

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 hardware requirements)

Checklist: Find – Inspect – Check off

No.	Description	Qty.	Item No.
1	Joint pin	18	1155-W10-A18
2	Shaft plug	8	7026-W10-H18
3	Shaft pin	9	7026-W10-L38
4	3-hole rod	1	7026-W10-Q1W
5	3-hole cross rod	5	7026-W10-X1W
6	3-hole dual rod	2	7061-W10-R1W
7	3-hole wide rounded rod, white	2	7064-W10-C1W
8	3-hole wide rounded rod, gray	6	7064-W10-C1S
9	5-hole rod, white	1	7013-W10-K2W
10	5-hole rod, gray	4	7013-W10-K2S
11	5-hole cross rod, white	2	7013-W10-K2W
12	5-hole cross rod, black	2	7013-W10-K2B
13	5-hole dual rod B, gray	6	7036-W10-G2S1
14	5-hole dual rod C, white	2	7026-W10-G2W
15	5-hole dual rod C, gray	2	7036-W10-G2S2
16	7-hole wide rounded rod, white	2	7064-W10-C2W
17	7-hole wide rounded rod, gray	6	7064-W10-C2S
18	7-hole flat rounded rod, gray	3	7064-W10-C2S
19	11-hole rod, white	2	7026-W10-C1W
20	Square frame B	2	7026-W10-T2W
21	Square frame A	1	7026-W10-V1W
22	Short frame, white	2	7013-W10-Q1W
23	14-hole dual rod, gray	2	7013-W10-H1S1
24	Motor shaft	4	7026-W10-L3W
25	3-cm axle	1	7013-W10-H1S
26	10-cm axle	1	7013-W10-L3S
27	90-degree converter X, white	4	7061-W10-L1W
28	90-degree converter Y, white	4	7061-W10-L2W

No.	Description	Qty.	Item No.
29	90-degree converter Y, gray	6	7061-W10-L2S2
30	Small gear	8	7026-W10-D2S
31	Worm	1	7204-W10-A13W
32	Crank bar	1	7026-W10-L2D
33	O-ring	2	R12-08S
34	Small pulley	2	7204-W10-H1S
35	Body plate 3	3	7202-W10-L3TD
36	Body plate 4	3	7202-W10-L2TD
37	Leg left	1	7202-W10-C1W
38	Leg right	1	7202-W10-C2W
39	Diagonal connector	6	7004-W10-R2S
40	30-mm tube	4	7000-W10-G1D
41	20-mm tube	1	7000-W10-G2D
42	Short anchor pin	6	880-W10-H1B
43	Anchor pin	51	7061-W10-C1B
44	Two-to-one converter	4	7061-W10-G1W
45	Button pin	4	7061-W10-E1B
46	Anchor pin lever	1	7062-W10-B1S
47	Motor unit 1	1	7202-W10-B1
48	Medium gear	10	7204-W10-C1S
49	Motor unit 2	1	7000-W10-A
50	6.5-cm axle	3	7016-W10-C1D
51	Jaw, upper	1	7016-W10-A1W
52	Jaw, lower	1	7016-W10-A2W
53	Bluetooth battery box	1	7016-W10-A
54	Ultrasonic sensor	1	7016-W10-A
55	Flexible shaft	2	7016-W10-C

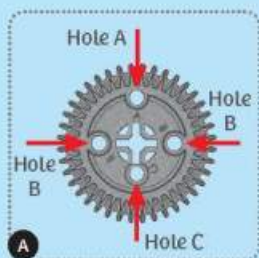


>>> TIPS AND TRICKS

Here are a few tips for assembling and using the models. Read them carefully before starting.

A. Pay attention to the hole alignment!

It is very important that you pay close attention to the alignment of the holes in the gear wheels. Make sure that you insert the shaft pins into the correct holes and that the gears are oriented exactly as shown in relation to each other and to the model. Otherwise, the animals will not move properly.



B. The part separator tool

In the box, you will find a little yellow tool called the anchor pin lever. End A of the part separator tool makes it easy to remove anchor pins from the frames.



C. Gear wheels

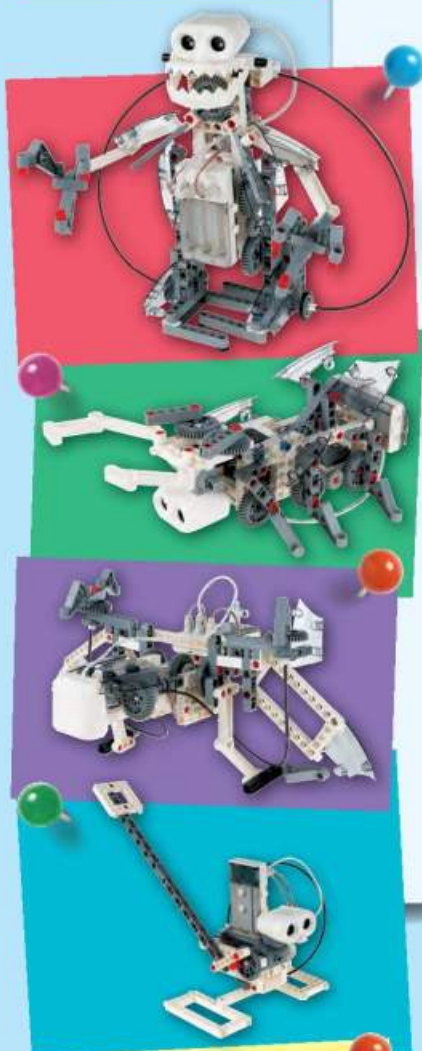
The models will often have several gear wheels installed in a row. In order for the models to work well, these gears will have to mesh well. Otherwise, the force from one gear wheel won't be properly transferred to the next.

