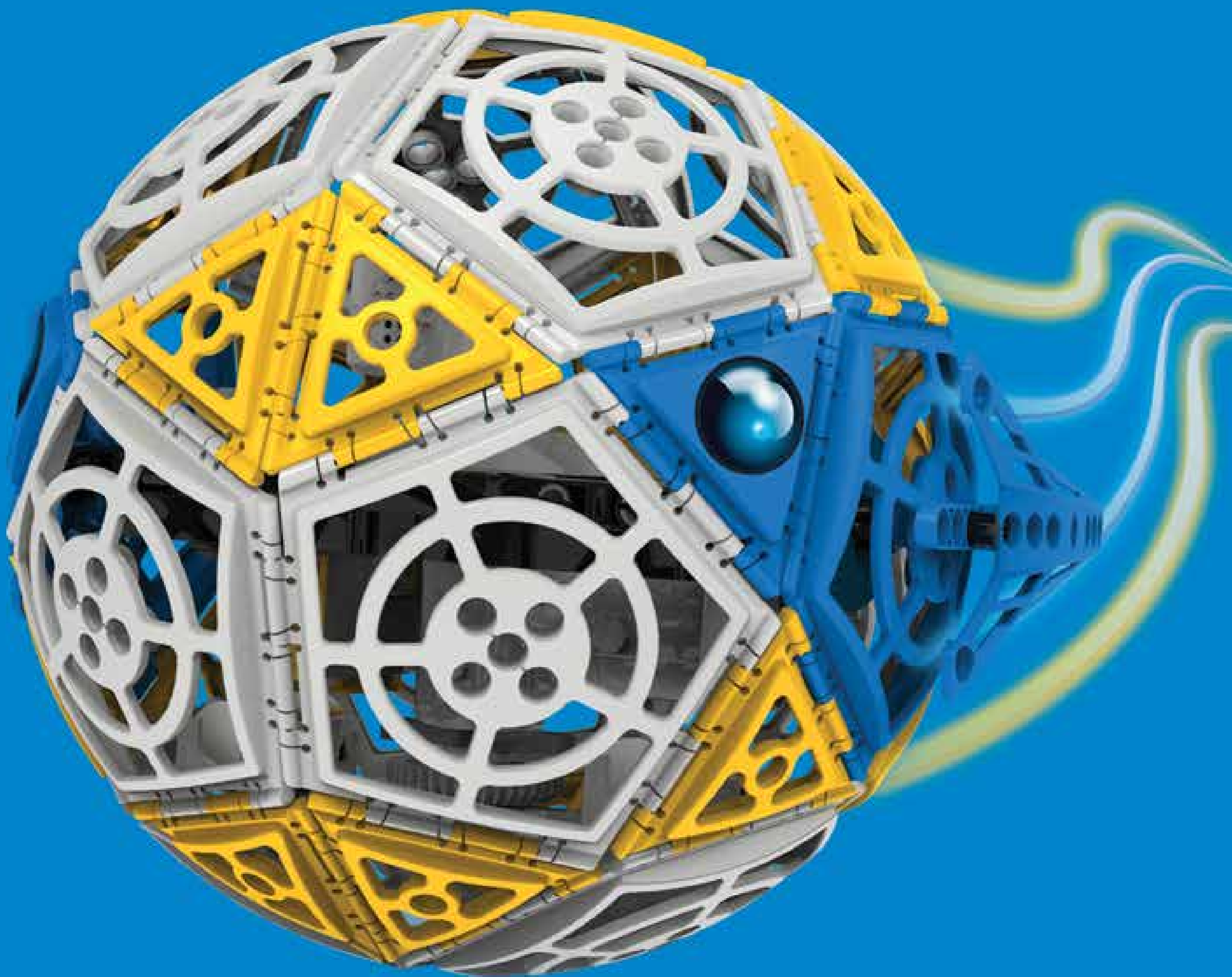
EXPERIMENT MANUAL

ROBOTICS
SMART MACHINES
SUPER SPHERE



THAMES & KOSMOS

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Safety Information

WARNING. Only for use by children aged 8 years and older, due to accessible electronic components. Instructions for parents or other supervising adults are included and have to be observed. Keep packaging and instructions as they contain important information.

WARNING. Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled.
Store the experiment material and assembled models out of the reach of small children.

Safety for Experiments with Batteries

››› To operate the models, you will need 3 AA batteries (1.5-volt, type AA/LR6) or 3 AA rechargeable batteries (1.2-volt, type AA, HR6/KR6), which could not be included in the kit due to their limited shelf life.

››› The supply terminals are not to be short-circuited. A short circuit can cause the wires to overheat and the batteries to explode.

››› Different types of batteries or new and used batteries are not to be mixed.

››› Do not mix old and new batteries.

››› Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.

››› Batteries are to be inserted with the correct polarity. Press them gently into the battery compartment. See page 2.

››› Always close battery compartments with the lid.

››› Non-rechargeable batteries are not to be recharged. They could explode!

››› Rechargeable batteries are only to be charged under adult supervision.

››› Rechargeable batteries are to be removed from the toy before being charged.

››› Exhausted batteries are to be removed from the toy.

››› Dispose of used batteries in accordance with environmental provisions, not in the household trash.

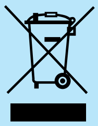
››› Be sure not to bring batteries into contact with coins, keys, or other metal objects.

››› Avoid deforming the batteries.

As all of the experiments use batteries, have an adult check the experiments or models before use to make sure they are assembled properly. Always operate the motorized models under adult supervision.
After you are done experimenting, remove the batteries from the battery compartments. Note the safety information accompanying the individual experiments or models!

Notes on Disposal of Electrical and Electronic Components

The electronic components of this product are recyclable. For the sake of the environment, do not throw them into the household trash at the end of their lifespan. They must be delivered to a collection location for electronic waste, as indicated by the following symbol:



Please contact your local authorities for the appropriate disposal location.

Dear Parents,

Before starting the experiments, read through the instruction manual together with your child and discuss the safety information. Check to make sure the models have been assembled correctly, and assist your child with the experiments. **We hope you and your child have lots of fun!**

FCC Part 15 Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Warning: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC RF Exposure Statement

To comply with the FCC RF exposure compliance requirements, this device and its antenna must not be co-located or operating in conjunction with any other antenna or transmitter.

For body worn operation, this device has been tested and meets FCC RF exposure guidelines when used with an accessory that contains no metal and that positions the device a minimum of 5 mm from the body. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

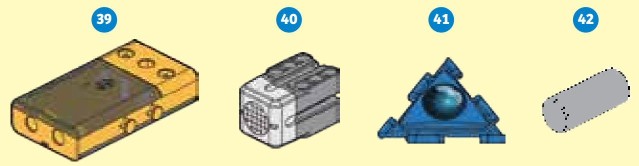
Simplified EU Declaration of Conformity
Thames & Kosmos hereby declares that the radio communication unit "Robotics Smart Machines" Bluetooth battery box module, model number 7452-W85-A-US, conforms to Directive 2014/53/EU. The complete text of the EU conformity declaration is available at the following Internet address: http://thamesandkosmos.com/rsmsupersphere/declaration.pdf

CAN ICES-3 (B)/NMB-3(B)

››› KIT CONTENTS

What's inside your experiment kit:

GOOD TO KNOW! If you are missing any parts, please contact Thames & Kosmos customer service.
US: techsupport@thamesandkosmos.com
UK: techsupport@thamesandkosmos.co.uk



You will also need:

• 3 AA batteries (1.5-volt, type AA/LR6) or 3 AA rechargeable batteries (1.2-volt, type AA, HR6/KR6) and a tablet or smartphone running iOS or Android (see page 7 for app information)

Checklist: Find – Inspect – Check off

✔	No.	Description	Qty.	Item No.
❍	1	11-hole rod, gray	3	7413-W10-P1SK
❍	2	9-hole cross rod, black	4	7407-W10-C2D
❍	3	9-hole rod, black	2	7407-W10-C1D
❍	4	7-hole wide rounded rod, black	6	7404-W10-C2D
❍	5	5-hole flat rounded rod, gray	2	7443-W10-C1S
❍	6	5-hole flat rounded rod for axle	2	7443-W10-C2B
❍	7	5-hole rod, gray	4	7413-W10-K2SK
❍	8	5-hole dual rod, black	4	7413-W10-W1D
❍	9	5-hole dual rod, gray	4	7413-W10-X1SK
❍	10	3-hole dual rod, black	3	7413-W10-Y1D
❍	11	3-hole cross rod, gray	8	7026-W10-X1S3
❍	12	3-hole wide rounded rod, black	6	7404-W10-C1D
❍	13	Curved rod, orange	4	7061-W10-V1O
❍	14	3-hole dual rounded rod with pegs	1	7404-W10-B1B
❍	15	Rod connector, orange	2	7026-W10-L2O
❍	16	Medium gear for axle, blue	1	7408-W10-D1B
❍	17	Medium gear with hole, gray	5	7408-W10-D2S
❍	18	Small gear, gray	6	7026-W10-D2S
❍	19	30-mm axle, black	6	7413-W10-N1D
❍	20	35-mm axle, gray	1	7413-W10-O1SK
❍	21	35-mm axle, black	2	7413-W10-O1D

✔	No.	Description	Qty.	Item No.
❍	22	60-mm axle, black	2	7413-W10-M1D
❍	23	70-mm axle, black	2	7061-W10-Q1D
❍	24	150-mm axle, black	1	7026-W10-P1D
❍	25	Short anchor pin, black	20	7344-W10-C2D
❍	26	Long anchor pin, gray	10	7061-W10-C1S
❍	27	Connector pin, pink	11	1187-W10-E1K
❍	28	Joint pin, blue	10	7413-W10-T1B
❍	29	Long joint pin, gray	4	7413-W10-U1S
❍	30	Shaft plug, orange	1	7026-W10-H1O
❍	31	Washer	2	R12#3620
❍	32	Large body plate, blue	2	7446-W10-A1B
❍	33	Motor and gearbox	2	7447-W85-C1
❍	34	Anchor pin lever	1	7061-W10-B1Y
❍	35	Triangular shell piece, yellow	18	7452-W10-A1Y
❍	36	Pentagonal shell piece, gray	10	7452-W10-B1SK
❍	37	Pentagonal shell piece, blue	2	7452-W10-B1B
❍	38	Weight housing, gray	2	7452-W10-C1SK
❍	39	Bluetooth battery box module	1	7452-W85-A-US
❍	40	Sound sensor	1	7452-W85-B
❍	41	Triangular shell piece, blue with eye	2	7452-W22-1
❍	42	Metal weight	2	M10#7452

››› TIPS AND TRICKS

Read these tips for assembling and using the models before starting.

A. Connecting the shell pieces

The spherical shell of the Super Sphere is made of 32 interlocking triangular and pentagonal pieces. They connect at their edges, forming flexible joints. Each joint has a bump and a groove. Slide the bump into the groove to snap the pieces together. The shell pieces are very strong when assembled correctly. However, if you push on it in the wrong way, it might come apart. When putting it together, hold both sides and use your fingers to connect the joints one at a time.

B. The anchor pin lever

This kit includes a little yellow tool called the anchor pin lever. End A of the anchor pin lever makes it easy to remove anchor pins from the frames. You can use the wide end to separate other parts, like the shell pieces.

C. Anchor pins and other connectors

Take a careful look at the different assembly components. Anchor pins, joint pins, and shaft plugs may all look pretty similar at first glance. When you assemble the models, it's important to use the right connectors. The black anchor pins are shorter than the gray ones.

D. Axles

The building system contains axles (also called shafts) of various lengths. When assembling the model, always be sure that you're using the right one.

E. Connecting rods

Use the anchor pins to connect frames and rods. Pay close attention to the instructions showing exactly which holes should be used in a particular step. The red and blue lines in the assembly diagrams show which holes to use.

F. Gear wheels

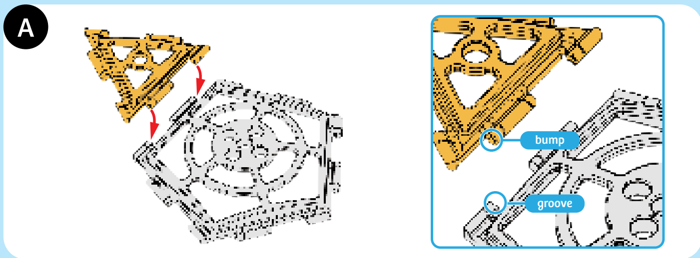
The models will often have multiple gear wheels installed in a row. In order for the models to work well, these gears will have to mesh well. Otherwise, the force from one gear wheel won't be properly transferred to the next.

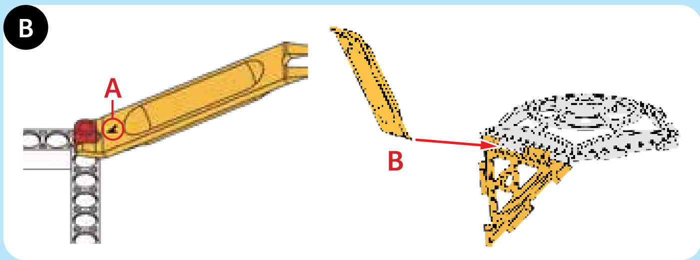
G. Inserting and replacing the batteries

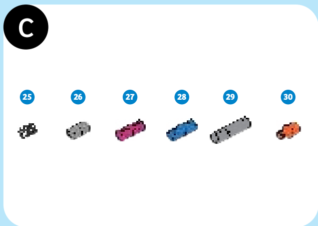
Before building any models, insert the batteries into the battery compartment in the Bluetooth battery box. Slide the transparent cover open. Insert (or replace) the batteries according to the indicated plus-minus polarity markings. Close the compartment by sliding the cover back on.

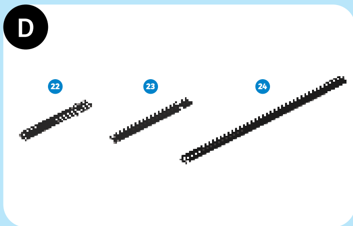
H. Inserting the motor wires into the Bluetooth battery box

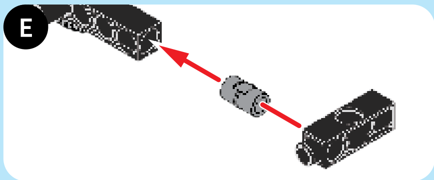
The plugs on the motor wires are reversible. By flipping them 180 degrees, you will change the direction the motor turns. In order for the models to move in sync with the remote controls in the app, you must insert the plugs correctly. Follow the specific plug orientations in the assembly steps for each model. Note the small indented line on one side of the plug to help you insert the motors correctly.

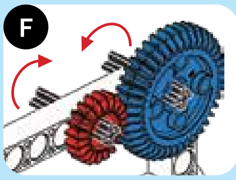


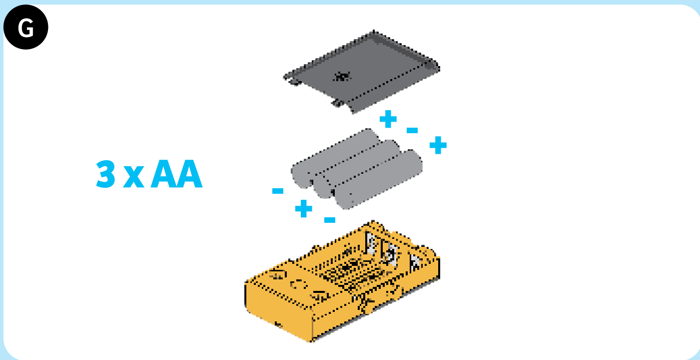


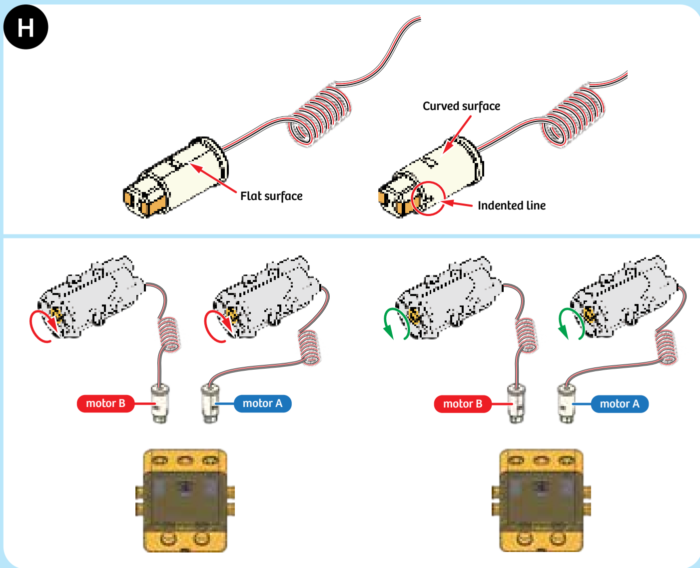












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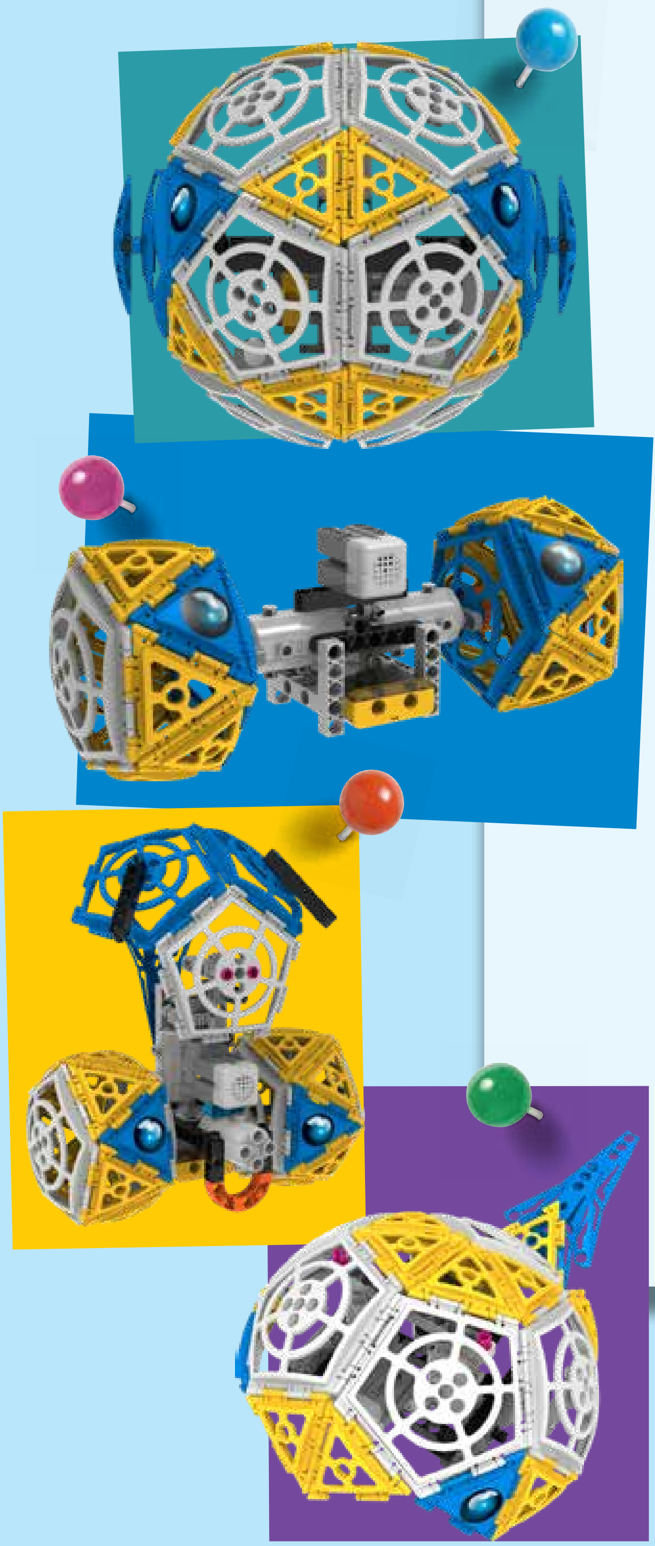
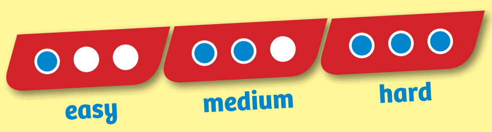


TIP!

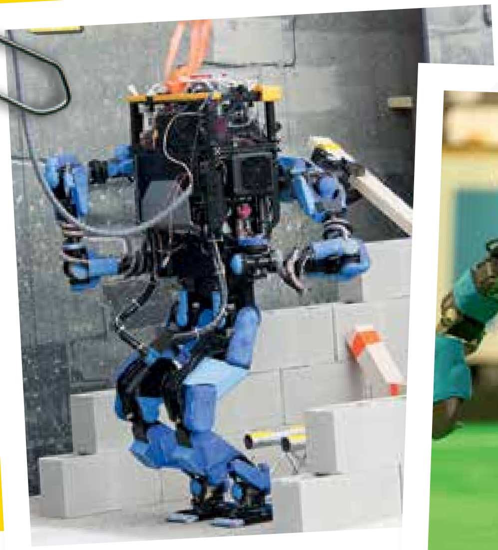
Above each set of assembly instructions, you will find a red bar:

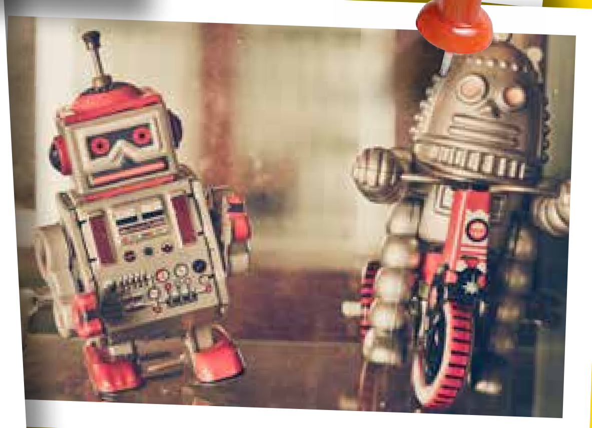
››› It shows you the difficulty level for the model's assembly:



Robots on the Move!

Robots are mechanical agents controlled by computer programs. They can be programmed to perform all sorts of tasks and movements. Robots can assemble cars, play soccer, vacuum floors, deliver packages, map terrain, climb mountains, entertain people, cook dinner — the list goes on and on. With this kit, you can build robots that move in fascinating ways, including a spherical robot that can roll in any direction. The kit also includes a sound sensor so you can program your robots to react to sounds. With the app, you can program the robots' motors to behave in different ways depending on the data coming from the sound sensor.





GETTING STARTED

There are four primary types of functional components in this kit that enable the robots to work:

A. The Bluetooth battery box connects to the app on your tablet or smartphone via a wireless Bluetooth connection. It provides power to the motors and receives input from the sound sensor via wires.

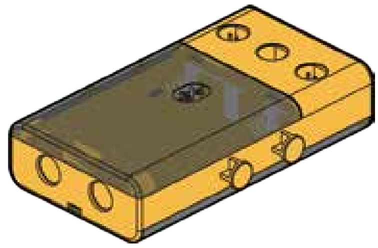
B. The motor units connect to axles and motor shafts to turn gears and wheels, activating your models. They are powered by the battery box.

C. The sound sensor — like an ear — has a membrane inside it that allows it to convert vibrations in the air (sound) into electrical signals. Specifically, it is an omni-directional electret condenser microphone. It is calibrated to receive a specific intensity (loudness) of sound. When it detects sound in this range (hands clapping), it triggers the programmed action.

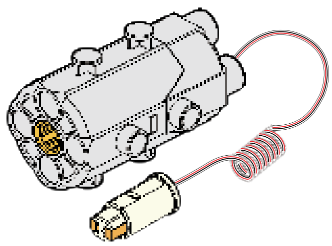
D. The app is the "brain" of your robotic models. It uses the input from the sound sensor and the program instructions to control the models.

These four elements, in combination with all the mechanical parts — rods, gears, axles, shell pieces, and so on — allow you to build and program mechanical robots that can perform different actions based on the number of high-decibel (loud) sounds that the sound sensor detects when a program is running.

A



B



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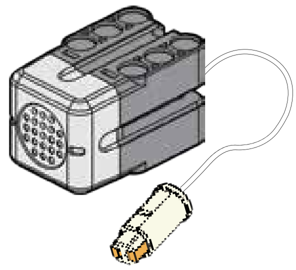


D

Super Sphere

Getting started with the Super Sphere:

We suggest you read and follow the instructions in this manual **in order.** But here is an overview of the instructions for building and using the Super Sphere to get you oriented:

1. **Download the app** following the instructions on page 7.
2. Follow the assembly instructions on page 14 to **build the first model, the Super Sphere.** Make sure you have inserted the batteries into the Bluetooth battery box correctly according to the instructions on page 2.
3. Shake the model until the blue light on the Bluetooth battery box turns on, indicating that the module is on. The module automatically turns off after about a minute of inactivity to save battery power. You simply have to jiggle the model when you want to turn it on again. It's a **movement-activated on-off switch!**
4. Now you can **connect** the tablet or smartphone to the model via the free app. Follow the instructions at the bottom of page 7.
5. To drive the Super Sphere in **remote control** mode, follow the instructions on page 8 and the **driving tips** on pages 22–23.
6. To run a **program** on the Super Sphere, follow the instructions on page 24. For detailed explanations of how the **programming mode** of the app works, refer to pages 9–13. Try editing the program for Super Sphere, or writing your own from scratch.
7. Now, proceed with building the **other models,** one at a time, and running the **sample programs** given on the programming page found after the assembly instructions for each model.

ABOUT SOUND

Sound is a form of energy that moves as a pressure wave through substances (gases, liquids, and solids). Typically, humans can hear and feel many sounds. Sounds are caused by **vibrations,** which are back-and-forth movements of particles. Humans can sense sound when these vibrating particles make contact with their eardrums, which send signals to their brains.

Many sounds vibrate at a **frequency** that the normal human ear can detect. Frequency is simply the number of waves in a given period of time. Typically, humans can hear sound waves in the frequency range of 20 hertz (which means cycles per second) to 20,000 hertz (20 kilohertz).

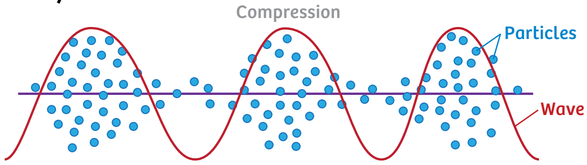
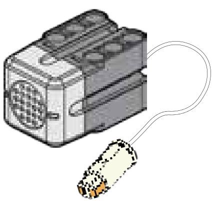


Illustration of a sound wave

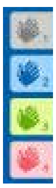
ABOUT THE SOUND SENSOR

Sound sensors work somewhat like a human ear. A sound sensor has a thin flexible membrane inside it called a **diaphragm.** The diaphragm vibrates when sound waves hit it. This vibrating motion of the diaphragm is converted into electrical signals, which are sent to a microprocessor for processing. A sound sensor is like a simple microphone.

The sound sensor in this kit is designed to sense the **intensity** of sound. The intensity of sound relates directly to loudness, and is a measure of the amount of energy in the sound wave. The programming app used with the robots in this kit receives the signals from the sound sensor and recognizes and counts brief sounds that are much louder than the ambient sound. The sound of your hands clapping once is a perfect example of a loud sound detected by this app. In other words, the app listens for the number of loud sounds — like claps — that the sound sensor senses. The app allows you to program different **sequences** of commands to run, depending on the number of claps the sound sensor detects. With this, you can program your robots to perform different actions depending on how many claps (one to four) it detects.



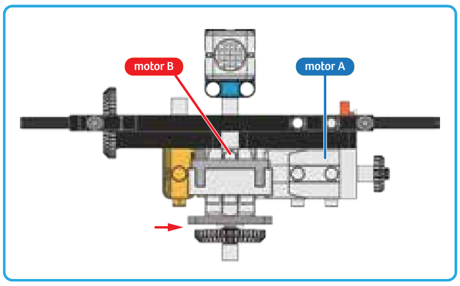
The sound sensor detects the number of claps.



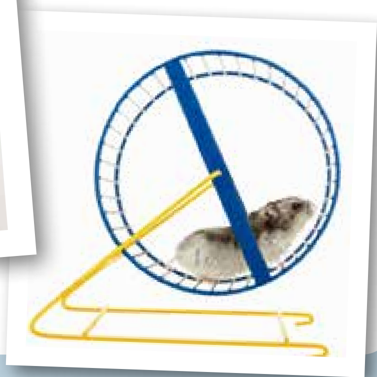
The app runs different parts of the program depending on how many claps it detects.

ABOUT THE SUPER SPHERE'S MOVEMENT

The primary robot model in this kit, the Super Sphere, moves in a very unique and interesting way. The Super Sphere has **two motors** (called motor A and motor B) mounted inside of it on a mechanical structure. The motors are connected to the **Bluetooth battery box,** which turns them on and off based on instructions coming from the app. Motor A is mounted horizontally and connects to a gear that is directly connected to the inside of the spherical shell. When motor A turns, it causes the sphere to roll forward or backward because there is a heavy weight keeping the inner mechanical structure upright while the lighter sphere spins around it. This is much like how a hamster running on the inside of a hamster wheel always stays at the bottom of the wheel because of its weight.



Motor B is mounted vertically inside the sphere. When it turns, it spins the weights which are hanging down from the inner mechanical structure. Due to a complex physics concept called angular momentum, when the heavy weights spin clockwise, the outer sphere actually rotates counterclockwise. Likewise, when the weights spin counterclockwise, the outer sphere rotates clockwise. Again, this is related to why the hamster spinning on the wheel always stays at the bottom, except the spinning motion is happening in a different plane. It is also related to how a toy top spins. Combining these two motions at the same time allows the robot to move forward or backward and turn to the left or right at the same time. But don't just take our word for it — build it and see for yourself how it works!



APP SETUP

DOWNLOAD AND INSTALL THE APP

You can download the free **Super Sphere app** for **iOS devices** from the **iOS App Store,** or for **Android devices** from **Google Play.** The app, also referred to as the **control app,** allows you to remotely control and program your robots.

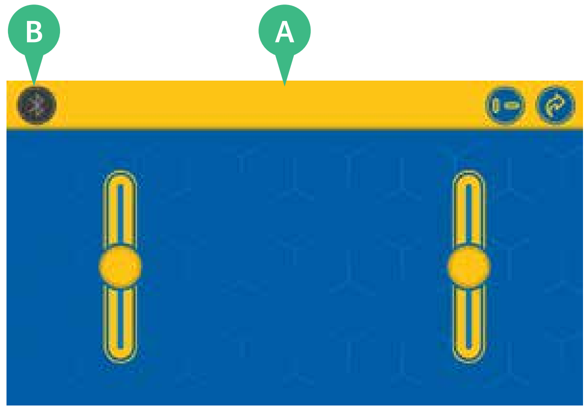
For specific device requirements, see the Information section in the Super Sphere app's download page.

To get the app:

1. Turn on your tablet or smartphone.
2. Scan the QR code to the right to take you to the product page for this kit (or search for the "Super Sphere Robotics app").
3. On the product page, scroll down until you see the images of the app icons and the links to the app pages in the app stores. Follow the links for the correct app store based on your device.
4. Follow the steps on the app download page to download and install the app on your device.
5. Open the app and the interface for **remote control mode (A)** will appear.

Super Sphere

Scan this QR code to go to the product page, where there are links to download the app from the app stores.



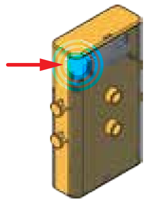
ESTABLISHING A CONNECTION

1. Connect the app to your robot's Bluetooth battery box by pressing the **Bluetooth button (B)** in the upper left corner of the app screen.
2. When the connection has been made, the Bluetooth symbol will change color, the **blue light** on the battery box will change from blinking to solid, and, if a motor is connected, the motor will drive for a brief moment to indicate the connection has been made. See the chart to the right for descriptions of each connection state.

Bluetooth not connected

Bluetooth icon in app:
Gray with blinking ring

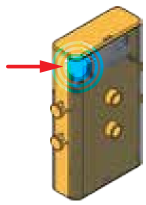
Blue light on battery box:
Blinking



App searching for Bluetooth connection

Bluetooth icon in app:
Blinking yellow

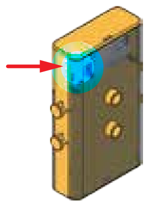
Blue light on battery box:
Blinking



Bluetooth connected

Bluetooth icon in app:
Solid yellow with blue circle

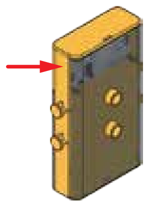
Blue light on battery box:
On and not blinking



Bluetooth battery box sleeping

- No Bluetooth connection
- Power-saving mode
- Automatically sleeps after about a minute of inactivity
- Jiggle it to wake it up

Blue light on battery box:
Off



TROUBLESHOOTING THE CONNECTION

If the Bluetooth connection isn't working:

››› Make sure the batteries are fully charged and the Bluetooth battery box is awake (the blue light is blinking).

››› Make sure Bluetooth is enabled on your device and location services are enabled for the Super Sphere app.

››› Try restarting the app or the device.

››› If the blue light on the battery box is solid but there is no Bluetooth connection, quit the app and wait for the blue light to start blinking again. Then restart the app.

››› Try removing and reinserting the batteries to reset the battery box.

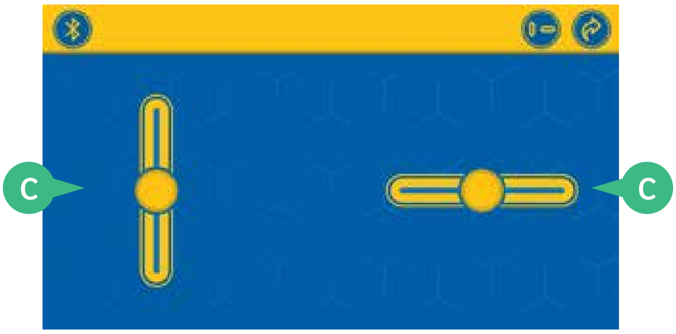
USING REMOTE CONTROL MODE

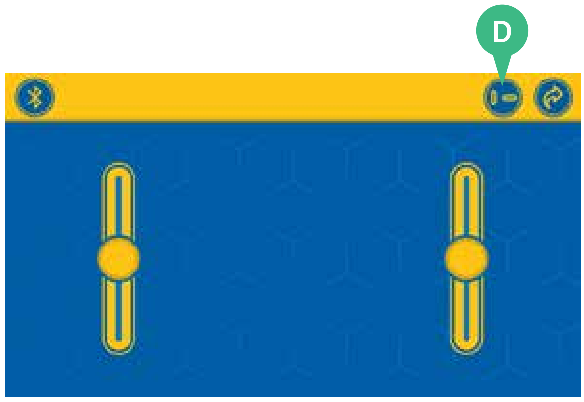
After you have built a robot model (assembly instructions start on page 14) and connected it to the app (see previous page), you can control it with the interface controls in the remote control mode.

You can use the **two slider controls (C)** to directly control the two motors on your models. Slide the left-hand slider up or down with your finger to make motor A spin clockwise or counterclockwise. Likewise, the right-hand slider controls motor B. **The direction in which the motors spin depends on the orientation of the motor wire into the Bluetooth battery box (see below).**

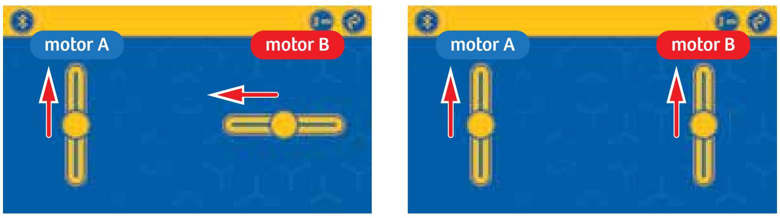
In the default setup for the remote control mode, the left-hand slider is vertical and the right-hand slider is horizontal. This is because for the Super Sphere, the left-hand slider controls the forward and backward motion, and the right-hand slider controls the left and right motion. However, if you tap the **slider orientation button (D),** the right-hand slider toggles between a horizontal and a vertical orientation. You can decide which slider orientation is easiest for you depending on the specific model you are controlling.

See page 22 for specific remote control driving instructions for the Super Sphere model.

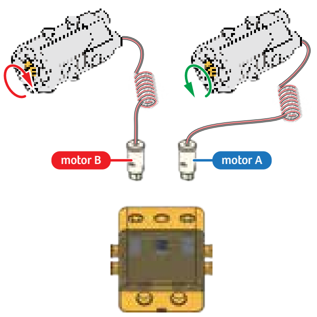




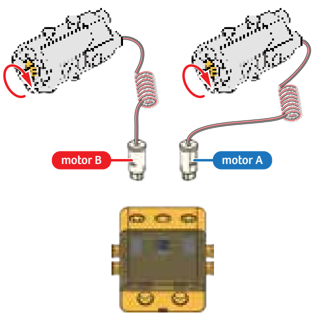
When you slide the sliders like this ...



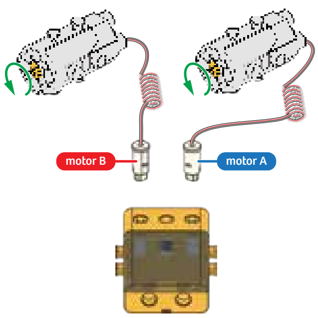
... the motors turn in these directions depending on the orientation of each motor's plug in the socket on the battery box.



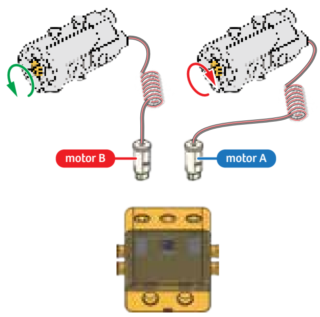
Rounded sides of both plugs facing forward



Rounded side of the motor B plug and flat side of the motor A plug facing forward



Flat side of the motor B plug and rounded side of the motor A plug facing forward



Flat sides of both plugs facing forward

PROGRAMMING MODE

USING PROGRAMMING MODE

Press the **programming arrow icon (E)** to enter the programming mode. When you press the icon, a list of programs appears. You can save up to 24 programs. The app comes with one demo program for each of the seven robot models, which are preloaded in **Programs 1–7.**

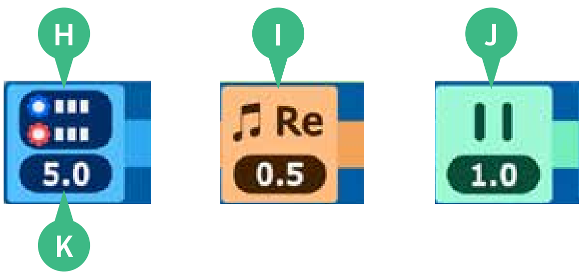
OVERVIEW OF THE PROGRAMMING SCREEN

Tap on Program 6 to load that program, which is the demo program for the Horseshoe Crab Bot. The programming screen appears with Program 6 loaded.

The **run program button (F)** runs the program.

When you press the run program button, the program starts to run and the run program button becomes a **stop program button (G).** Pressing the stop program button stops the program immediately.

As a program runs, the app steps through a sequence of command blocks. There are three types of command blocks: **motor commands (H), notes (sound) commands (I),** and **rest (pause) commands (J).** Each command is set to run for a certain amount of **time** (zero to five seconds) in the program **(K).**



You can tap a command block to edit it as long as the program is not running. Tap the plus sign to add a command block. See page 11 for details on writing programs.

The command that is currently running is highlighted with a **yellow outline around the command block (L).**

For each program, up to **four sequences (M)** of command blocks can be entered. Each sequence correlates to the number of claps (or other very loud sounds) sensed by the sound sensor on the robot.

When the program is running and the sound sensor detects a certain number of claps (one to four), the program runs the sequence of commands for that number of claps. For example, if the sound sensor detects three claps, it will run the third sequence from the top.

You can also trigger a sequence to run by simply tapping on the symbol of the clapping hands when the program is running.

DELETE ALL

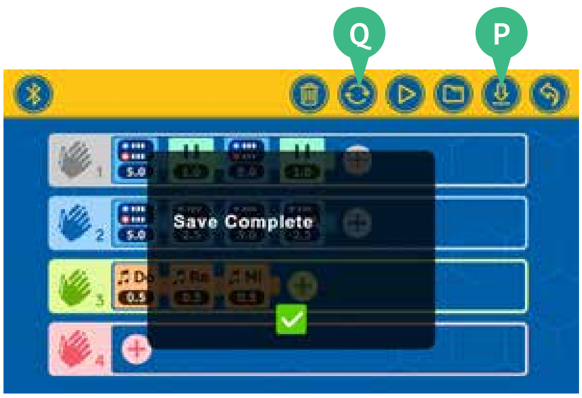
To clear an entire program and set it back to the default blank program mode, press the **trash can button (N)** in the menu bar.

SWITCHING BETWEEN PROGRAMS

If you want to move to a different program, click the **program library button (O)** to open the library of saved programs and select which program you want to open.

SAVING PROGRAMS

When you want to save a program you have written, press the **down arrow button (P).** The program script will immediately be saved inside the program you are currently in. A confirmation screen will appear.

