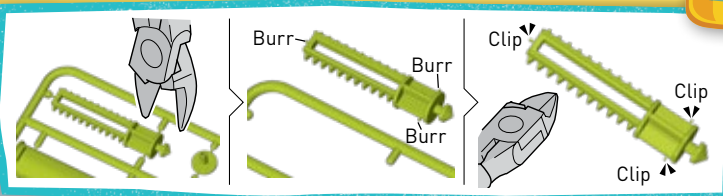
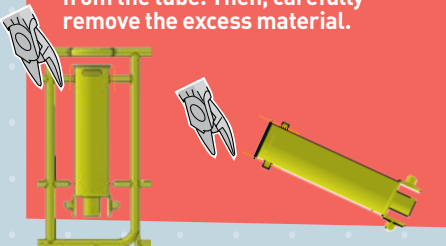
IMPORTANT TIPS

- 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 each piston seal (P13) inside the hydraulic cylinders with oil. See page 5.



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.

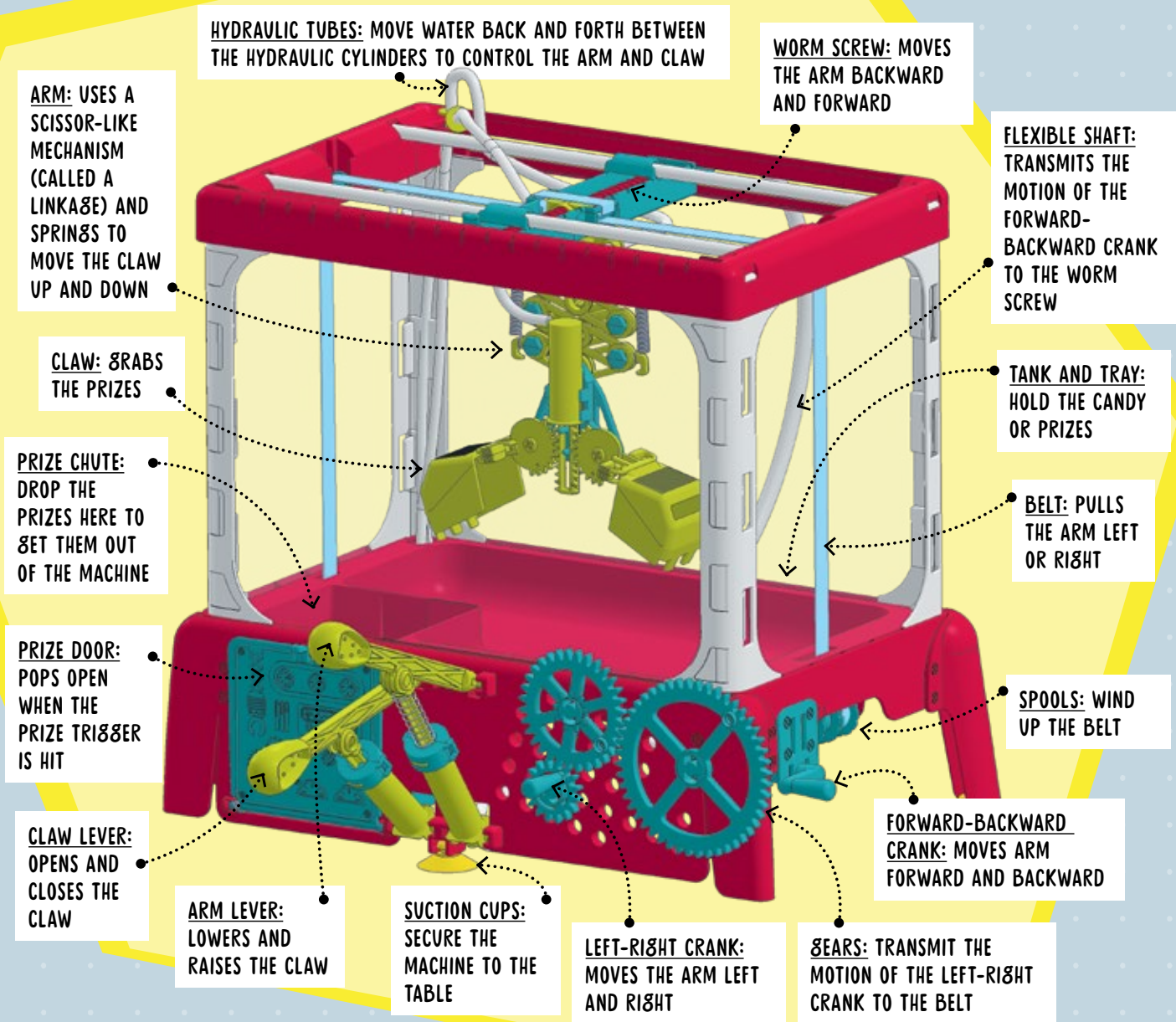


The Amazing Candy Claw Machine

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:



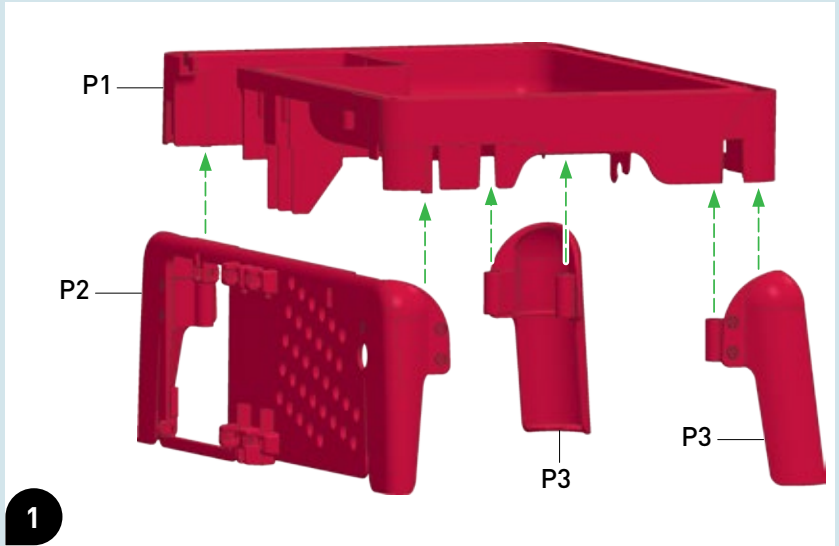


CANDY CLAW MACHINE ASSEMBLY

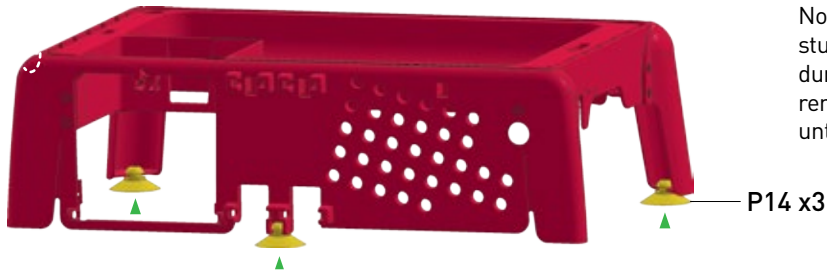


ASSEMBLY VIDEO!

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



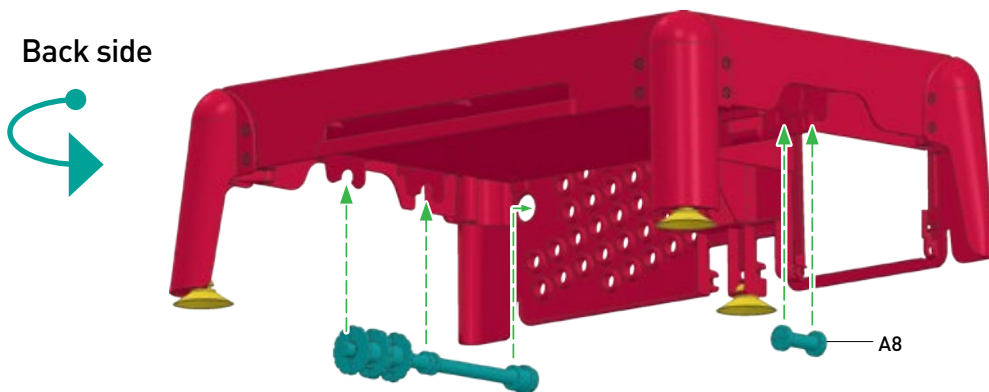
Note: If the suction cups get stuck to your work surface during assembly, you can remove them from the model until the end.