D. Installing batteries in the Bluetooth battery box

Slide the transparent cover open. Insert the batteries according to the indicated plus-minus polarity. Close the compartment by sliding the cover back on.



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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:



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Publisher's information Inside back cover



Robots: Sensing, Thinking Machines

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 use an ultrasonic sensor to sense their environment. With the app, you can program the robots' motors to behave in different ways depending on the data coming from the ultrasonic sensor. In this way, you can create different robots that perform different tasks!



GETTING STARTED

There are five primary 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, and provides power to the motor units via wires.
- B. Motor units 1 and 2** connect to axles and motor shafts to turn gears and wheels, activating your models. They are powered by the battery box.
- C. The ultrasonic sensor** sends out ultrasound waves and “listens” for them to bounce off of objects. It gives this information to the app.
- D. The app** is the “brain” of your robotic models. It uses the feedback from the ultrasonic sensor and program instructions to control the models.

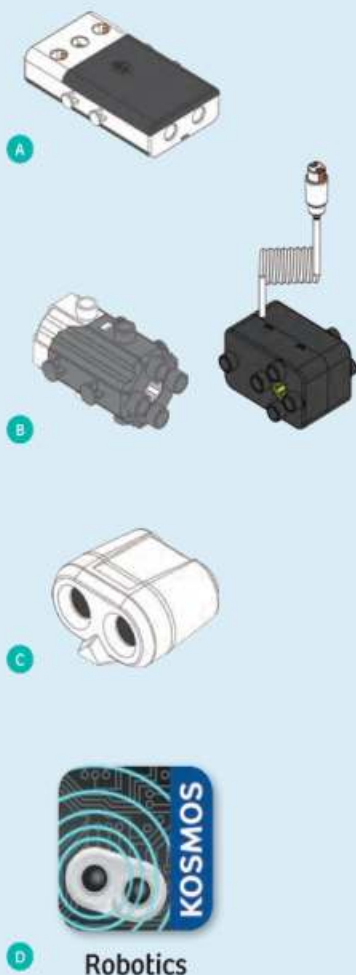
These five elements, in combination with all the mechanical parts — rods, gears, axles, frames, and so on — allow you to build and program mechanical robots that can sense their surrounding using sound waves.

First, follow the assembly instructions starting on page 13 to build one of the models. The Spy Bot model starting on page 18 is one of the easiest.

Make sure you have inserted the batteries correctly according to the battery information on page 2.

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!

Now you can connect the tablet or smartphone to the model via the free app. Instructions to download and use the app start on page 7.





ABOUT ULTRASOUND

ABOUT ULTRASOUND

Ultrasound is a sound pressure wave that moves through substances (gases, liquids, and solids) and has a frequency greater than that which humans can hear.

Frequency is simply the number of waves in a given period of time. Humans can hear sound waves in the frequency range of 20 hertz (which means cycles per second) to 20,000 hertz (20 kilohertz).

ANIMAL SONAR

In the natural world, bats, whales, and some birds use sound waves to detect objects around them. This is especially useful in the darkness of night or underwater, where seeing visible light is difficult or impossible.

This type of sensing is called **echolocation**, or biosonar. It works like this: The animal emits sound waves that move outward in all directions around it. When the sound waves hit an object, they bounce off of it and travel back to the animal's ears. The sound waves reach each of the animal's two ears at slightly different times. The animal can interpret this time difference to perceive the size, direction of movement, and speed of objects.

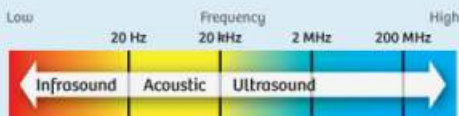
Animals use echolocation to hunt prey in the dark of night. They can also navigate and find their way around without normal eyesight.

ACTIVE SONAR

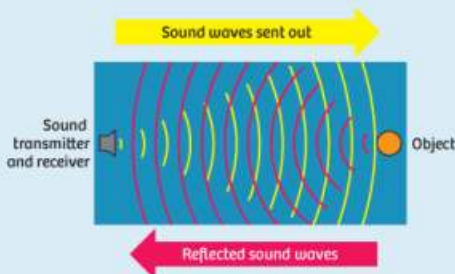
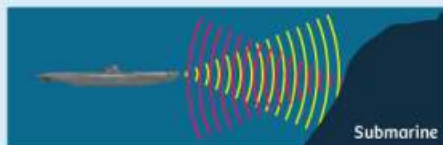
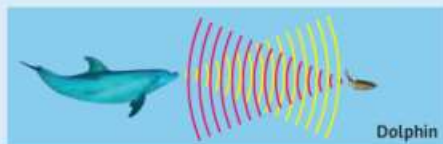
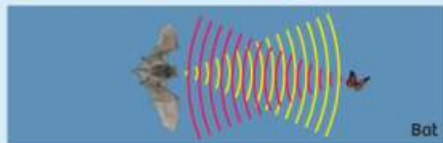
Humans have developed a technology to replicate echolocation, which is called **sonar**. Sonar is an acronym for **SOund Navigation And Ranging**. Sonar is used for navigation in submarines, ships, and airplanes. A similar technology using electromagnetic radio waves instead of sound waves is called **radar** (**RA**dio **D**etection **A**nd **R**anging).

With sonar and radar, airplane pilots are able to find their way and avoid collision with other planes, even in complete darkness or in thick clouds. Police use radar to detect speeding cars.