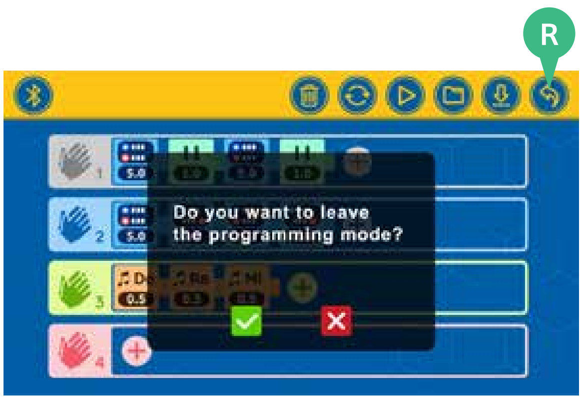


REVERT TO SAVED

To revert to the last saved version of the program and erase all unsaved changes, press the **revert to saved button (Q).**

EXITING PROGRAMMING MODE

When you want to leave the programming screen, press the **backward arrow button (R).** A window will pop up asking if you are sure you want to leave the programming screen. Press the green check mark button to go back to the main remote screen.



PROGRAMMING MODE

WRITING A PROGRAM

When you are ready to write your first program, you can refer to the step-by-step instructions below to do so.

1. Tap the **programming arrow button (A)** to enter the programming mode. Choose a blank program (Program 8 starts out blank).
2. The programming screen appears.
3. Press the **plus sign "+" button (B)** in one of the sequences to add a command to that sequence.
4. The **commands menu (C)** pops up. You can select between three types of commands:

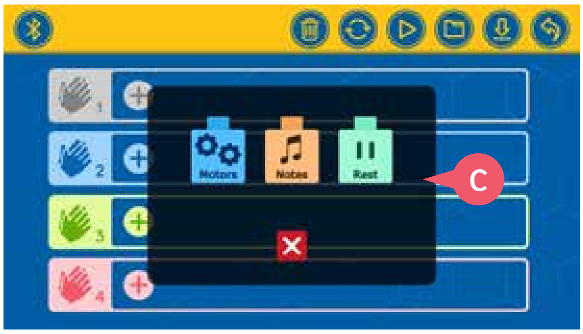
   • Choose **motors** to add motor commands.

   • Choose **notes** to add sound commands.

   • Choose **rest** to add a pause command.

   Or press the **red X button** to exit the commands menu.

Continued on next page >>>



TROUBLESHOOTING THE SENSOR CONNECTION

If the sensor connection isn't working:

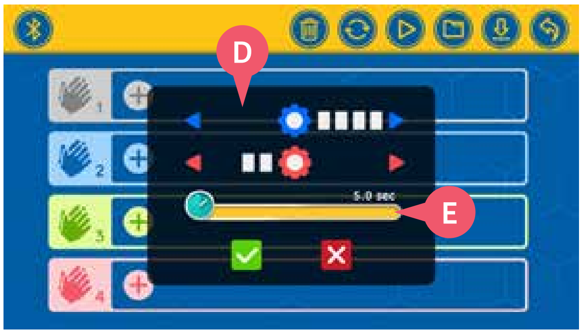
››› **Disconnect and then reestablish the Bluetooth connection.**

››› **Make sure the sensor cable is securely plugged into the battery box.**

››› **Exit the program you are in and relaunch it.**

PROGRAMMING MOTORS

1. Tap the motors command icon and the motor **programming window (D)** appears.
2. In the motor programming window, you can create a command to control **motor A (blue)** and/ or **motor B (red)** to turn **clockwise or counterclockwise.** You can choose a **relative speed** from -4 (fastest in one direction) to 4 (fastest in the other direction).

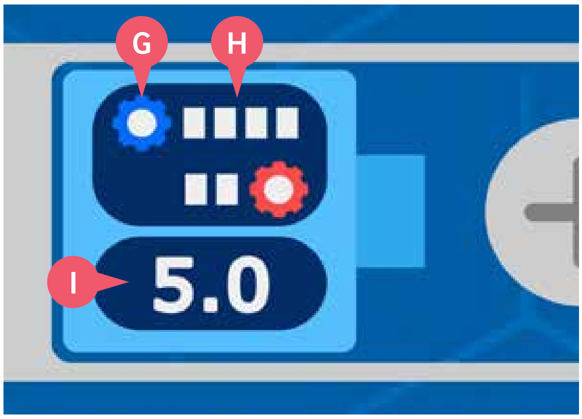


Note: A positive speed (1–4) in the motor command doesn't always mean your model will move forward! You will have to test which direction results in the desired output direction on your specific models, because the orientation of the motor and the gearing will change the direction. See the bottom of page 8 for more information.

3. With the **time slider (E),** you can also set the duration for which the motor(s) will turn, from **0 to 5.0 seconds.**
4. When you are satisfied with your selections, press the green check mark button and the **motor block (F)** appears in the program segment.

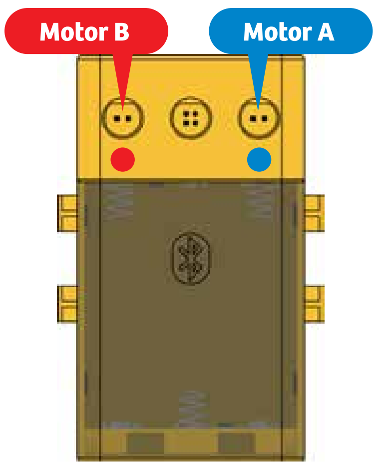
   The blocks show which **motor(s) (G)** the command will turn, and at what speed and in what **direction (H)** each motor will turn. Below that, it shows **how long** the motor(s) will turn **(I).**

   The blue gear wheel represents motor A and the red gear wheel represents motor B.



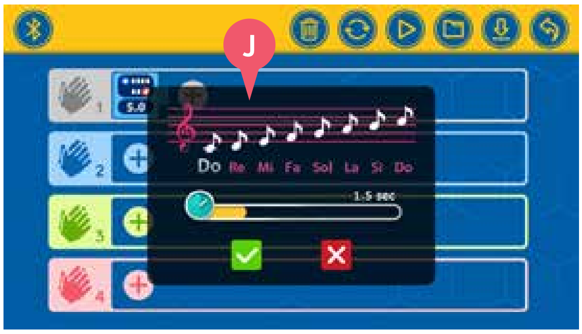
Tip! Add red and blue dots or stickers to the battery box and motors so you can easily keep track of which motor you are programming.

5. You can add more command blocks to the same segment by pressing the **"+" button (B)** again.



PROGRAMMING MODE

PROGRAMMING SOUNDS



1. Press the notes command icon and the **sound programming window (J)** appears.
2. In the sound programming window, you can create a command to make sounds. You can choose the pitch (Do, Re, Mi, Fa, Sol, La, Si, and Do) and the duration (0 to 5 seconds) for each note command.
3. Press the green check mark button and the **note block (K)** appears in the program segment.

   In this way, you can program a simple melody with multiple note blocks that will play when the program segment runs.

PROGRAMMING PAUSES

1. The last command option is to add a pause, or rest, to the program. Press the rest command icon and the **rest programming window (L)** appears. You can choose the duration (0 to 5 seconds) of the pause in the program. Press the green check mark button and the **rest block (M)** is added to the program segment.

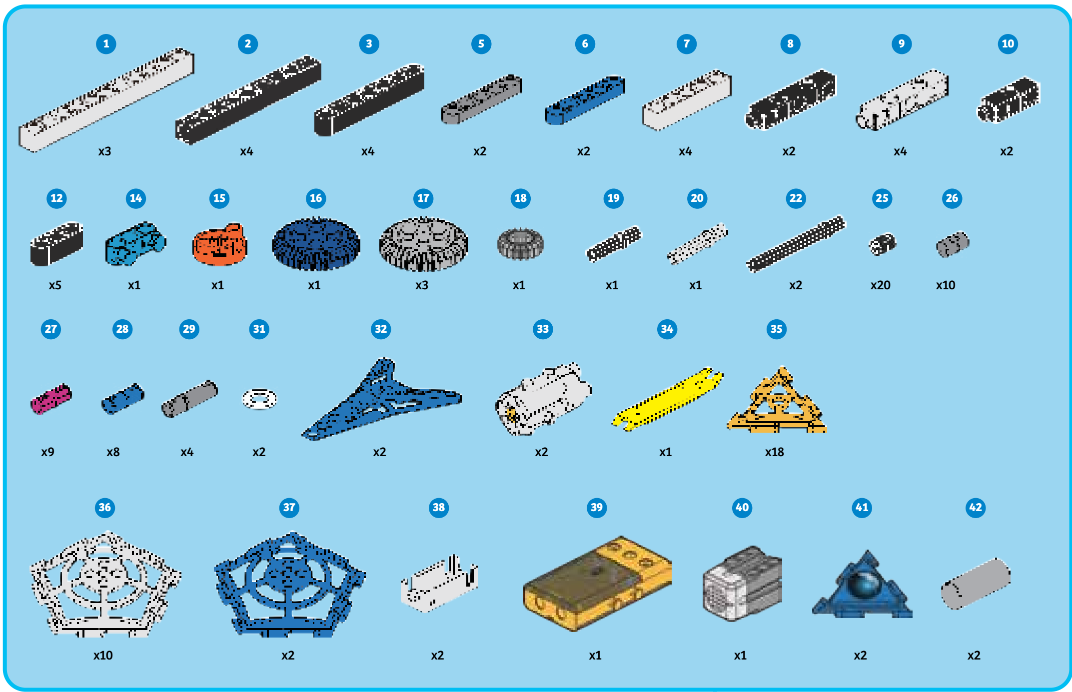
DELETING COMMANDS

To delete a command block, press the block you want to delete to open its programming window. Then press the **trash button (N)** in the bottom corner.

WRITING A COMPLETE PROGRAM

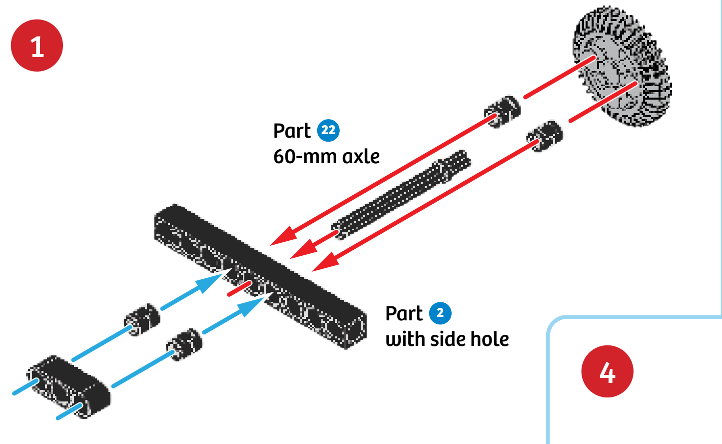
Following the previous instructions for adding commands, you can now go and write programs for all of the segments. You can think of the different actions you want your robot to perform when the sound sensor detects different numbers of claps.

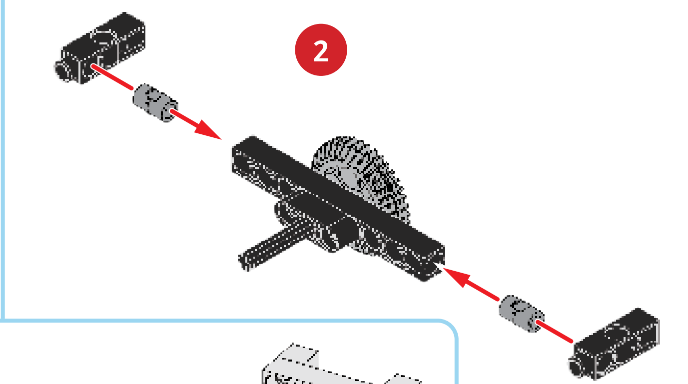
Don't be afraid to try a lot of different ideas and play around with different combinations of command blocks in different sequences.

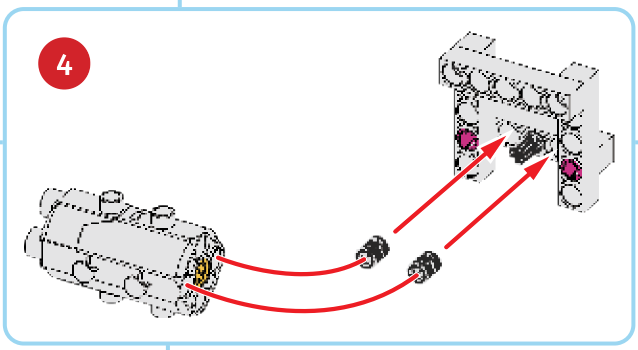


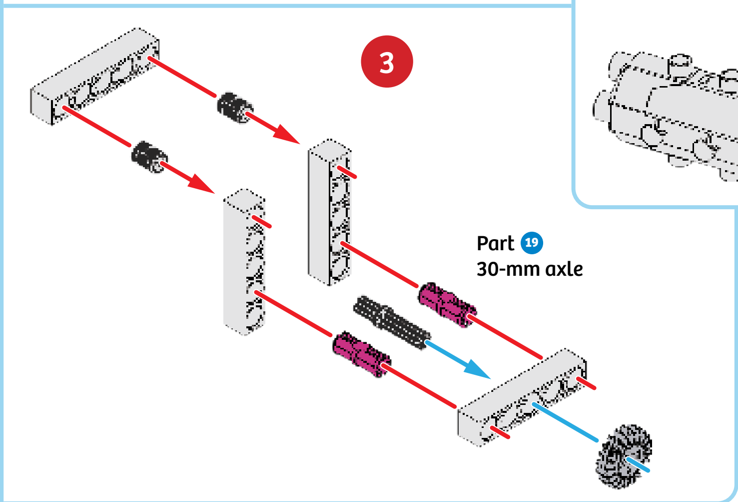
First, follow these assembly instructions to build the model. Then, you can use the model in remote control mode, or you can follow the instructions on the programming page immediately after these assembly instructions to run a program for this model.

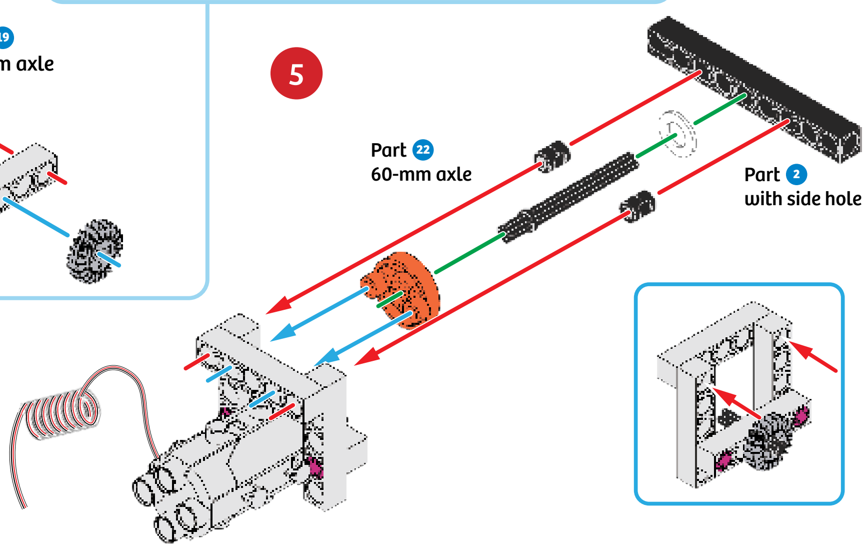
Please read the driving tips on pages 22 and 23.











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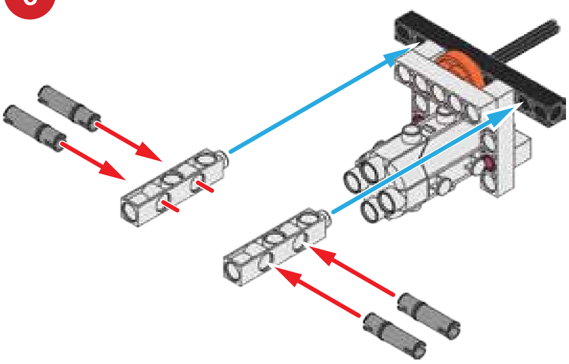

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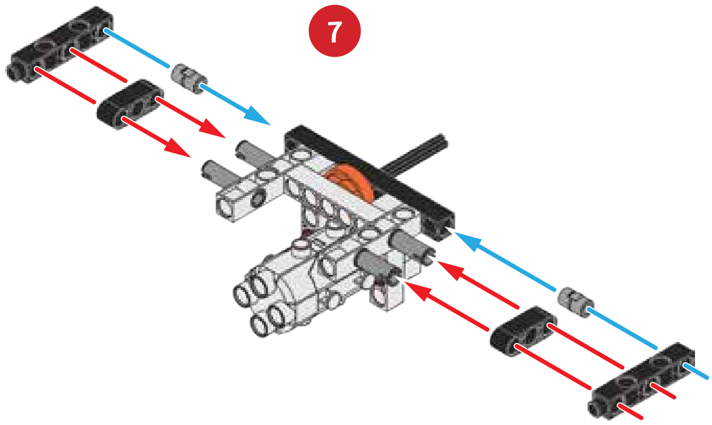

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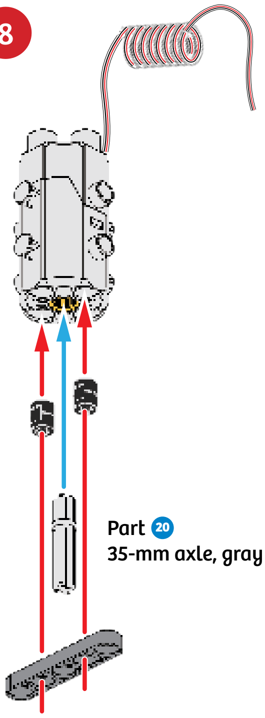

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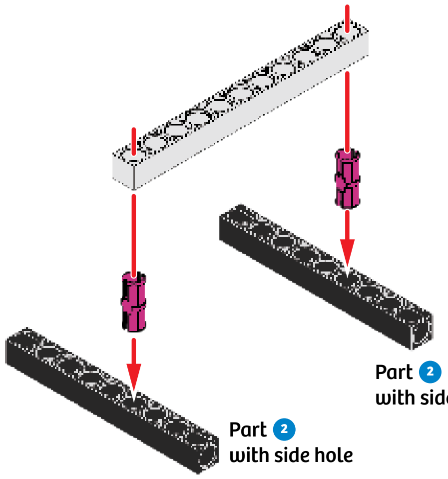

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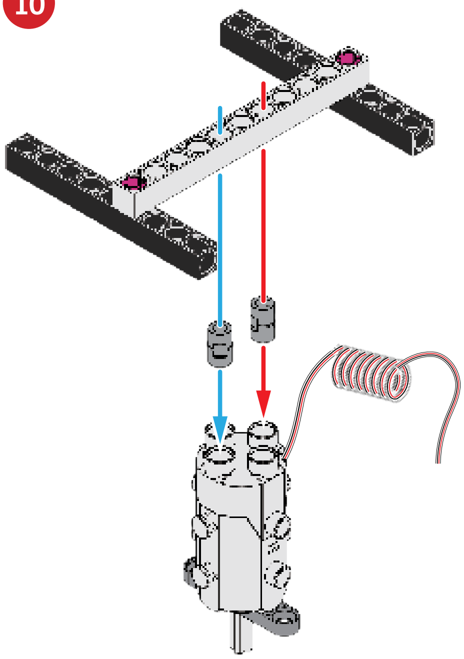
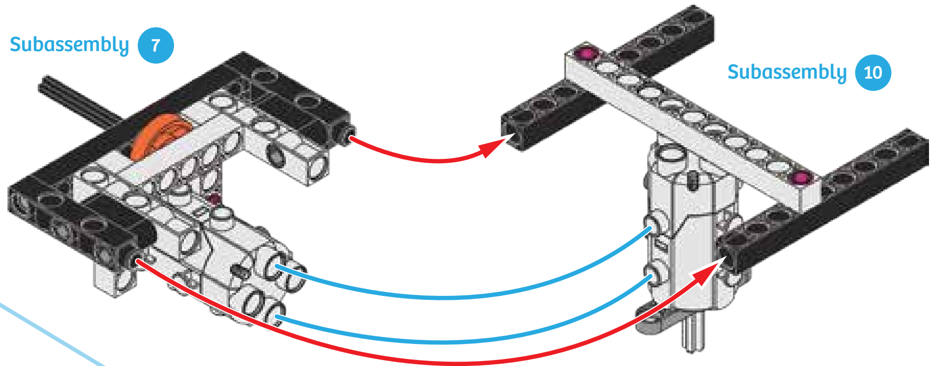
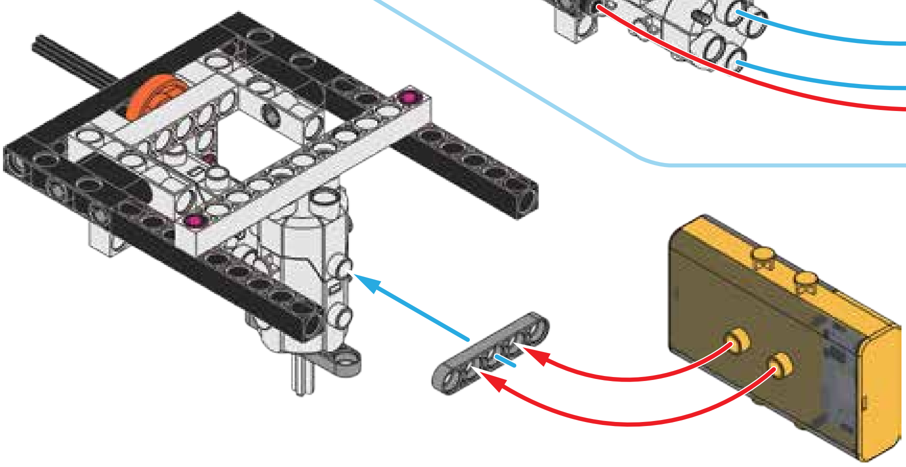


11



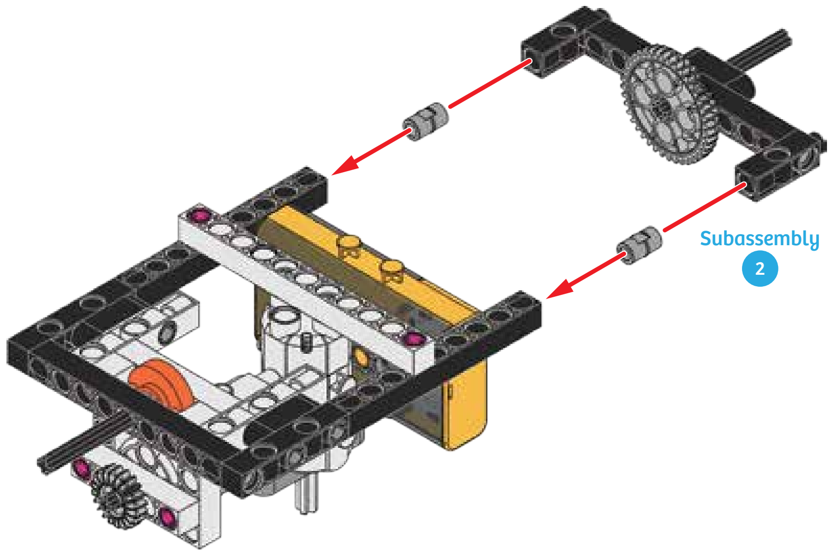
12



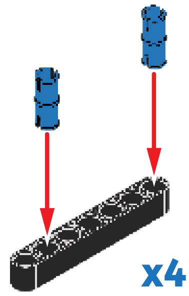
Make sure the batteries are already inserted into the battery box. See page 2.

Pay attention to the orientation of the battery box in this step.

13



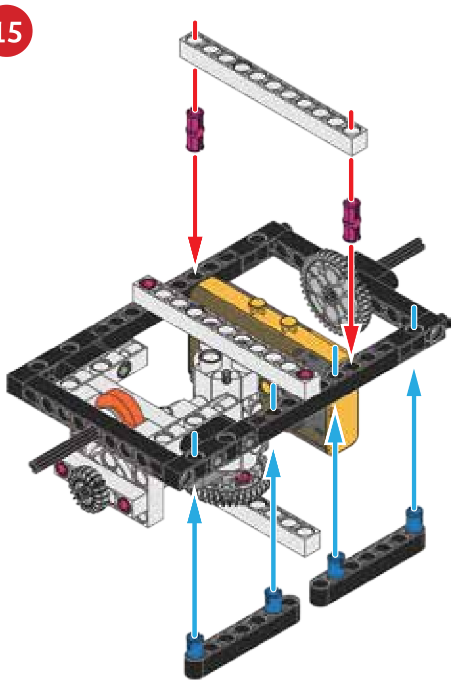
14



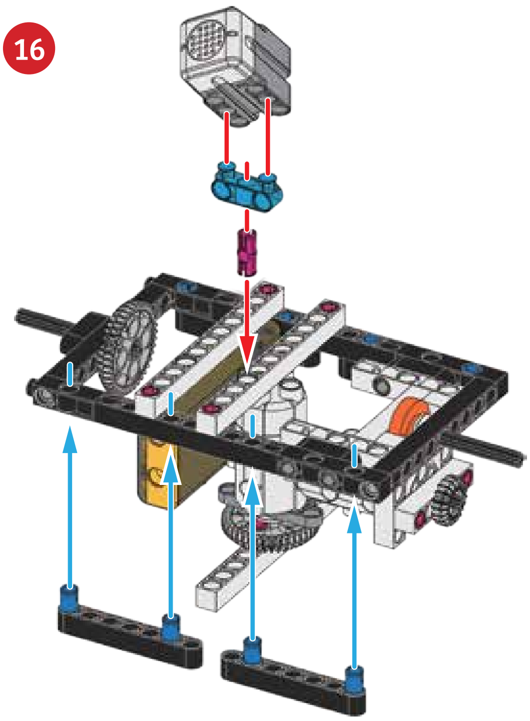
x4

Do this step four times.

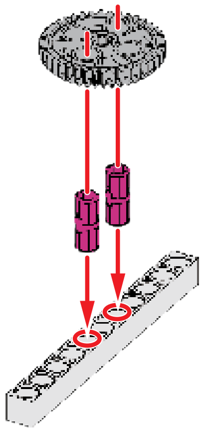
15



16



17



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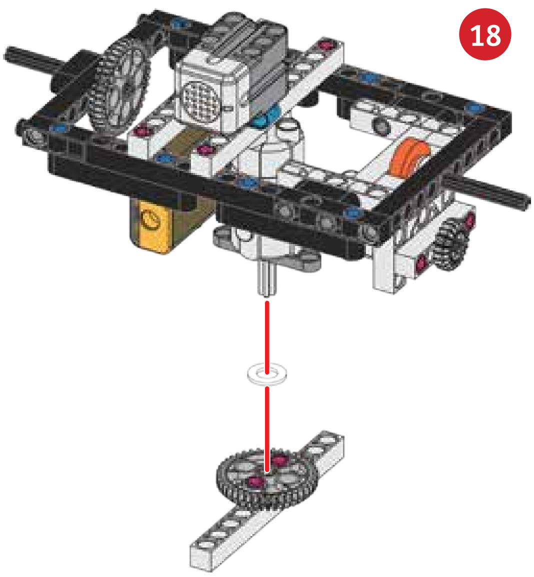
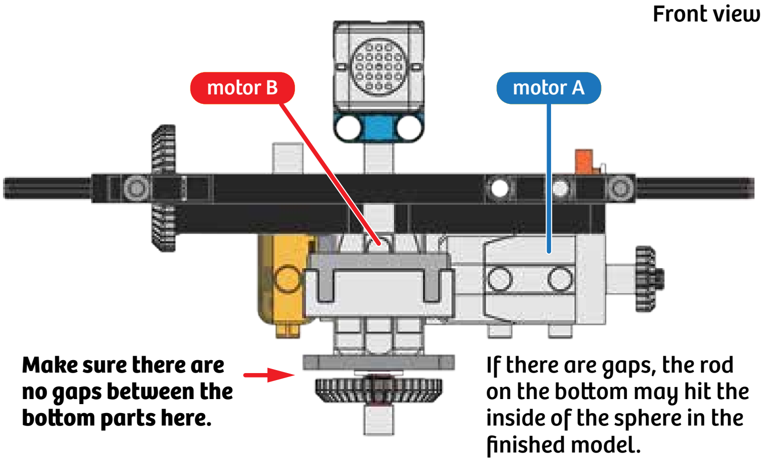


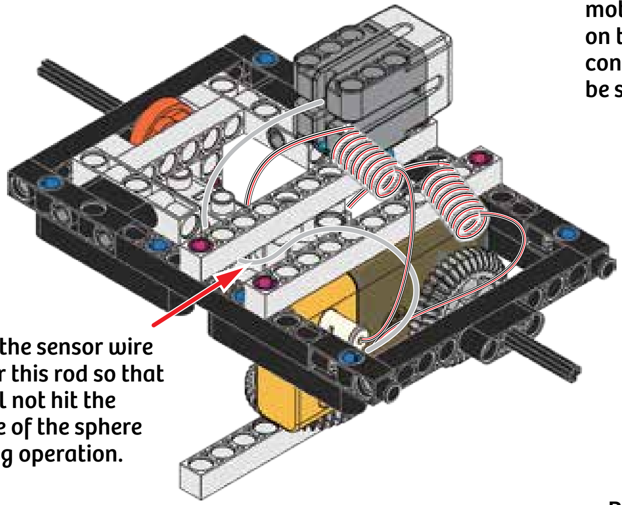
Front view



Make sure there are no gaps between the bottom parts here.

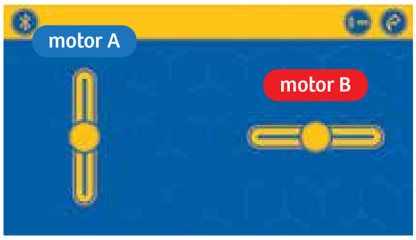
If there are gaps, the rod on the bottom may hit the inside of the sphere in the finished model.

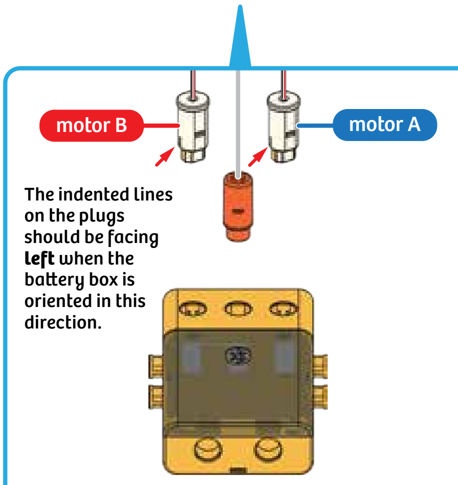
Attach the wires to the battery box.



Pass the sensor wire under this rod so that it will not hit the inside of the sphere during operation.

Make sure you plug the wire from motor B into the socket on the **left** and the wire from motor A into the socket on the **right,** or else the controls in the app will be switched.

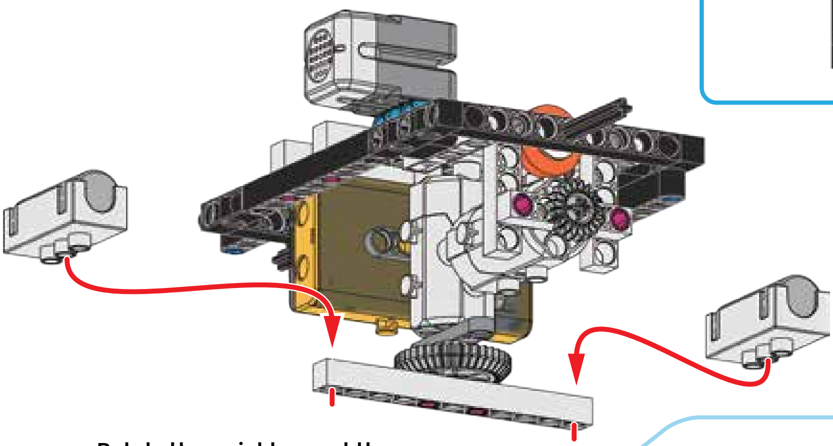


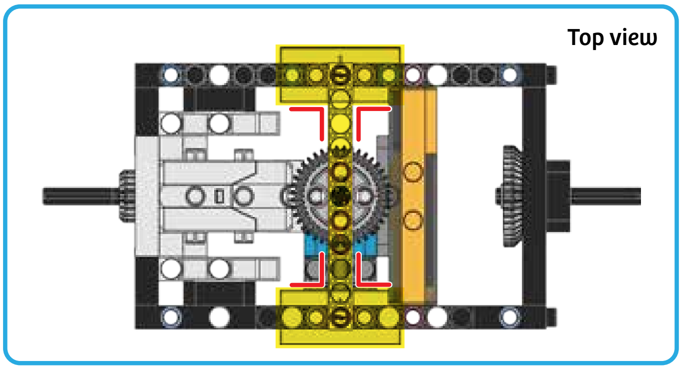


Pay attention to the orientation of the indented lines while plugging in the motor wires.

19

Insert the metal weights into the weight housings and then attach them to the bottom rod.

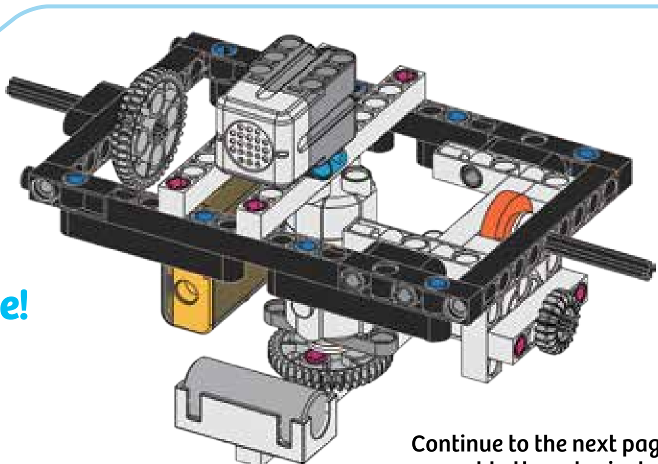




Make sure that the weights are attached to the bottom rod so that they are exactly perpendicular to the bottom rod.

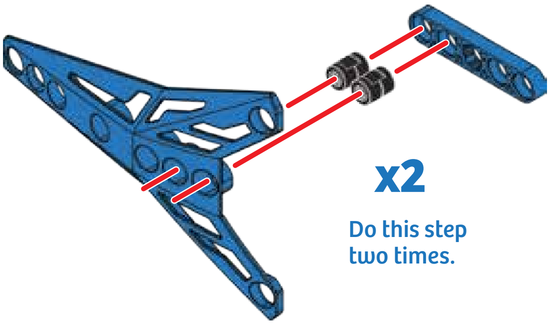
Rotate the weight arm at the bottom of the assembly to make sure it rotates smoothly.

Inner assembly done!



Continue to the next page to assemble the spherical shell.

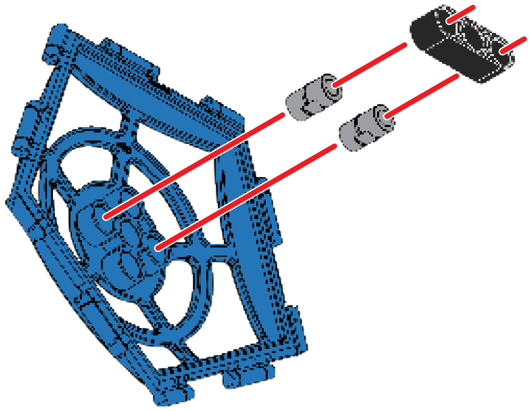
20



x2

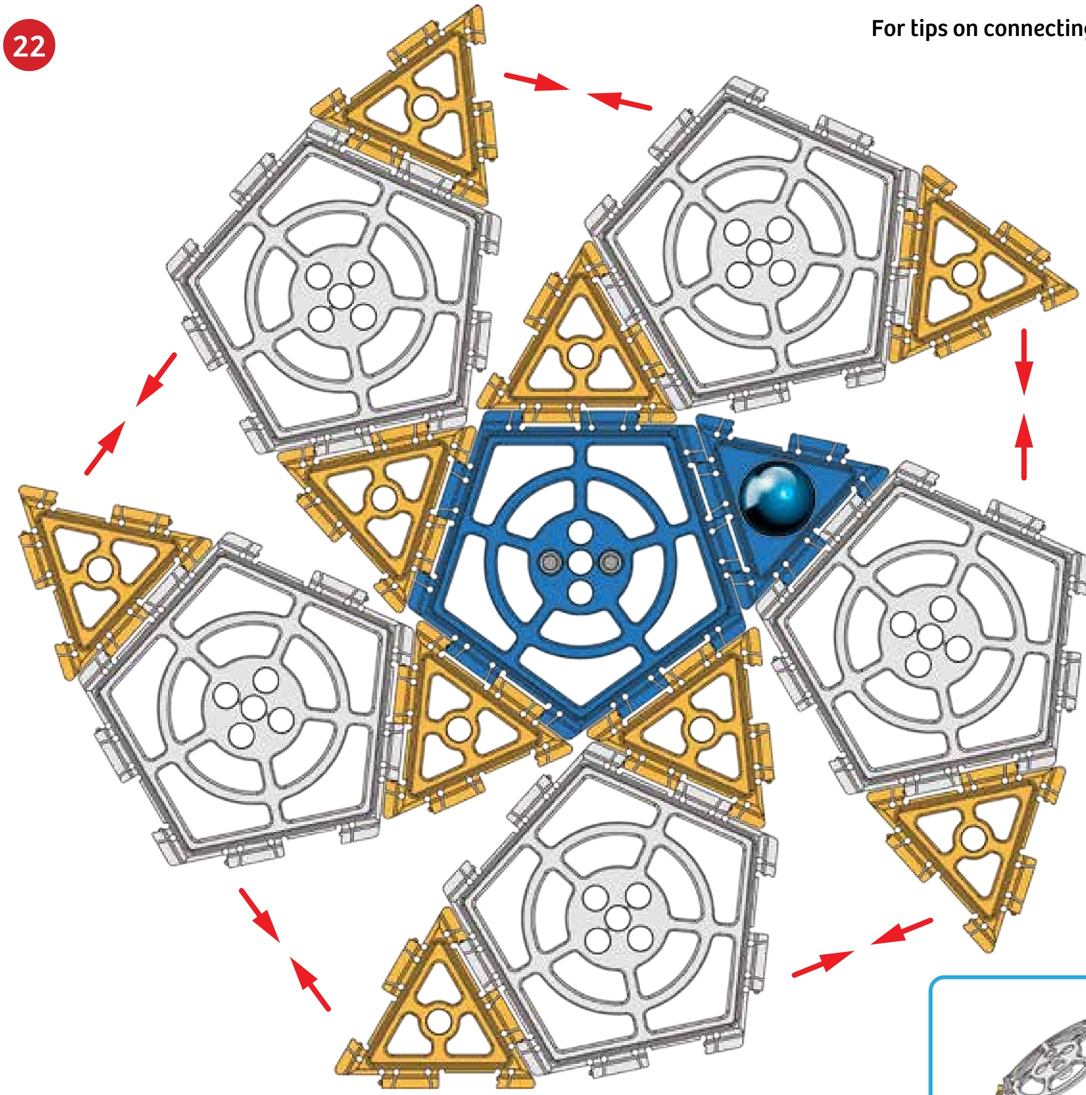
Do this step two times.

21



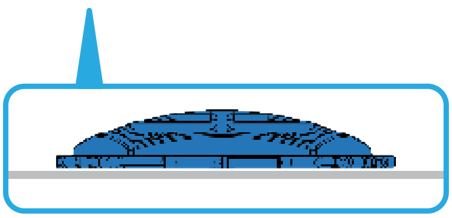
22

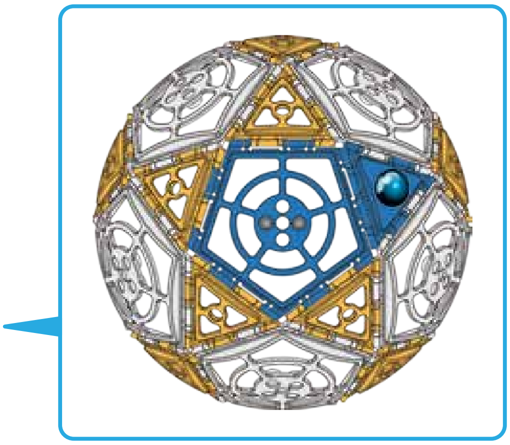
For tips on connecting the shell pieces, see page 2.



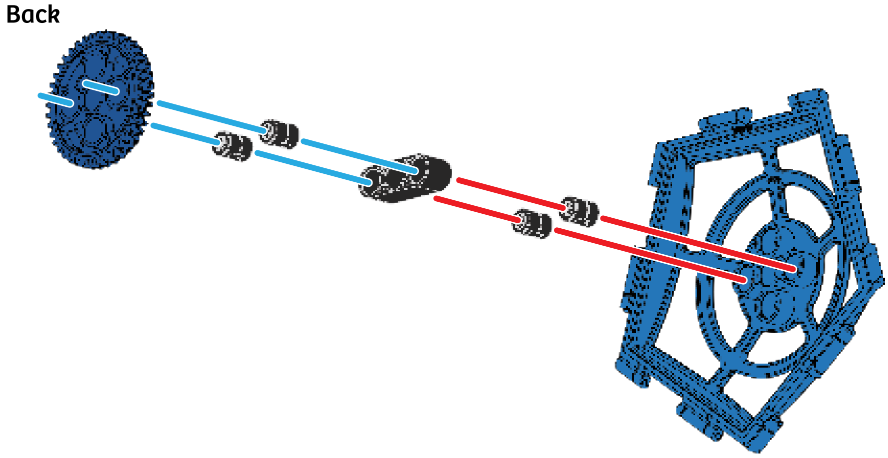
Pay attention to the alignment of the black anchor pins in the blue pentagon and the blue triangle.