2



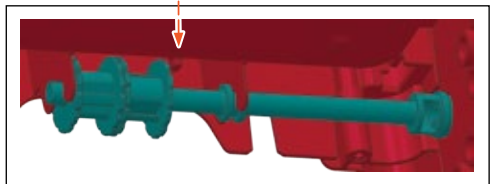
3

Back side

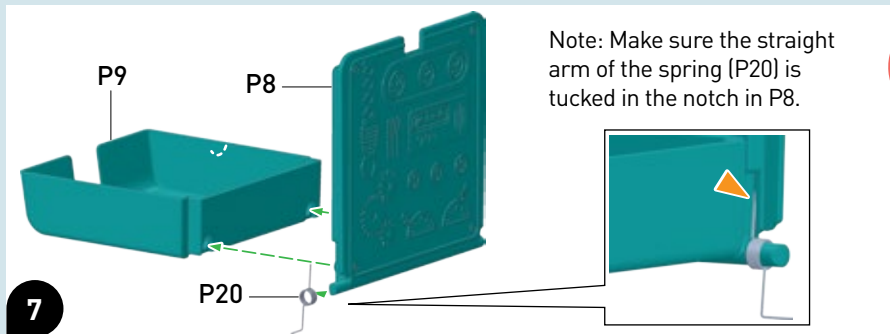
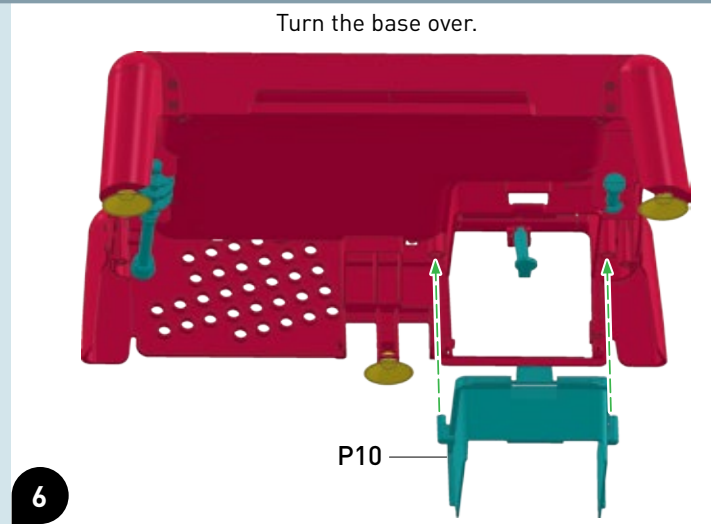
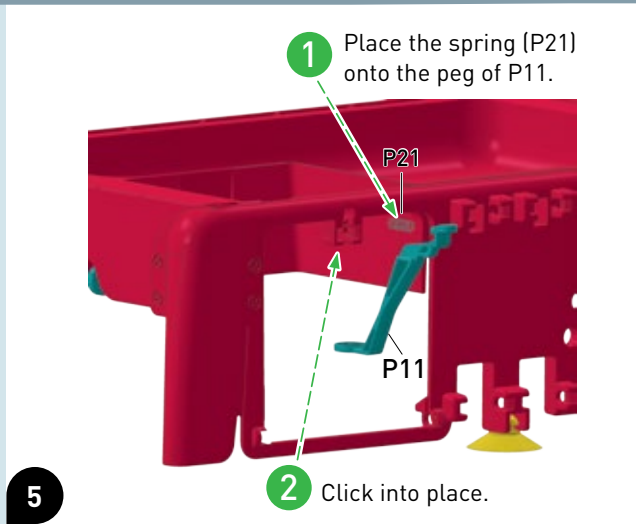


Note: There is a small tab on the bottom of P1. When the spools (A9) are on the left side of the tab, they can not rotate relative to the driveshaft (A1).

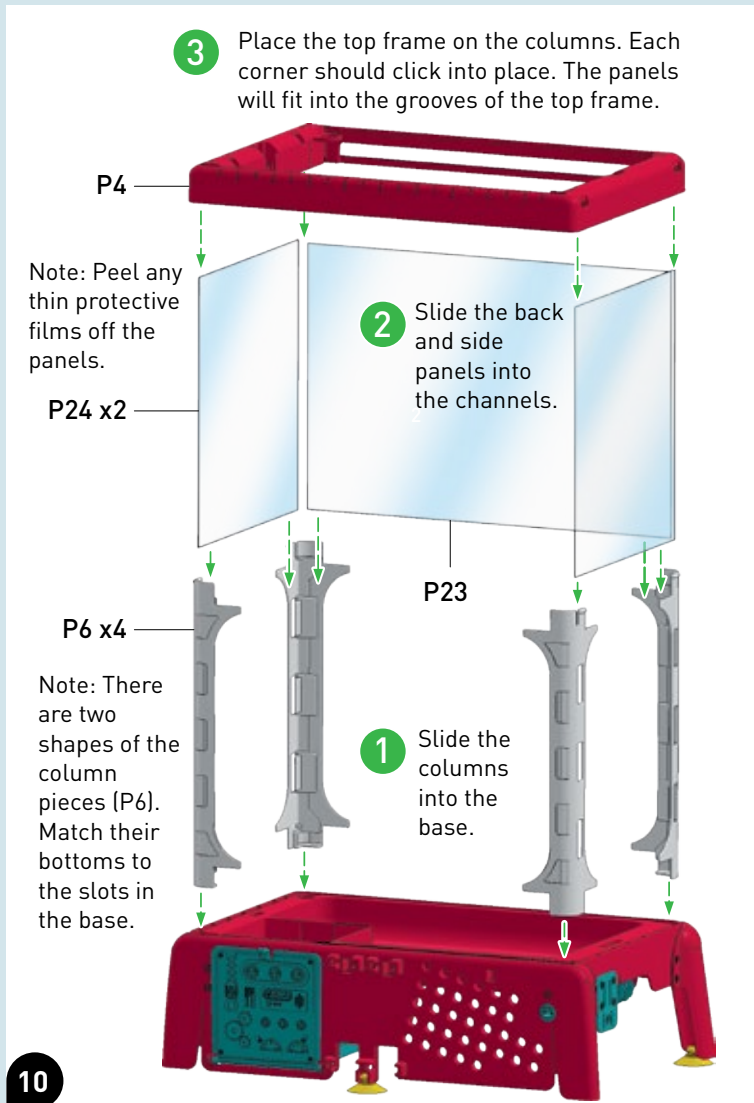
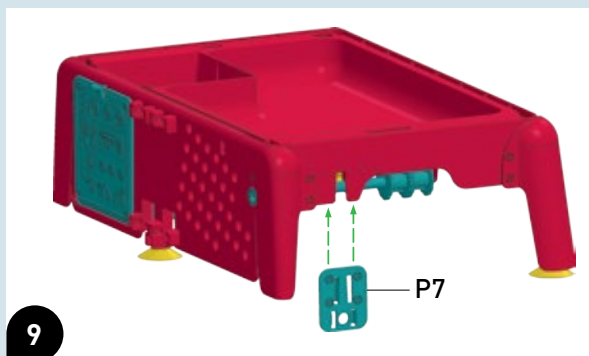
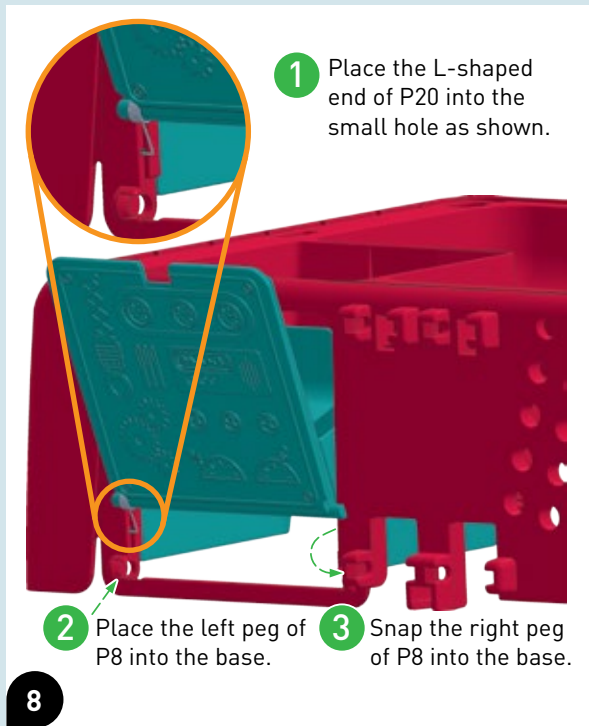
Later, when installing the ribbon (step 43), the spool on the inside moves to the other side of the tab so that it can spin freely without rotating the drive shaft.