Your ultrasonic sensor also sends out sound waves. You can't hear them because they are ultrasonic! One "eye" on the sensor head is a transmitter and the other is a receiver. The transmitter sends out ultrasonic waves, like a speaker, and the receiver senses the waves that bounce back, like a microphone. In this way, the sensor is able to sense objects in front of it, even in the dark.



Sound waves of emitted call Echo sound waves



The ultrasonic sensor has one transmitter and one receiver.



DOWNLOADING AND USING THE APP

DOWNLOAD THE APP

You can download the free app for iOS devices from the iOS App Store, or for Android devices from Google Play.

- iOS devices must support Bluetooth 4.0 and must be running iOS 8.0 or later.
- Android devices must support Bluetooth 4.0 and must be running Android 4.4 or later.

To get the app:

1. Turn on your tablet or smartphone.
2. If you have a QR code reader installed, you can scan one of the QR codes to right to take you directly to the app download page for your device.
3. Alternatively, you can search for the "Robotics: Smart Machines" app or follow one of these links:
 iOS: www.thamesandkosmos.com/apps/620375/ios
 Android: www.thamesandkosmos.com/apps/620375/android
4. Follow the steps on the download page to download and install the app on your device.
5. Open the app and the remote control screen will appear.

REMOTE CONTROL MODE

1. Connect the app to your model by pressing the Bluetooth button in the upper left corner (A).
2. When the connection has been made, the Bluetooth symbol will change color (B) and, if a motor is connected, the motor will drive for a second to indicate the connection has been made.
3. The ultrasonic functionality will now be available if the ultrasonic sensor is connected properly. The concentric circular rings indicate the relative distance to an object in front of the sensor. The ring lights up when an object is detected. Closer objects light up the inner rings; objects that are farther away light up the outer rings. Test it out by moving an object in front of the sensor.
5. You can use the two slider controls (C) to directly control the two motors on your models. Slide the slider up or down with your finger to make the motor spin clockwise or counterclockwise.



Robotics



iOS app



Android app



Object Near

Object Far



WRITING PROGRAMS

PROGRAMMING MODE

Press the gear icon (D) to enter the programming mode. When you press the icon, a list of programs appears. You can save up to eight programs. The app comes with demo programs preloaded in Programs 1-7 and Program 8 is blank.

UNDERSTANDING THE ULTRASONIC DETECTION INTERVALS

1. Enter Program 8 (the blank program). The programming screen appears.
2. The Go button (E) runs the program. When it is pressed, the number in the upper left (F) will start indicating the distance to the object that the sensor is detecting.
3. After you press the Go button, it becomes a Stop button (G) and the program runs. You can see in this example that the sensor is reading a distance of "21." This equates roughly to a distance of 21 centimeters. Press the Stop button.
4. The sensor distance indicator line (H) has adjustable ranges. Different program segments can run in each of these ranges. By default, there are three ranges. The first range marker (I) is set at 30 and the second marker (J) at 50. This means there are four program segments by default:
 - The "Opening" program segment (K) runs once at the beginning when the Go button is pressed.
 - When an object is detected between 0 and 30, the blue 0-30 segment (L) runs.
 - When an object is detected between 30 and 50, the green 31-50 segment (M) runs.
 - When an object is detected between 50 and 100, the purple >51 segment (N) runs.

You can slide the range markers to change the distance ranges. You can also increase the number of distance range segments by pressing the add range marker button (O). You can delete a segment with the delete button (P).

Range markers must be a minimum of 5 distance units apart. You cannot add a new range marker if there is another marker at 90 or higher.



WRITING A PROGRAM

1. Now you are ready to write your first program.
Click the gear 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 program segments to add a command.
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.



WRITING PROGRAMS

PROGRAMMING MOTORS

1. Press the motors command icon and the motor programming window appears (D).
2. In the motor programming window, you can create a command to control motor one (blue) and/or motor two (red) to turn forward or backward. 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.

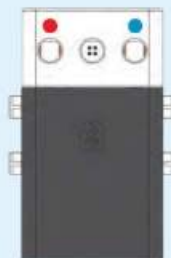
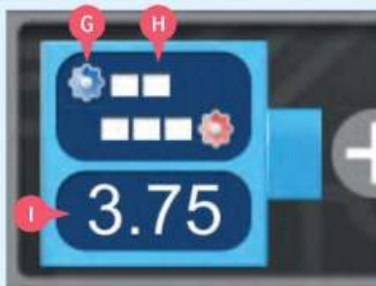
3. With the time slider (E), you can also set the duration for which the motor(s) will turn, from 0.5 to 5.0 seconds.
4. When you are satisfied with your selections, press the green check mark button and the motor block (F) appears in the program segment.

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 one and the red gear wheel represents motor two.

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.



Motor indicator dots

PROGRAMMING SOUNDS

1. Press the notes command icon and the sound programming window appears (J).
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 (0.5 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 appears (L). You can choose the duration (0.5 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.



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 ultrasonic sensor reads objects at different distances in front of it.

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



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 PROGRAMS

DELETE ALL

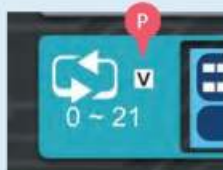
To clear an entire program and set it back to the default blank program mode, press the trash can button (O) in the menu bar. This also resets the range markers to the default settings.



LOOP CHECKBOX

When the loop checkbox (P) is checked, the program segment will run in a continuous loop, over and over again, when the program segment is active.

When the loop checkbox is unchecked, the program segment will run just once when the program segment is triggered.



SWITCHING BETWEEN PROGRAMS

If you want to move to a different program, click the storage box button (Q) and select which program you want to open.