The blue pentagon in the middle is Subassembly 21.

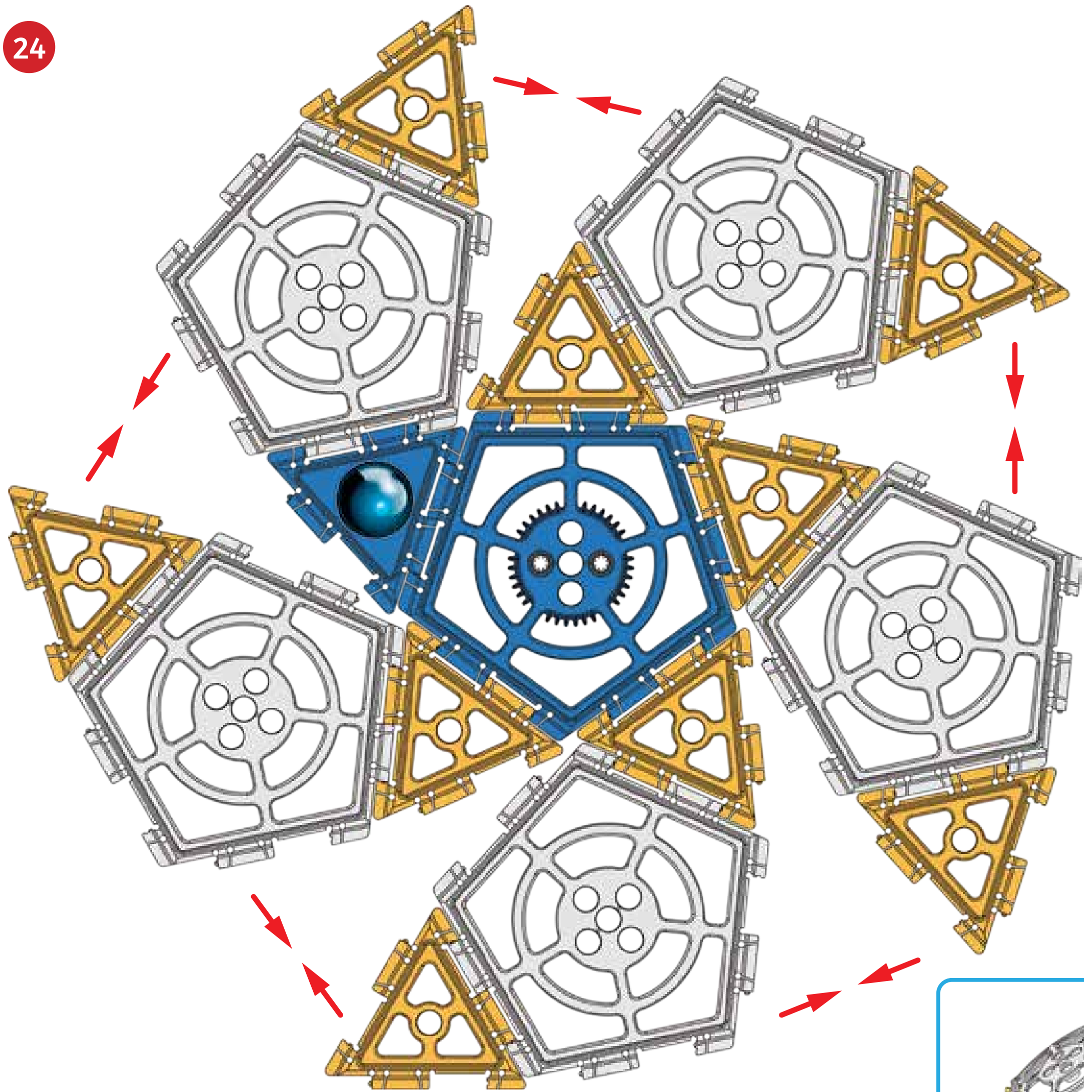




23

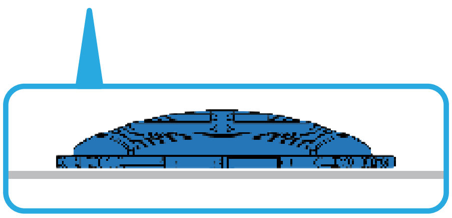


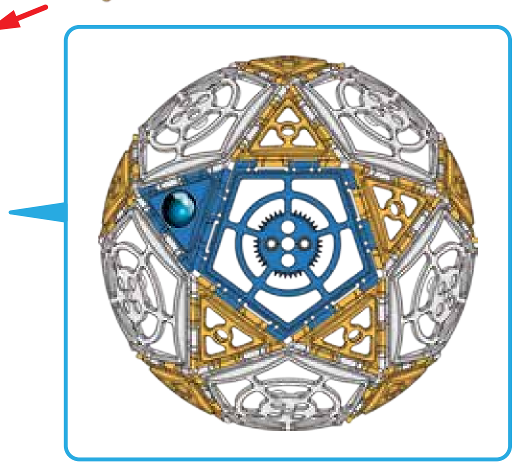
24



Pay attention to the alignment of the blue gear attached to the blue pentagon and the blue triangle.

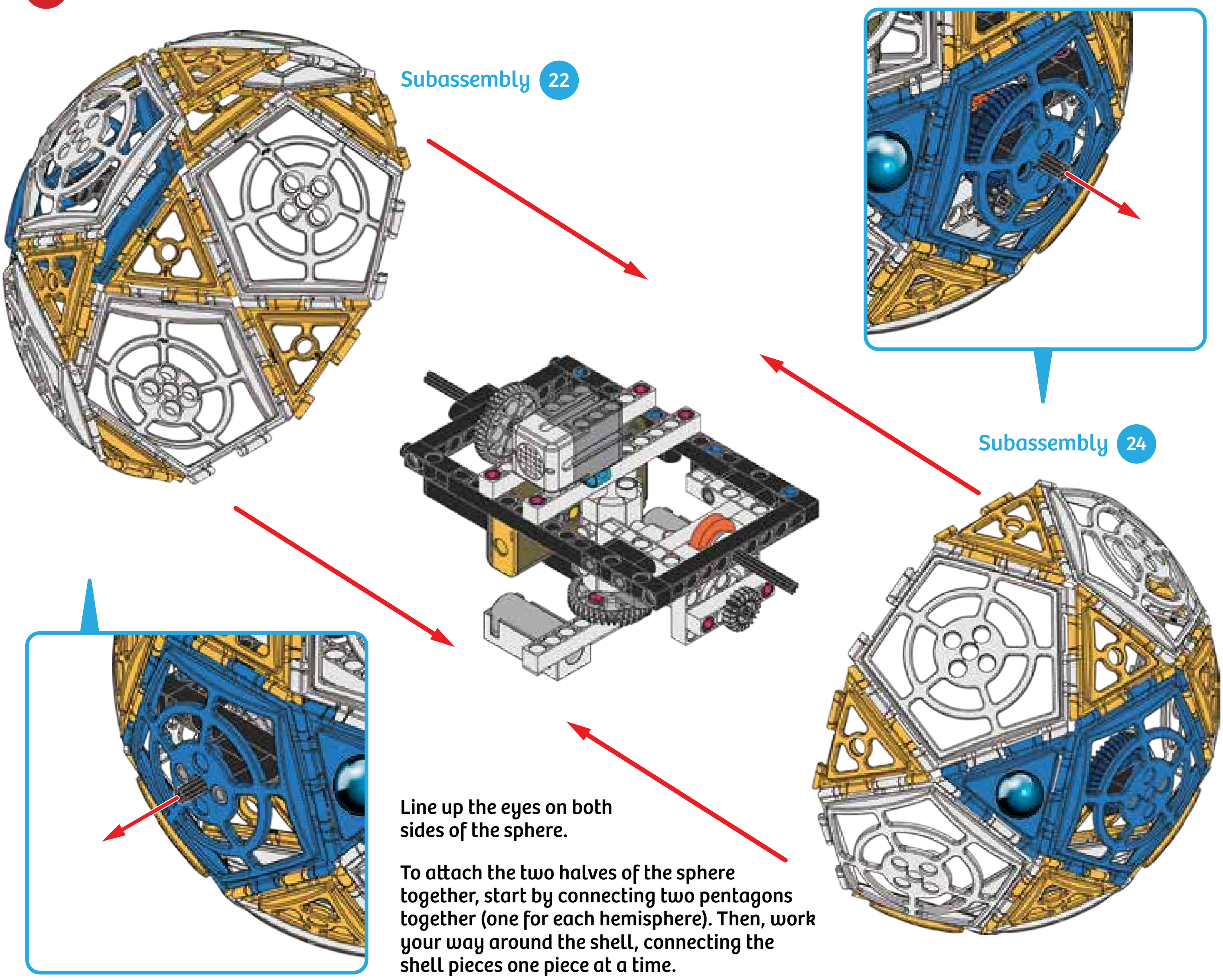
The blue pentagon in the middle is Subassembly 23.





Make sure that the side of the sphere with the blue gear is on the side of the inner assembly with the small gray gear, and that the gears mesh when you attach the shell to the inner assembly.

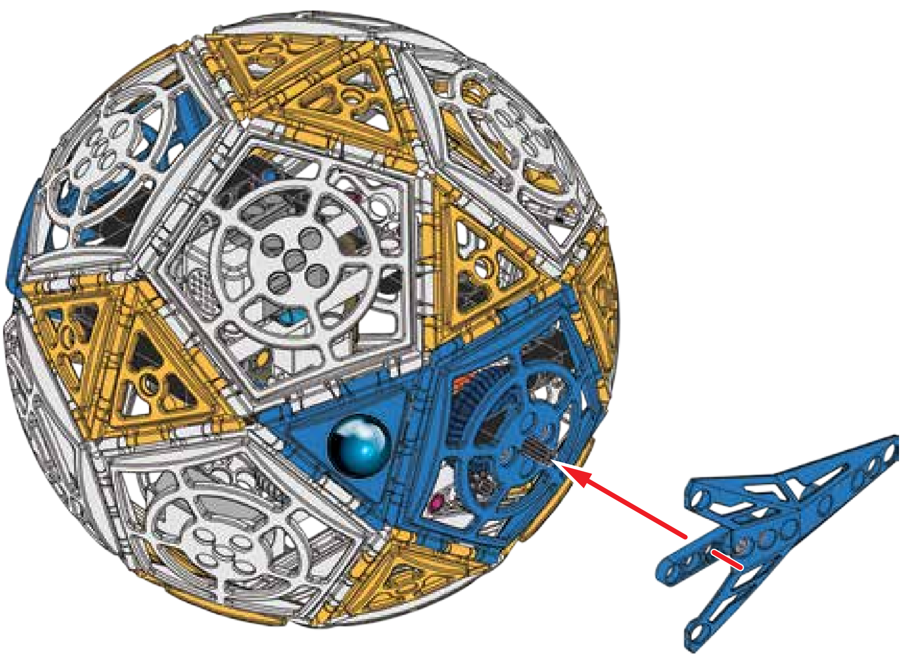
25



Line up the eyes on both sides of the sphere.

To attach the two halves of the sphere together, start by connecting two pentagons together (one for each hemisphere). Then, work your way around the shell, connecting the shell pieces one piece at a time.

26



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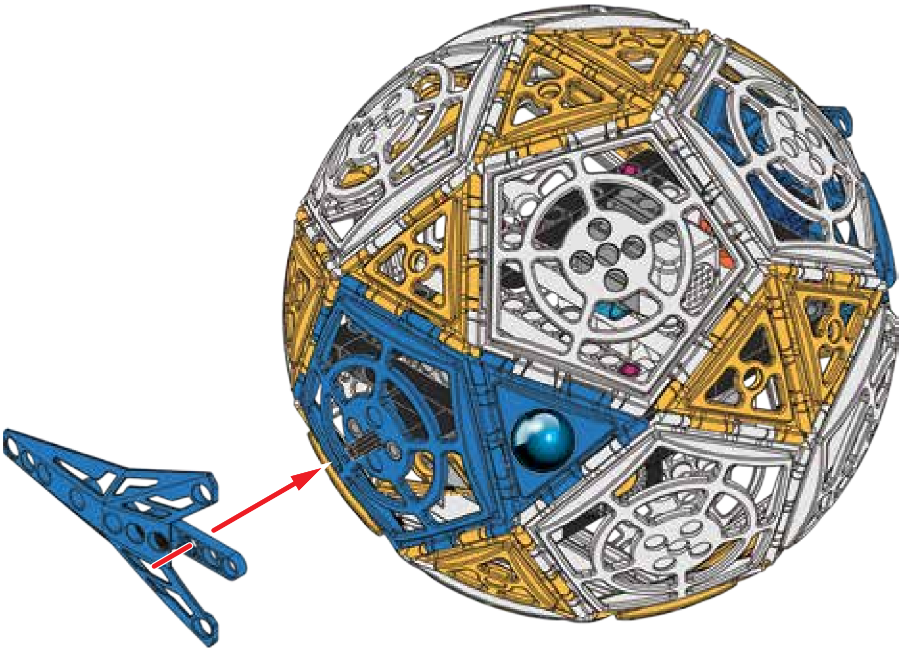
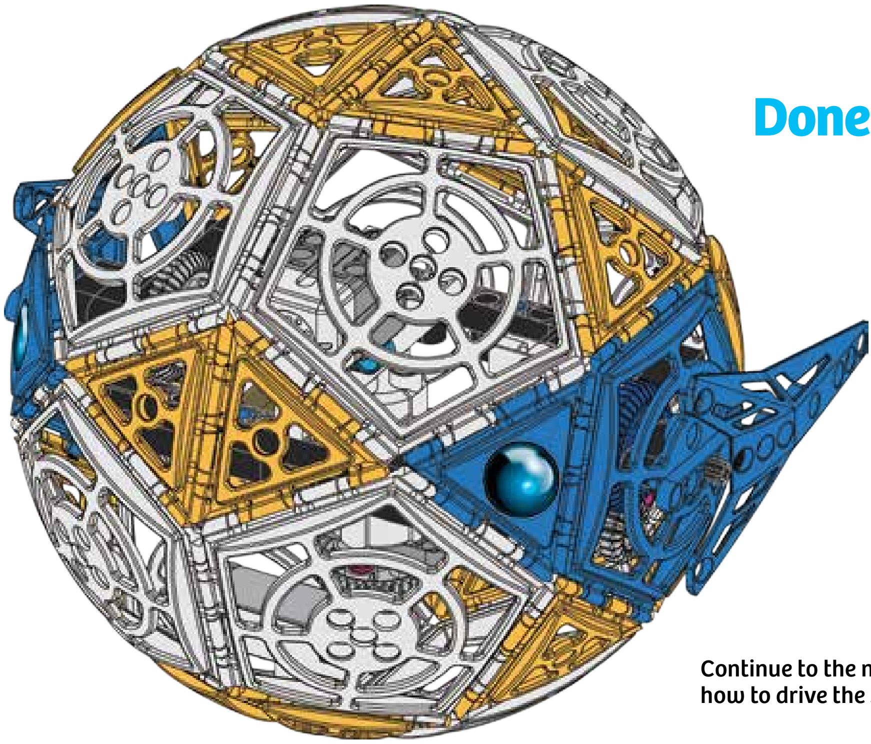
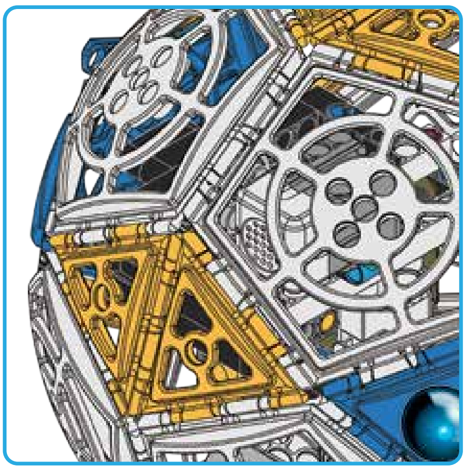




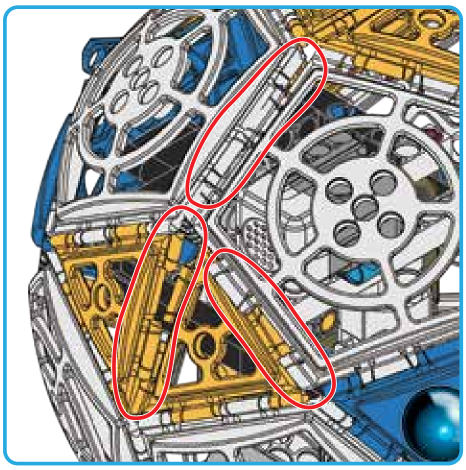
Done!

Continue to the next page to learn how to drive the Super Sphere.

To ensure that the sphere is strong and stable while rolling on the floor, make sure that all of the joints between the shell pieces are securely connected.



Spherical shell securely connected



Spherical shell not securely connected

DRIVING TIPS VIDEO

Scan this QR code to see a video with tips for learning to drive your Super Sphere.

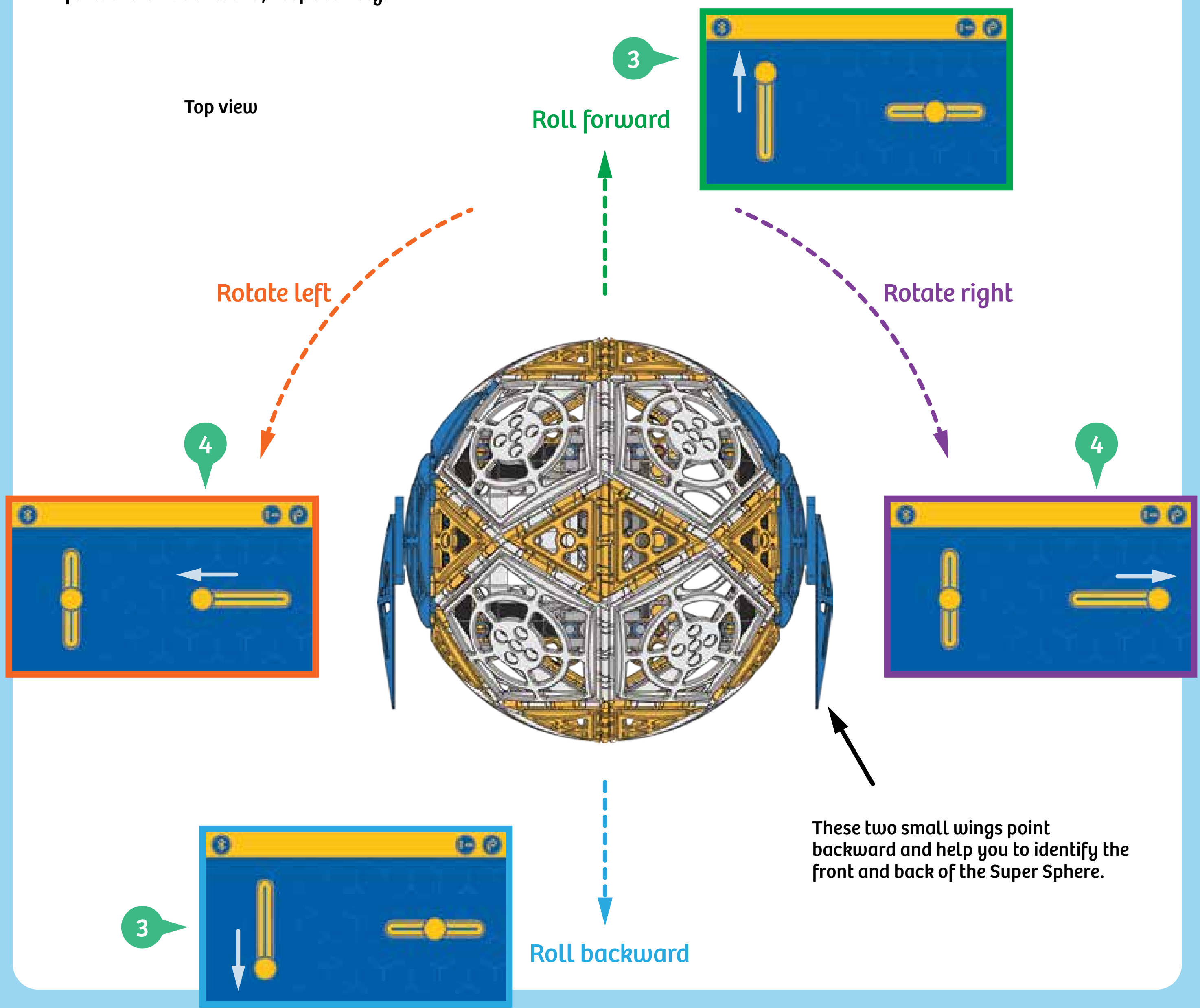
DRIVING SCHOOL

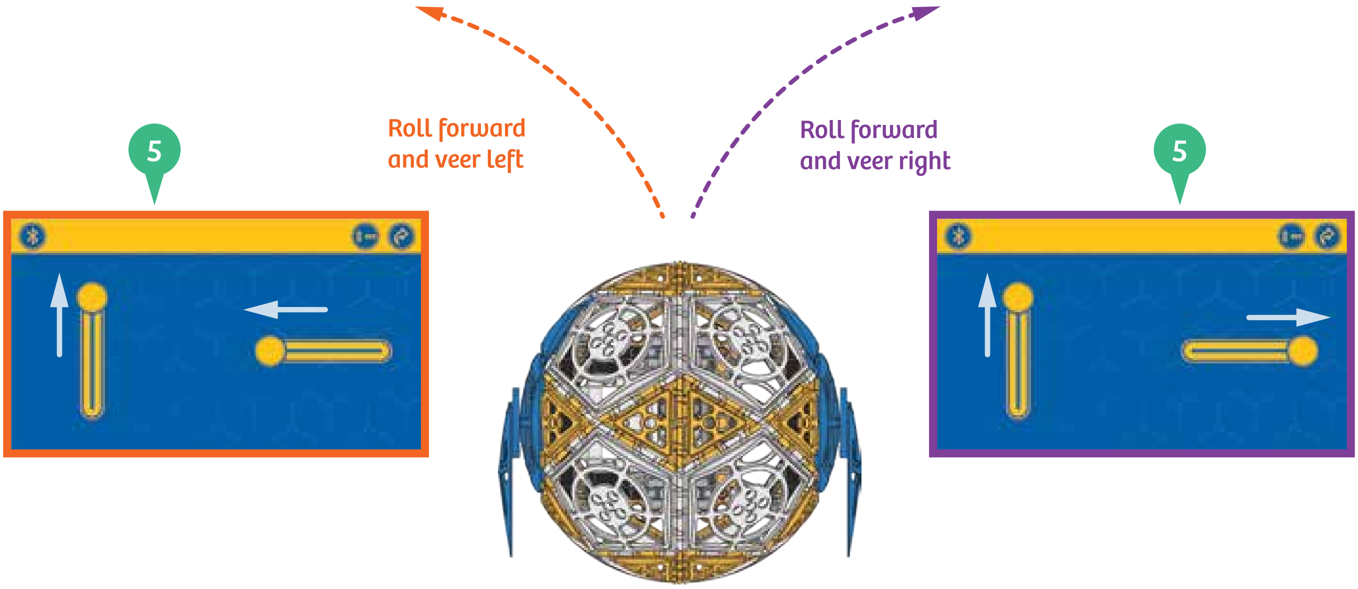
Now that you have assembled your Super Sphere, follow these instructions to drive it with the app in remote control mode. Driving the Super Sphere is different from driving a common toy RC car, but with a little practice, you will get the hang of it.

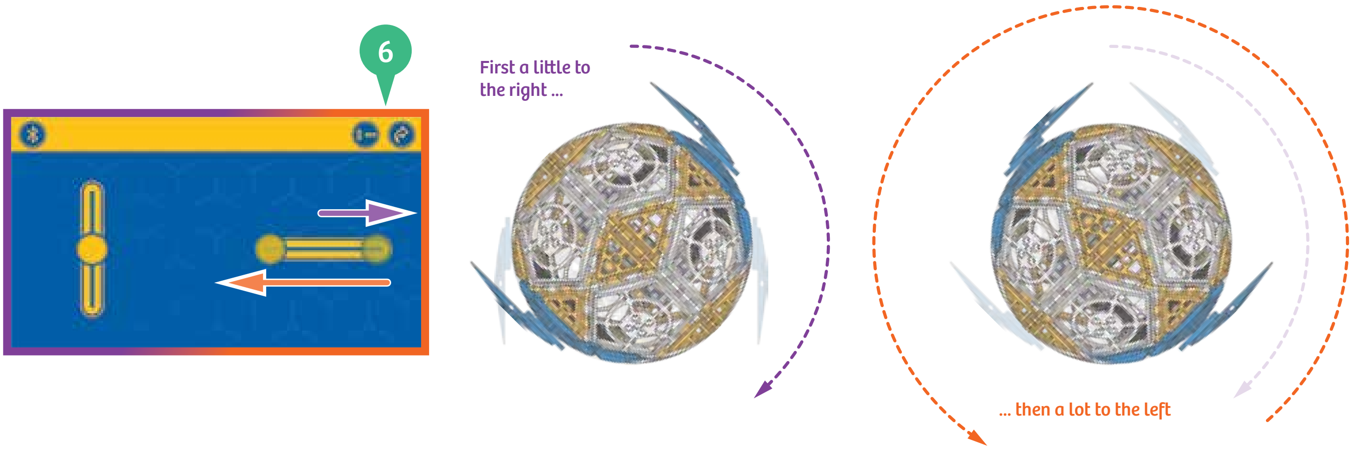
1. Place the Super Sphere in a large, open area of **smooth, hard flooring.** It drives best on wood, laminates, and tiles. **It does not turn well on carpeting, rugs, or textured surfaces.**
2. Load the app on your tablet or smartphone and establish a Bluetooth connection between the app and the Super Sphere. Refer back to page 7 for instructions.
3. In remote control mode, slide the left-hand slider (motor A) forward or backward to make the Super Sphere roll forward or backward, respectively.
4. Slide the right-hand slider (motor B) left or right to make the Super Sphere turn left or right, respectively.

NOTE: If your model moves in the opposite direction from how it should, you need to reverse the direction in which the motor wire is inserted into the battery box. See page 17.

5. Now try sliding both sliders at the same time. Can you get your Super Sphere to roll forward and veer to the left at the same time? Can you get it to veer to the right as it rolls forward? How about in reverse?
6. Try this: If you slide the right-hand slider to the right, and then suddenly slide it to the left, the sphere will rotate even more. When the sphere is already in motion, it can turn even more than when it is stationary.



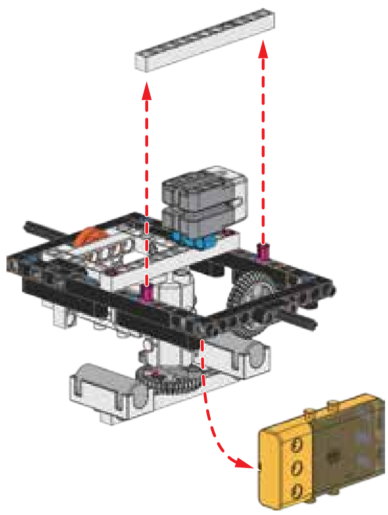


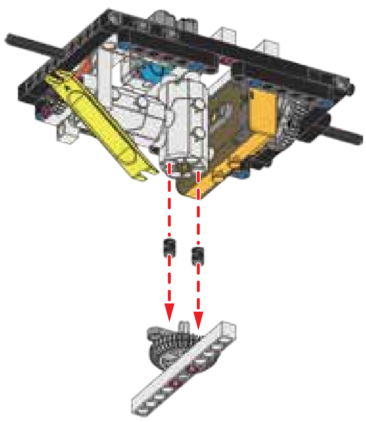


TIPS:

- Super Sphere works best on hard surfaces: wood, laminate, tile.
- It does not work well on carpeting or rugs. If you only have this type of flooring available, try building the other models in this kit, which will work better on it.
- It works best if you use it in a big, open area.
- It turns better when it is already rolling, rather than when it is stationary.
- Make sure the weights aren't hitting the bottom of the sphere when they spin. See assembly step 18.
- Try setting up an obstacle course for your Super Sphere and practice getting it to go exactly where you want it to go.

- To replace the batteries, pry open the spherical shell, remove the 11-hole rod as shown and take the Bluetooth battery box off.

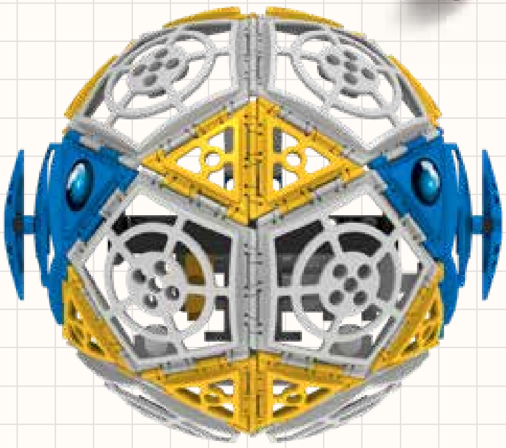




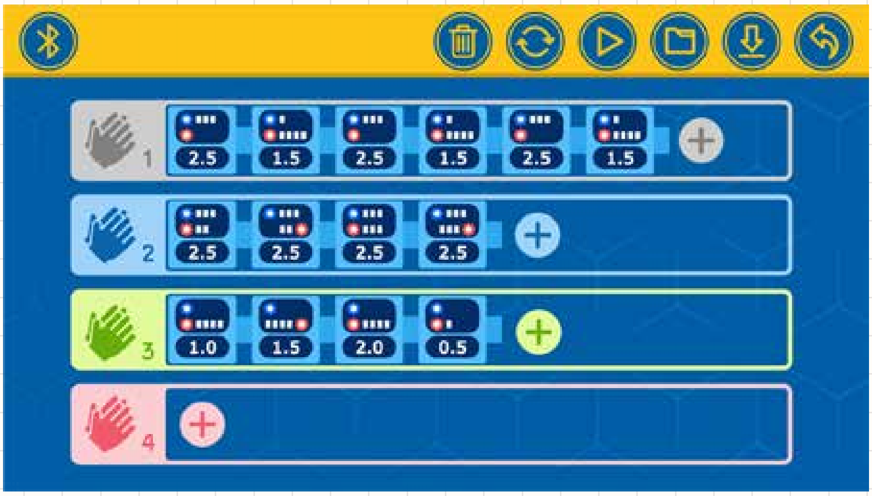
- Disassembly tip: The 35-mm gray axle is intentionally very tight. Use the anchor pin lever to remove the weight arm.

Continue to the next page to learn how to program the Super Sphere.

SAMPLE PROGRAM FOR THE SUPER SPHERE



1. Place the Super Sphere in a large, open area of smooth, hard flooring. It drives best on wood, laminates, and tiles. It does not turn well on carpeting, rugs, or textured surfaces.
2. Load the app on your tablet or smartphone and establish a Bluetooth connection between the app and the Super Sphere. Refer back to page 7 for instructions.
3. In programming mode, load **Program 1.** The command sequences shown below are preset in Program 1. Tap the run button and clap your hands one to four times near the sound sensor.
4. Observe how the robot behaves for each sequence! Write your own program in the four-clap sequence.



PROGRAM 1

1 Clap: Go forward, turn, go forward, turn, go forward, turn

2 Claps: Drive in an S-shaped curve

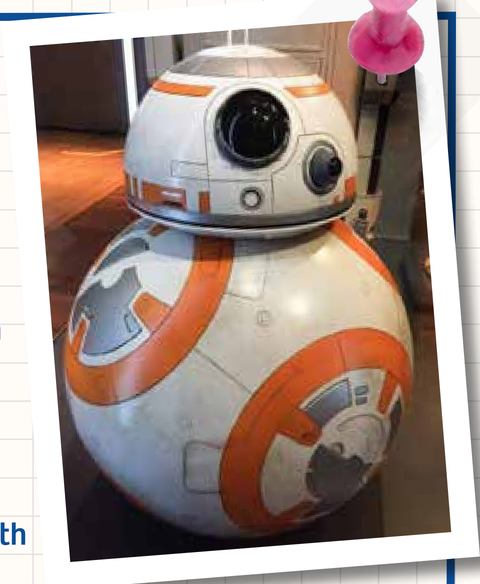
3 Claps: Spin around left and right

4 Claps: Create your own program!

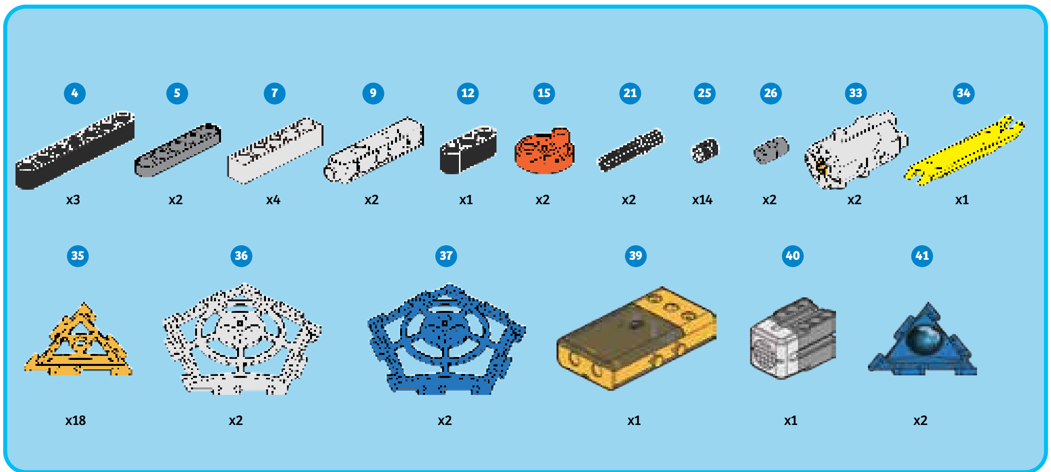
Spherical Robots

There are many types of **spherical robots,** or ball-shaped robots. Writers, engineers, and inventors have imagined and constructed spherical robots for many years. Spherical robots have many advantages: they can move in any direction by simply spinning on their vertical axis; they are self-contained inside their spheres so they are well-protected from the environment and could travel on land, in water, and in space; and spheres are very strong shapes, so spherical robots are durable.

Two of the most well-known spherical robots are a robot toy called *Sphero* and the droid *BB-8* from the sci-fi fantasy movie series *Star Wars* (pictured here). *GroundBot* is a spherical robot with cameras on it that can be used for security and filming sporting events from the field! Samsung's *Ballie* is a spherical personal assistant robot that can roll around after you and interact with you.

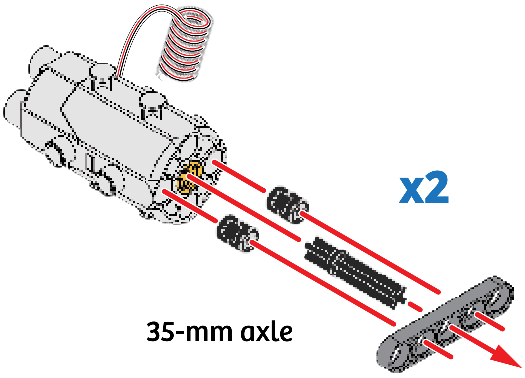


JUMBO-WHEEL BOT



First, follow these assembly instructions to build the model. Then, you can use the model in remote control mode, or you can follow the instructions on the programming page immediately after these assembly instructions to run a program for this model.

1



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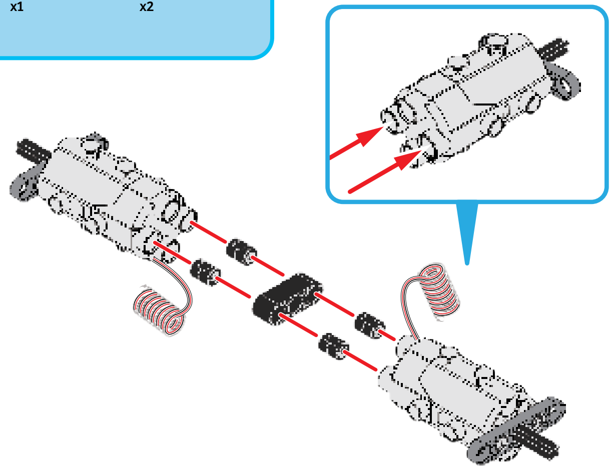

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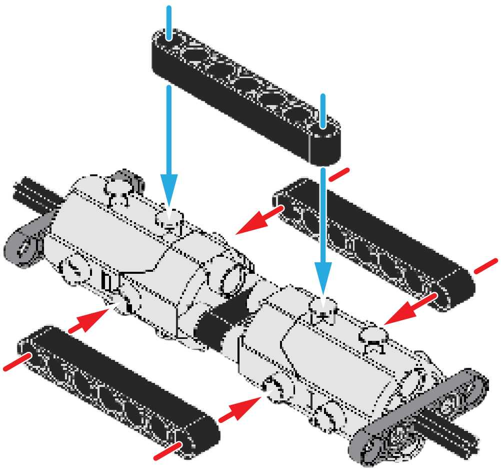

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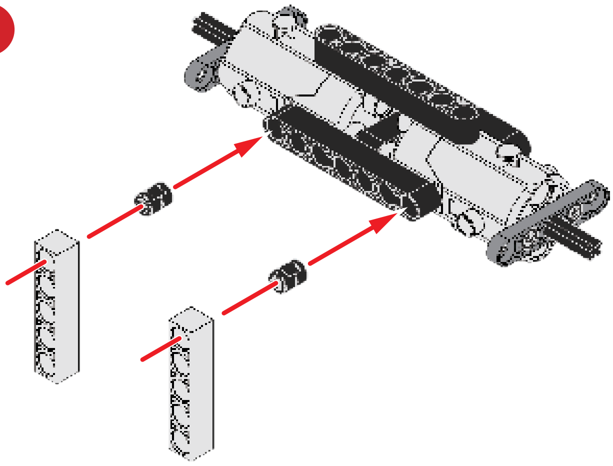

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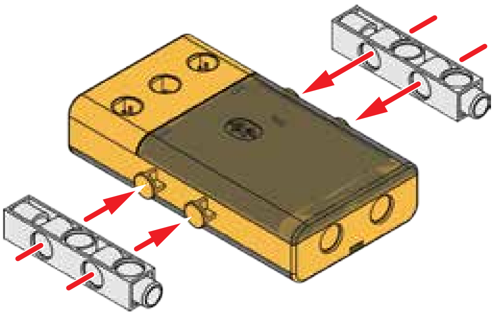

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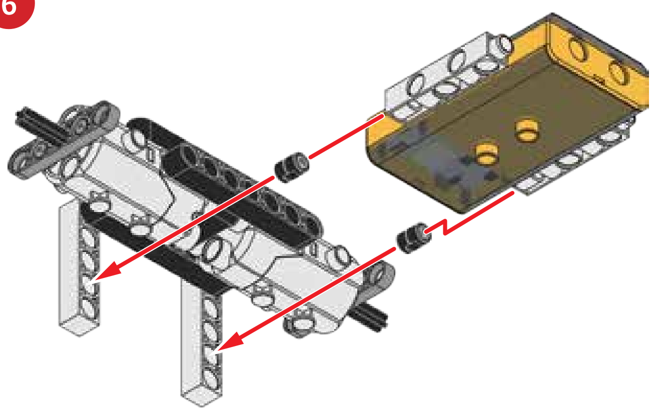

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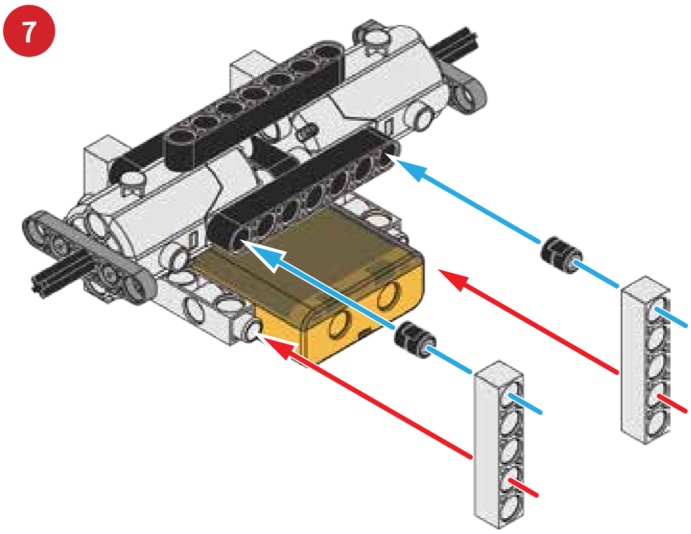

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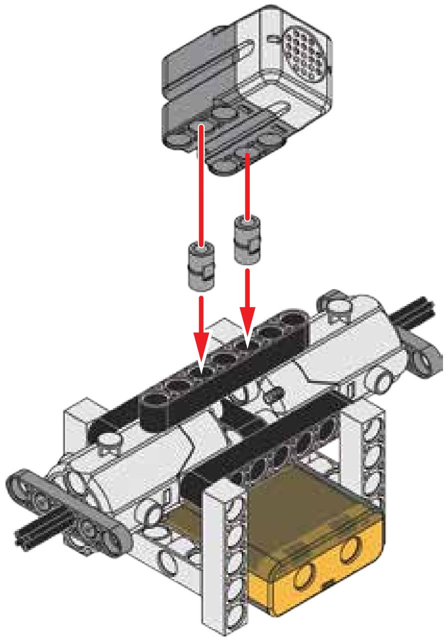

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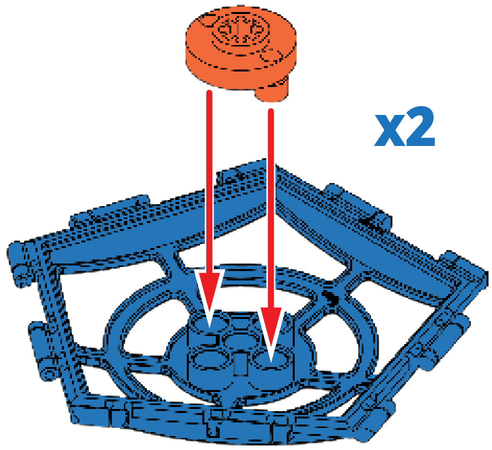
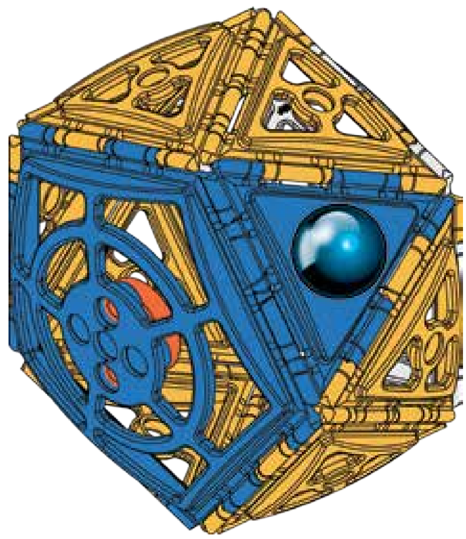


Wheels done!