4



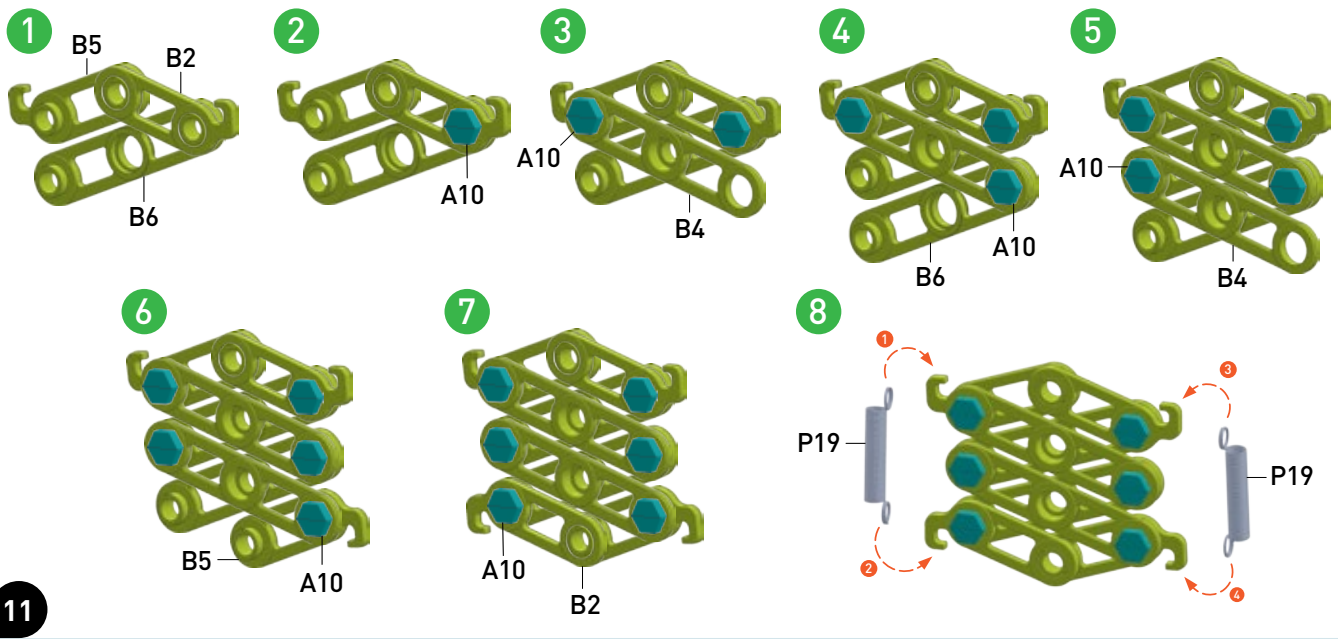
! ALTERNATE ASSEMBLY
See the back cover of this manual for an alternate setup of the prize door.



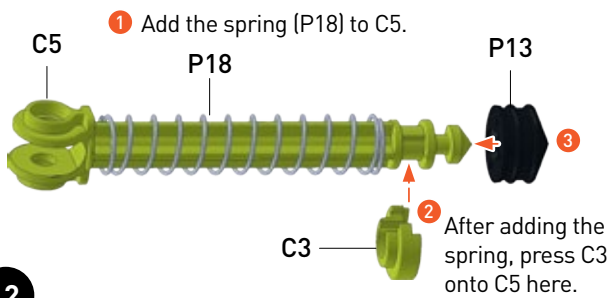


Assemble the scissor arm mechanism. Lay the parts flat on a table. These images show the parts viewed from above.

Note: When inserting A10, pick up the parts with both hands. Make sure the parts are fastened together before moving on to the next step.



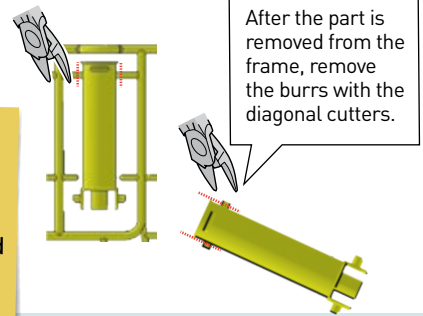
11



12

Carefully remove C8 from the plastic frame and set aside.

CAUTION
The tabs on C8 are thicker and must be cut little by little, and as far away from the part as possible.

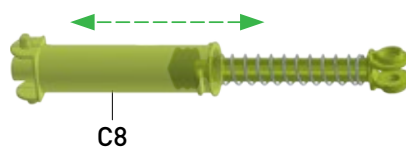


Pour vegetable oil into a small bowl. Then dunk the piston seal (P13) into the oil, making sure to coat it completely.



13

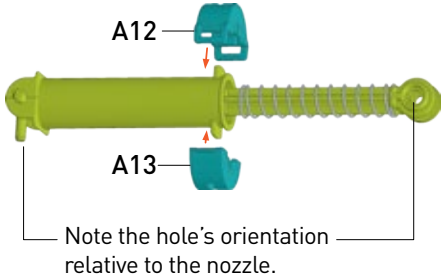
Insert the piston from step 12 into the hydraulic cylinder (C8) and move it back and forth several times to coat the inside of the cylinder with oil. Reapply oil as necessary.



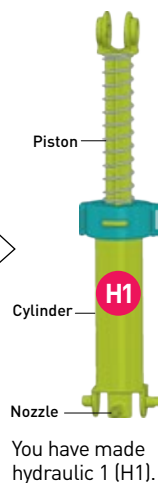
Repeat steps 12 and 13. You will end up with two hydraulic cylinders:



With the first cylinder, make sure the spring (P18) is **completely outside** of the cap (A12 + A13).

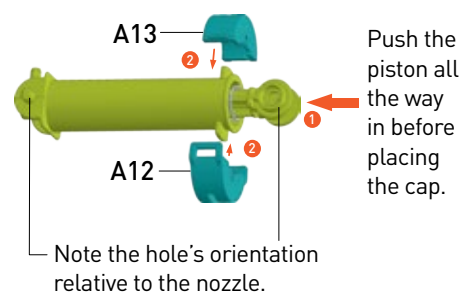


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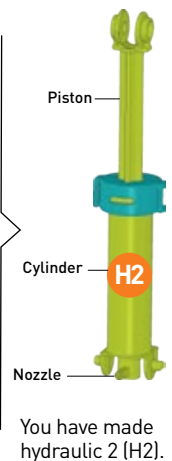


You have made hydraulic 1 (H1).

With the second cylinder, make sure the spring (P18) is **completely inside** of the cap (A12 + A13).



15



You have made hydraulic 2 (H2).

16

Lubricate P13!

Move C6 back and forth several times to coat the inside of the cylinder (C4) with oil. Reapply oil as necessary.

You have made hydraulic 3 (H3).

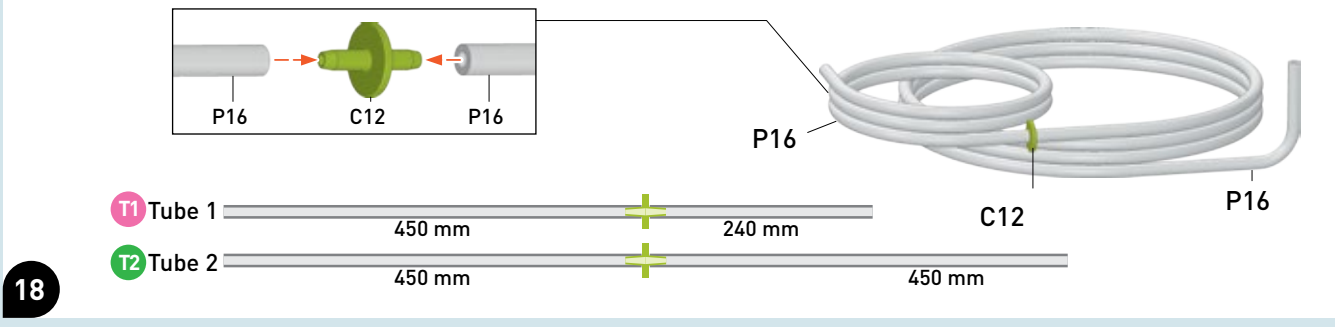
17

Lubricate P13!