SAVING PROGRAMS

When you want to save a program you have written, press the disk button (R). The program script will immediately be saved inside the program (1-6) you are currently in. A confirmation screen will appear.



REVERT TO SAVED

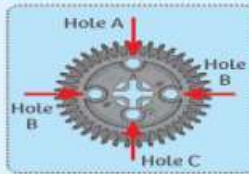
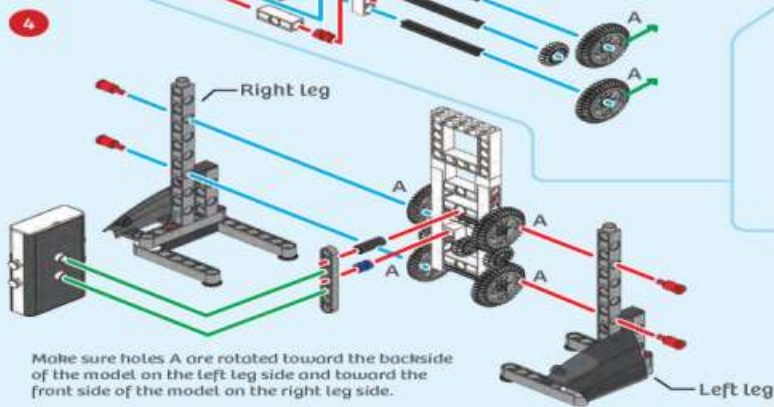
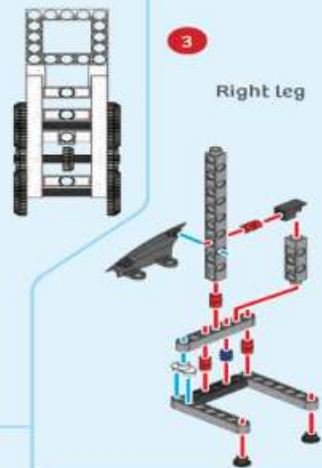
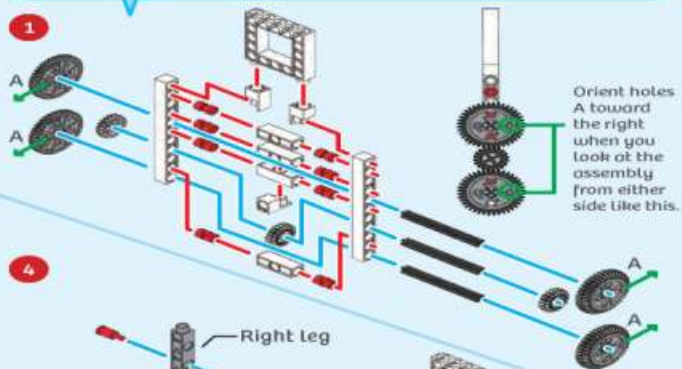
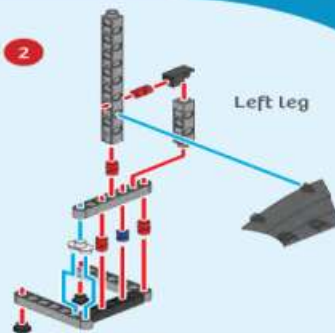
To revert to the last saved version of the program and erase all unsaved changes, press the revert to saved button (S).



EXITING PROGRAMMING MODE

When you want to leave the programming screen, press the door button (T). 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.

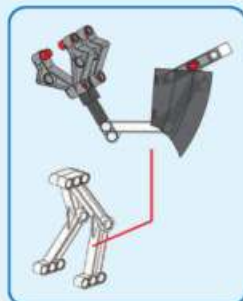
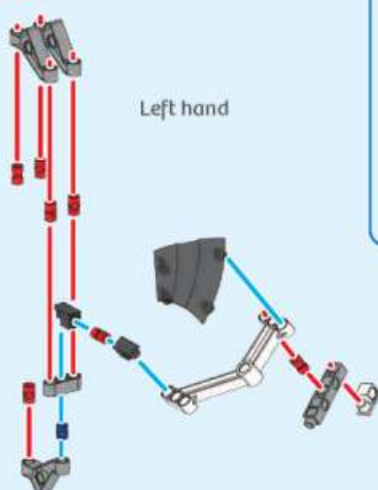
Bipedal Droid



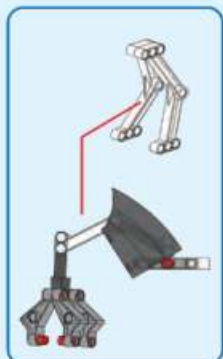
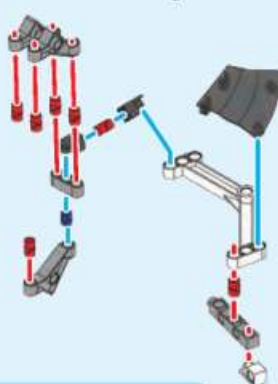


BIPEDAL DROID

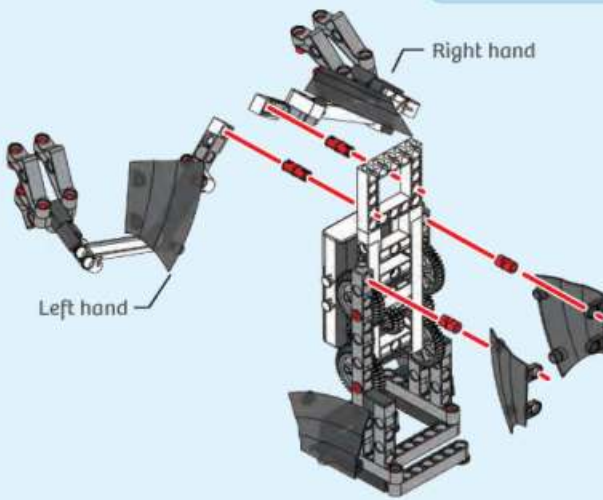
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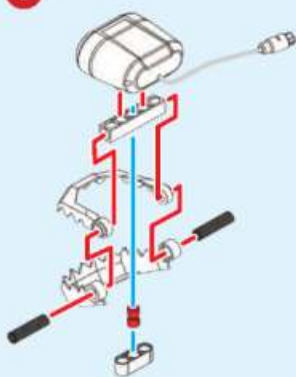
6