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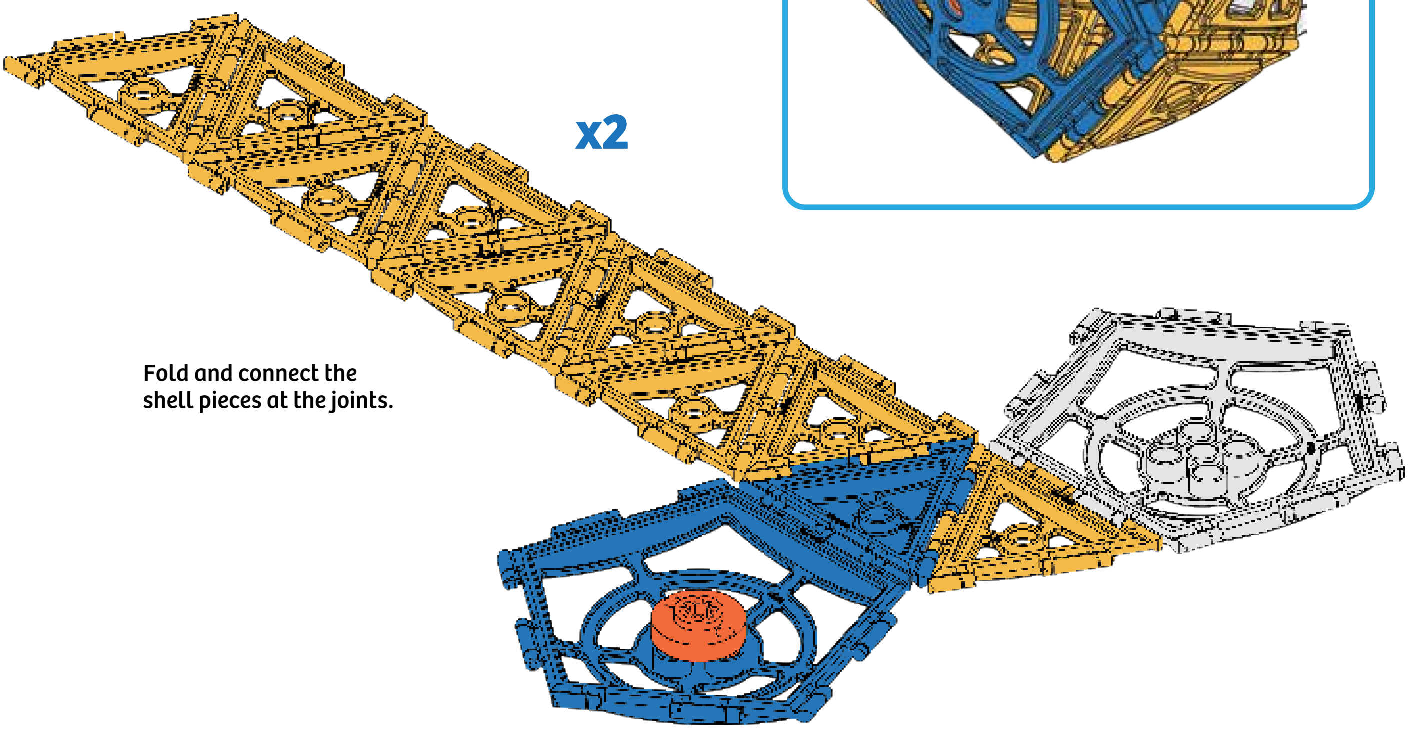
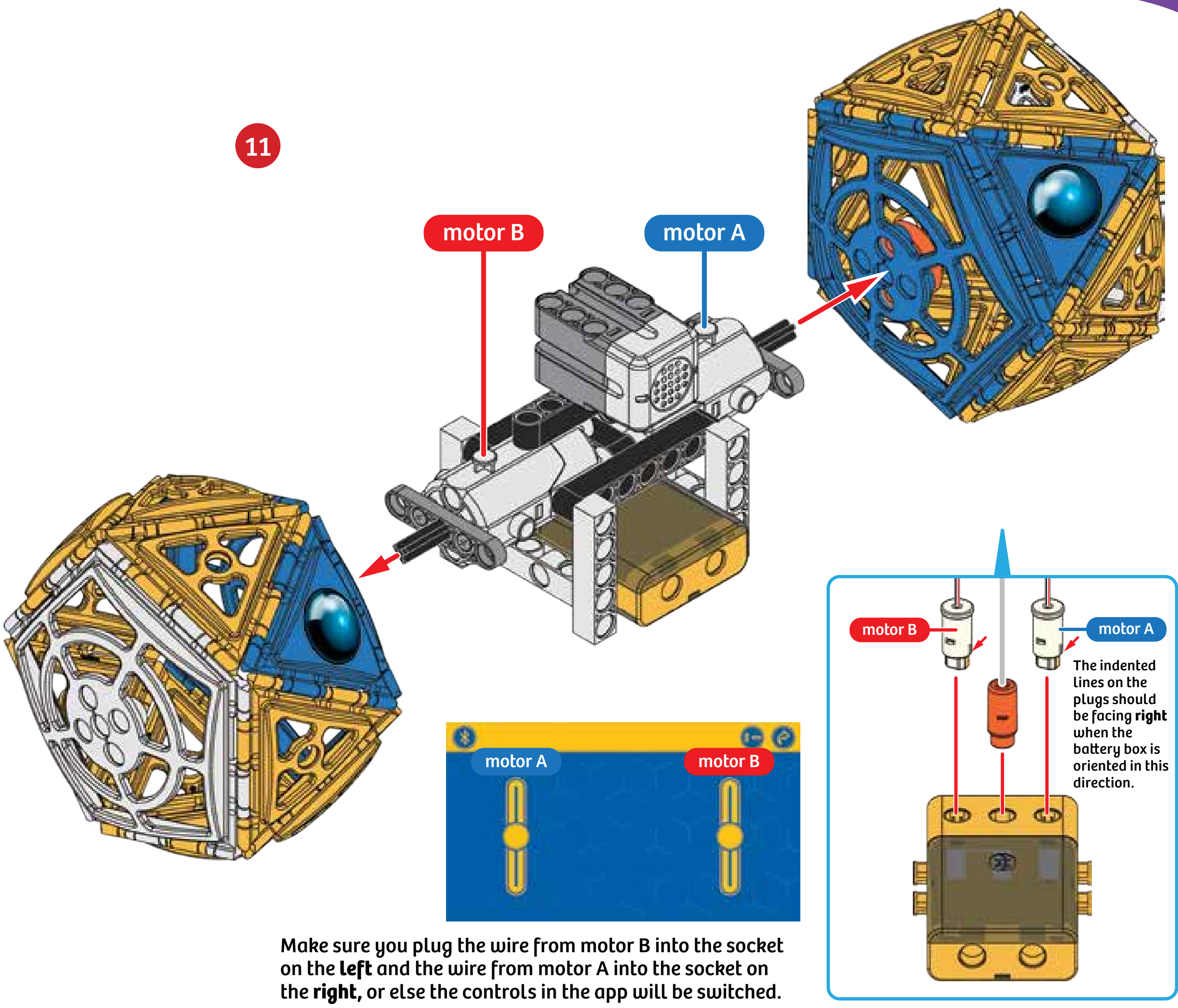
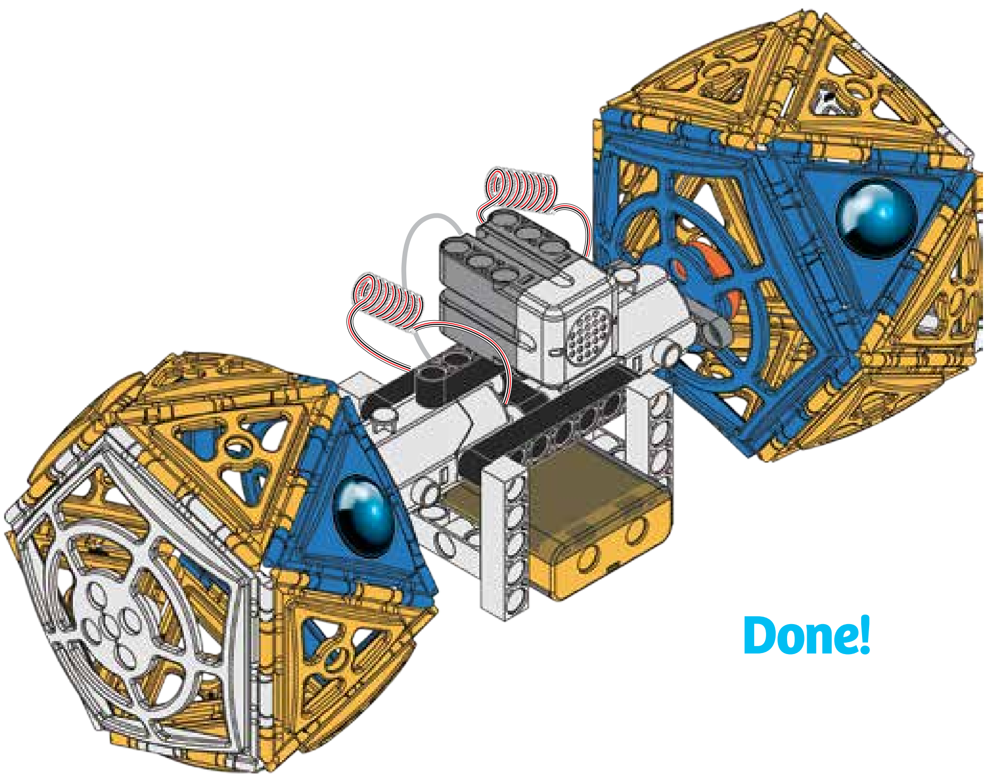


Fold and connect the shell pieces at the joints.

11



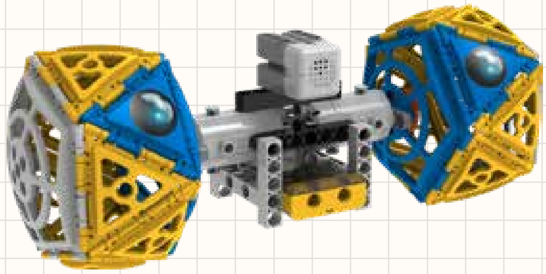
Make sure you plug the wire from motor B into the socket on the **left** and the wire from motor A into the socket on the **right**, or else the controls in the app will be switched.

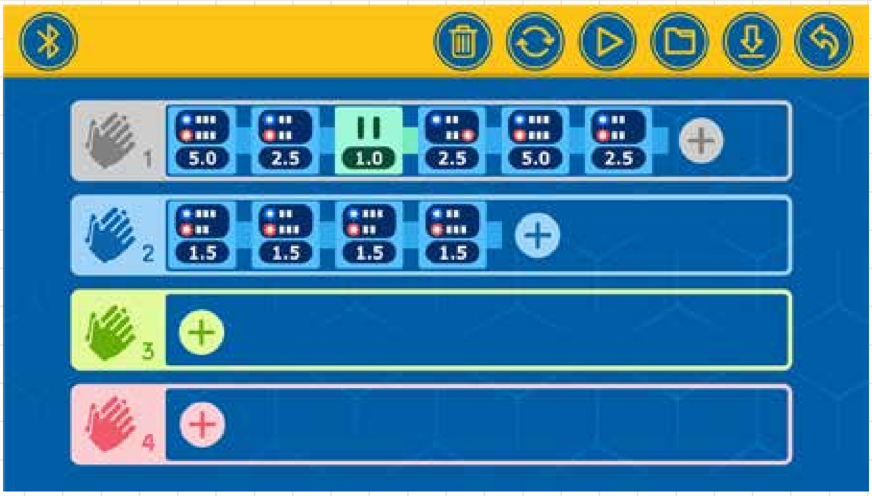


Done!

SAMPLE PROGRAM FOR THE JUMBO-WHEEL BOT

1. Place the Jumbo-Wheel Bot in a large, open area. You can try it on various types of flooring: wood, tile, laminate, and carpeting.
2. Load the app on your tablet or smartphone and establish a Bluetooth connection between the app and the robot. Refer back to page 7 for instructions.
3. In programming mode, load **Program 2.** The command sequences shown below are preset in Program 2. Tap the run button and clap your hands one to four times near the sound sensor.
4. Observe how the robot behaves for each sequence! Write your own program in the three- and four-clap sequences.





PROGRAM 2

1 Clap: Go forward, drive slower, rest, rotate, go forward, drive slower

2 Claps: Drive in an S-shaped curve

3 Claps: Create your own program!

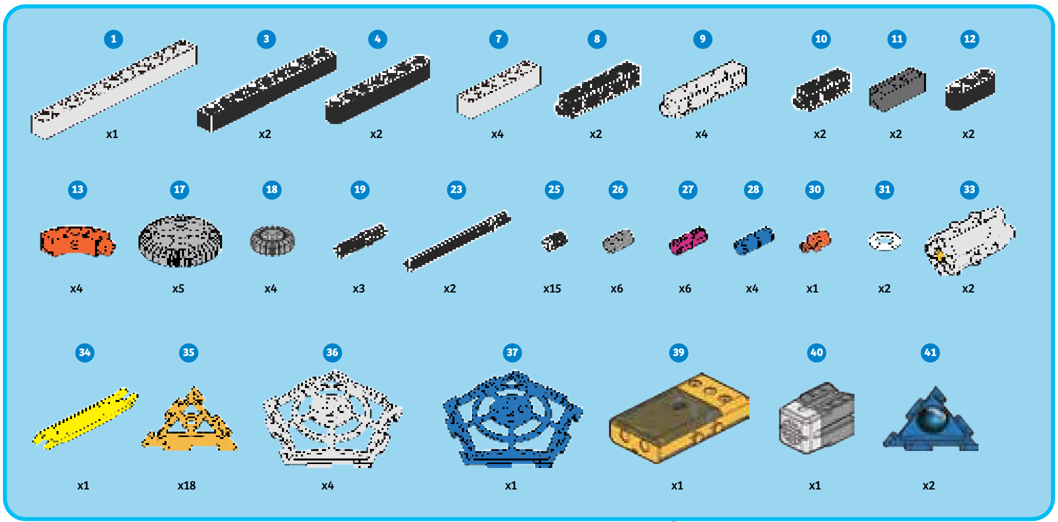
4 Claps: Create your own program!

Gigantic Wheels

Many trucks and industrial vehicles have huge wheels, like your Jumbo-Wheel Bot. Big wheels have many advantages over smaller ones. Big wheels provide more grip and traction than small wheels, because more surface area is in contact with the ground. Big wheels provide more ground clearance and better cornering. Big wheels also offer better braking. And big wheels can be much stronger and hold heavier loads than small wheels. This is why you often see big tires on construction vehicles and heavy-duty trucks. Of course, there are also some disadvantages, such as reduced speed, quicker wear, and higher fuel consumption.

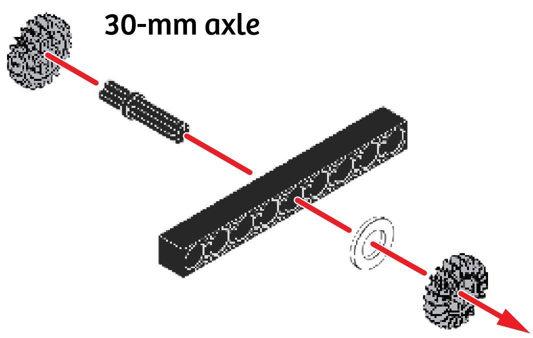
Compare the maneuverability of your Jumbo-Wheel Bot to that of the Super Sphere. Which one is faster? Which one can turn better on your floor?

BIGFOOT BOT



First, follow these assembly instructions to build the model. Then, you can use the model in remote control mode, or you can follow the instructions on the programming page immediately after these assembly instructions to run a program for this model.

1



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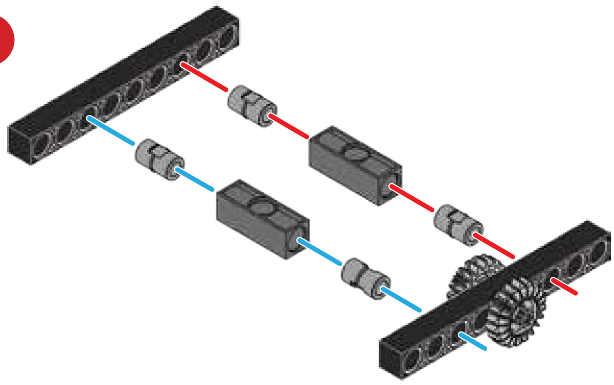

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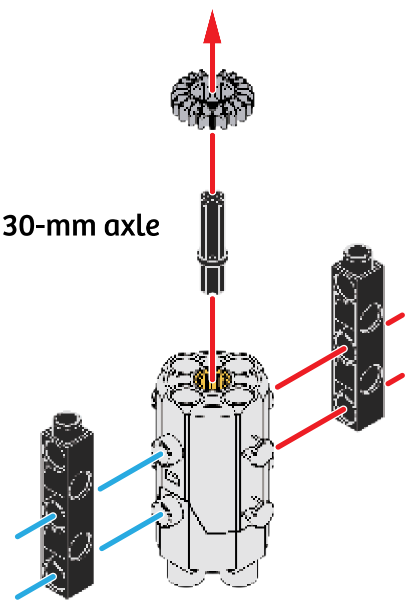

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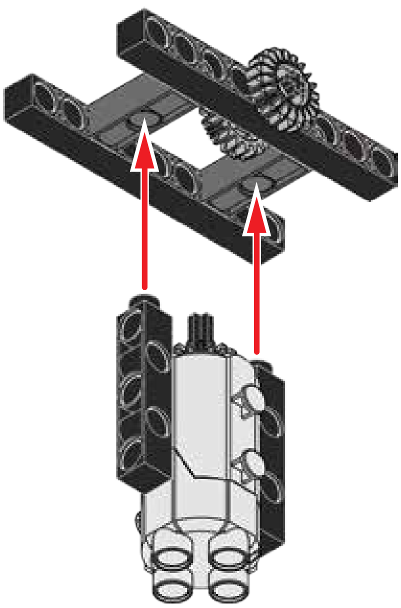

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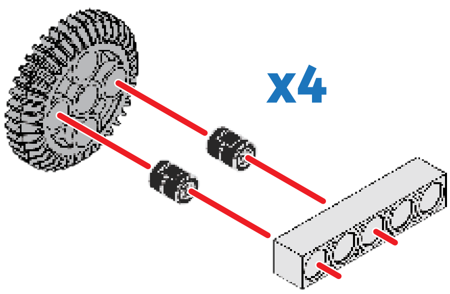

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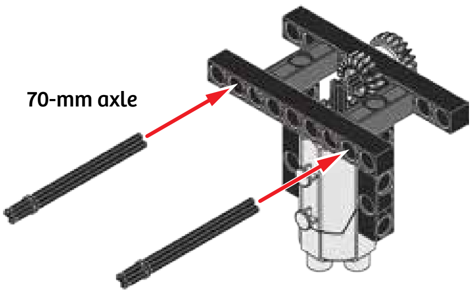

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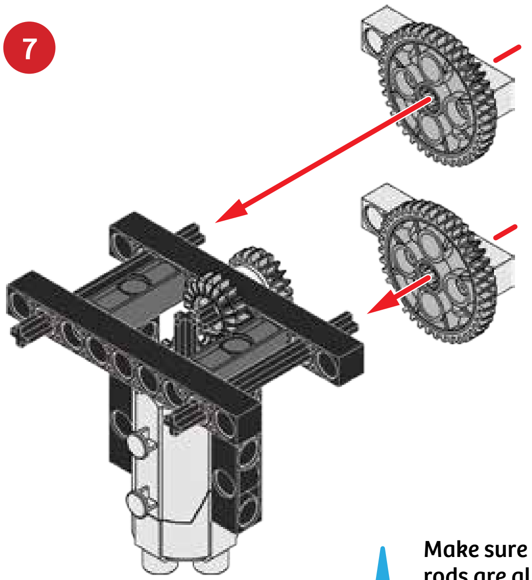
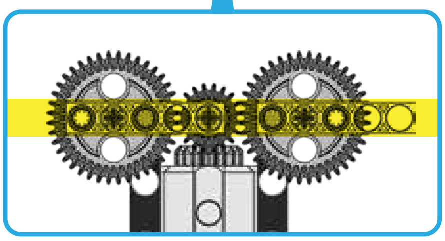


Make sure the rods are aligned.



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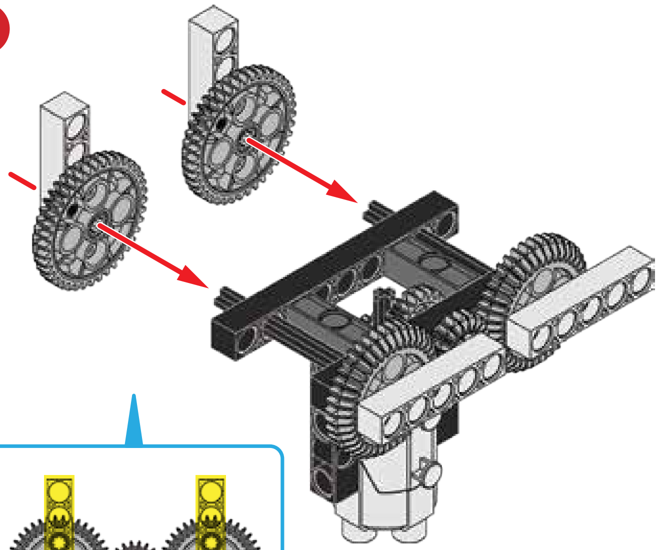
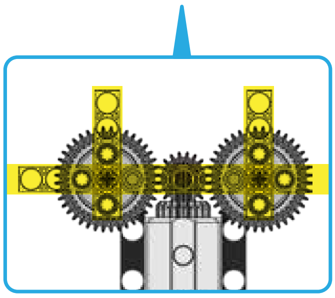
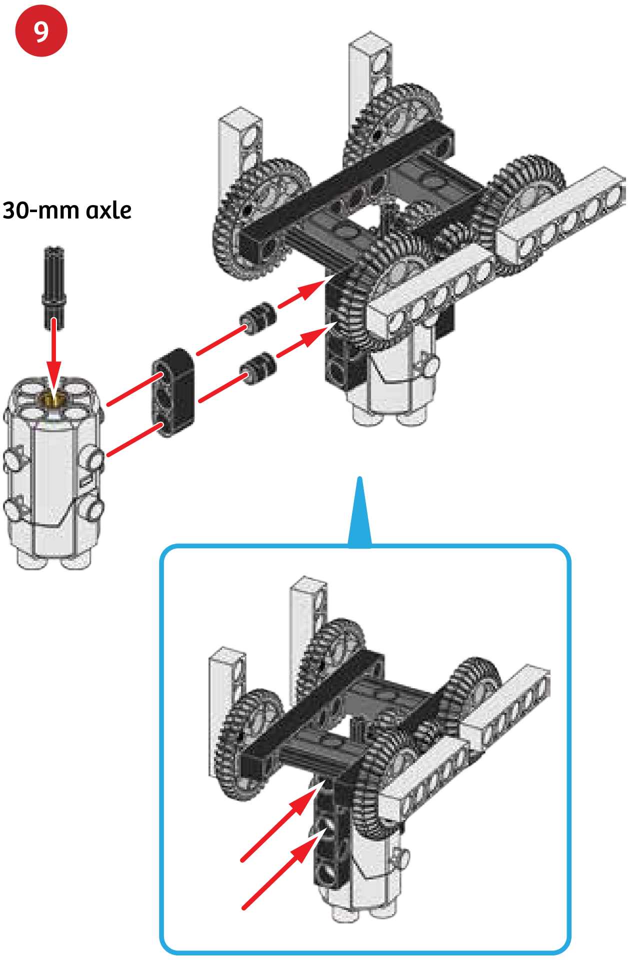




Make sure the rods are parallel to one another and perpendicular to the rods on the other side.

9



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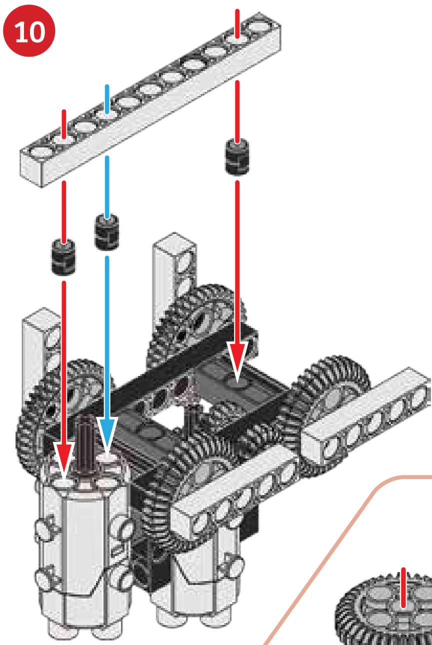

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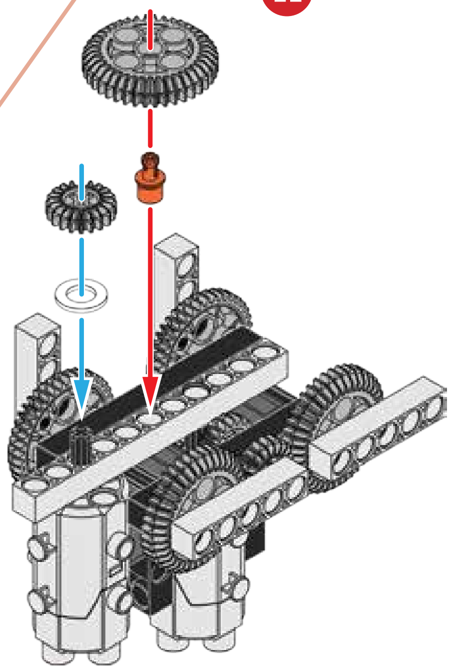

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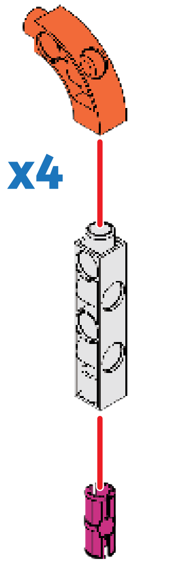

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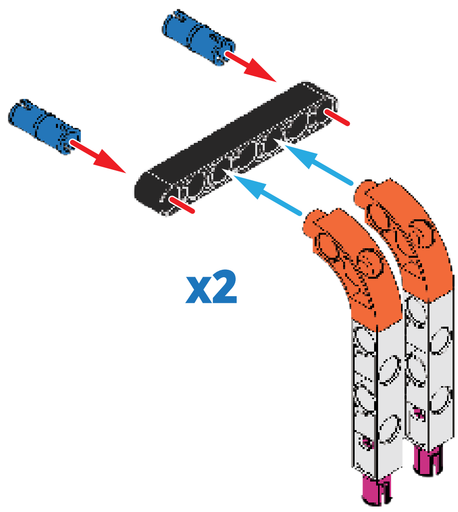

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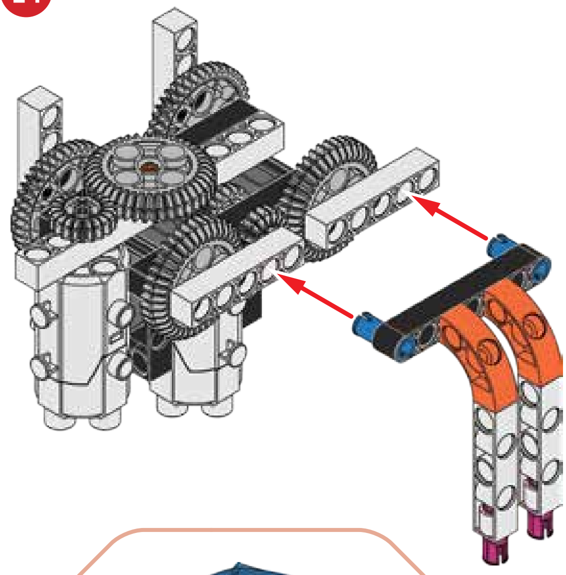

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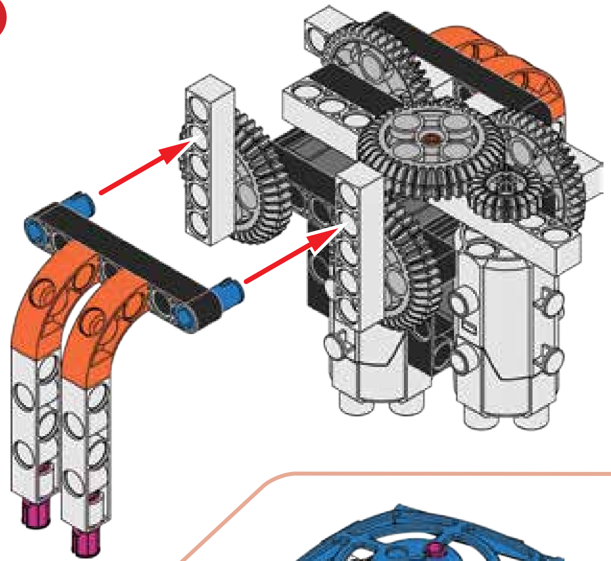

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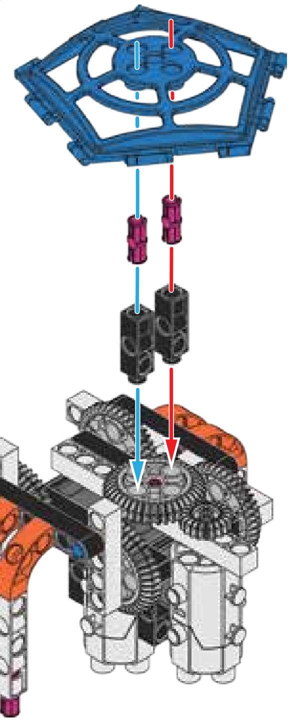

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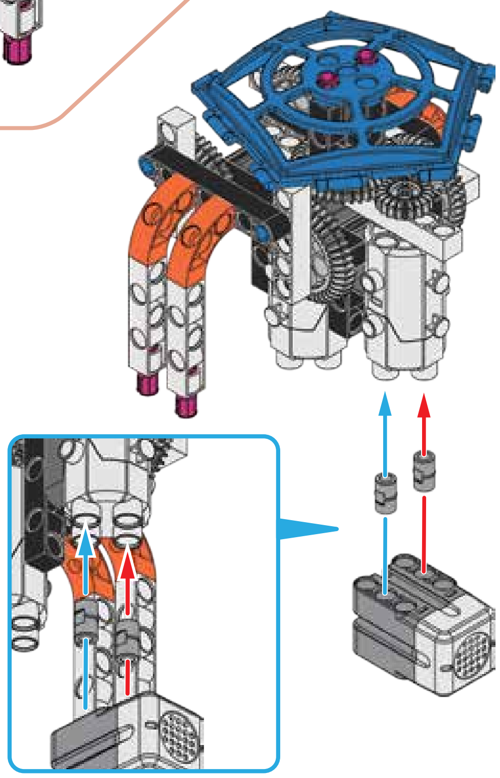

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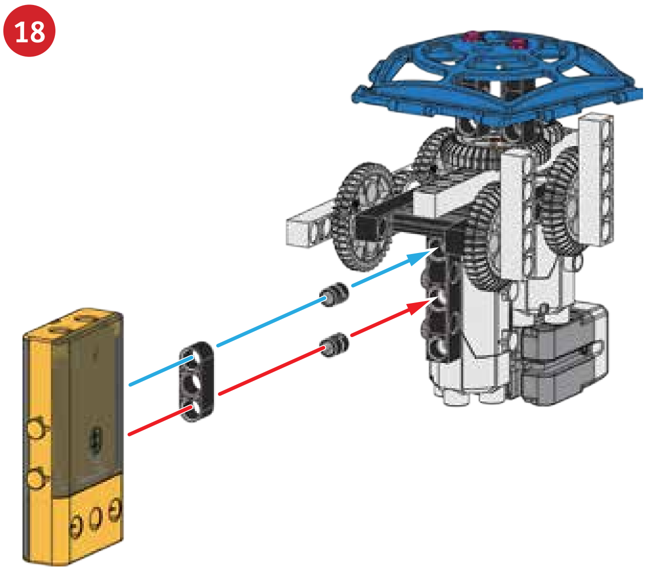

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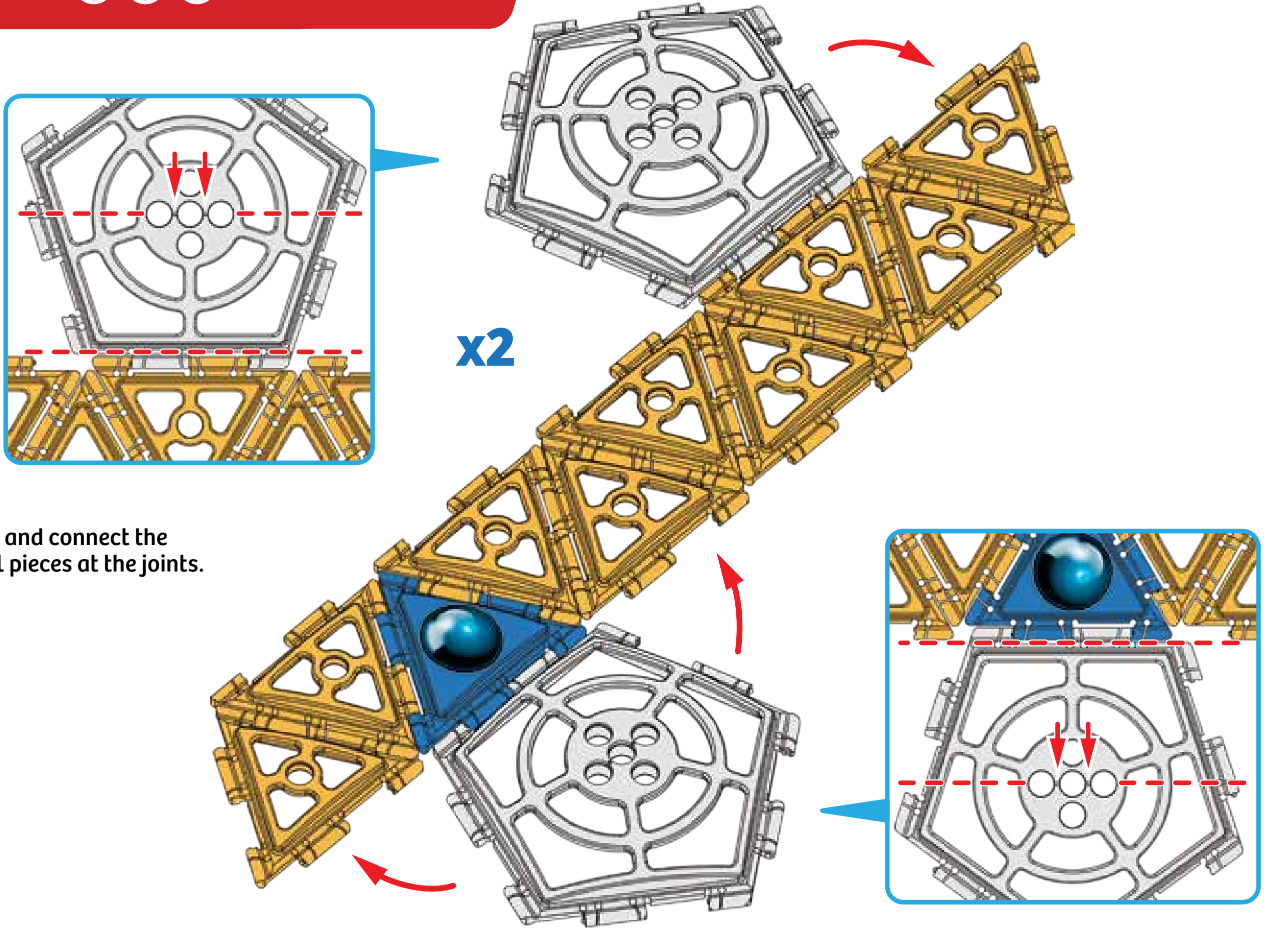
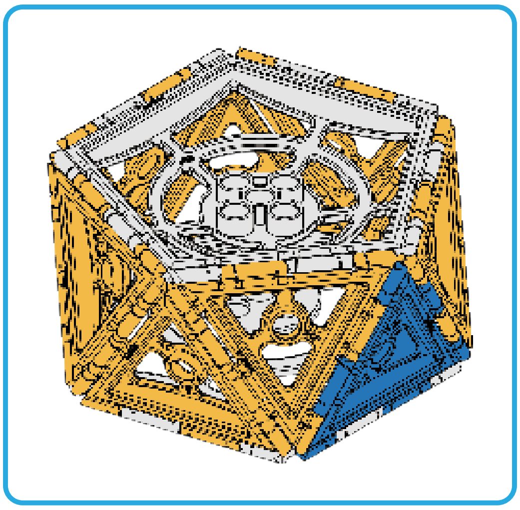


Fold and connect the shell pieces at the joints.

Feet done!