Move C11 back and forth several times to coat the inside of the cylinder with oil. Reapply oil as necessary.

You have made hydraulic 4 (H4).

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



19

Connect the long end of tube T1 to the nozzle of H1.

Submerge the loose end of T1 in the basin of water. Orient the nozzle of H1 toward the top, then move the piston up and down until H1 and T1 are filled with water.

! Watch for leaks as you fill the cylinders. Only water should be filling the cylinder. If you see air filling the cylinder, try the following:

- Carefully remove the cap (A12 and A13) and re-oil the piston.
- Check for cracks in the tube (C8).
- Check for tears in the piston seal (P13).

If any part is damaged, contact technical support for a replacement.

Water will remain in the cylinder and tube. Set aside.

20

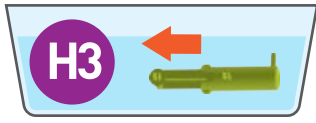
Connect the tube T2 to the nozzle of H2.

Submerge the loose end of T2 in the basin of water. Orient the nozzle of H2 toward the top, then move the piston up and down until the tube and the top of H2 are filled with water.

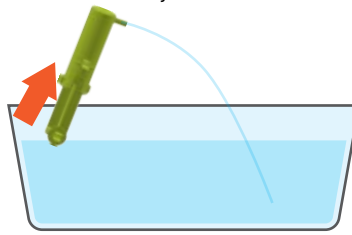
Let the spring draw the piston back into the cylinder. Water will remain in the tube. Set aside.



Submerge cylinder H3 in the basin of water, then pull back the piston.



Aim the nozzle back into basin, then push the piston back into the cylinder.

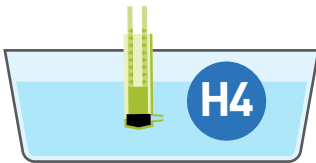


Some water will remain in the top of H3. Set aside.

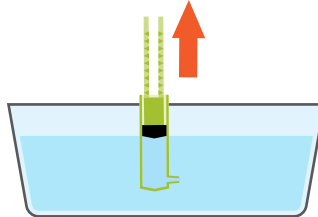


21

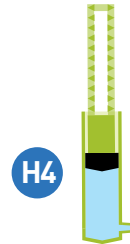
Submerge the nozzle of H4 in the basin of water.



Pull the piston upward to fill the cylinder with water.

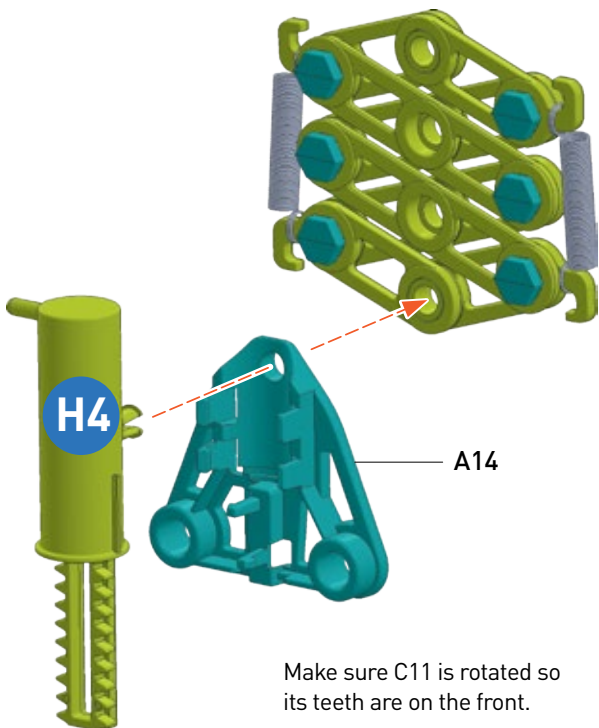


Water will remain in the cylinder. Set aside.



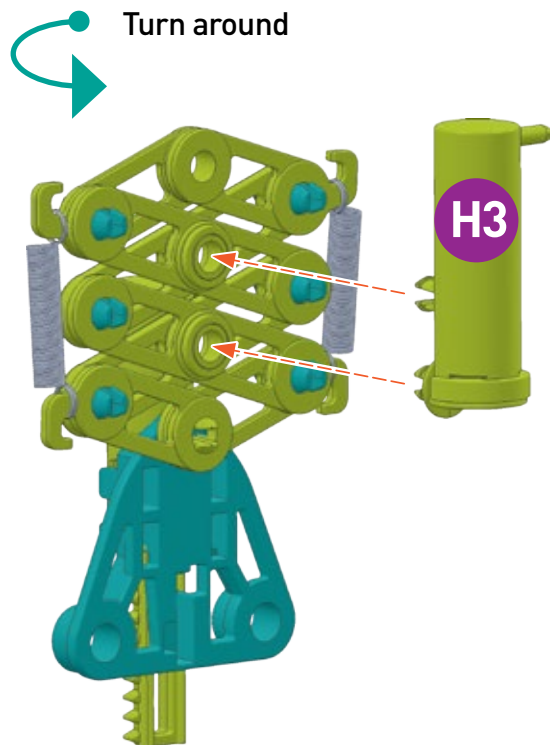
22

! When you are finished filling the hydraulics with water you will have:



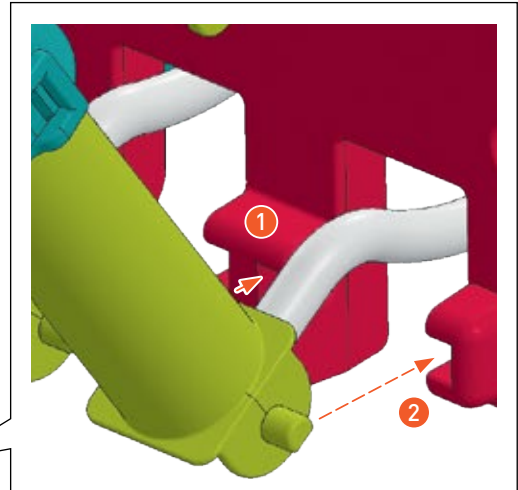
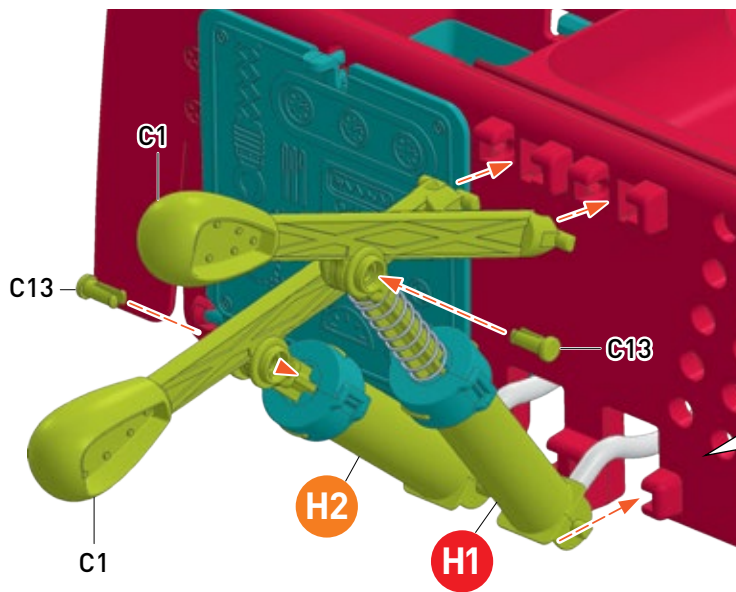
Make sure C11 is rotated so its teeth are on the front.

23



24

Attach the handles (C1) to hydraulic cylinders H1 and H2 using the clips (C13). Then, attach the pegs as show below. H1 is on the right; H2 is on the left.