7



8



Bipedal Droid

A diagram of a circular plate with four holes labeled Hole A, Hole B, Hole C, and Hole D. Arrows indicate flow directions: Hole A (top) has an arrow pointing down into the hole; Hole B (left) has an arrow pointing right into the hole; Hole C (bottom) has an arrow pointing up into the hole; and Hole D (right) has an arrow pointing left into the hole.

Connect to hole C

10

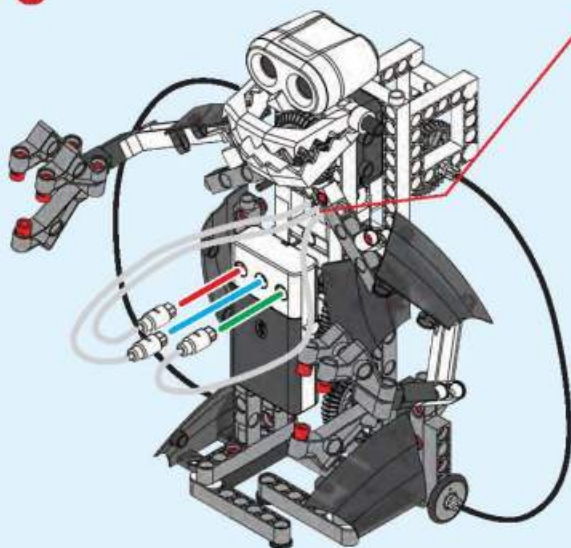
1: Do first.
2: Do second.
Last: Do last.

last

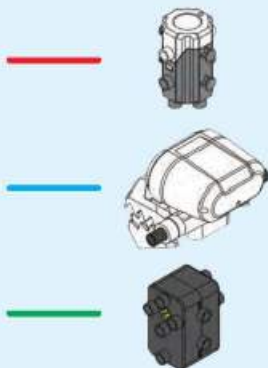


BIPEDAL DROID

11

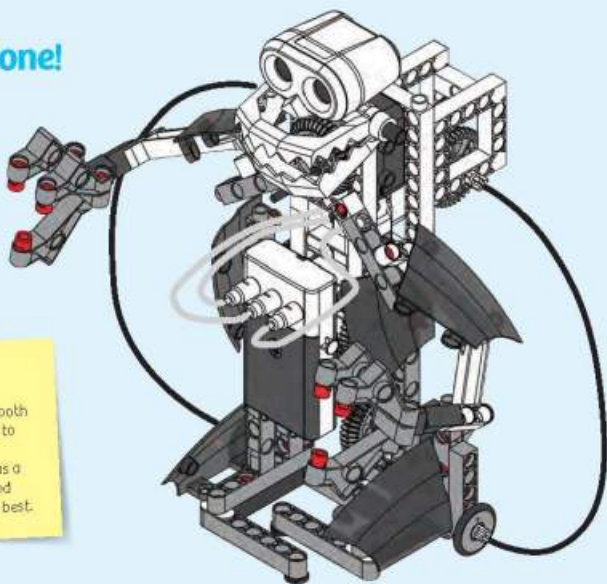


The three wires pass through the middle frame.



12

Done!



NOTE!

This model requires a smooth tabletop or floor in order to turn properly. Try it on different surfaces, such as a glass table and hardwood floor, to see what works best.

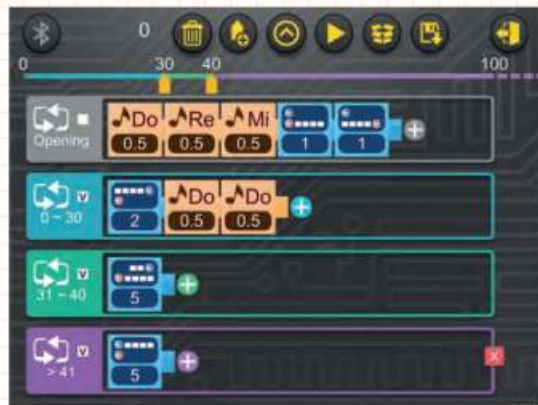
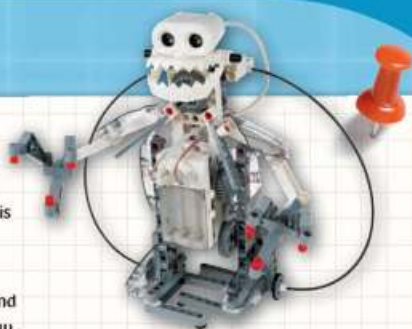
PROGRAMMING



SAMPLE PROGRAM FOR THE BIPEDAL DROID

Use this program to make your bipedal droid walk forward until it detects an obstacle with the ultrasound sensor. When the obstacle is detected, the robot will turn to the side. When the robot no longer detects an obstacle, it will walk forward again.

This program is preloaded in the app under Program 7. Test it out and write down how the robot behaves for each program segment below.