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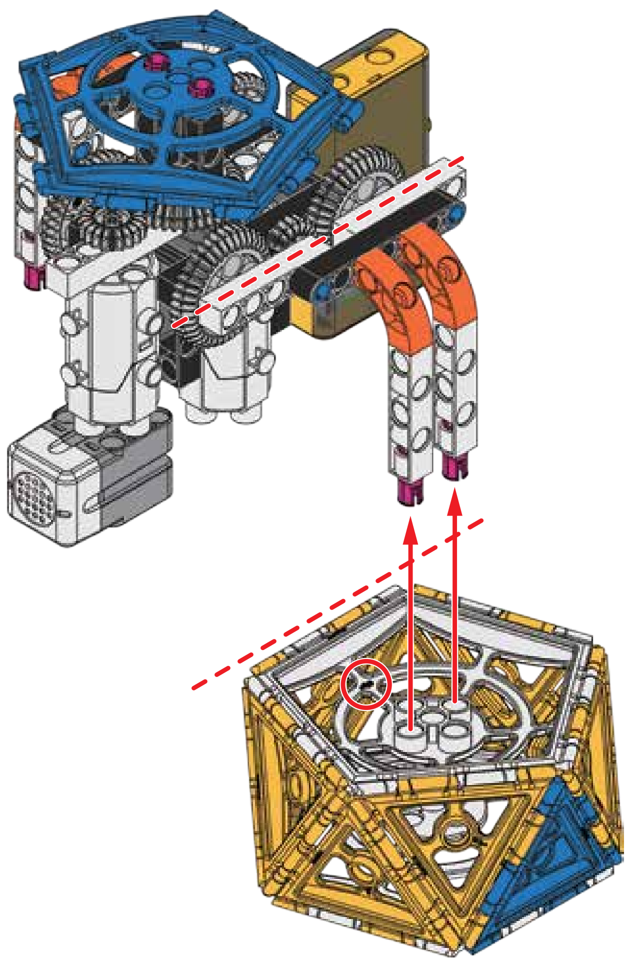

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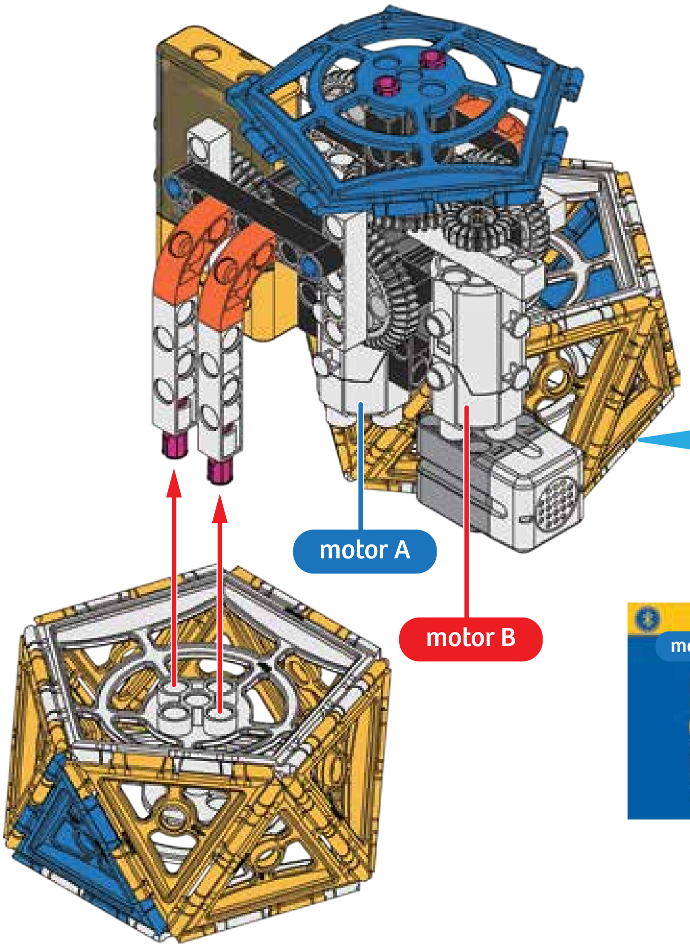
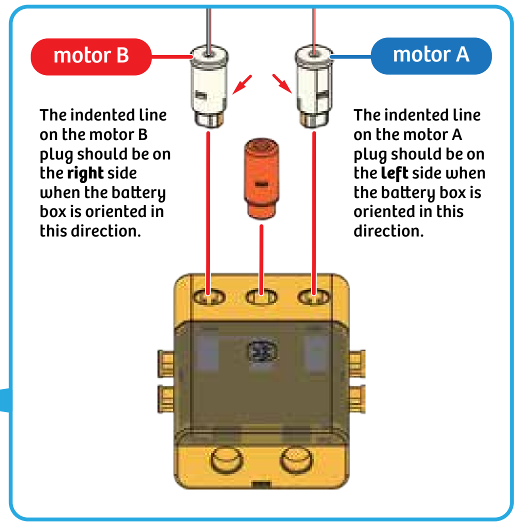
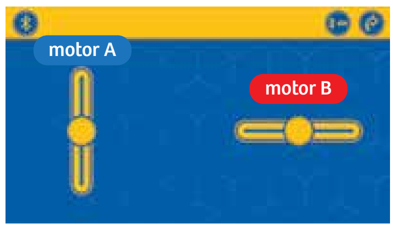
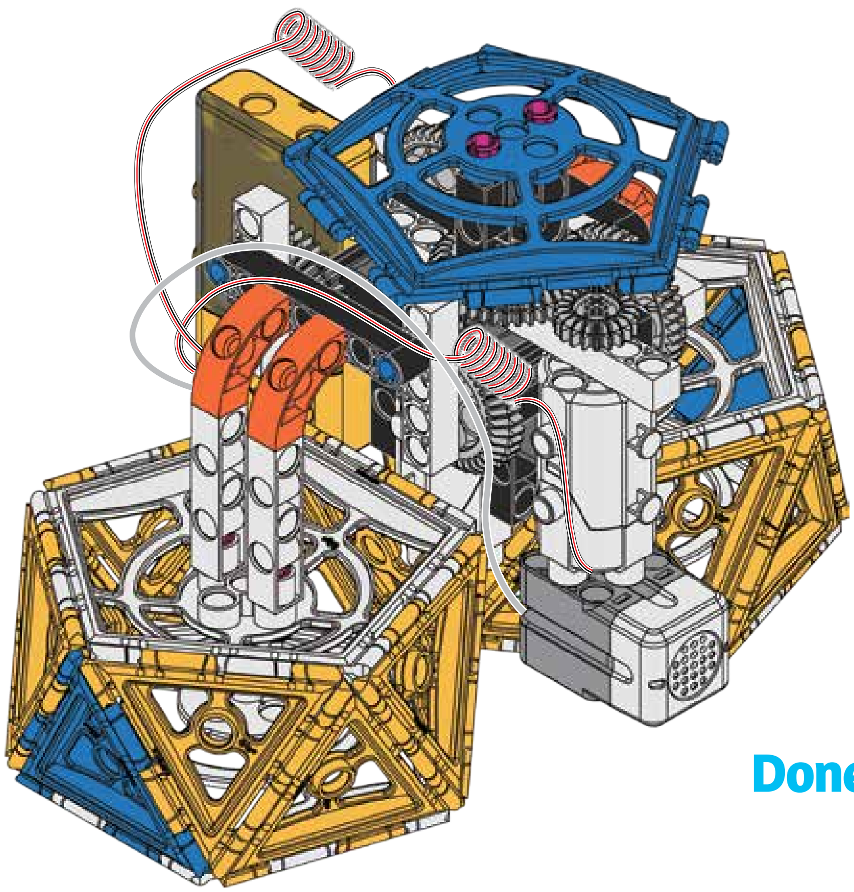






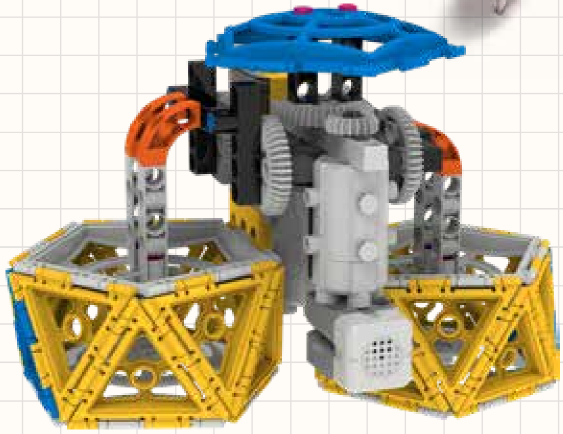
Make sure you plug the wire from motor B into the socket on the **left** and the wire from motor A into the socket on the **right,** or else the controls in the app will be switched.



Done!

SAMPLE PROGRAM FOR THE BIGFOOT BOT

1. Place the Bigfoot Bot in an open area.
2. Load the app on your tablet or smartphone and establish a Bluetooth connection between the app and the robot. Refer back to page 7 for instructions.
3. In programming mode, load **Program 3.** The command sequences shown below are preset in Program 3. Tap the run button and clap your hands one to four times near the sound sensor.
4. Observe how the robot behaves for each sequence!



PROGRAM 3

1 Clap: Go forward, walk faster

2 Claps: Spin head faster and faster

3 Claps: Play a simple song

4 Claps: Play a simple song

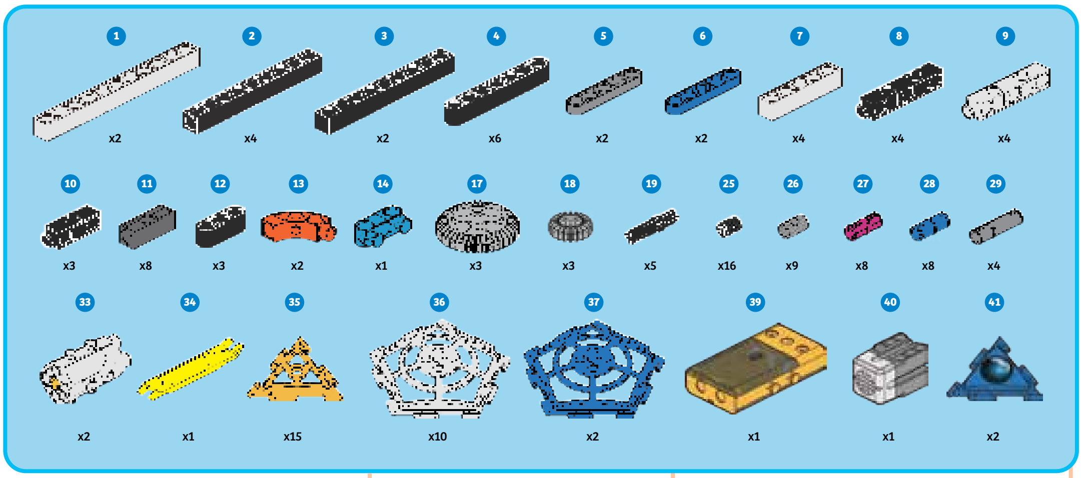
Walking Robots

Legged robots are robots that walk on mechanical limbs. While many robots roll around on wheels — which are mechanically very efficient — legged robots have the ability to walk over obstacles and surfaces that wheeled robots cannot move over. Legged robots can go places that wheeled robots cannot. Designing a robot to walk on legs is more complicated than designing one that rolls on wheels. The ability for various animals, humans included, to walk on legs is actually quite a feat of nature. Robot engineers often look to nature for inspiration when it comes to designing legged robots.

Legged robots can have any number of legs. The more legs, the more stable the robot is. But robots with fewer legs are more maneuverable. Legged robots must keep their balance while shifting from one leg to another. One way this has been achieved, as with the Bigfoot Bot, is to make the feet very large so the center of gravity always stays above the foot that is on the ground. This keeps the robot from falling over.

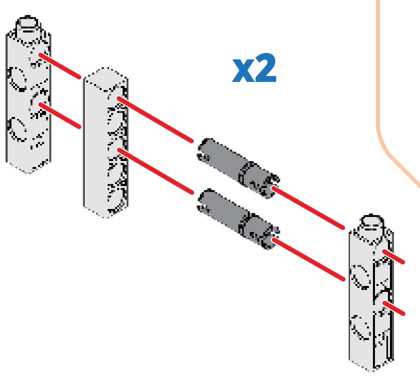
Walking robots also use sensors like gyroscopes and accelerometers to tell their motors how to move in order to stay balanced. It takes a lot of power to move a robot's legs, and when that power comes from heavy battery packs inside the robot's body, it can pose quite a challenge. As batteries get lighter, and sensor systems get more advanced, it is becoming increasingly popular for robots to mimic human and animal walking motion.

PENGUIN BOT



First, follow these assembly instructions to build the model. Then, you can use the model in remote control mode, or you can follow the instructions on the programming page immediately after these assembly instructions to run a program for this model.

1



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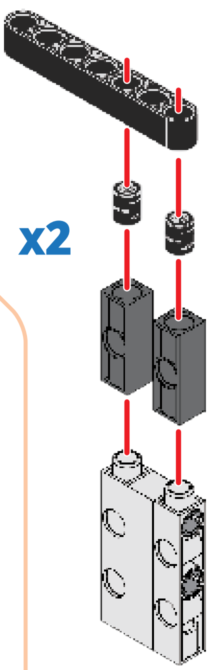

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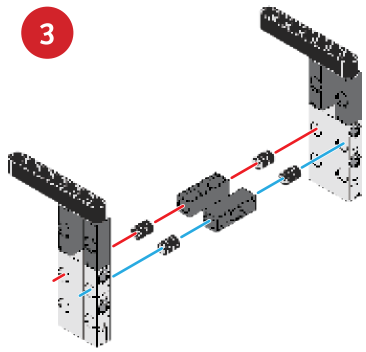

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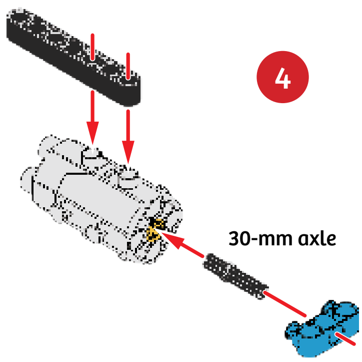

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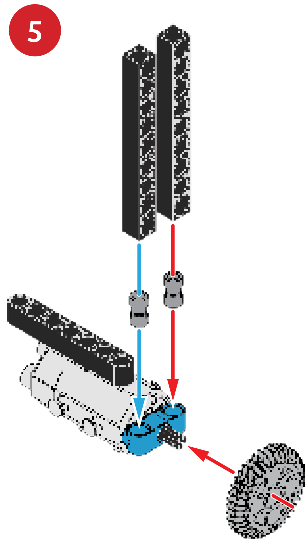

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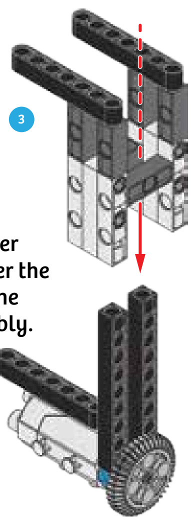
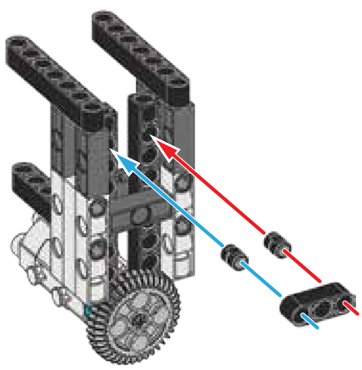


Slide the upper assembly over the two rods of the lower assembly.

7



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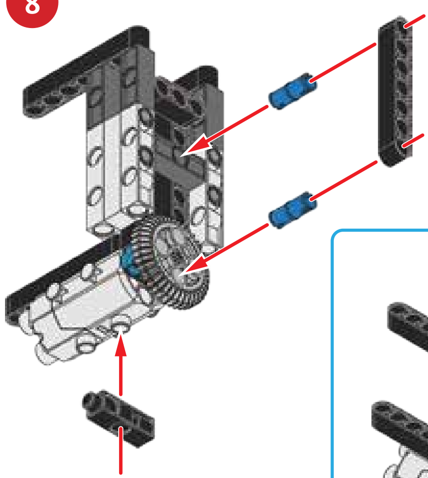
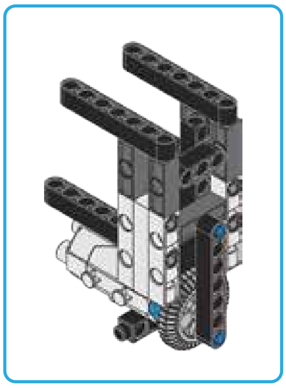


Rotate the gray gear and make sure the upper assembly can move up and down smoothly.

Head assembly done!



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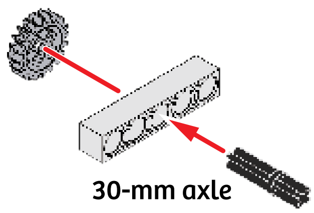

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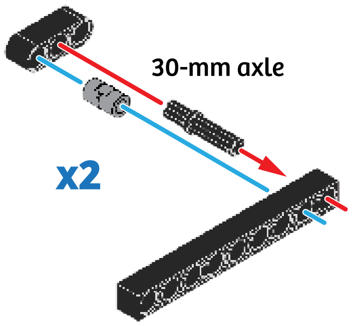

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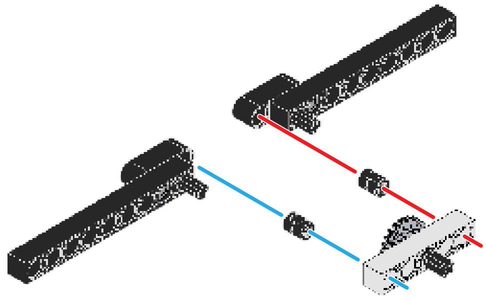

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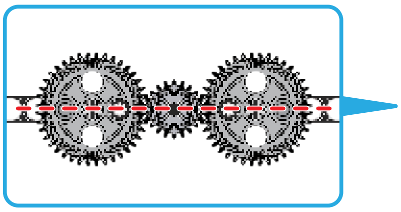
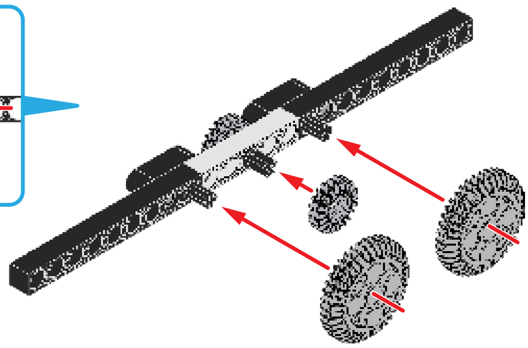


Make sure the middle holes are aligned.



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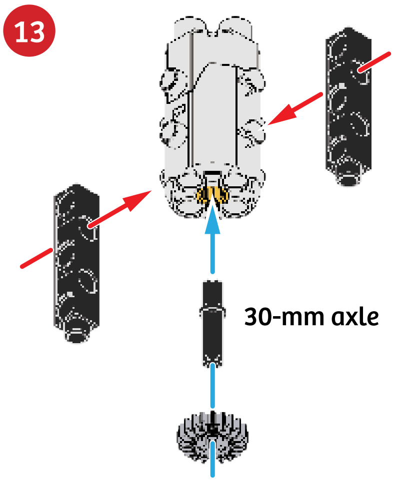

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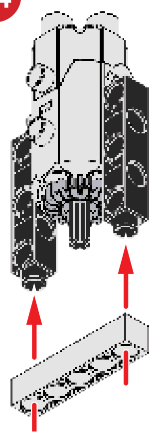

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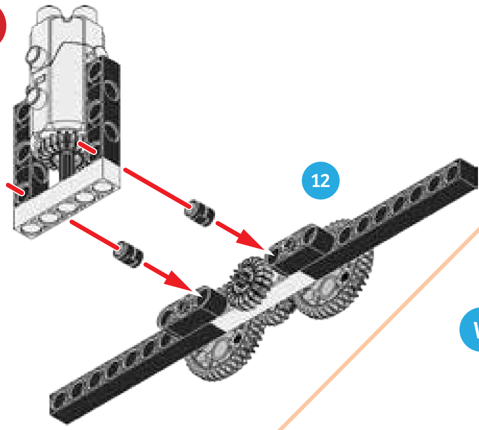

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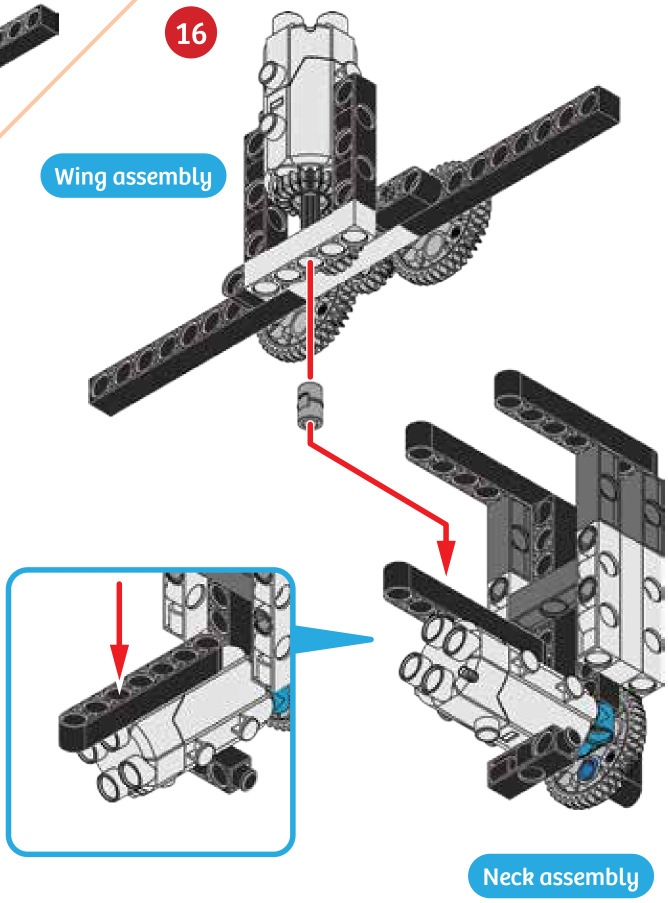
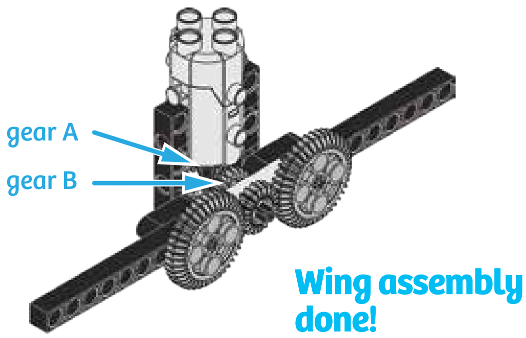


Make sure the motor is positioned vertically. Rotate gear A and make sure gear B turns smoothly.



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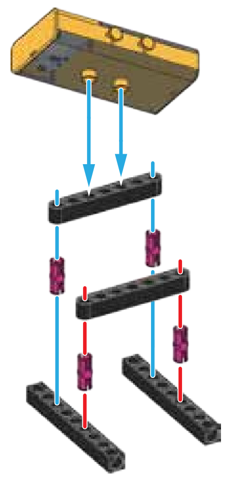

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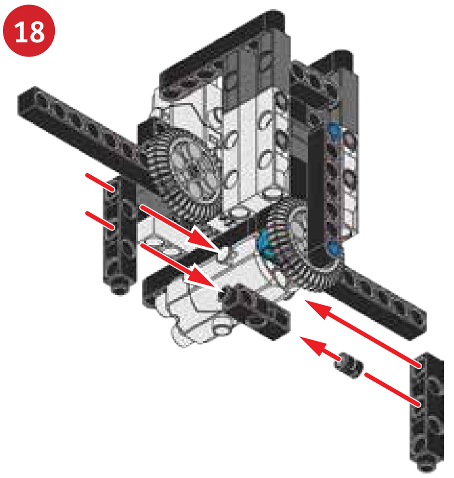

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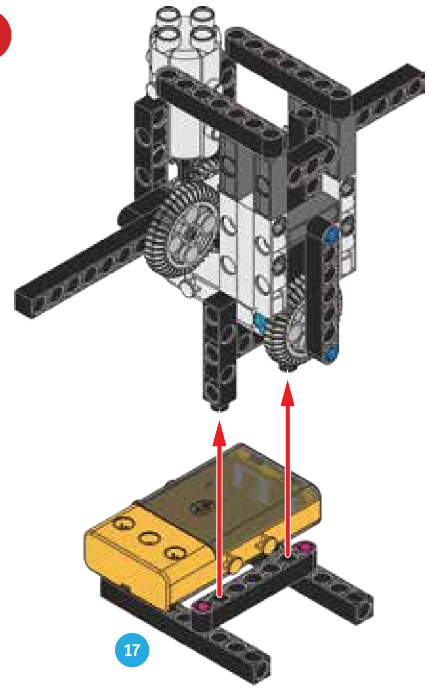

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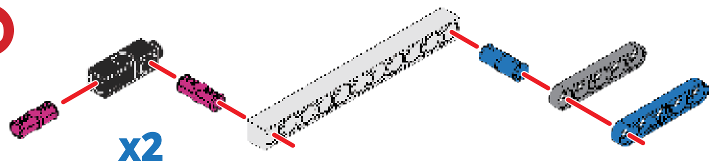

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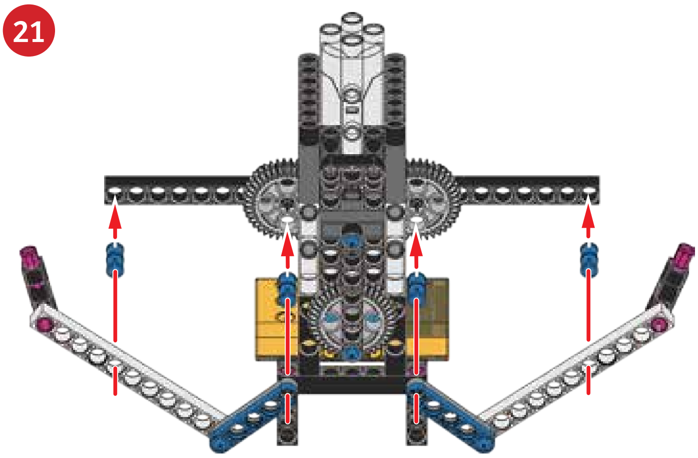

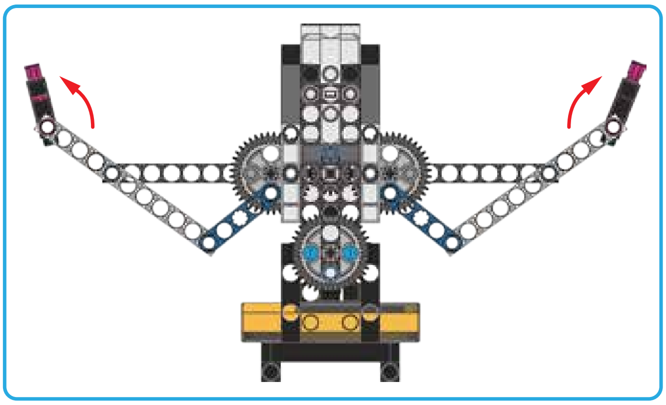

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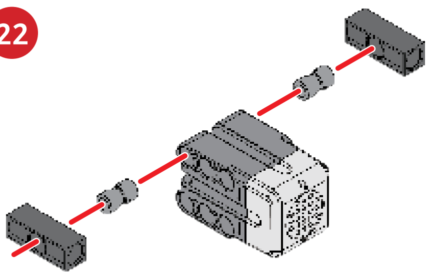

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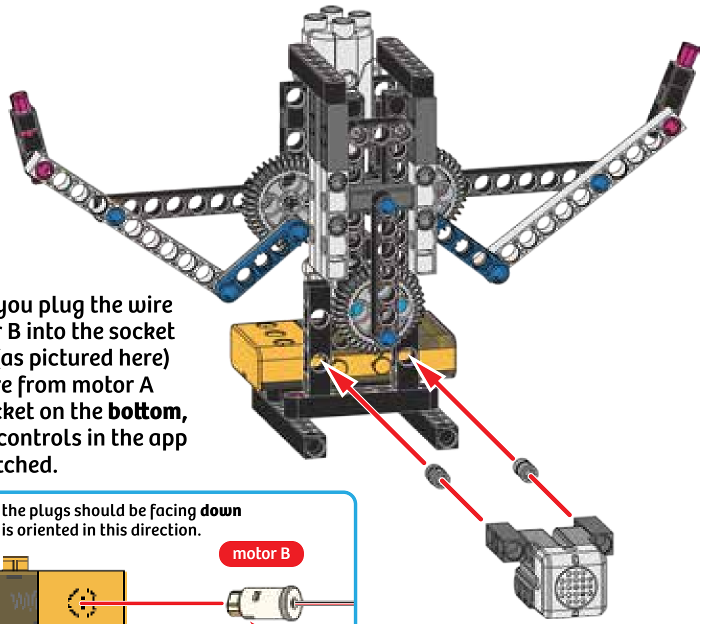
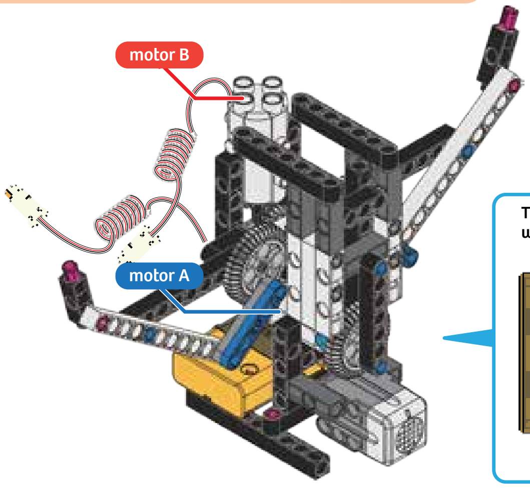
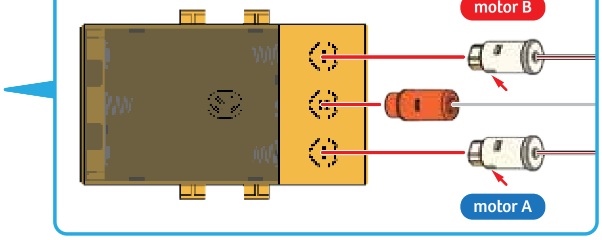


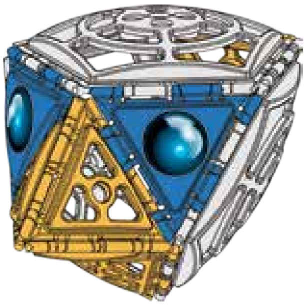


Make sure you plug the wire from motor B into the socket on the **top** (as pictured here) and the wire from motor A into the socket on the **bottom**, or else the controls in the app will be switched.

The indented lines on the plugs should be facing **down** when the battery box is oriented in this direction.



Head assembly done!



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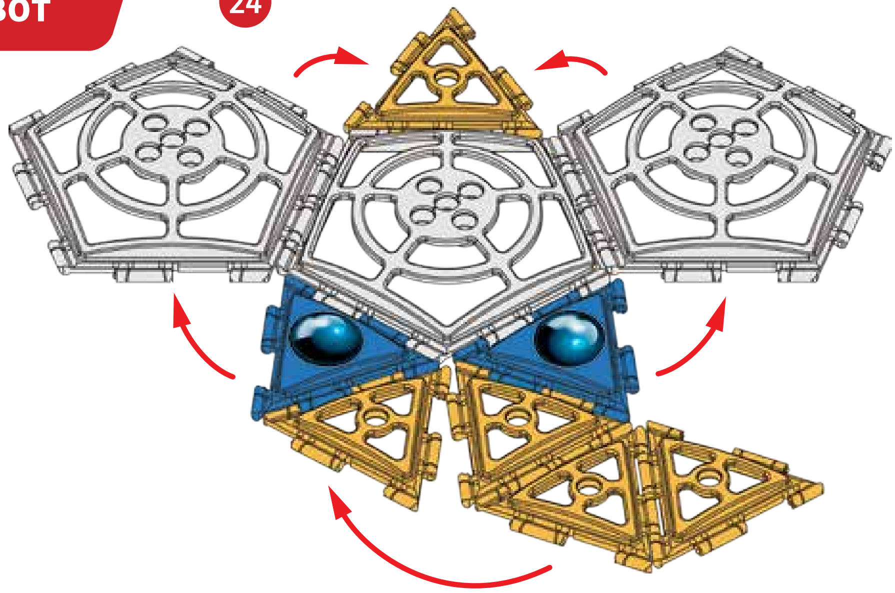
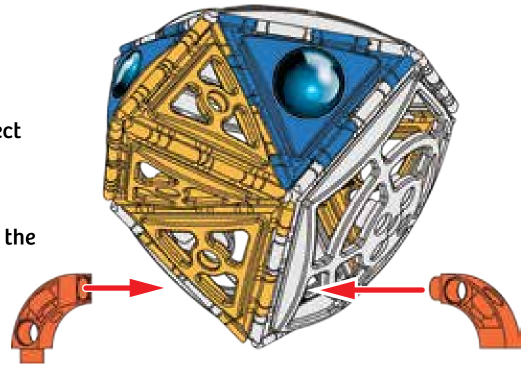
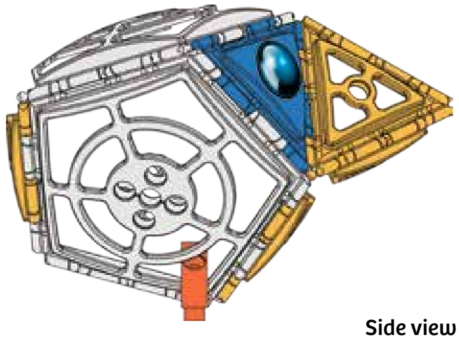


25

Tip: You can connect the orange curved rods together first and then pass the assembly through the holes in the shell.





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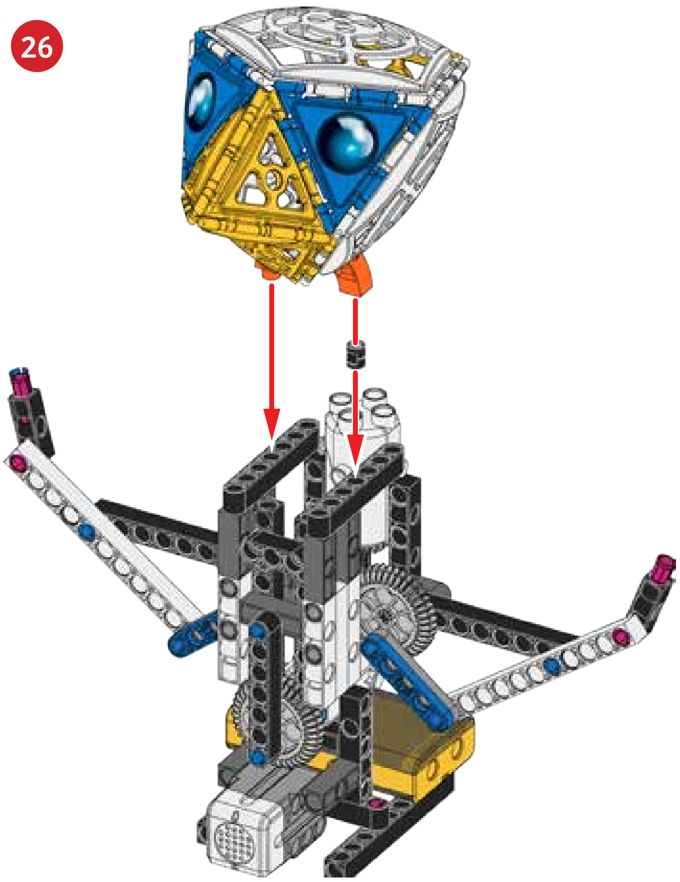

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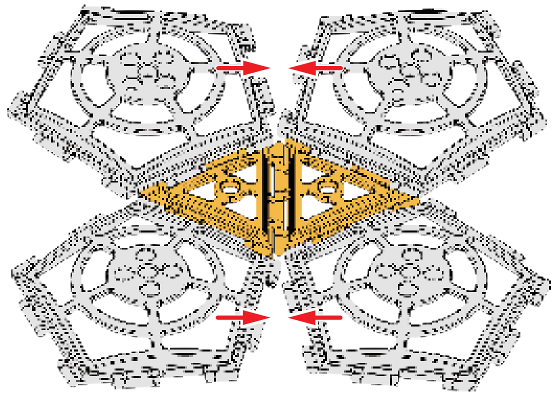
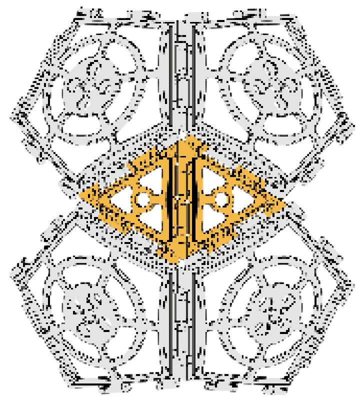
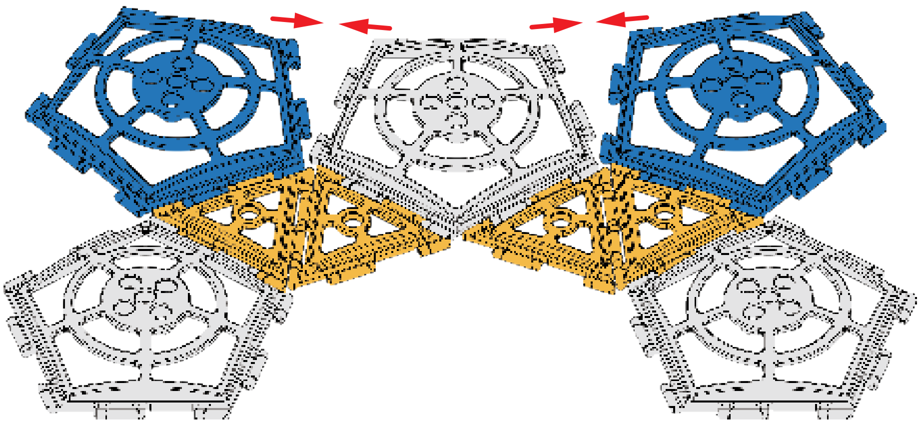
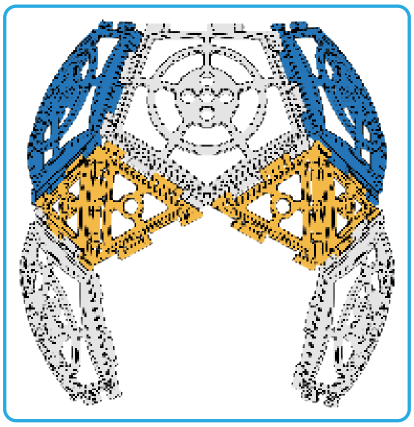




Back body assembly done!

28

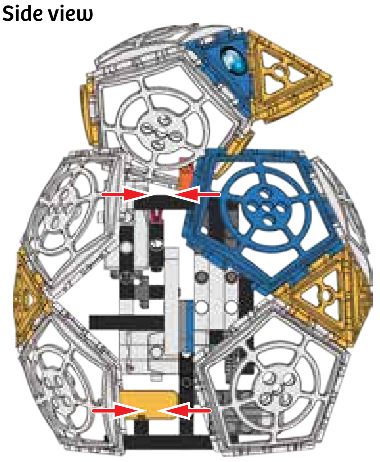




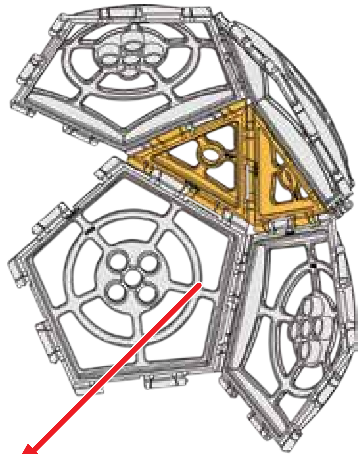
Front body assembly done!