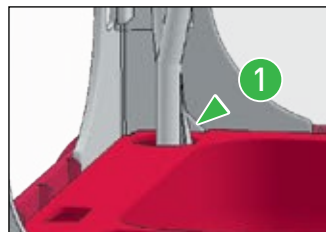
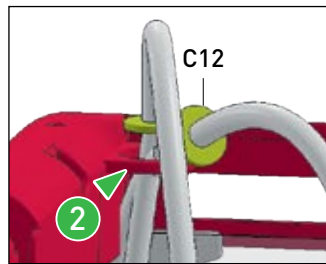


For each cylinder, snap the left peg into the base first. Then snap in the right peg. Guide the tubes back, under the base.

25

Guide the tubes up through the holes in the base (1) and top (2) of the machine.

Once the first tube is already passing through the holes, it is harder to pass the second tube connector (C12) through the holes. You just have to wiggle it and push it through. It will fit.



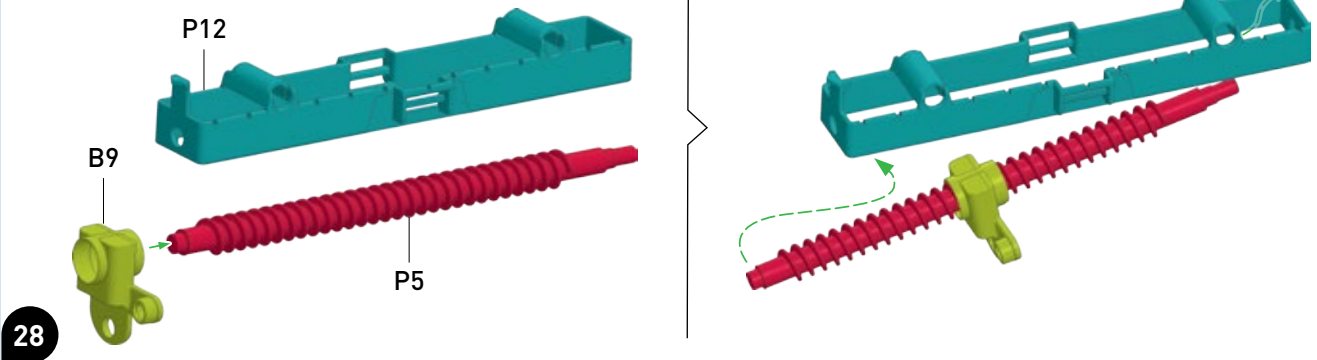
26



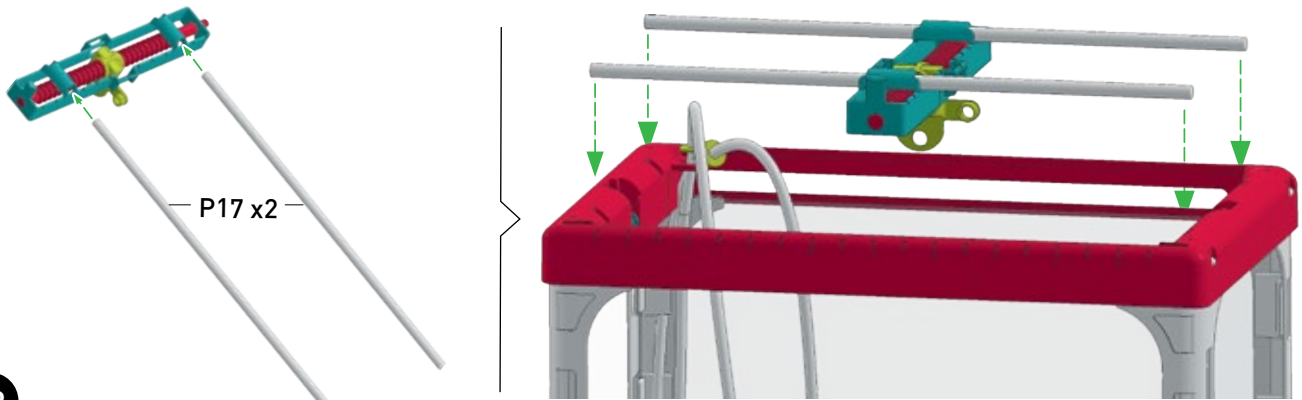
27



Screw B9 onto P5. Then insert P5 into P12 as shown.

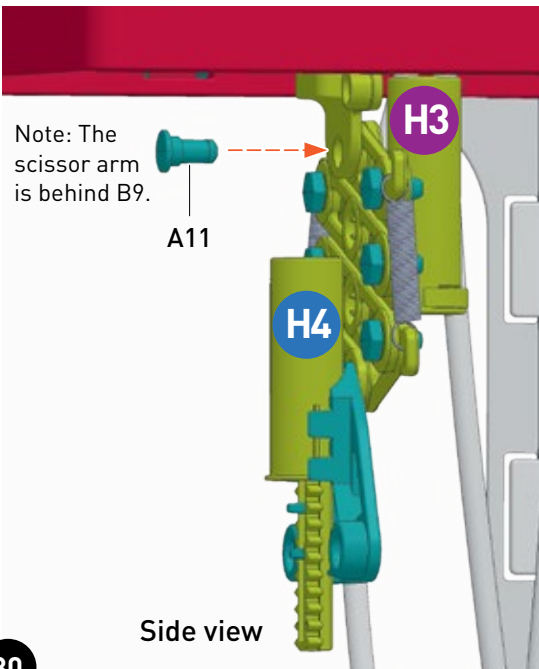


28



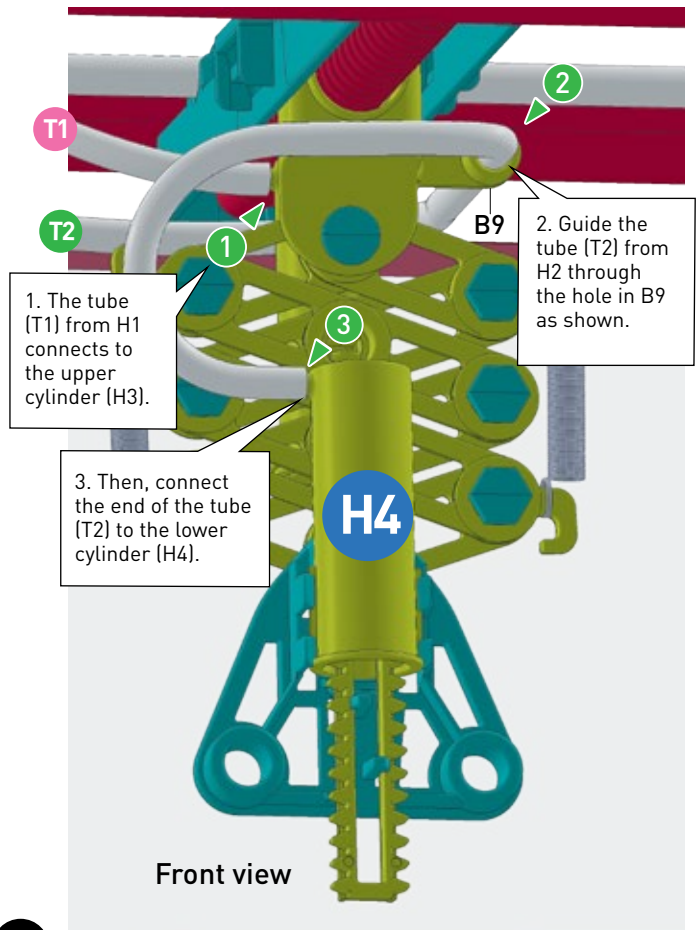
29

Attach the scissor arm mechanism to B9 using A11.



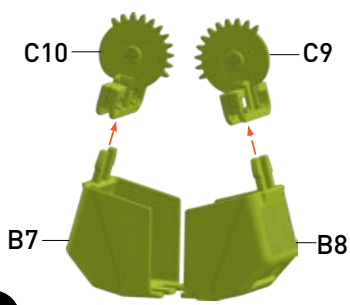
30

Connect the tubes to the hydraulic cylinders as shown.