PROGRAMMING NOTES

DEMO PROGRAM:

Program 7

OPENING SEGMENT:

SEGMENT 0-30:

SEGMENT 31-40:

SEGMENT >41:



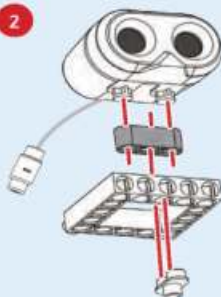
SPY BOT



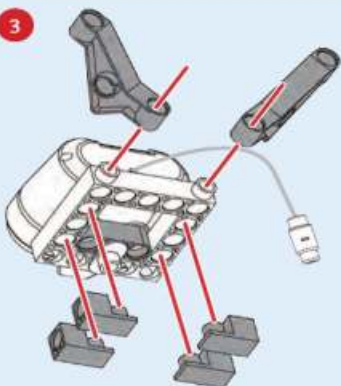
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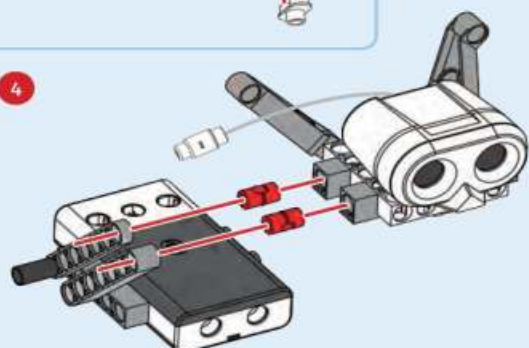
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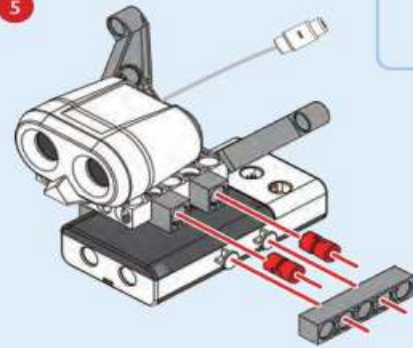
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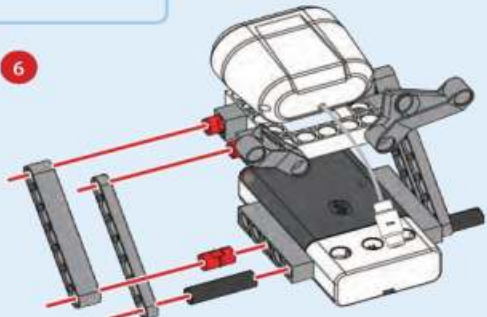
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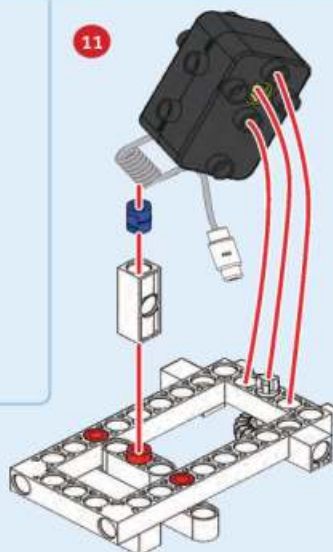
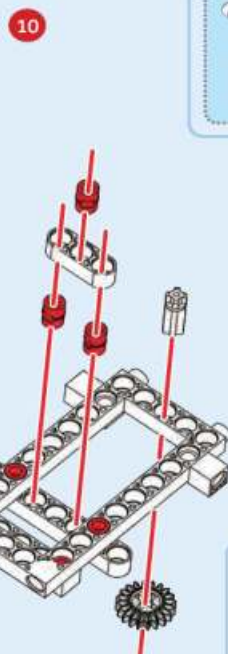
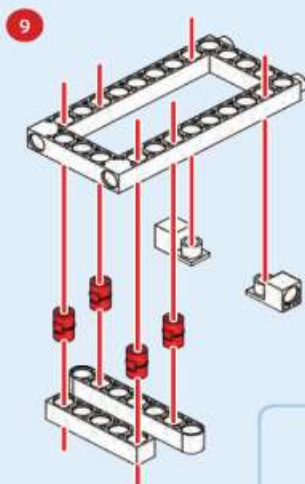
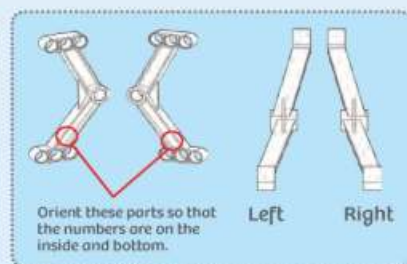
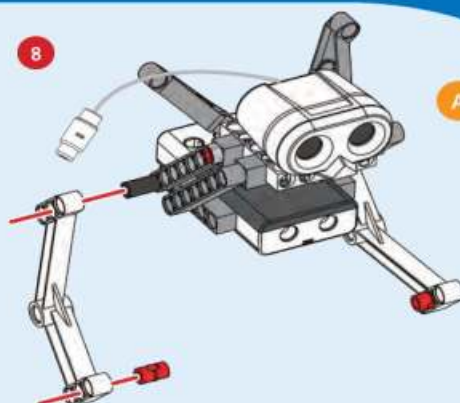
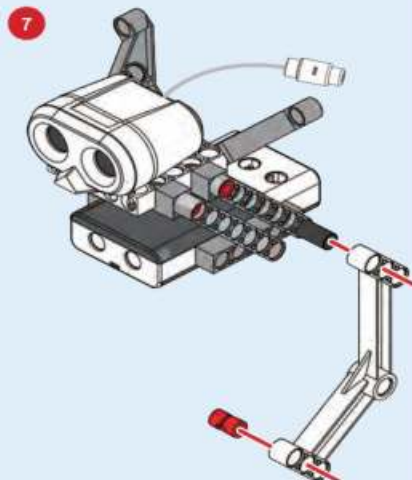