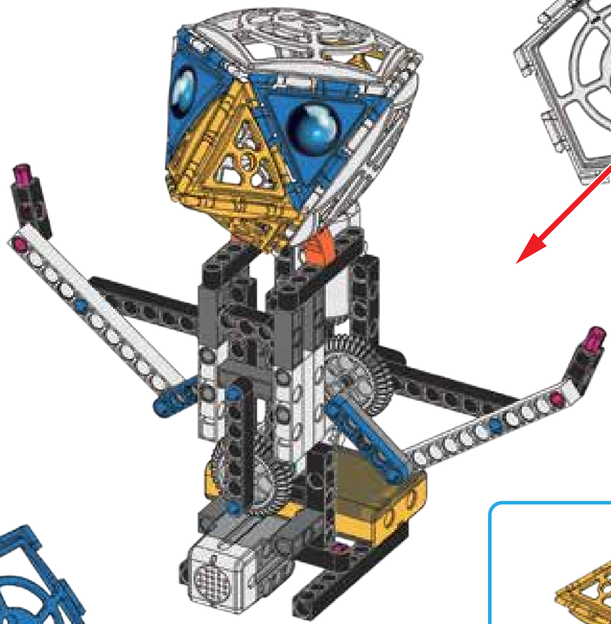
29

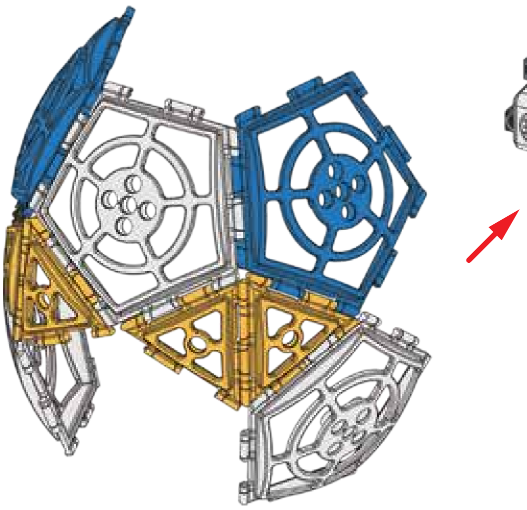
Side view



Back body

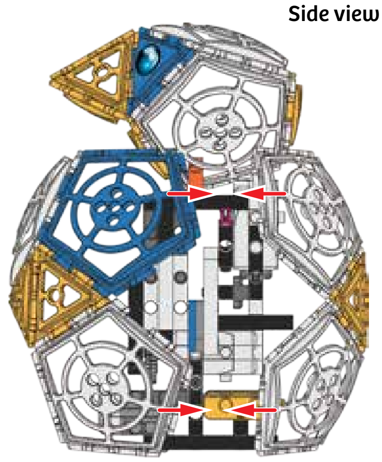






Front body

Side view



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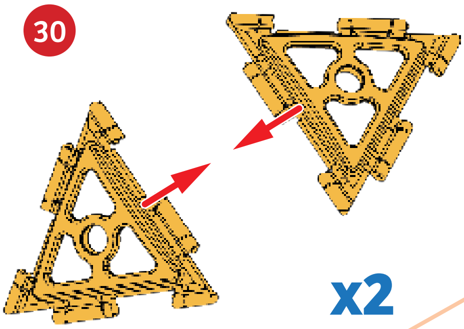

x2

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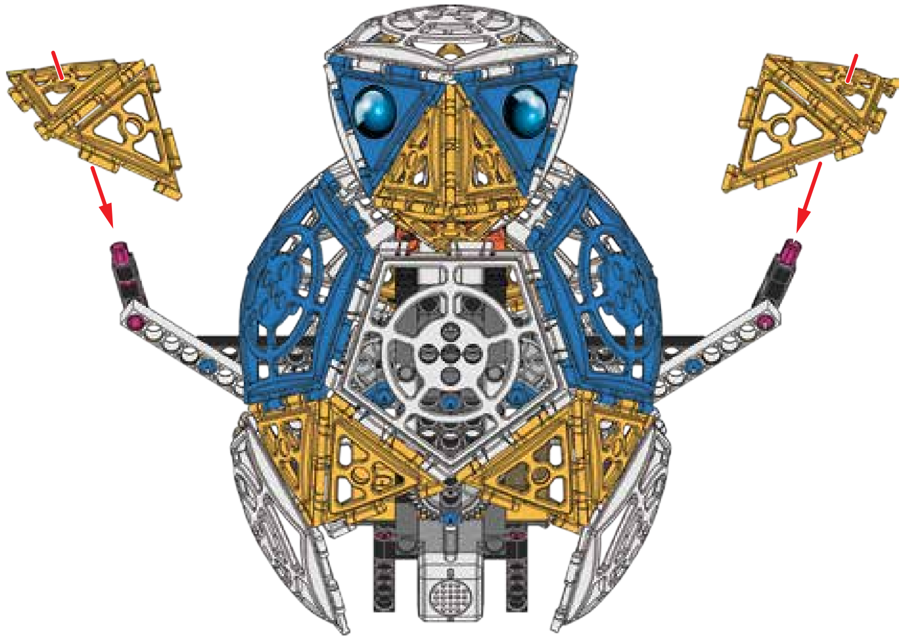
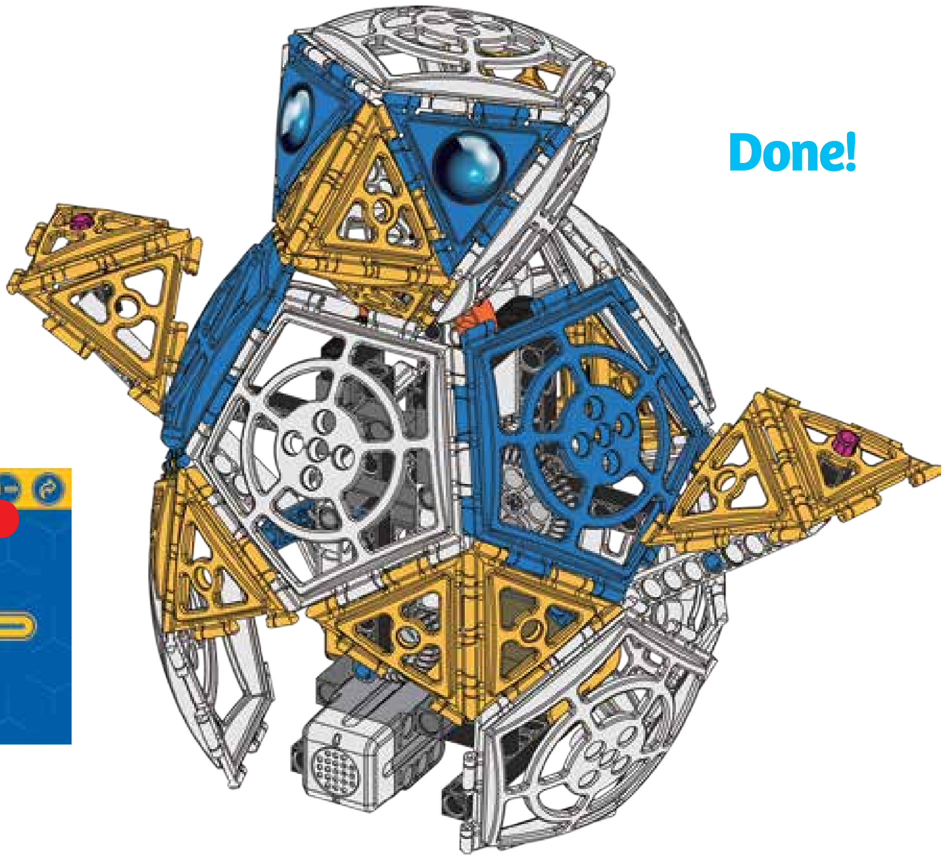
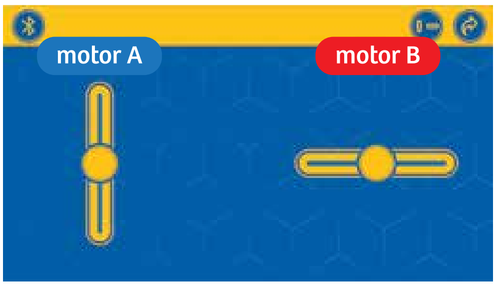




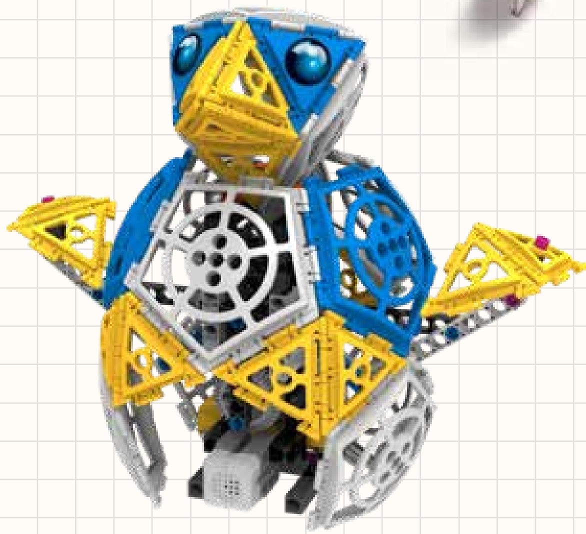
Done!



PROGRAMMING

SAMPLE PROGRAM FOR THE PENGUIN BOT

1. Place the Penguin Bot on a table or on the floor.
2. Load the app on your tablet or smartphone and establish a Bluetooth connection between the app and the robot. Refer back to page 7 for instructions.
3. In programming mode, load **Program 4.** The command sequences shown below are preset in Program 4. Tap the run button and clap your hands one to four times near the sound sensor.
4. Observe how the robot behaves for each sequence! Write your own program in the four-clap sequence.



PROGRAM 4

1 Clap: Flap wings, shake head

2 Claps: Shake wings, shake wings faster, rest, shake wings again

3 Claps: Move head

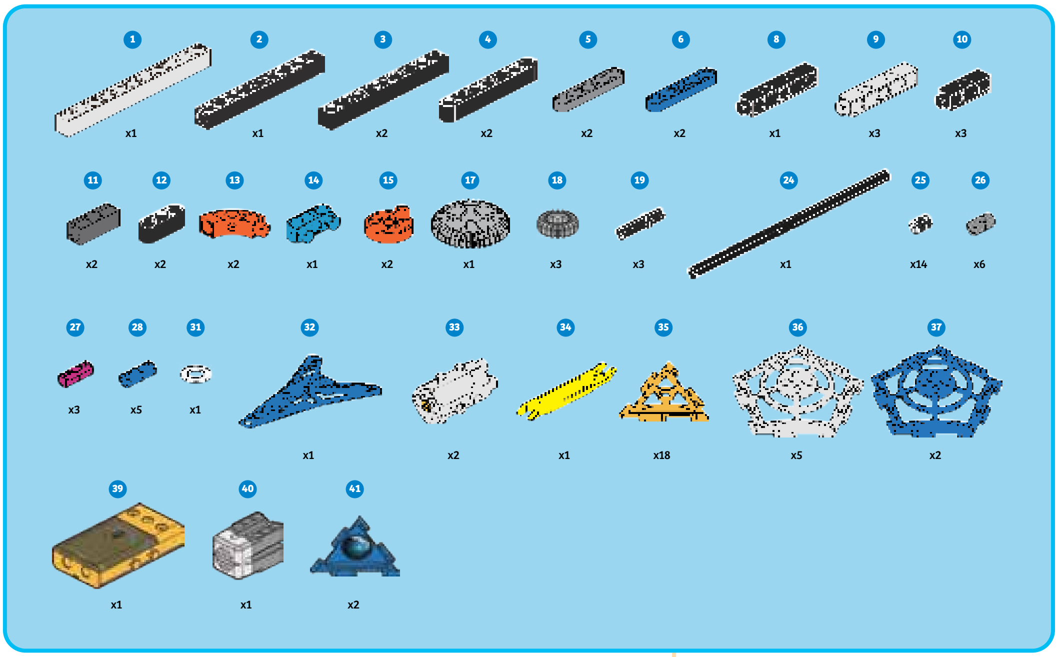
4 Claps: Create your own program!

Robotic Animals

Biomimetics is a term used to describe the imitation of things from the natural world for the purposes of performing tasks or solving problems. Humans take inspiration from the structures and materials of the natural world, and find ways to artificially mimic them. Examples include airplane wings that mimic bird wings, sticky materials that mimic the sticky footpads of a gecko, and strong ceramics that mimic the strong composition of seashells.

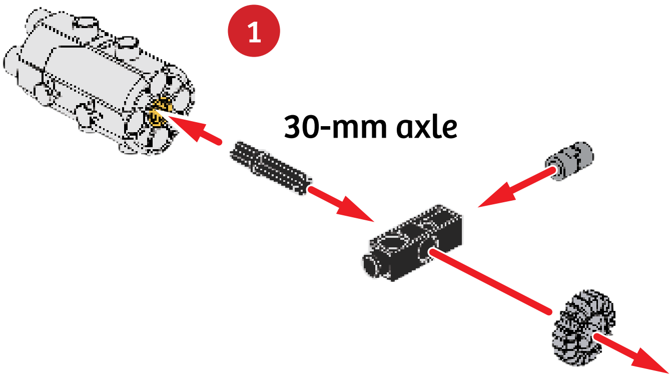
This robot model mimics the way a penguin flaps its wings and shakes its head. Penguins are birds that have evolved to swim very well, but they cannot fly at all. Their wings have evolved into flippers and their sleek, streamlined bodies help them glide through the water. On land, they are slow and seemingly awkward. While on land, penguins are slow and seemingly awkward, they glide through the water thanks to their streamlined bodies and wings that have evolved into flippers!

DANCING BOT



First, follow these assembly instructions to build the model. Then, you can use the model in remote control mode, or you can follow the instructions on the programming page immediately after these assembly instructions to run a program for this model.

1



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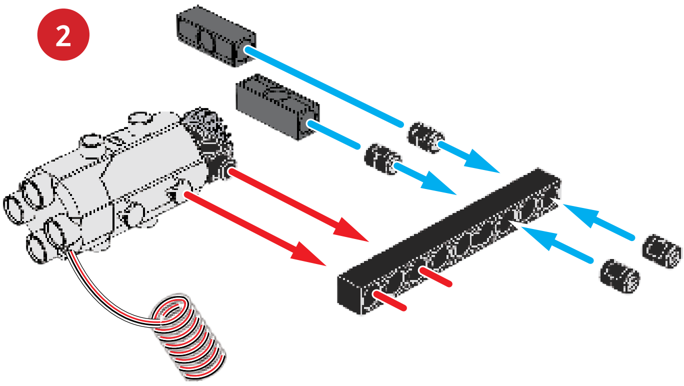

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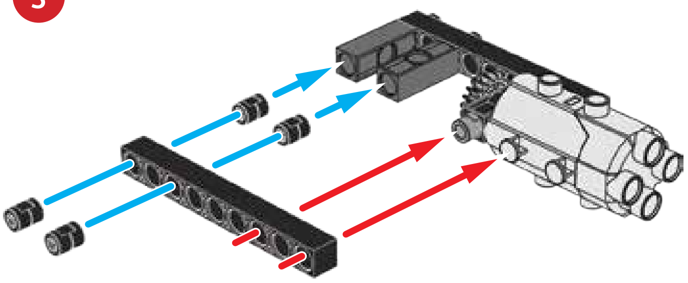

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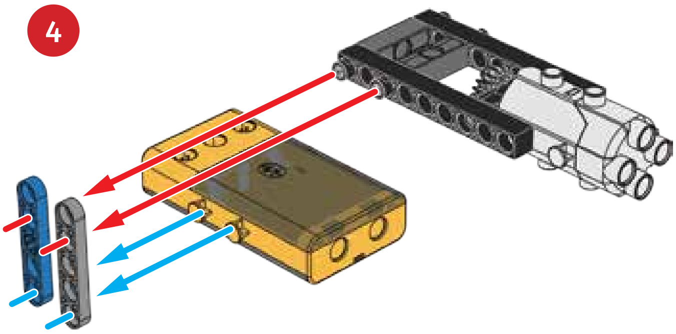

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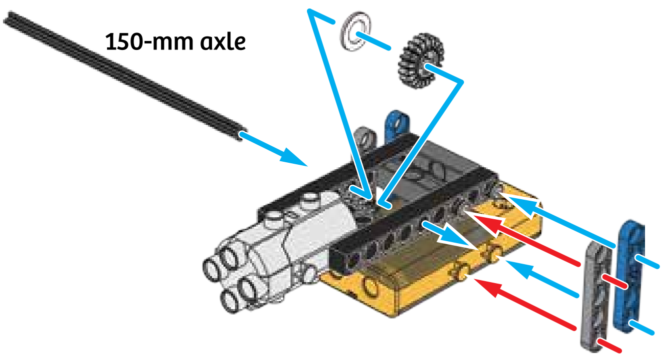

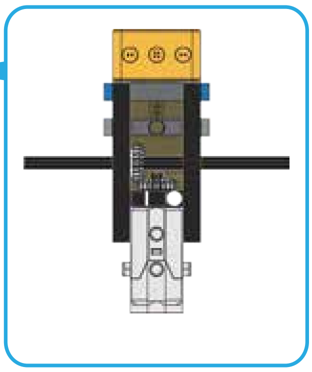

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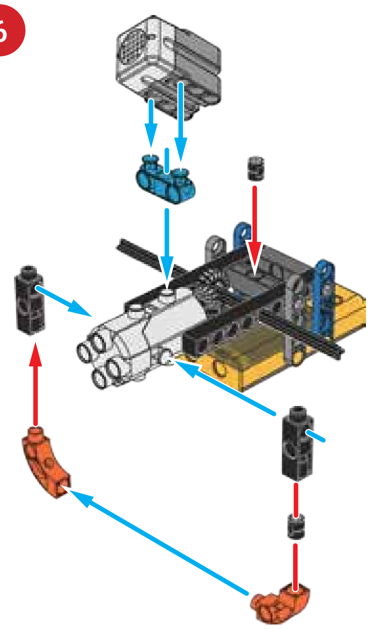

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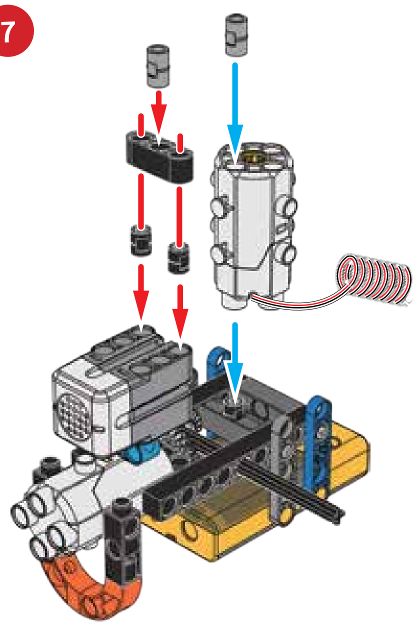

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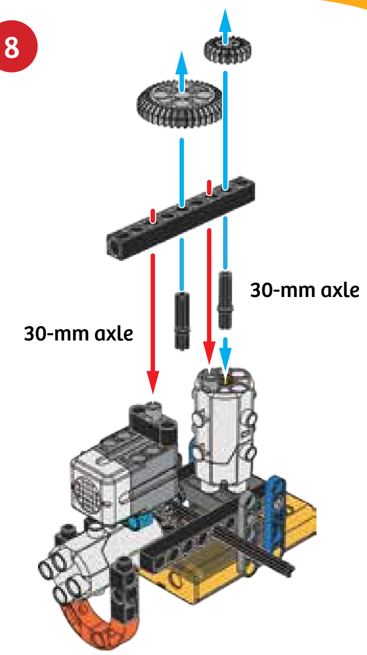

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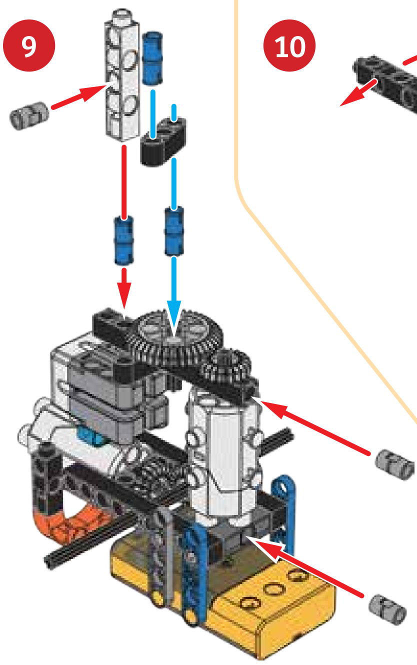

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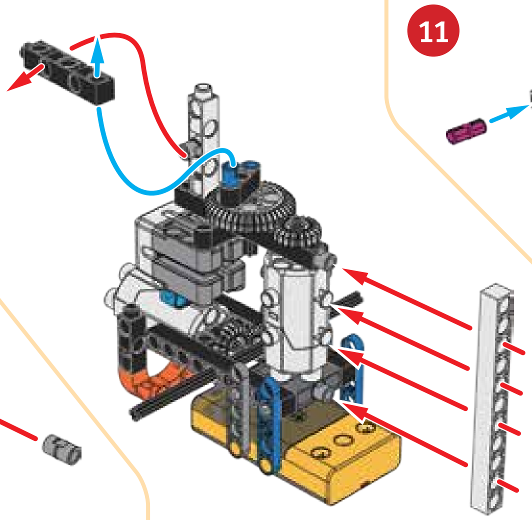

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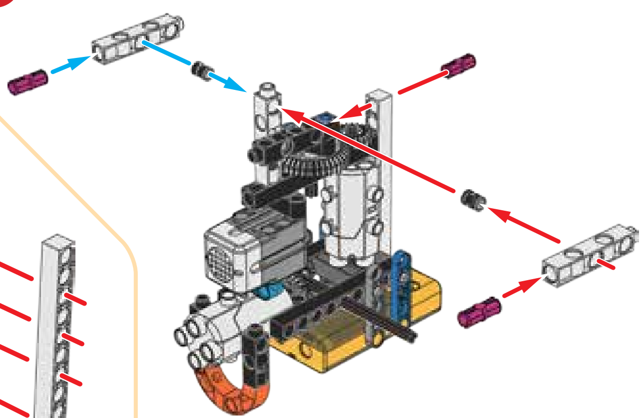

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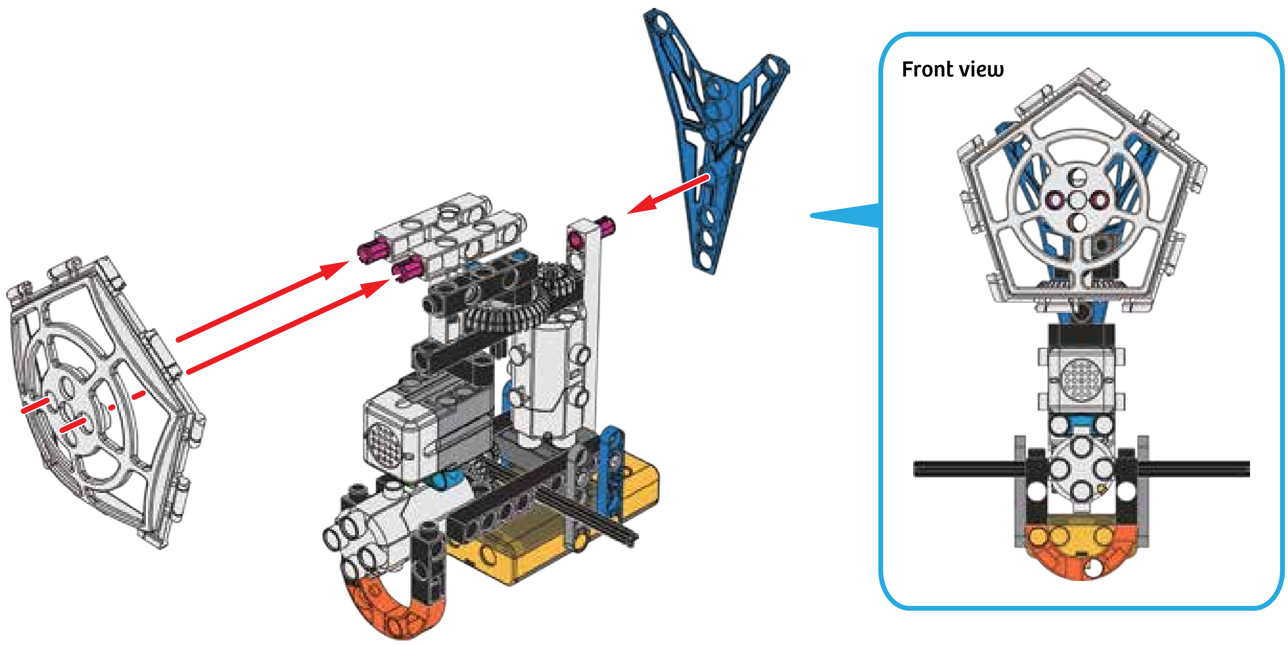

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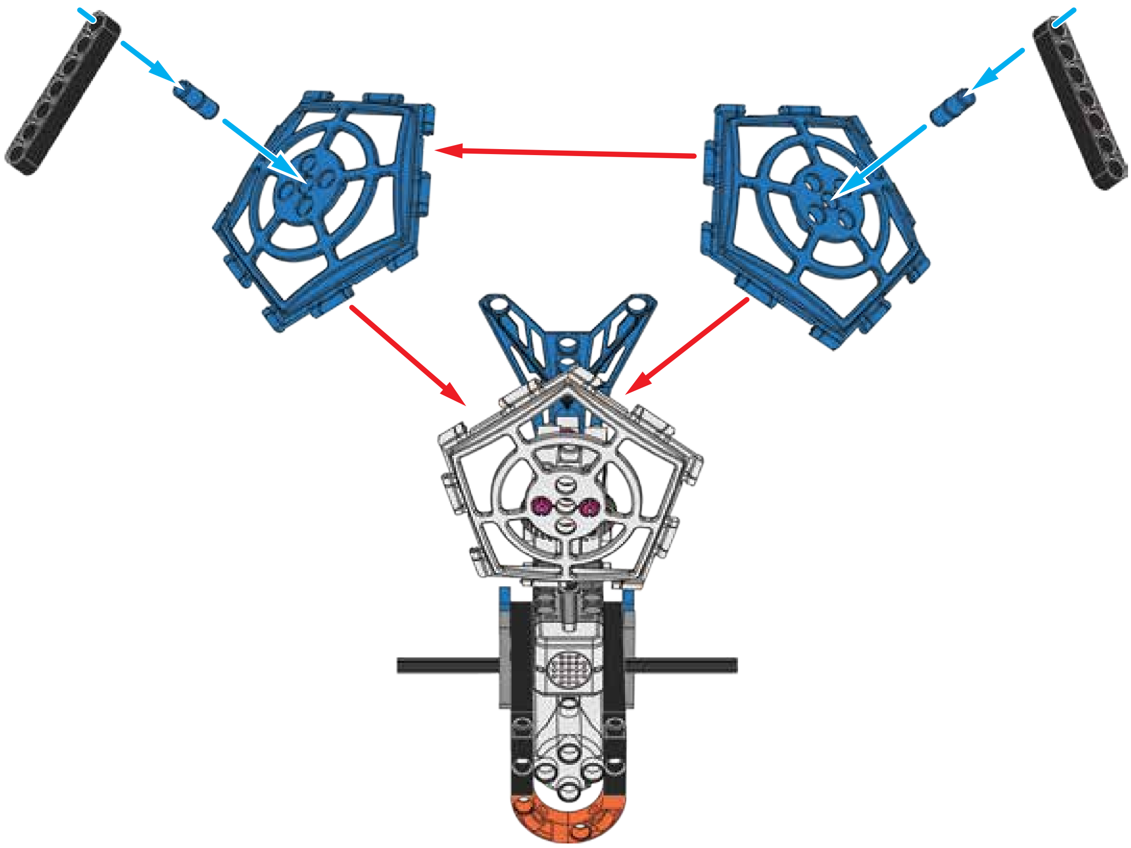

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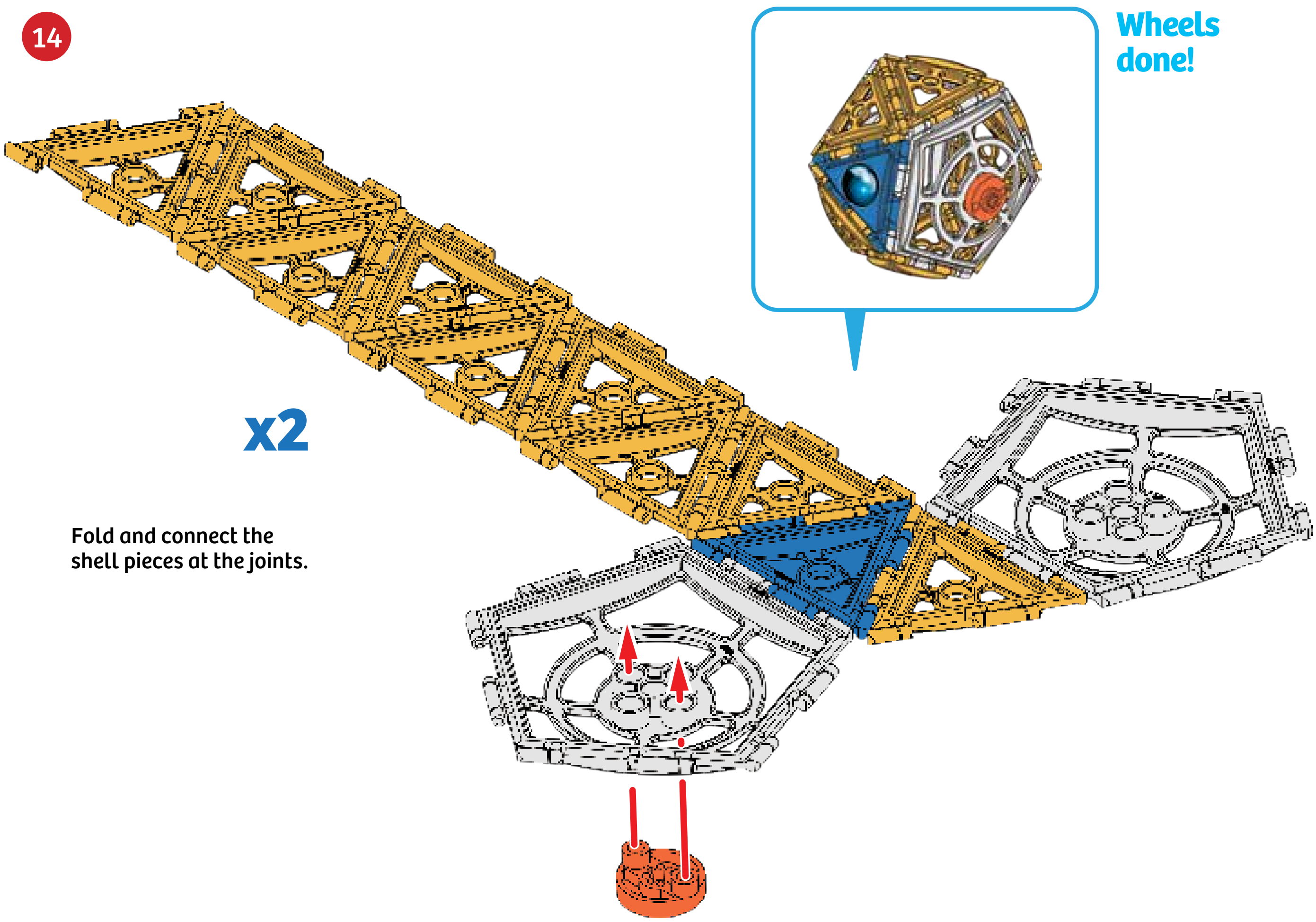
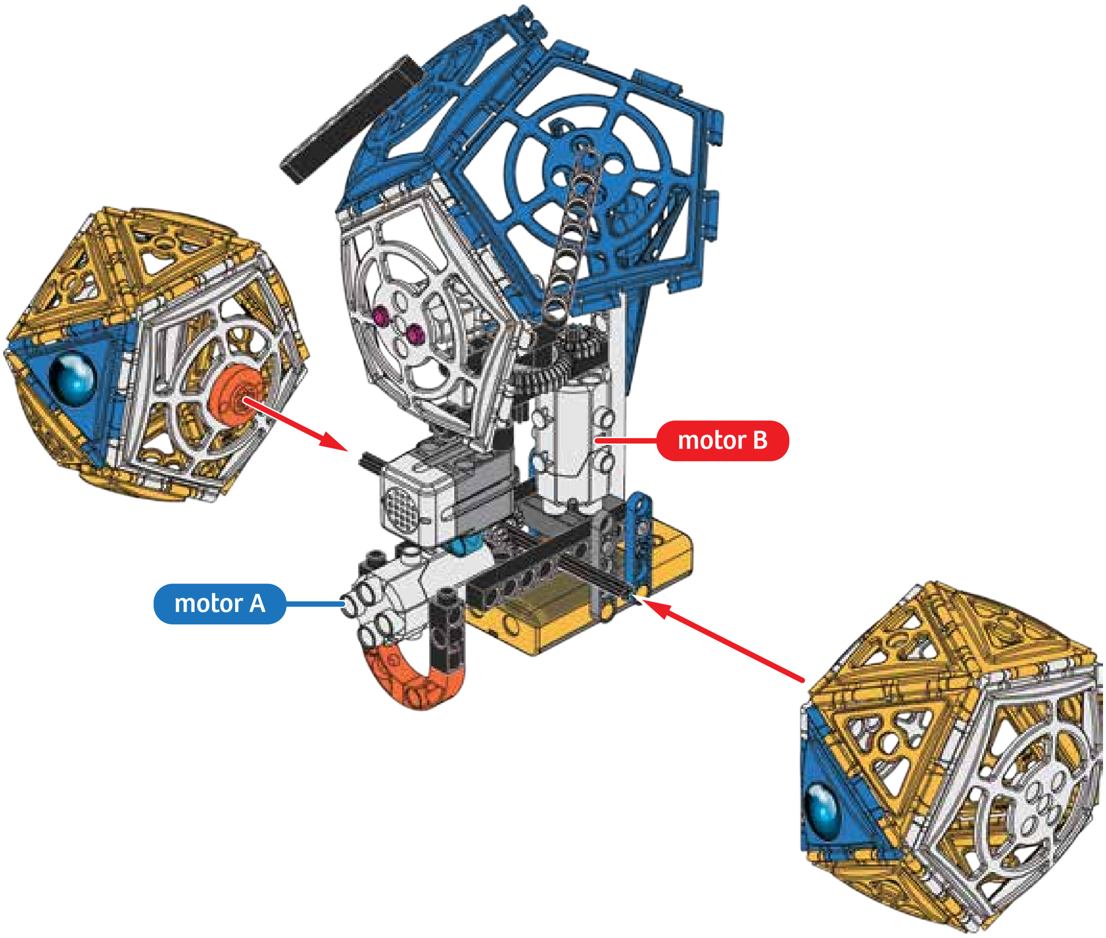


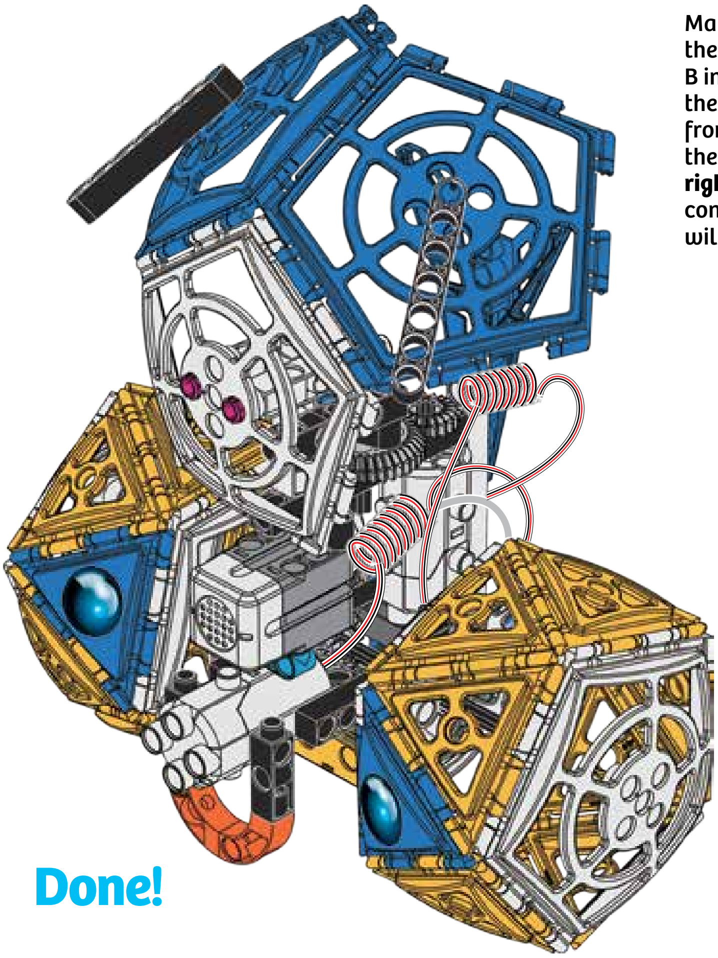
Wheels done!

x2

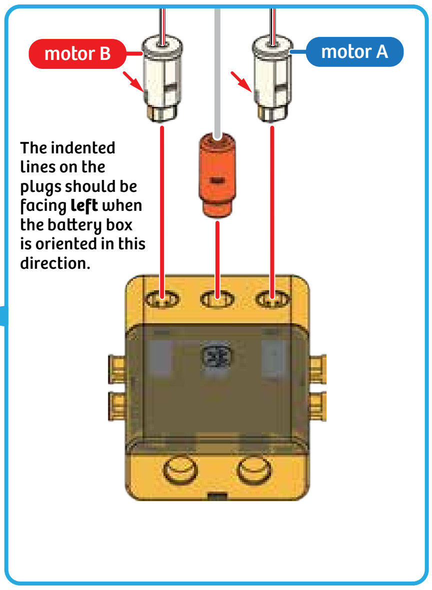
Fold and connect the shell pieces at the joints.

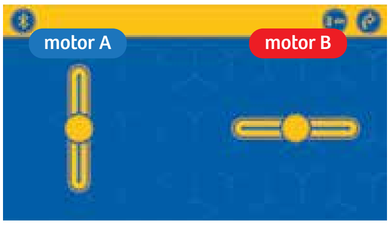
15





Make sure you plug the wire from motor B into the socket on the **left** and the wire from motor A into the socket on the **right**, or else the controls in the app will be switched.

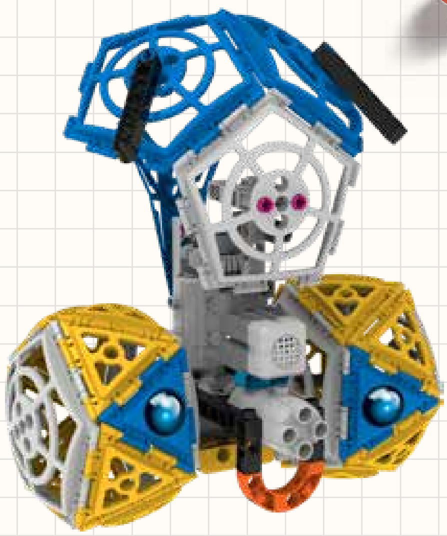


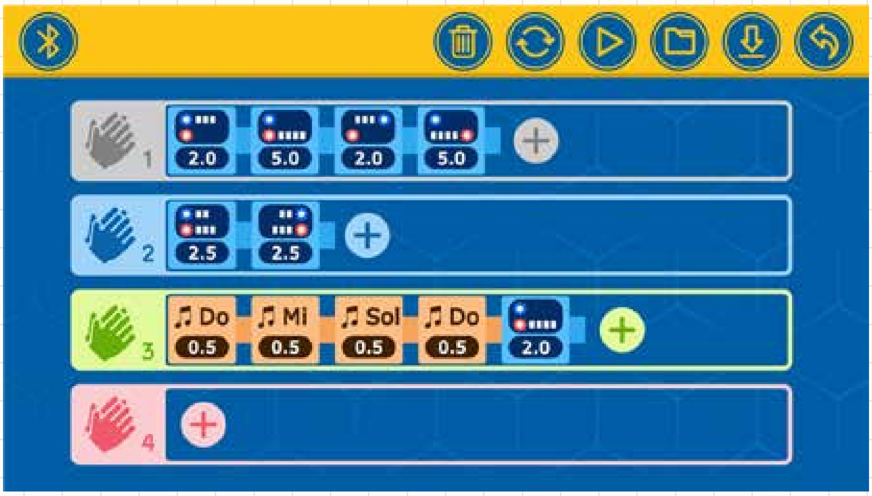


Done!

SAMPLE PROGRAM FOR THE DANCING BOT

1. Place the Dancing Bot in an open area.
2. Load the app on your tablet or smartphone and establish a Bluetooth connection between the app and the robot. Refer back to page 7 for instructions.
3. In programming mode, load **Program 5.** The command sequences shown below are preset in Program 5. Tap the run button and clap your hands one to four times near the sound sensor.
4. Observe how the robot behaves for each sequence! Write your own program in the four-clap sequence.





PROGRAM 5

1 Clap: Go forward, shake head, go backward, shake head

2 Claps: Move and shake head at the same time (dance)

3 Claps: Play a song and dance

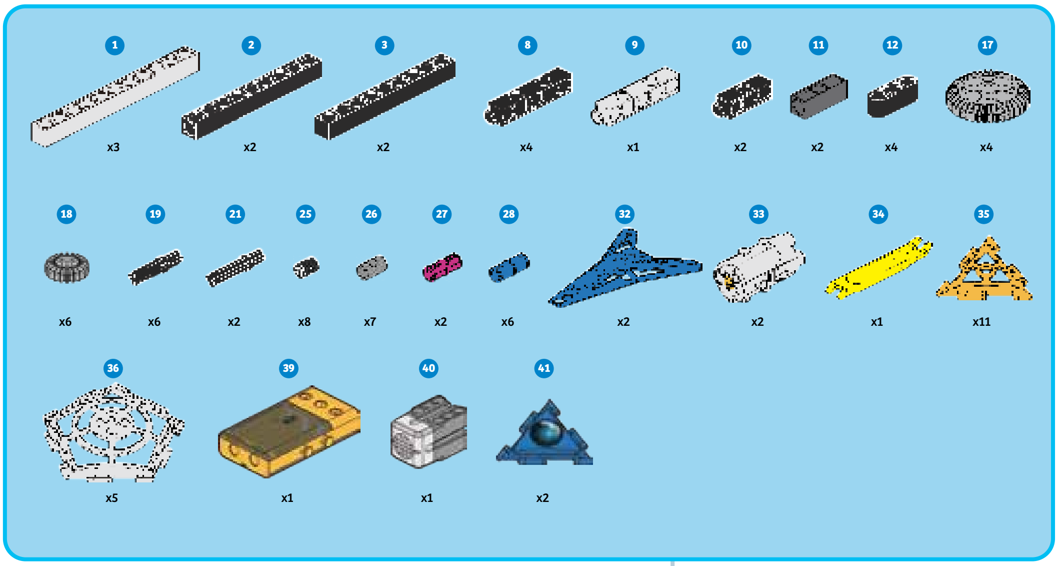
4 Claps: Create your own program!

Dancing Robots

Have you ever seen a robot dance? Or, have you ever seen someone do the dance move called “the robot?” Robot engineers have been inspired by dancers — and dancers have been inspired by robots — for a long time!

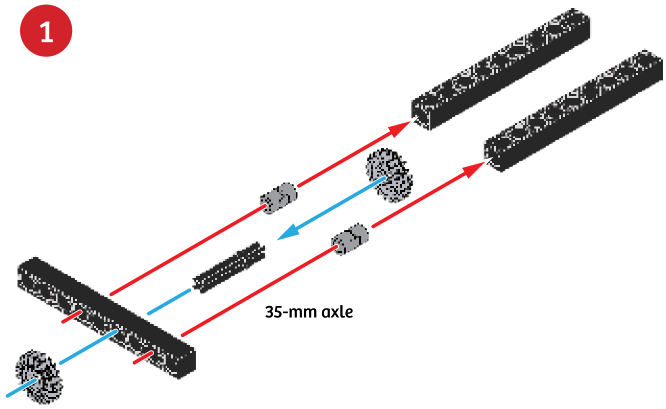
Robots’ movements are controlled by programs and sensor input. In many ways, a choreographed dance performance is a lot like a program that controls a robot’s movement. Choreography is the artistic practice of creating sequences of movements for bodies that define the motion and/or the orientation of the bodies over a duration of time. In the same way, a robot’s program is a sequence of defined movements that the robot performs over time. The big difference is that humans are much more capable of subtle, refined movements, improvisation, and expressing emotion through dance. But robots are getting more human-like every year. Do you think robots will dance as well as humans someday?