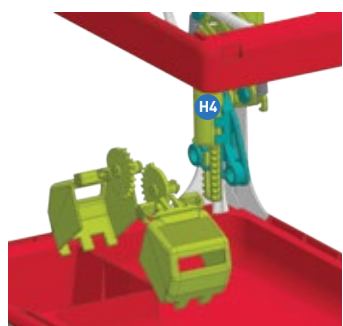
31

! After completing step 31, where you connect T1 to H3 and T2 to H4, test the movement of the claw and scissor arm by moving the handles (C1). Excess water will drip out of the machine; this is normal. If the hydraulics don't work, give them a little push with your hand. If they still don't work, watch the assembly video (see p. 3) and refill the hydraulic system (steps 19–22).



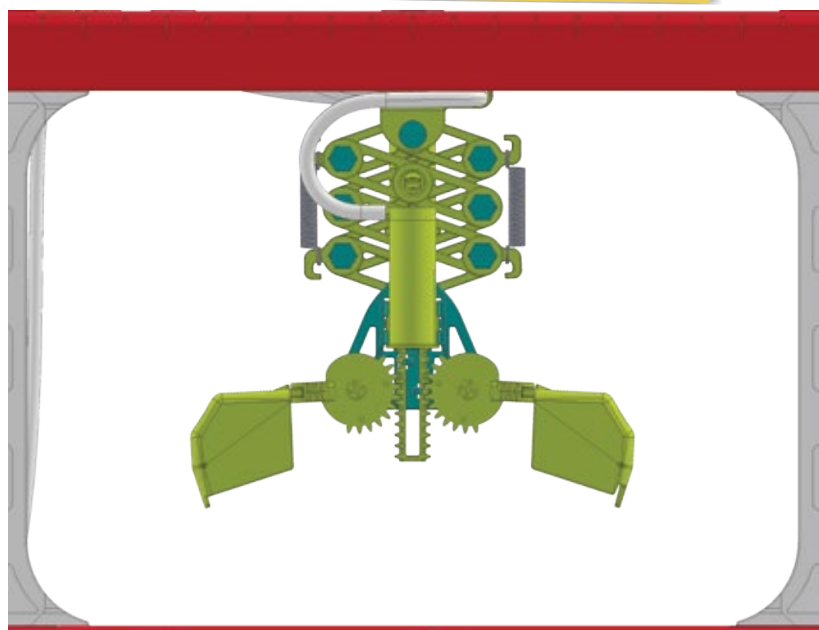
32

Install the claws.

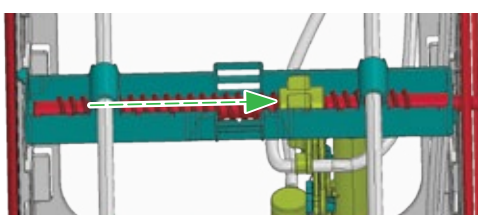


33

! Align the claws exactly as shown.

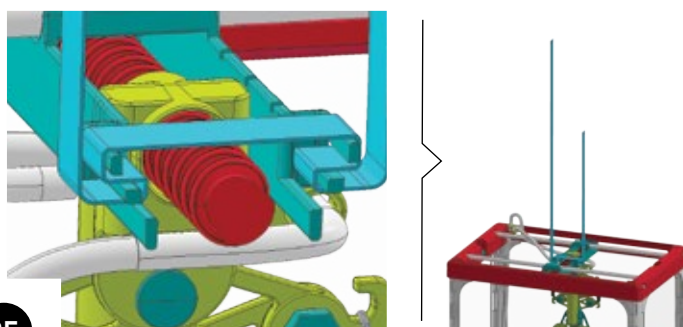


Move the claw assembly out of the way of the slots in P12 by twisting the red worm gear (P5).



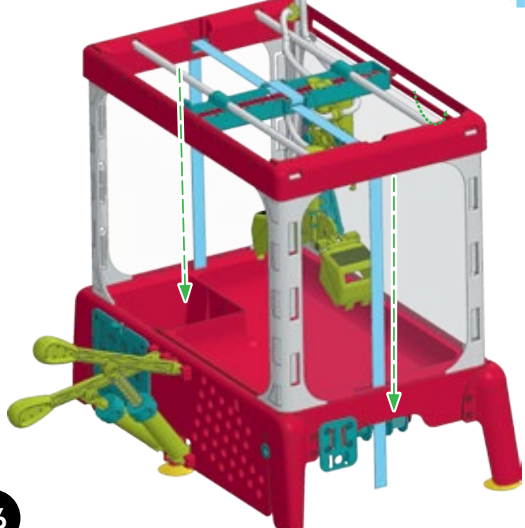
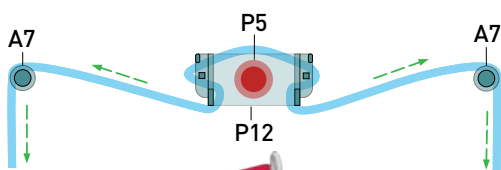
34

Thread the ribbon through the slots of P12 as shown. The ribbon on the left should be about 12 inches longer than the ribbon on the right.



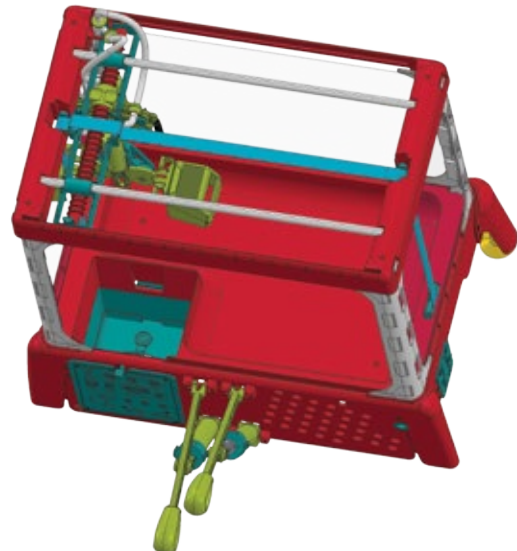
35

Thread the ribbon through the rest of the machine as shown. Make sure the ribbon sits above the rollers (A7).



36

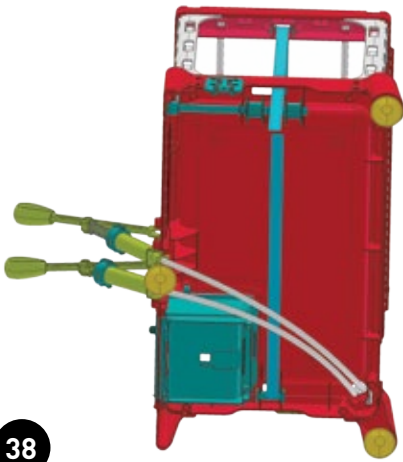
Move the claw assembly to the left of the machine.



37

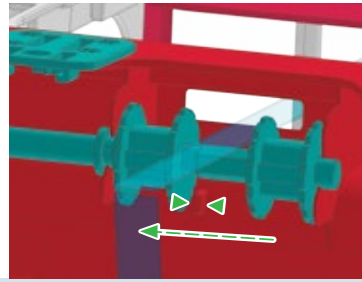


Turn the machine onto its left side so you can see the bottom of the machine.



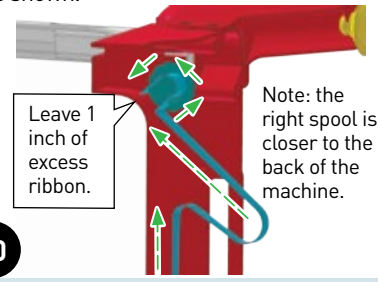
38

Move the left spool (A9) to the left, past the tab on P1. You may need to pull the drive shaft (A1) away from the machine slightly in order to move the spool past the tab.



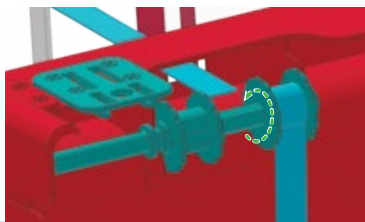
39

Bring the ribbon that is on the bottom of the machine up to the spools, making sure that it is not twisted. Thread it through the two slots of the **right spool** as shown.



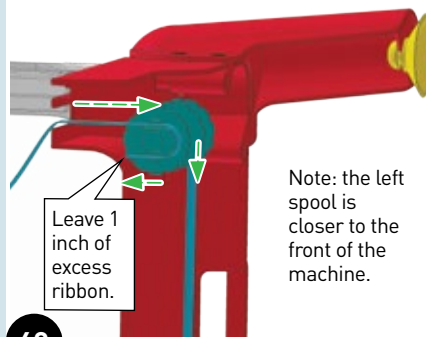
40

Wind the right spool several times, turning the spool counterclockwise (as viewed from the front of the machine). Hold some tension on the ribbon as you do this. The drive shaft (A1) will rotate.