5



6

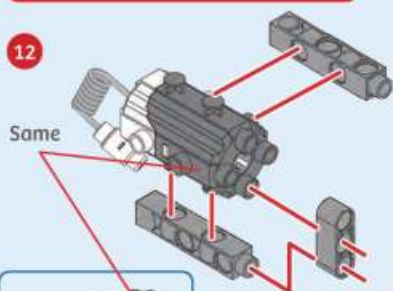




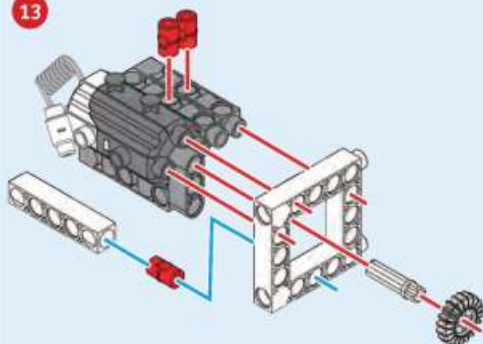


SPY BOT

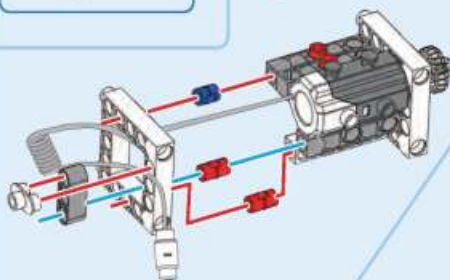
12



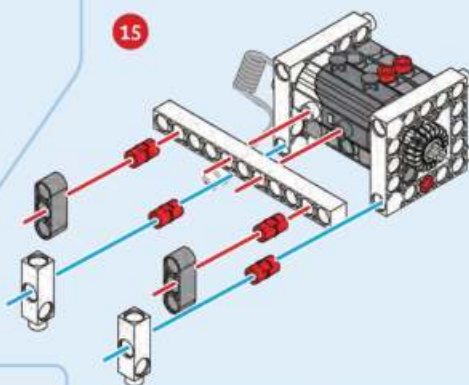
13



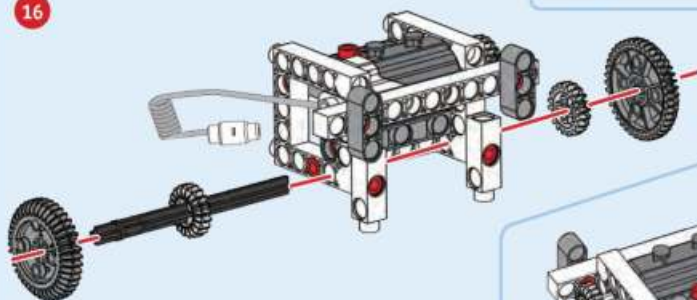
14



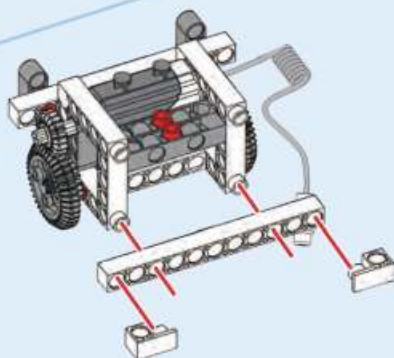
15



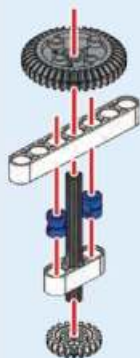
16



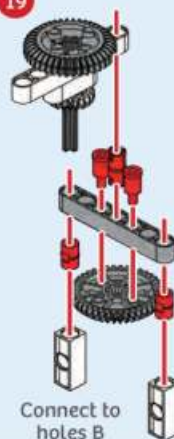
17



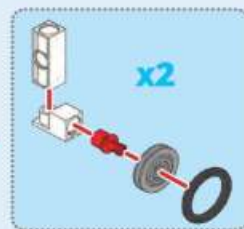
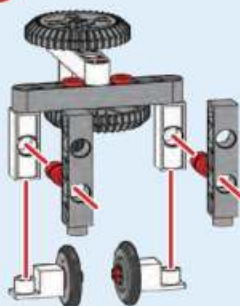
18