HORSESHOE CRAB BOT



First, follow these assembly instructions to build the model. Then, you can use the model in remote control mode, or you can follow the instructions on the programming page immediately after these assembly instructions to run a program for this model.

1



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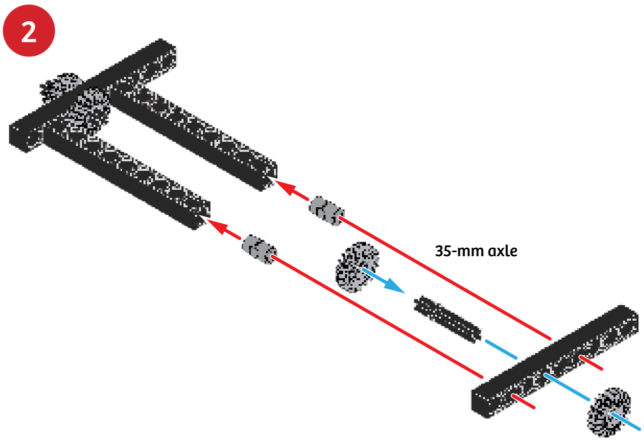

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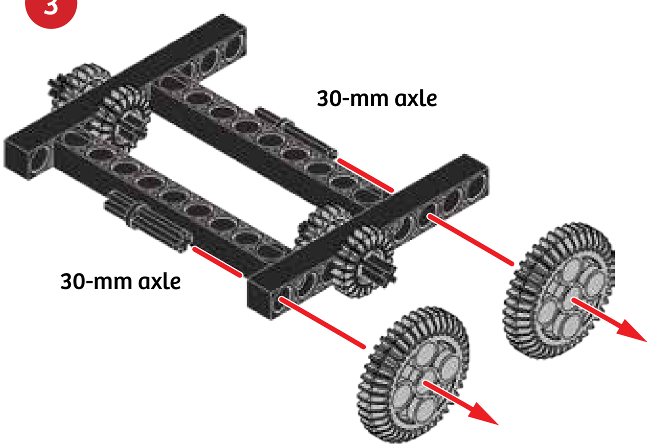
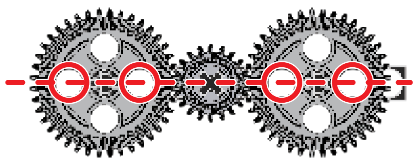
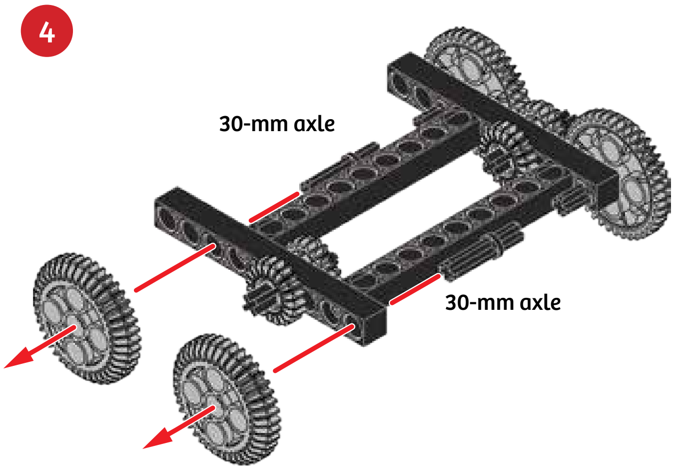


Right side view

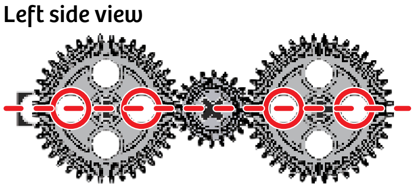


Align the holes.

4

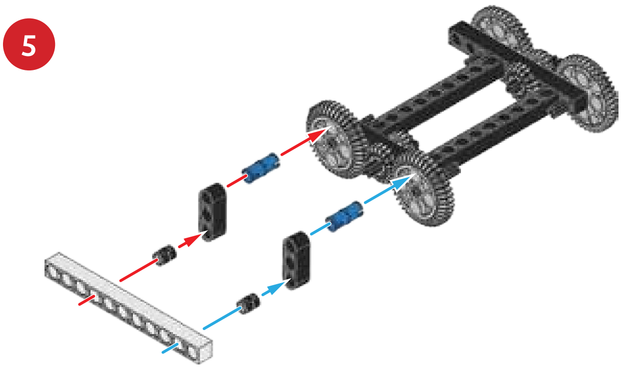


Left side view



Align the holes.

5



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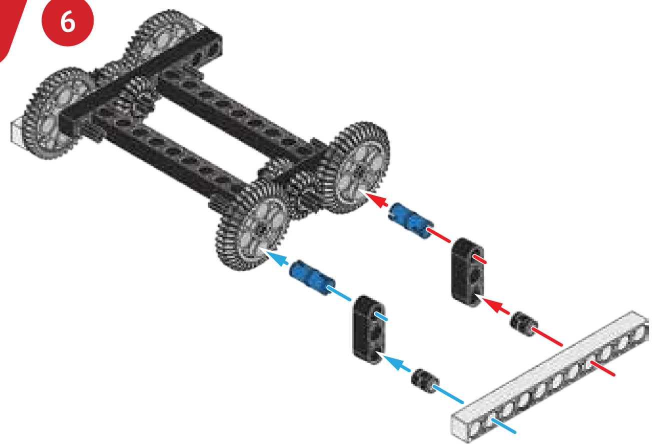

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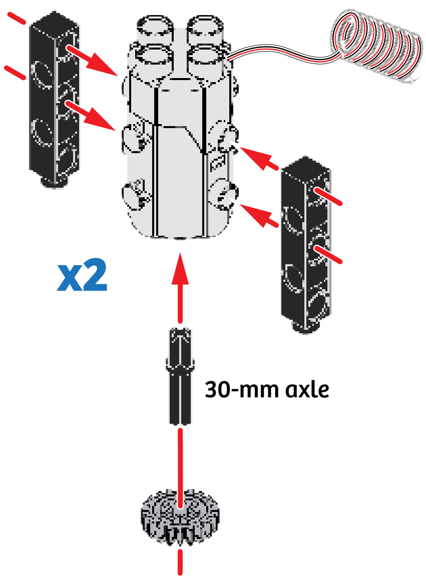

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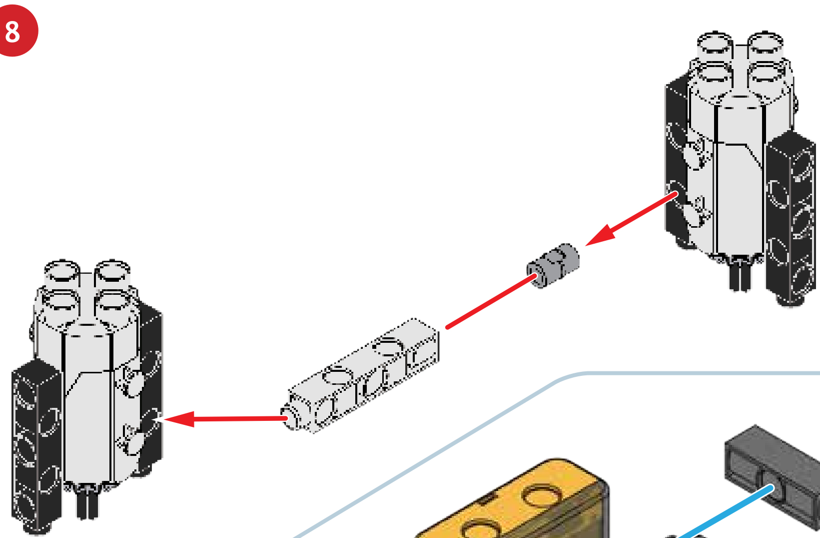

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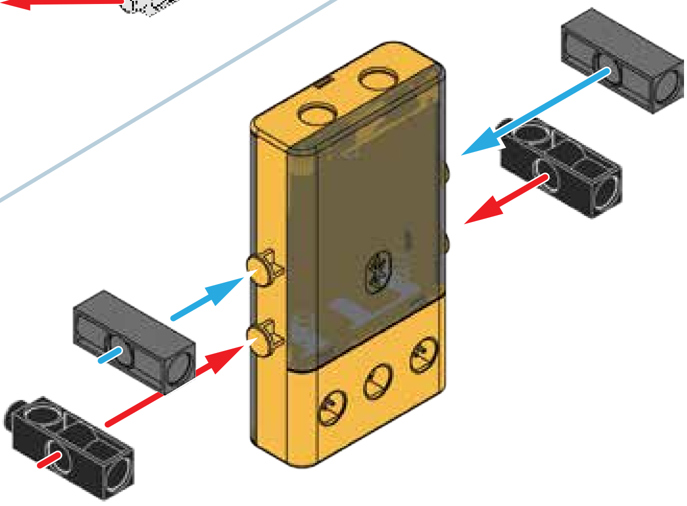

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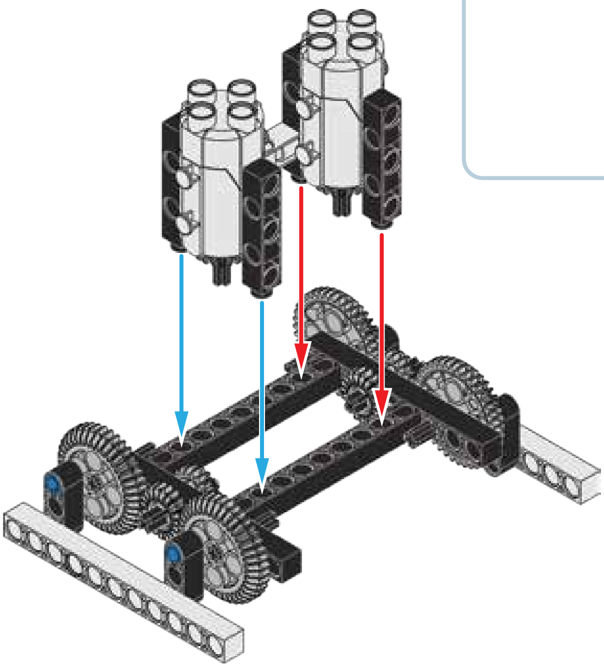

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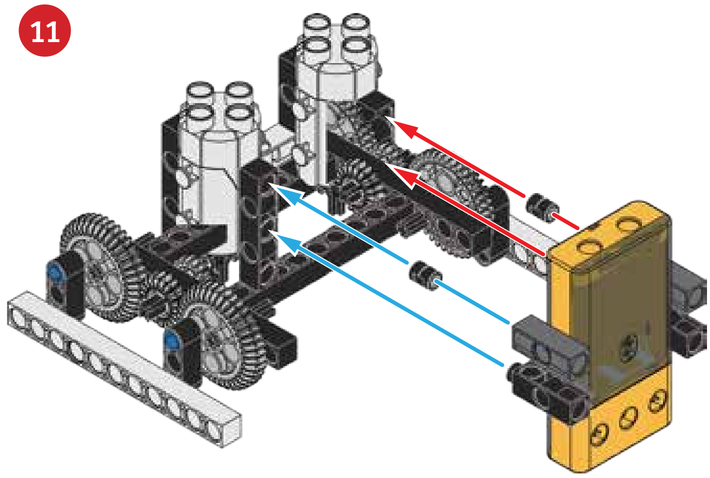
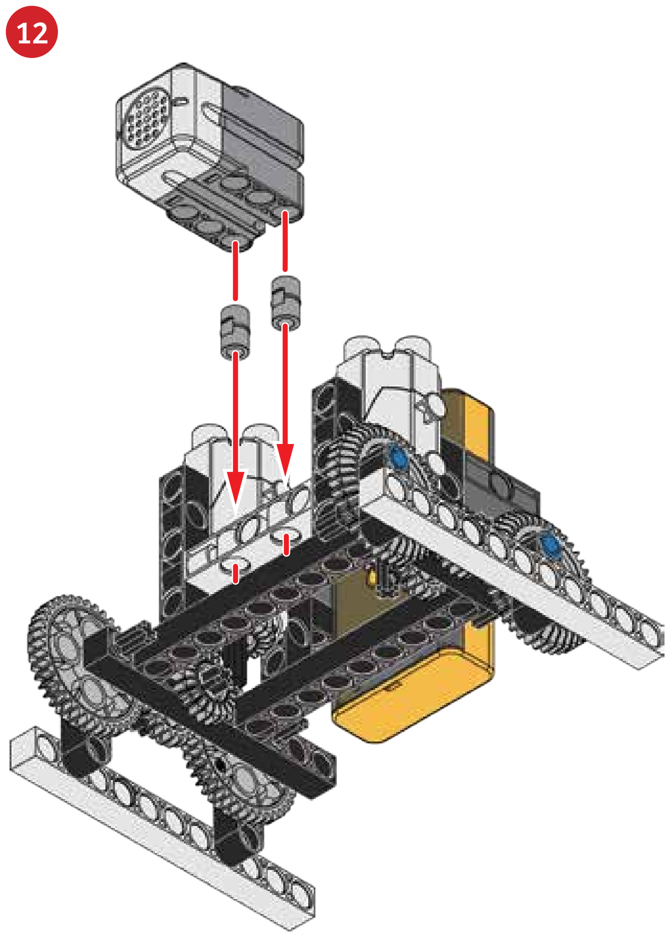
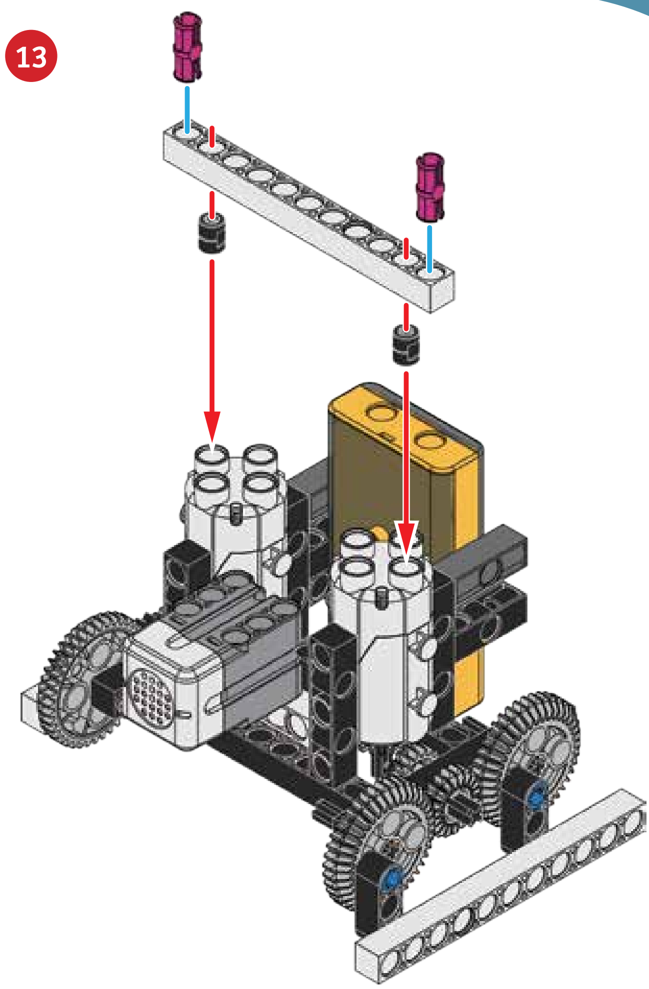
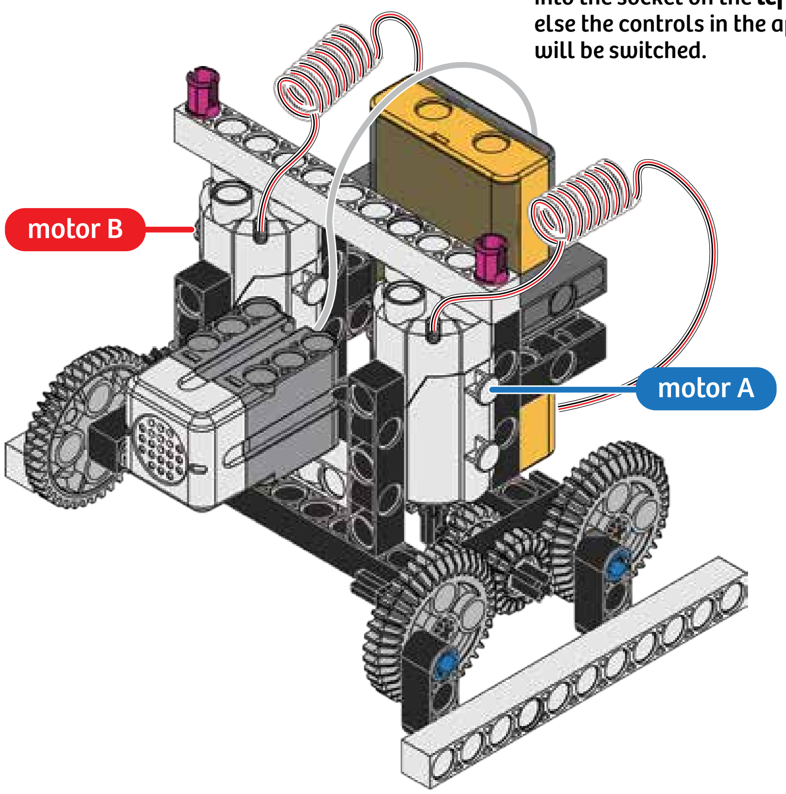


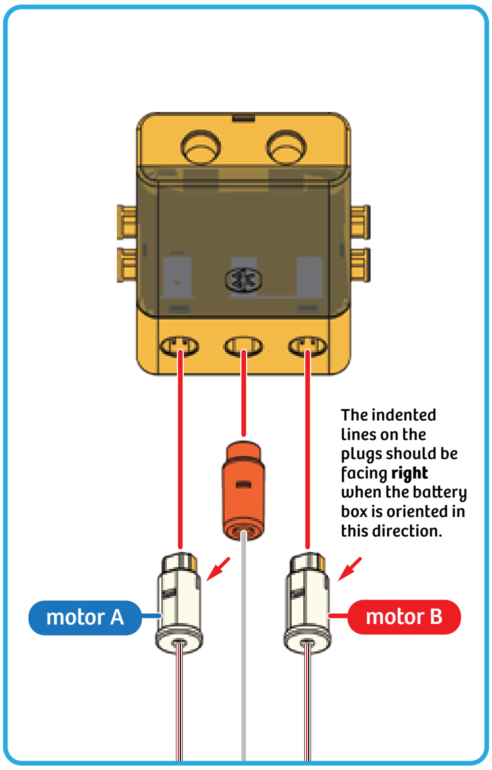




Body done!

Make sure you plug the wire from motor B into the socket on the **right** (as pictured here) and the wire from motor A into the socket on the **left**, or else the controls in the app will be switched.





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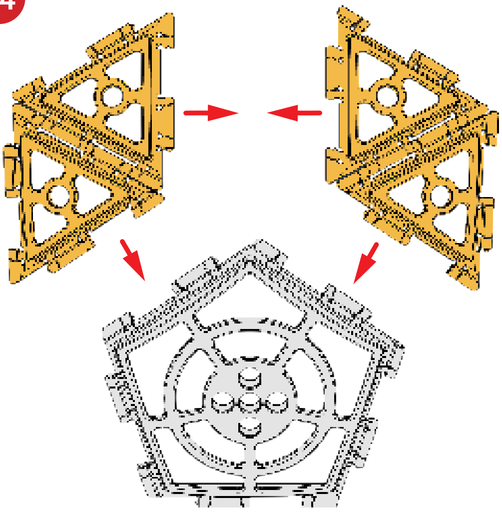

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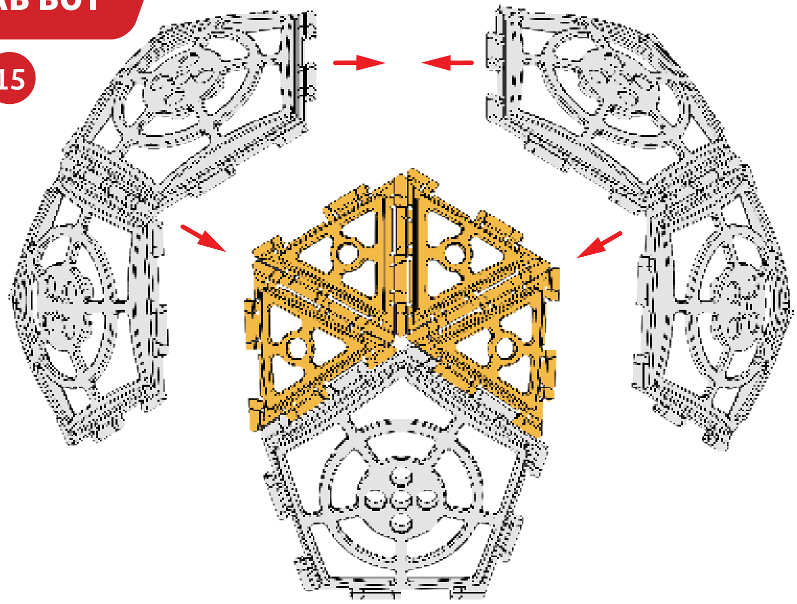

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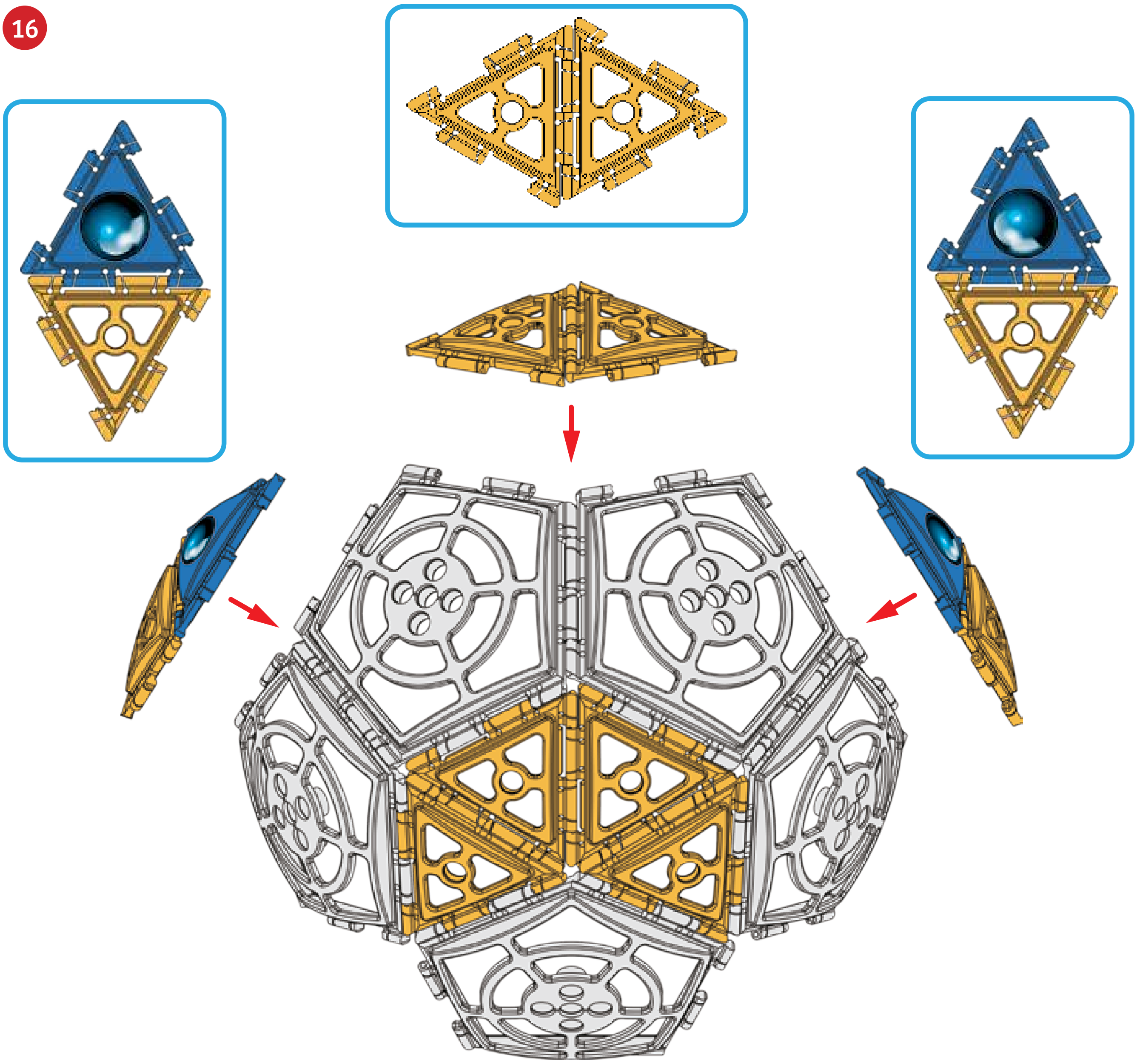

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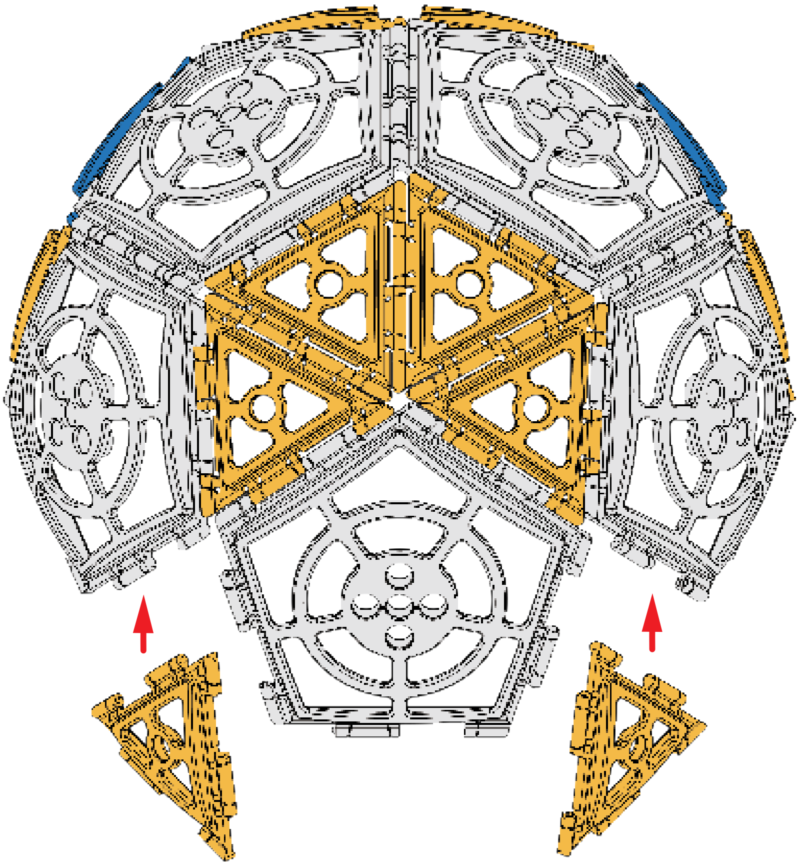

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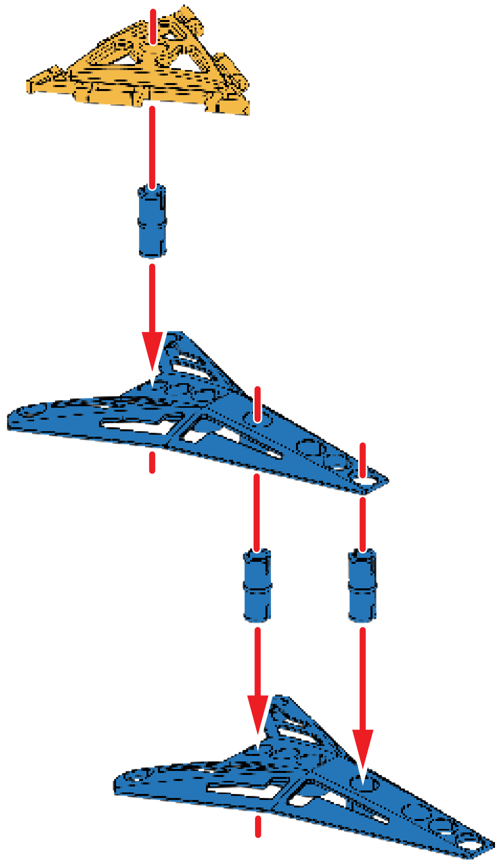

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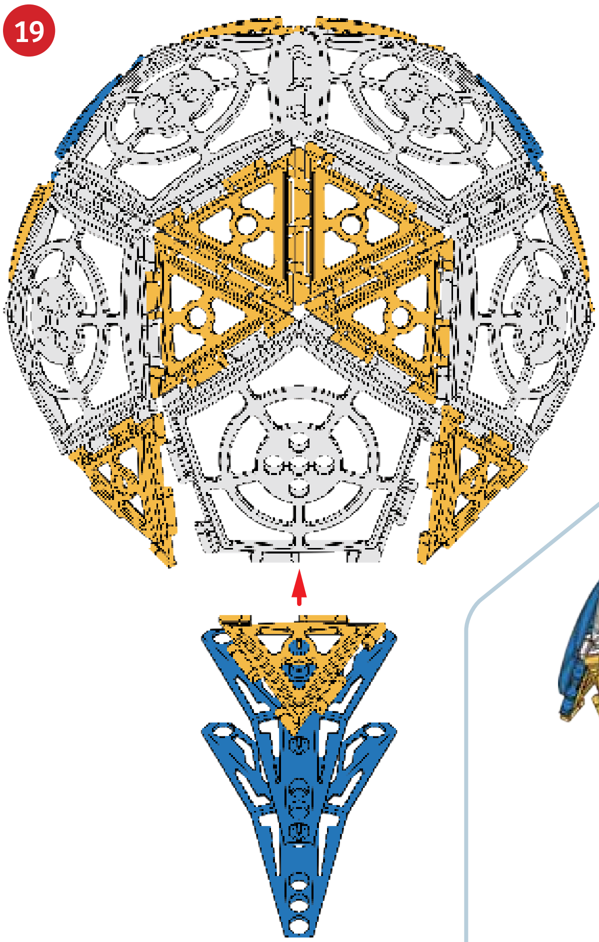
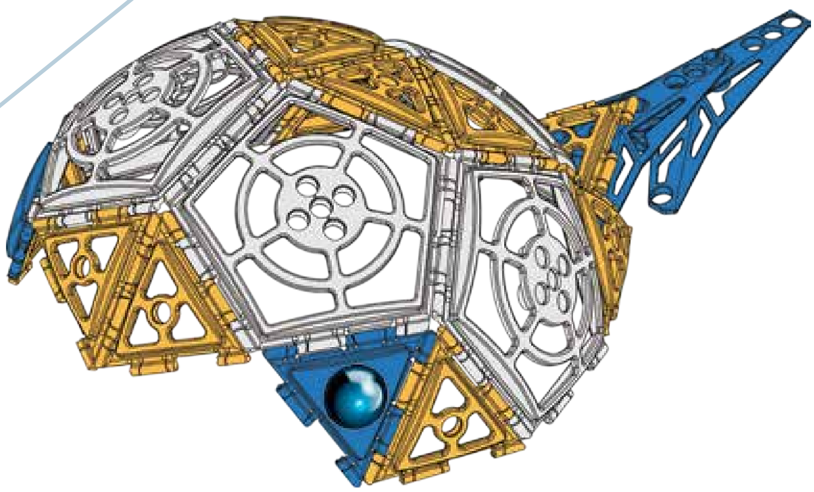


Shell done!



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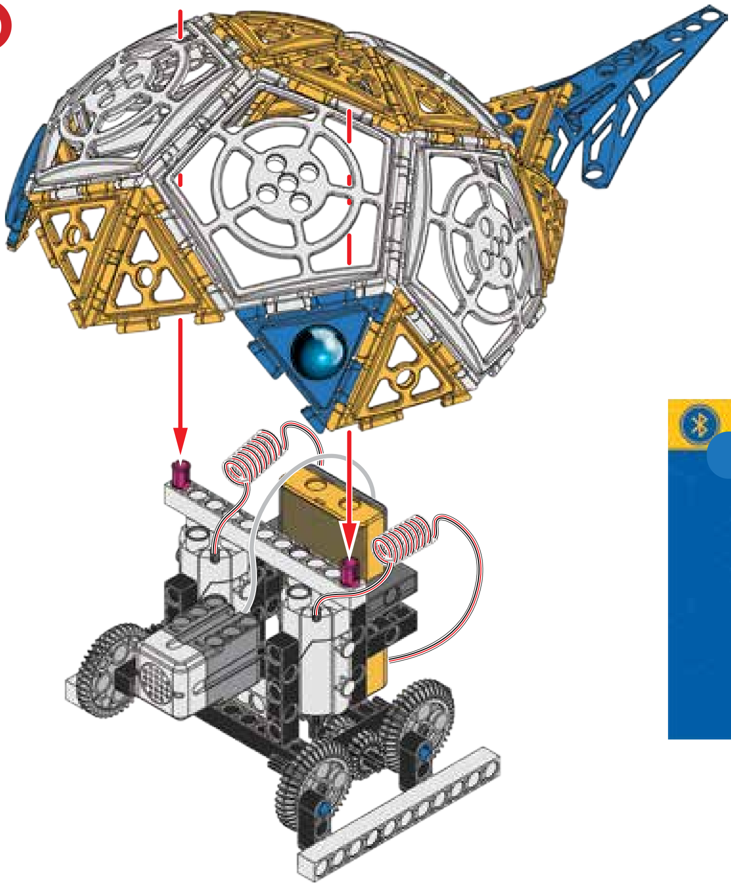
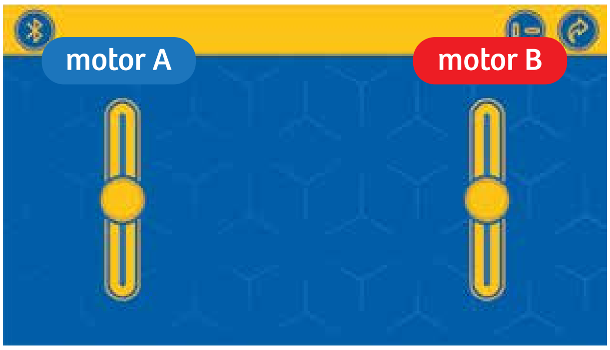
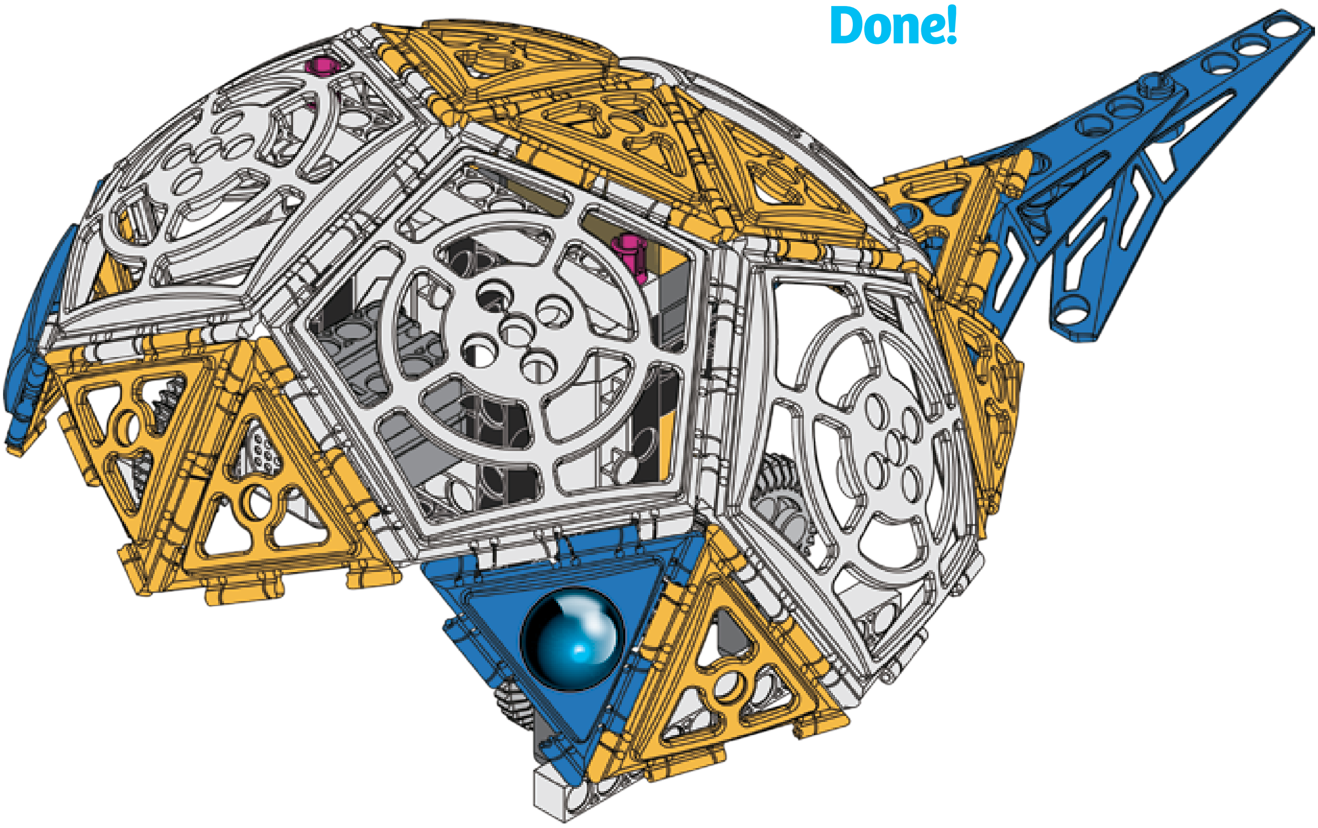




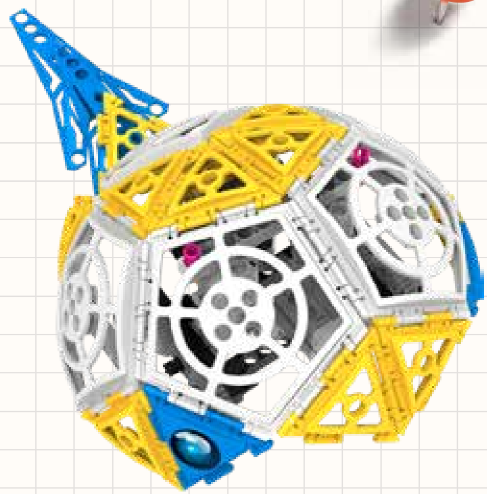
Done!

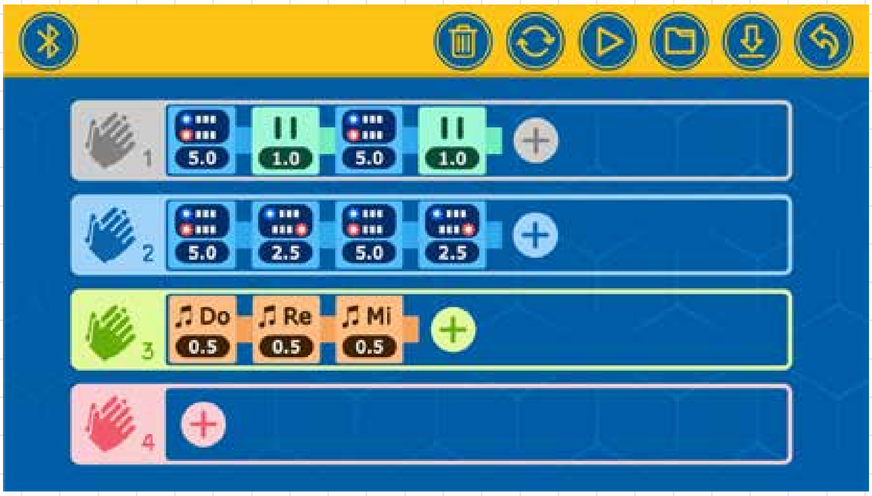


PROGRAMMING

SAMPLE PROGRAM FOR THE HORSESHOE CRAB BOT

1. Place the Horseshoe Crab Bot on the floor.
2. Load the app on your tablet or smartphone and establish a Bluetooth connection between the app and the robot. Refer back to page 7 for instructions.
3. In programming mode, load **Program 6.** The command sequences shown below are preset in Program 6. Tap the run button and clap your hands one to four times near the sound sensor.
4. Observe how the robot behaves for each sequence! Write your own program in the four-clap sequence.