41

Thread the end of the ribbon that is coming from the slot above into the two slots on the **left spool** as shown.



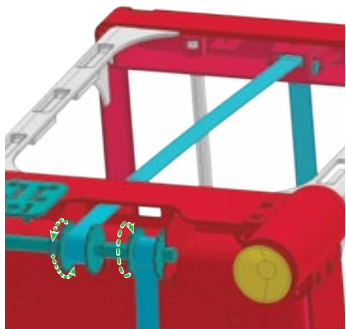
42

Wind the left spool in a clockwise direction (as viewed from the front of the machine) until all of the ribbon slack is taken up. Hold some tension on the ribbon as you do this. The drive shaft (A1) will not rotate.



43

Rotate the two spools in opposite directions so that the ribbon is taut.

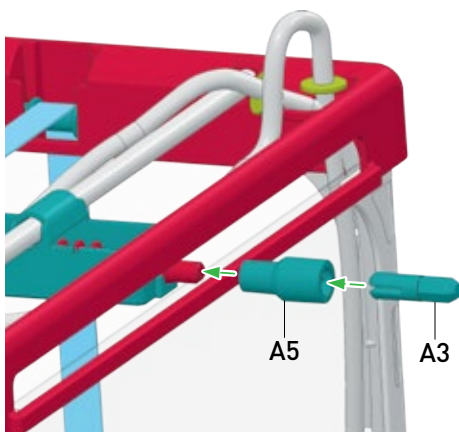


44

Then, slide the left spool to the right past the tab on P1. If you are having trouble pushing the spool past the tab, try pulling it away from the machine slightly as you move it.

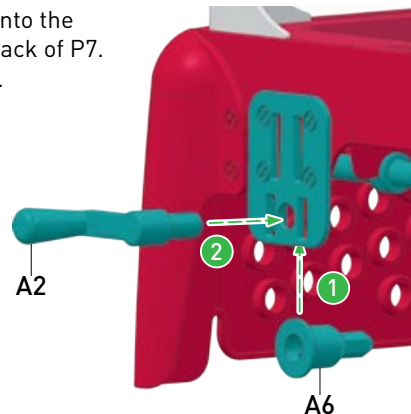


!
After completing step 43, turn the machine upright and test the movement of the claw from side to side by rotating the drive shaft (A1) in both directions. You may need to re-tighten the ribbon (step 43).
If you are having trouble with installing the ribbon, watch the assembly video (see p. 3).



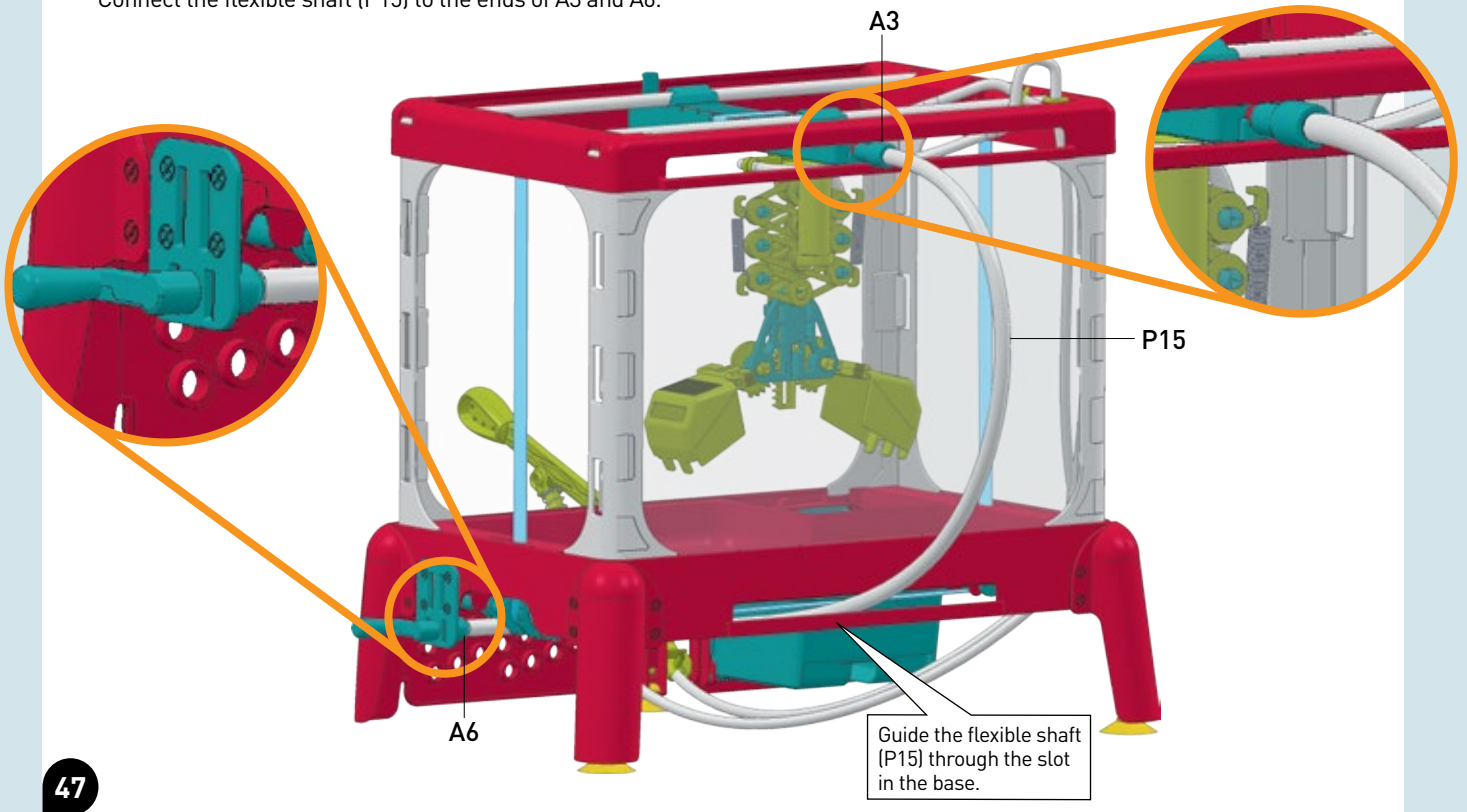
45

1. Slide A6 into the slot in the back of P7.
2. Insert A2.

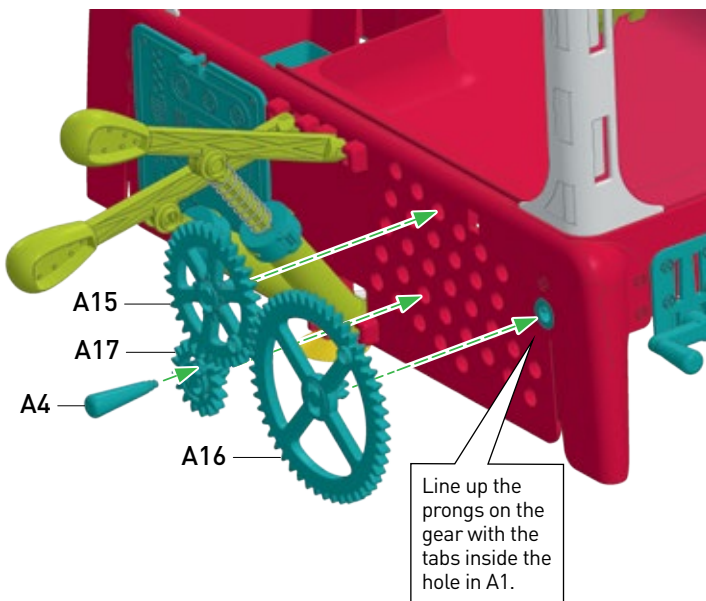


46

Connect the flexible shaft (P15) to the ends of A3 and A6.