PROGRAM 6

1 Clap: Crawl forward, rest, crawl forward, rest

2 Claps: Crawl forward, turn, crawl forward, turn

3 Claps: Play a simple song

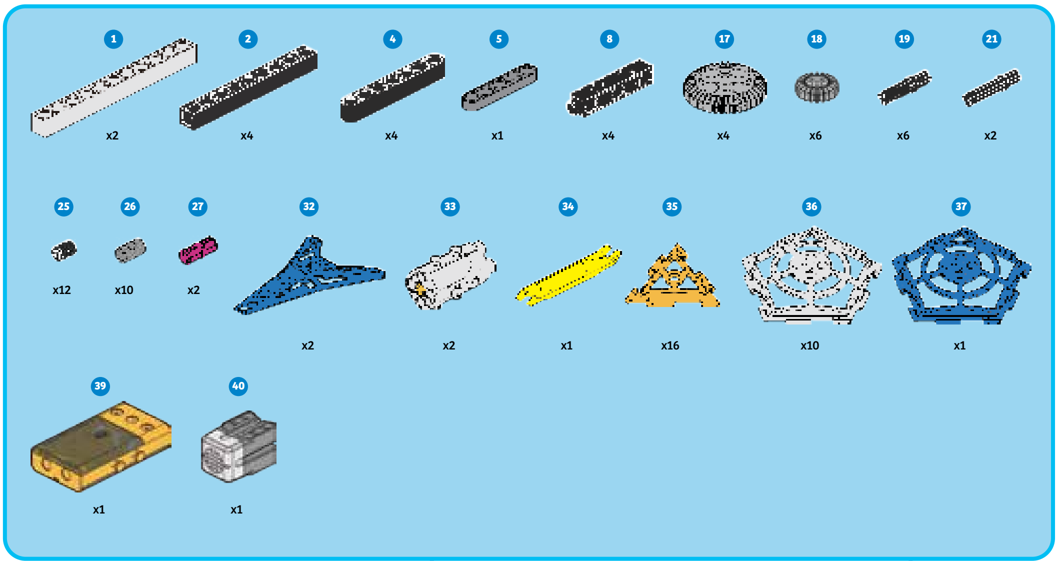
4 Claps: Create your own program!

Exoskeletons and Geodesic Domes

A horseshoe crab is a marine animal with a hard, dome-like shell covering its whole body. It is very well protected from above, which is part of the reason why this family of animals has been able to survive for so long. They are called living fossils because scientists can trace their origins back 450 million years! The horseshoe crab's large shell and all the other hard exterior structures that cover the rest of its body (visible under the shell) make up its exoskeleton — short for external skeleton.

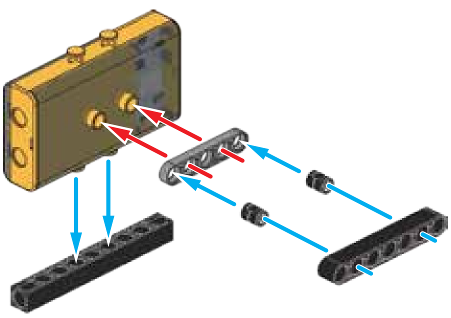
The shell of your Horseshoe Crab Bot is reminiscent of another structure as well: the geodesic dome. A geodesic dome is a thin-shelled hemispherical structure that is made up of many triangular frames. They are amazingly strong relative to the small amount of material they use, because they take advantage of the stable structural properties of the triangle.

CORNHOLE BOT



First, follow these assembly instructions to build the model. Then, you can use the model in remote control mode, or you can follow the instructions on the programming page immediately after these assembly instructions to run a program for this model.

1



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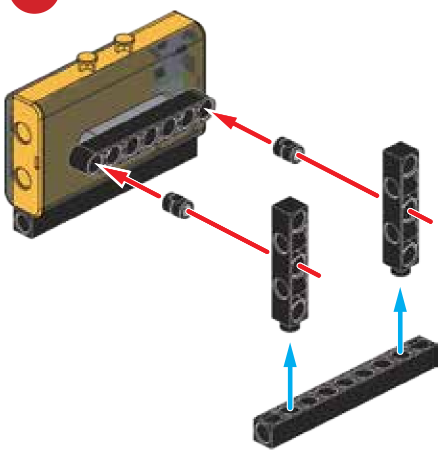

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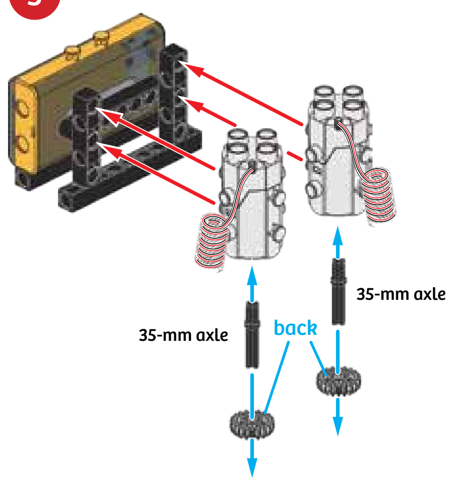

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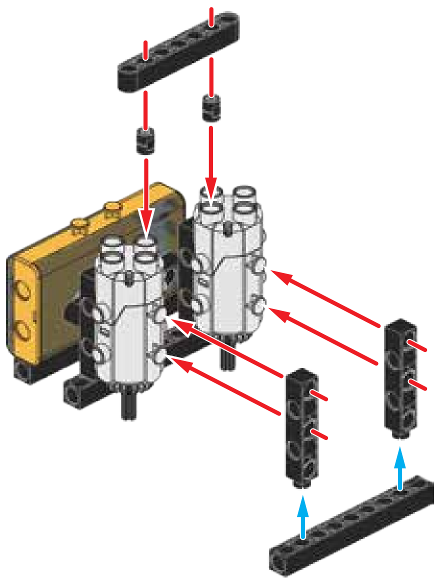

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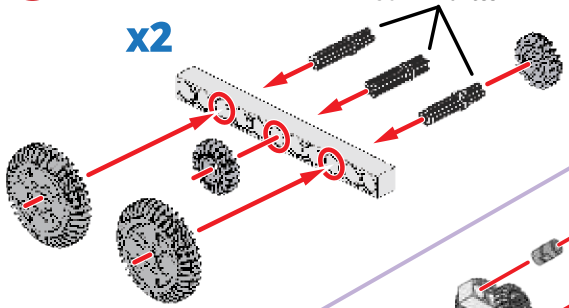

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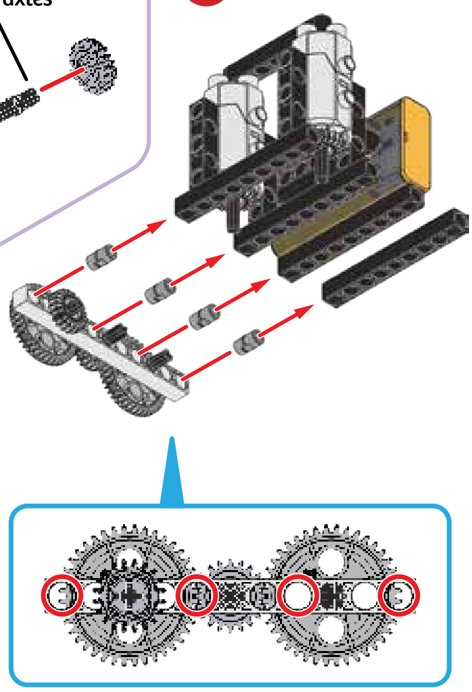

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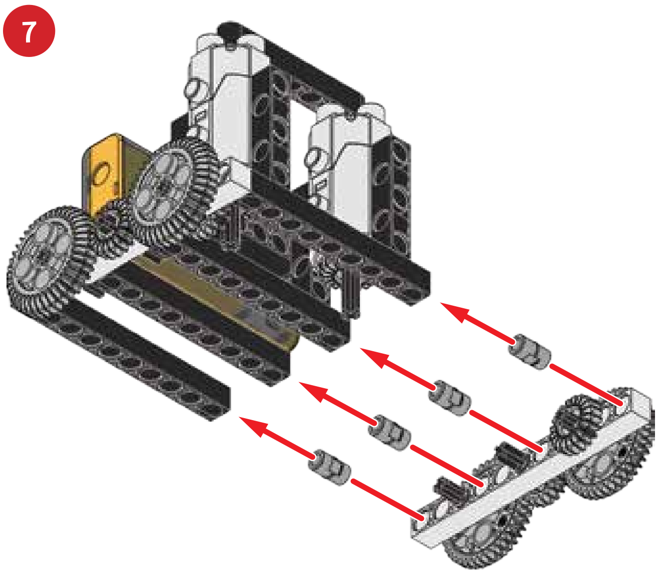

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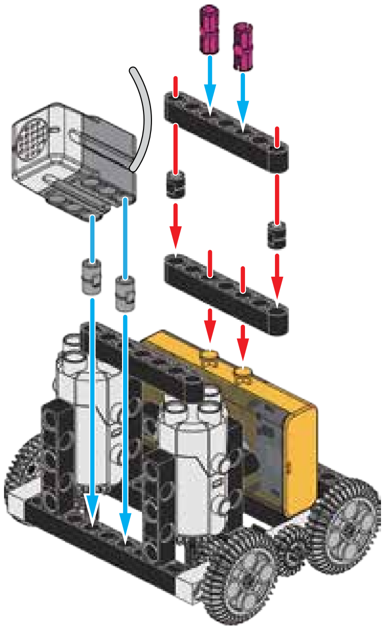

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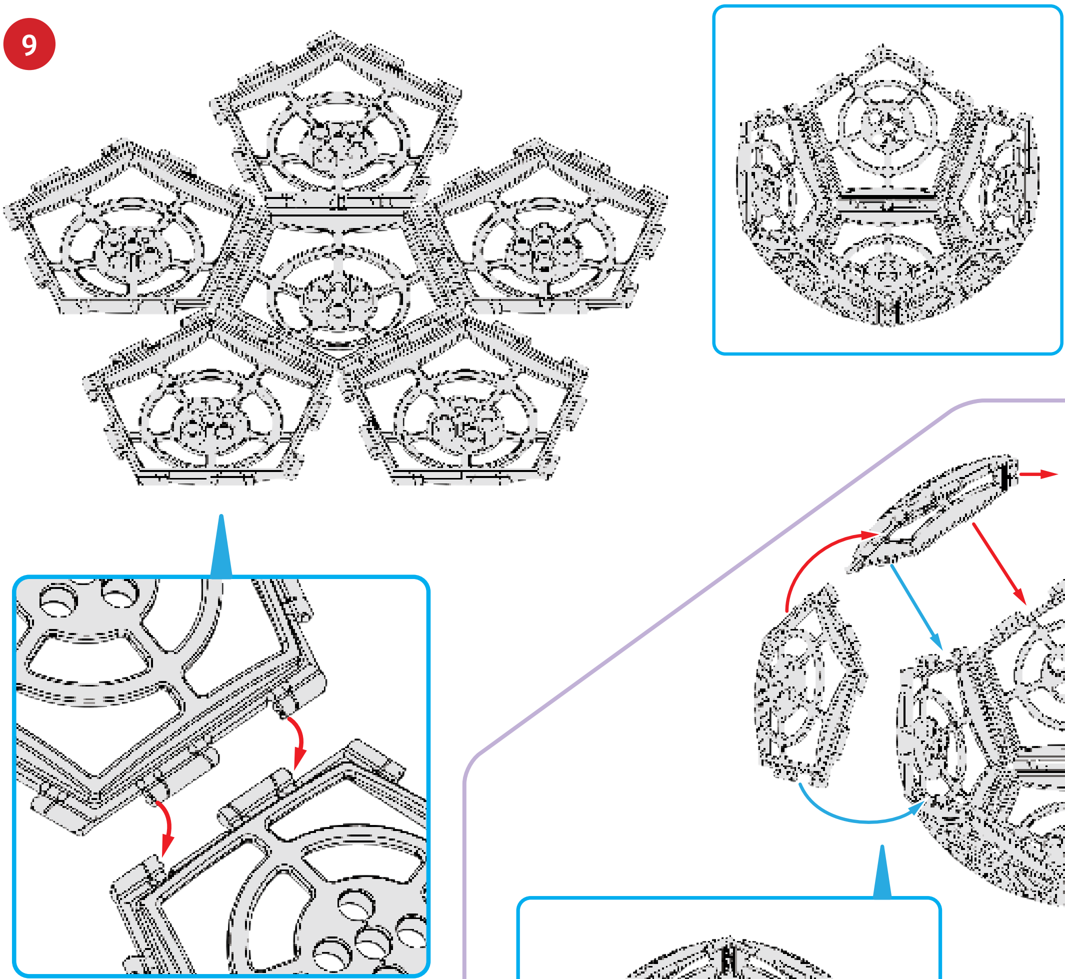

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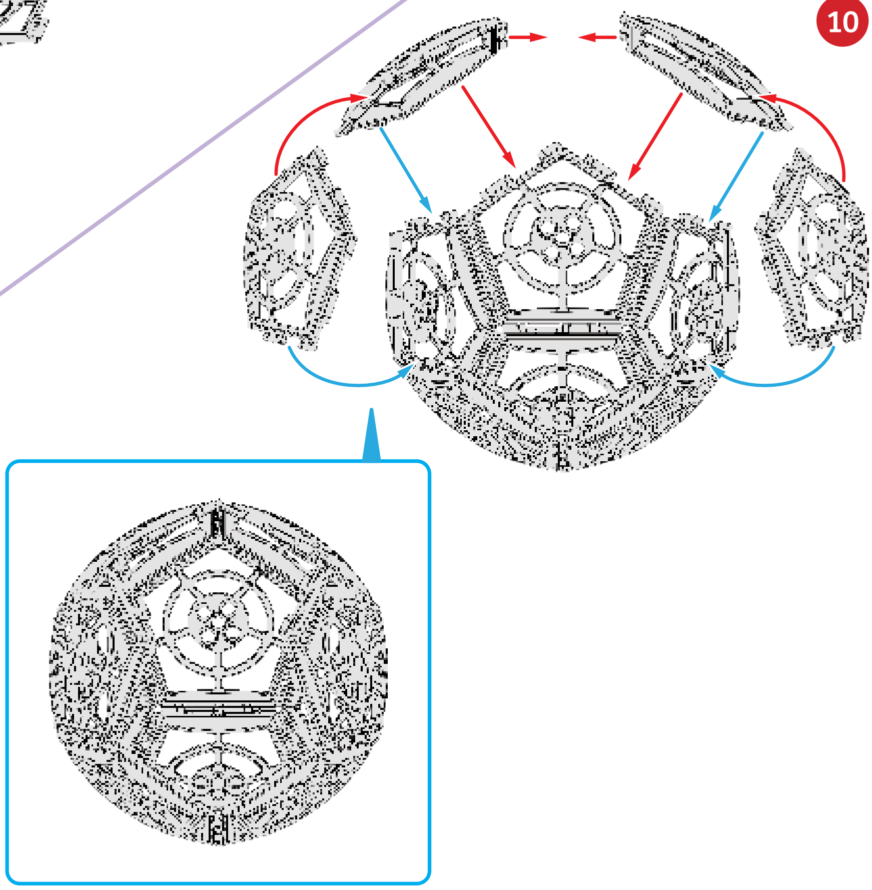

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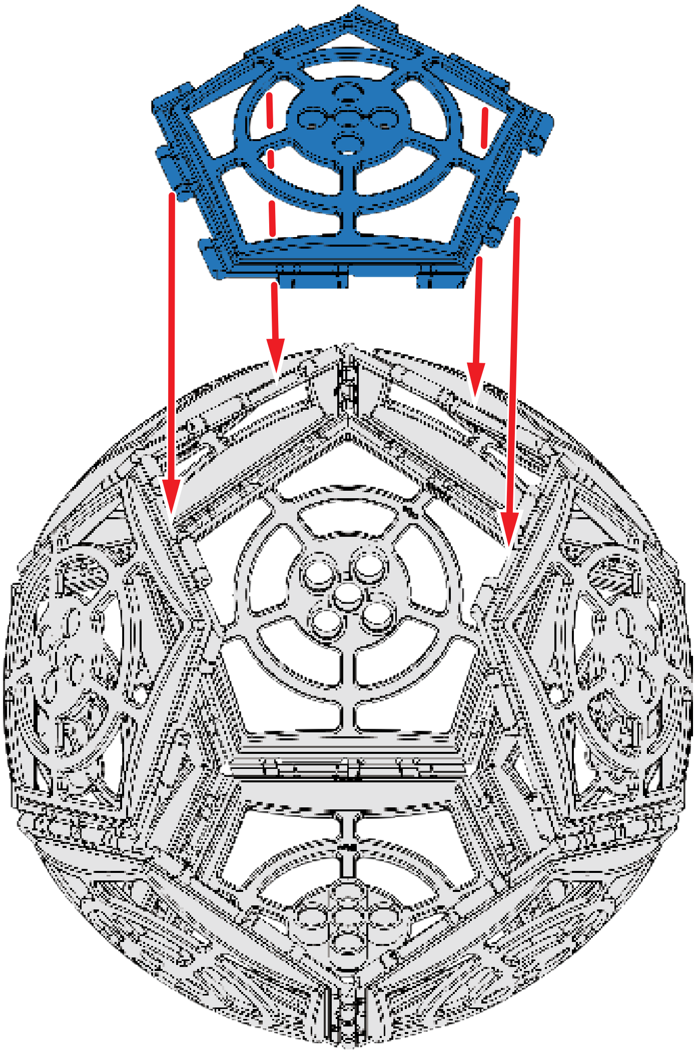

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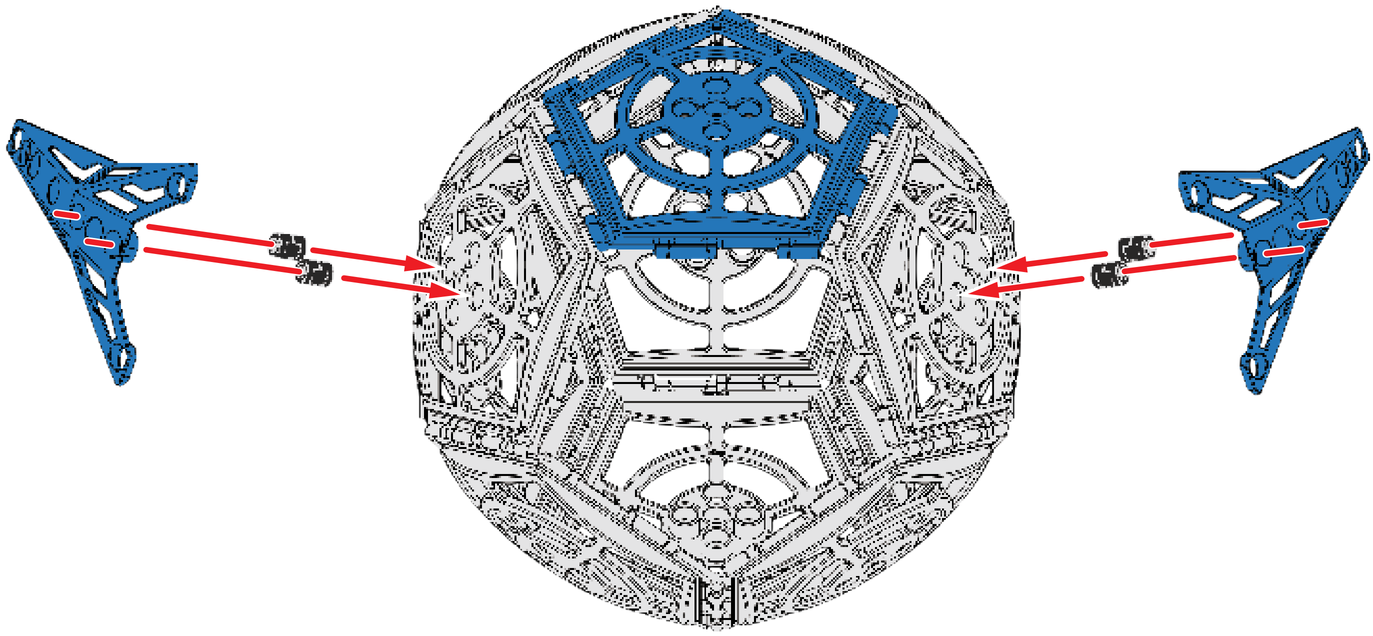

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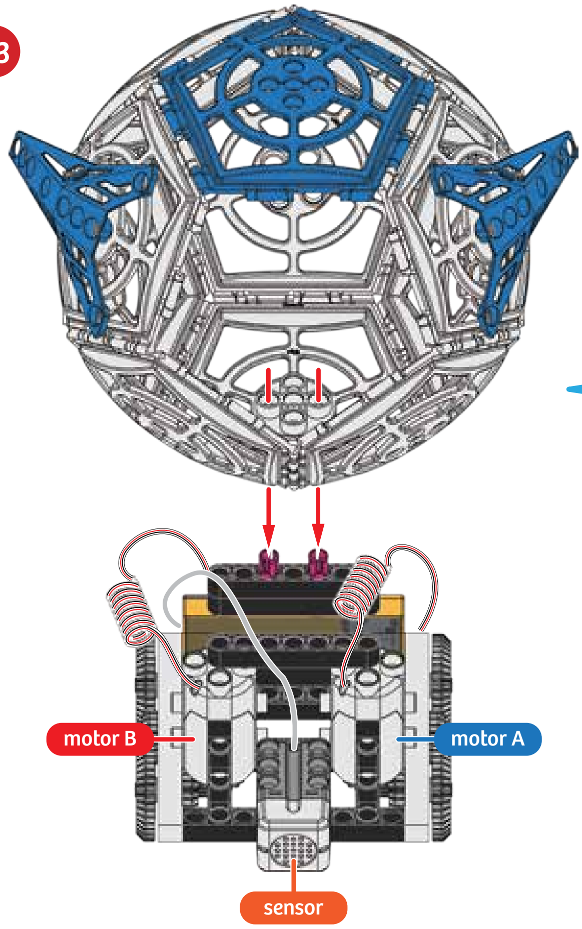
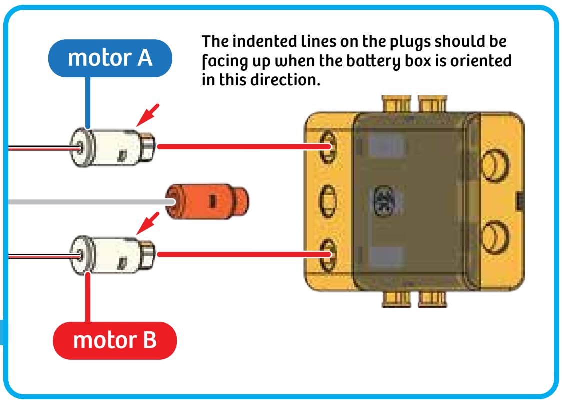
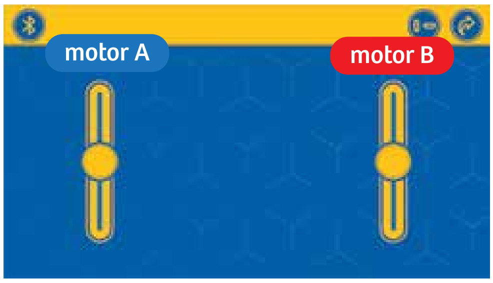




Make sure you plug the wire from motor B into the socket on the **bottom** (as pictured here) and the wire from motor A into the socket on the **top**, or else the controls in the app will be switched.



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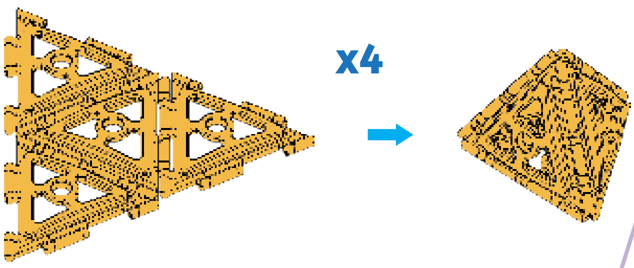
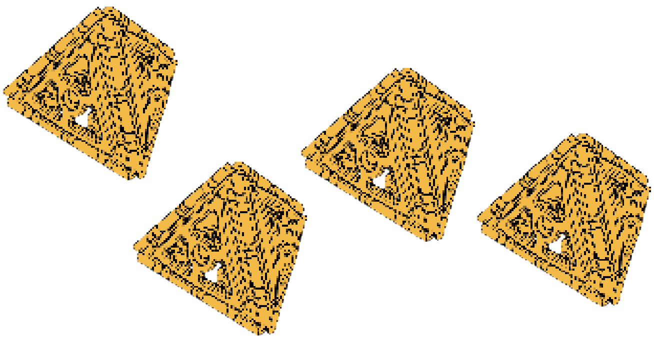
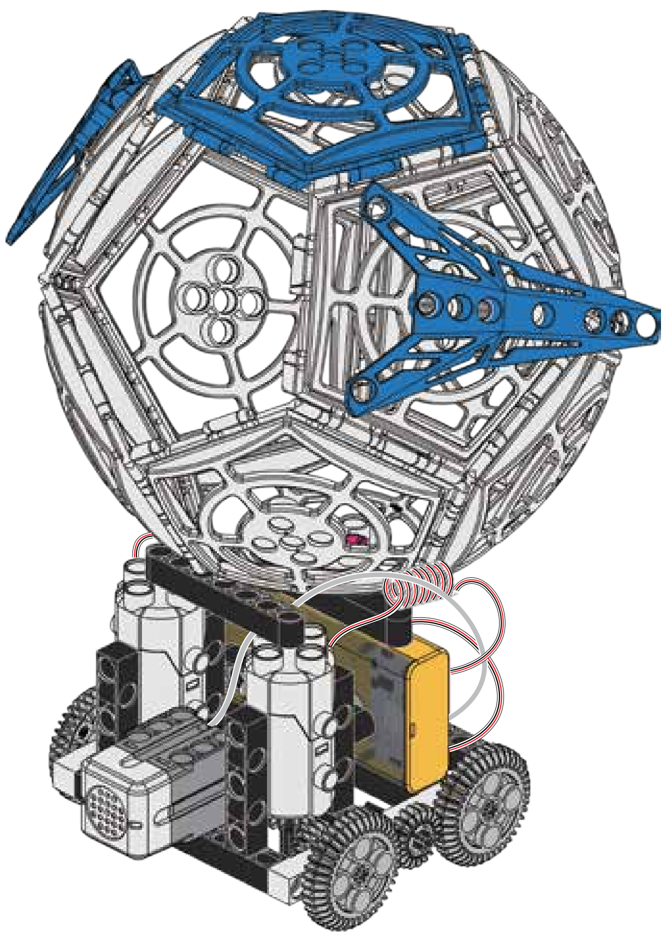


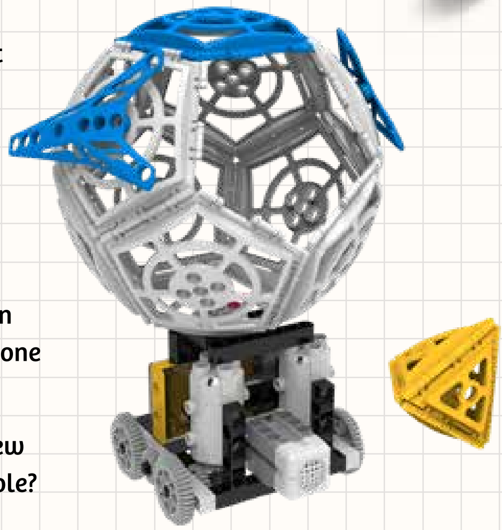
Done!

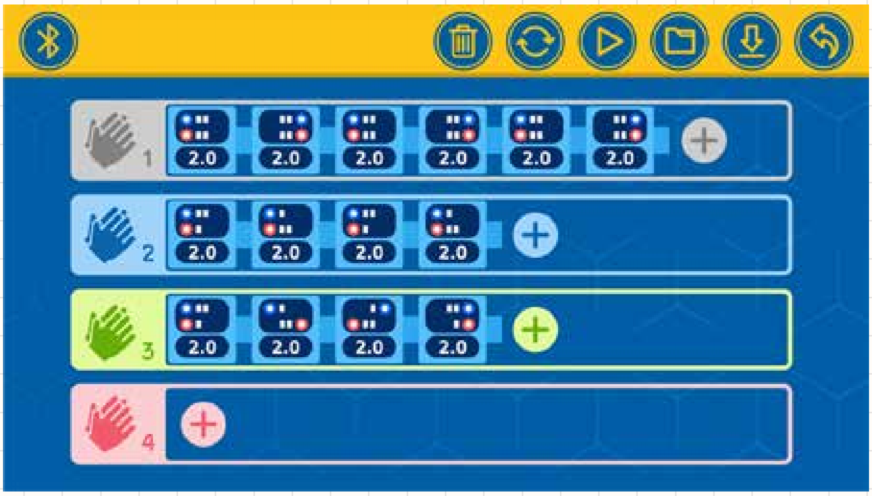




SAMPLE PROGRAM FOR THE CORNHOLE BOT

1. Place the Cornhole Bot in a large, open area of smooth, hard flooring. It drives best on wood, laminates, and tiles. It does not drive well on carpeting, rugs, or textured surfaces.
2. Load the app on your tablet or smartphone and establish a Bluetooth connection between the app and the robot. Refer back to page 7 for instructions.
3. In programming mode, load **Program 7.** The command sequences shown below are preset in Program 7. Tap the run button and clap your hands one to four times near the sound sensor.
4. Try to toss the yellow shape into the hole in the robot's sphere from a few feet away as the robot moves around. Can you get the shape into the hole?





PROGRAM 7

1 Clap: Go forward, go backward, go forward, go backward, go forward, go backward

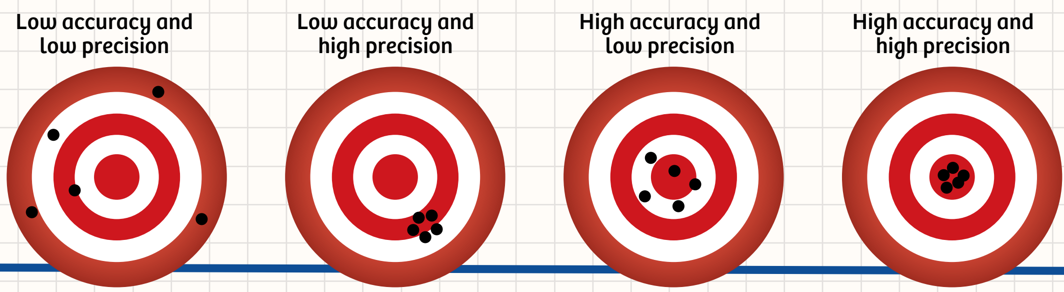
2 Claps: Drive in an S-shaped curve

3 Claps: More challenging moving target

4 Claps: Create your own program!

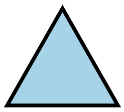
Accuracy and Precision

Cornhole is a popular game in which the goal is to toss bean bags through a hole in a board. The physics concepts of accuracy and precision are important in cornhole. Accuracy is how close your results (or tosses) are to your target value — in this case, the hole in the board. Precision is how often you are able to get the same value, or have your bean bag land in the same place. Look at the pictures below to see how accuracy and precision are related. Accuracy and precision are both critical concepts in the scientific world.

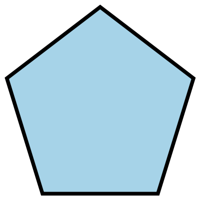


GEOMETRIC SHAPES LESSON

Using only the pieces shown, can you make the five different geometric shapes shown here? Note: They are all completely enclosed — no sides are left open. The solutions are on the next page.

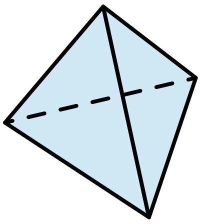


Triangle

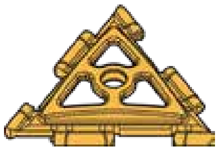


Pentagon

1

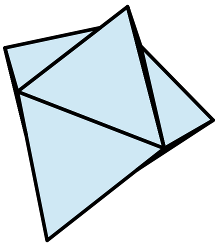


Tetrahedron

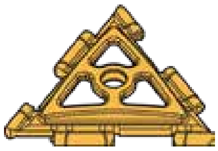


x4

2



Four-pointed 3D Star



x12

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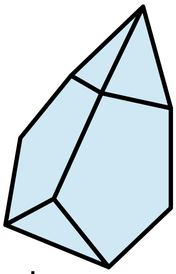
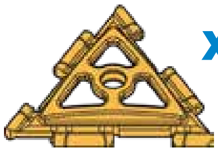


Teardrop



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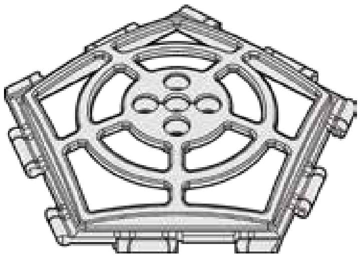

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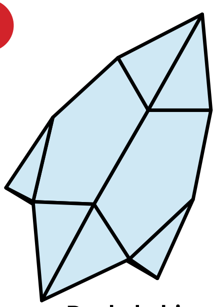
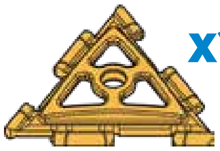


Rocket ship



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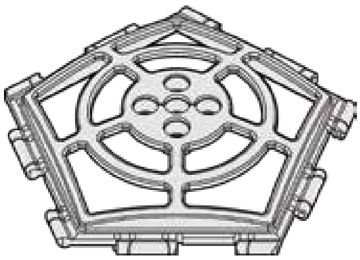

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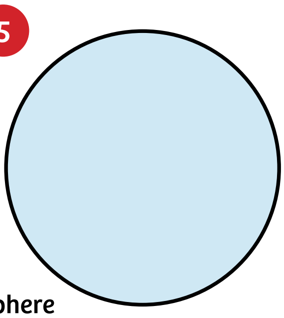
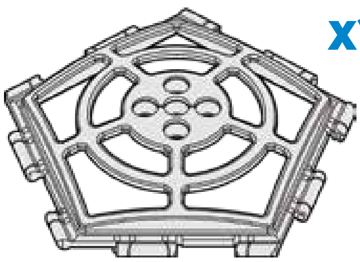


Sphere



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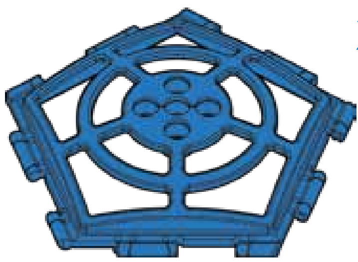
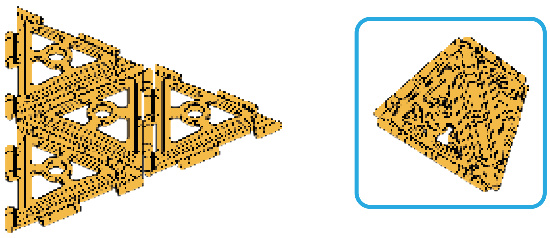


x2

Solutions

1



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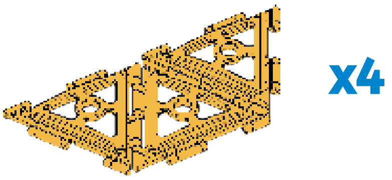

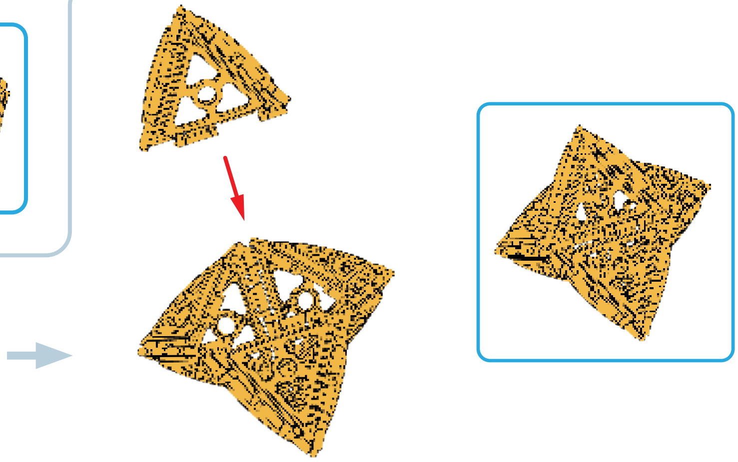

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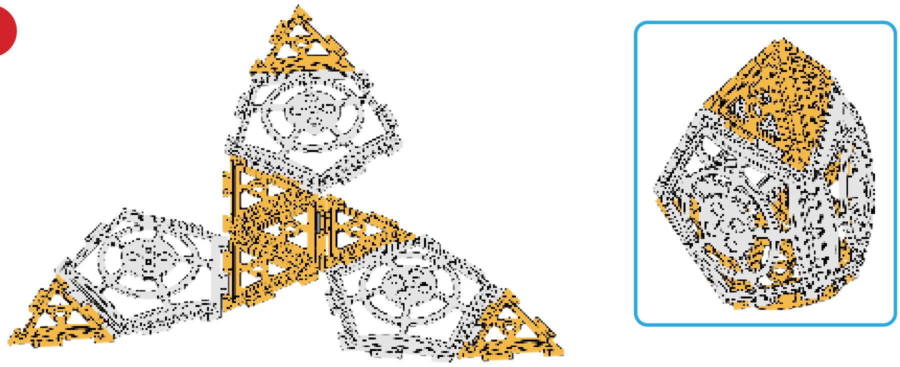

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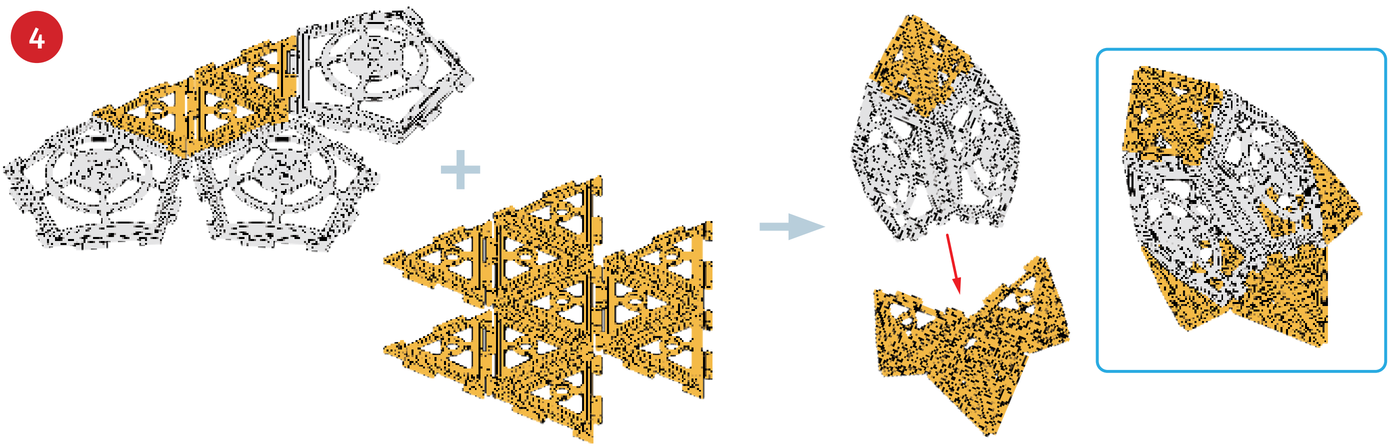

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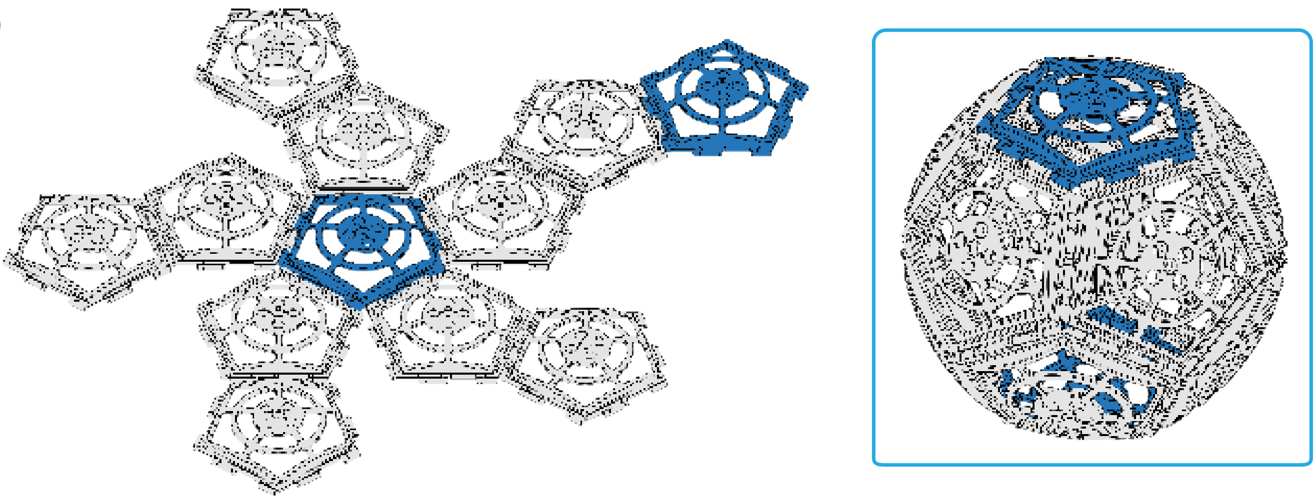

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