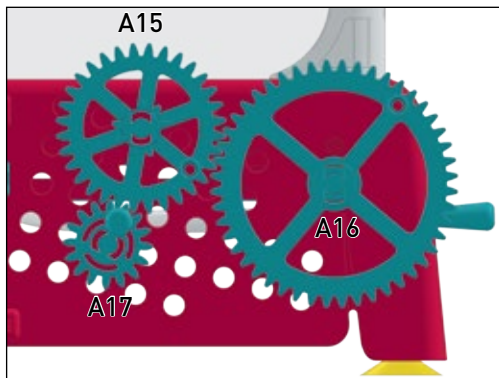
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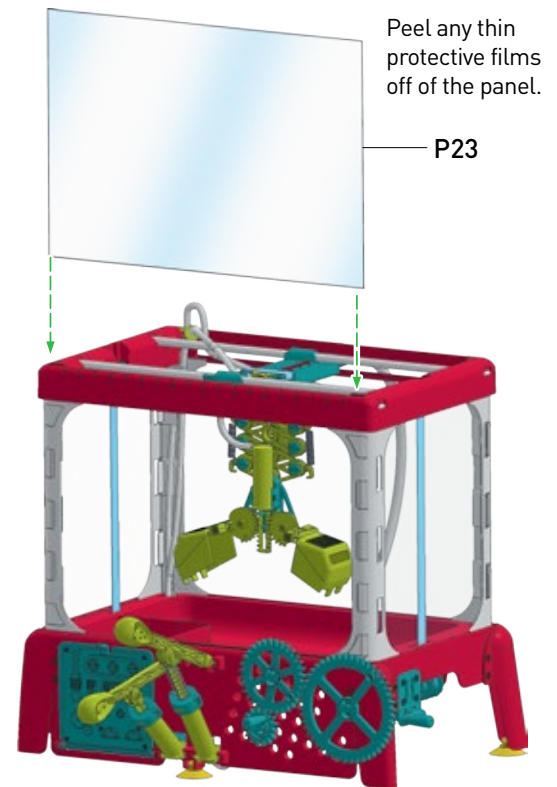
!

You can reconfigure the gears in different ways.

What do you notice when you do this?



48



Wipe up any water that has spilled out of the hydraulic system.

Done!

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, close the claw by pulling up on the claw lever. Make sure you grabbed the prize with the claw. 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 target, release the claw lever.
- 7** When the prize drops, it should hit the bullseye of the prize trigger. This will cause the prize door to pop open and the prize to pop out!

! 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!



A1

B. More direct control

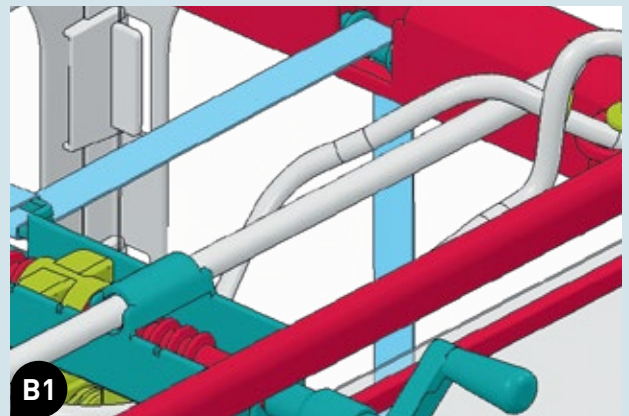
1. Remove the flexible shaft and the small shaft A3.
2. Connect the crank A2 directly to the connector A5. Observe the differences in how the worm screw operates with this configuration.



A2

C. Gears, gears, gears

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



B1

! When you need to refill the hydraulic system with more water, you don't have to take the tubes entirely out of the machine. Just disconnect the tubes at the tube connector, put the ends of the tubes in a cup of water, and pull on the hydraulic pistons to draw more water into the tubes.



C1



C2

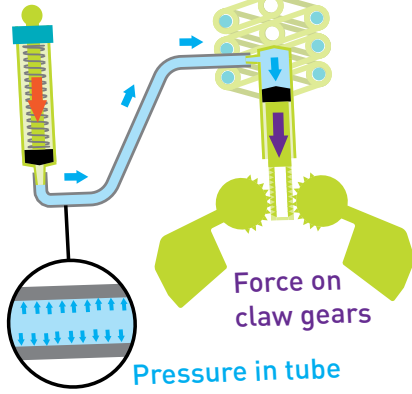


C3

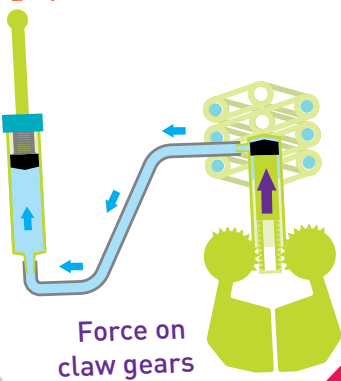


C4

Force of spring



Force from hand



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** inside the cylinders apply forces to the pistons to keep them either pushed in or out. This sets the default state of the claw as open 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.



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.

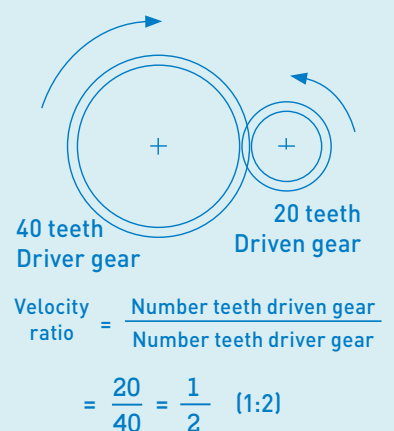
The area defined by all of the positions in space that the end of the robotic arm can reach is known as the **workspace**. If the object that the robotic arm needs to pick up is not in the workspace, the robot cannot pick it up! The workspace depends on the degrees of freedom, limitations of the joints,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



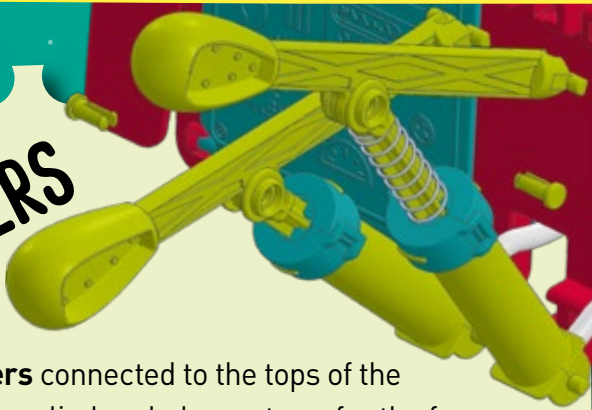
GEARS AND GEAR RATIOS

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



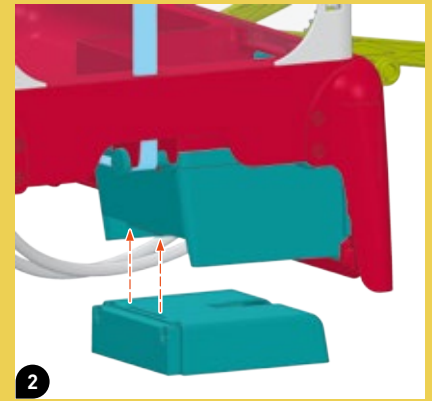
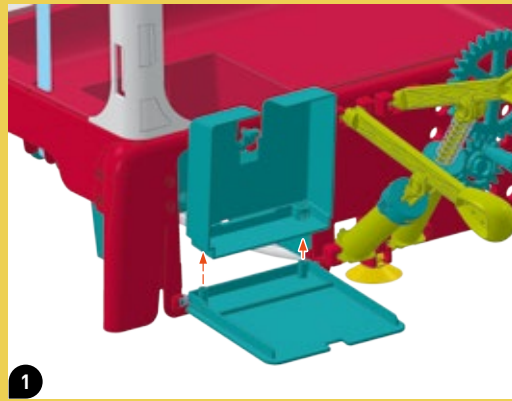
The **levers** connected to the tops of the hydraulic cylinders help you transfer the force from your hand to move the pistons inside the cylinders. Levers are rigid bars that pivot on a point called the **fulcrum**. A **weight (or load)** at one point on the bar can be moved by applying a **force (the 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.



TIP

You might find that some prizes you want to use in the claw machine are too big and get stuck when they should be ejected from the prize chute. In this case, you can easily remove the ejector tray from the prize door and install it in a fixed position at the bottom of the prize chute. In this setup, the prize door simply pops open and you can reach in to get your prize.



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