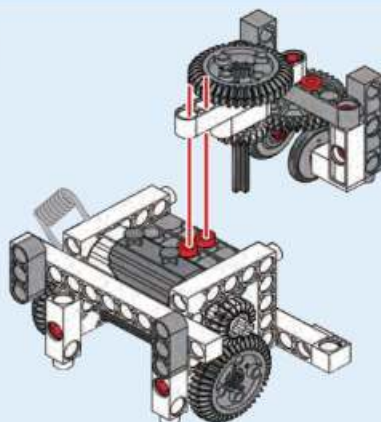
19



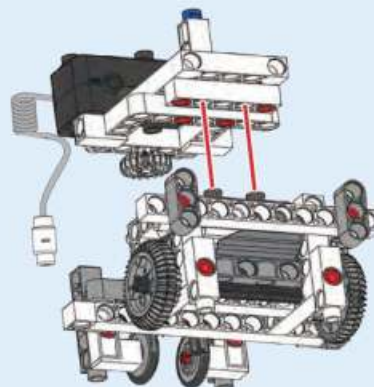
20



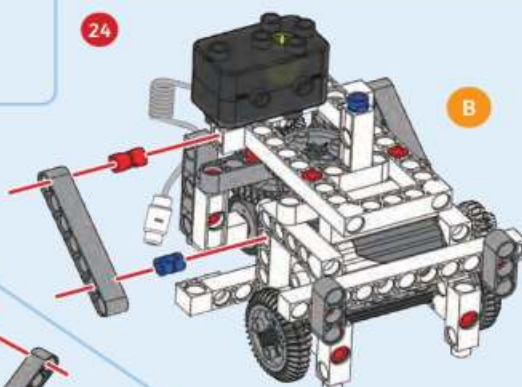
21



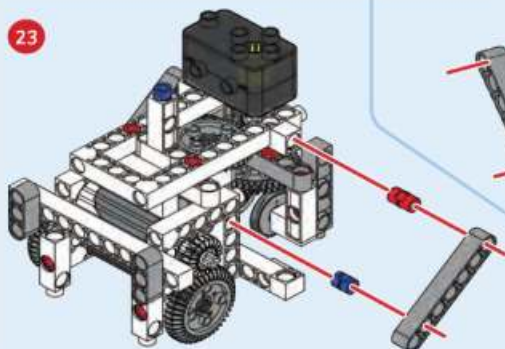
22



24



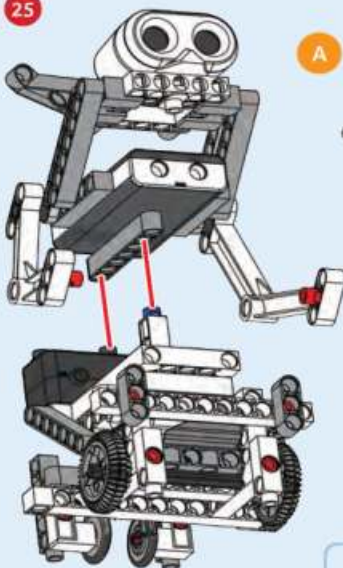
23



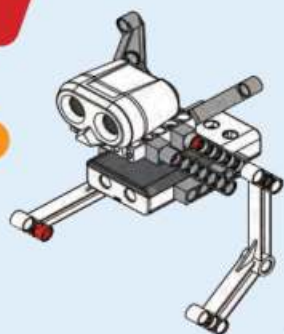


SPY BOT

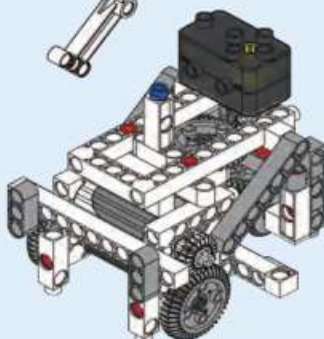
25



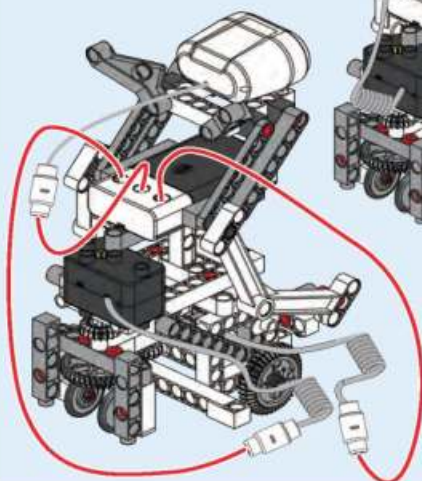
A



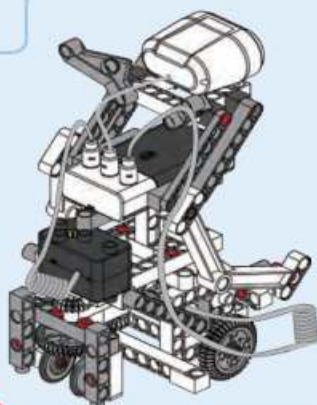
B



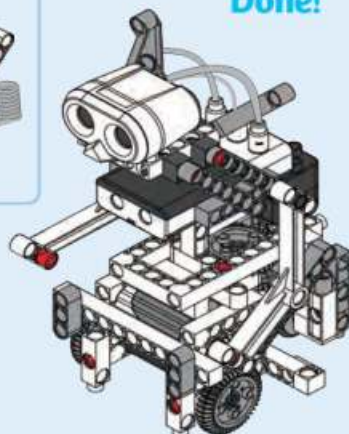
26



27



Done!



PROGRAMMING

**MANUALLY CONTROLLING THE SPY BOT**

Test out the app's remote control capabilities with this cute little robot. Drive it around your house directly with the remote control mode on the app. And here's a cool idea: You can place a second smartphone or small tablet in the holder on the front of its body, and then use the device's built-in video camera to record what the robot "sees." You could even stream it back to another computer via a video chat program.

Motor 1 moves the robot forward or backward and Motor 2 turns the robot around.

In this way, this cute robot can become a stealthy spy bot or a remote expedition bot.



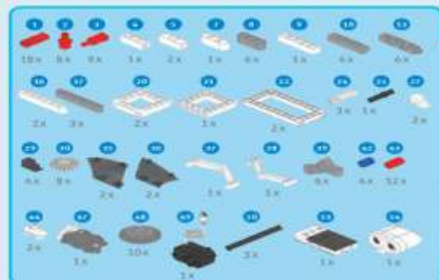
Position the smartphone or small tablet here.

CHARTING A COURSE

Draw a floor plan of your home or classroom here and then draw a route for your spy bot to follow. Can you use the remote controls to follow the route the entire way?



BEETLE



1

x6

2

4

3

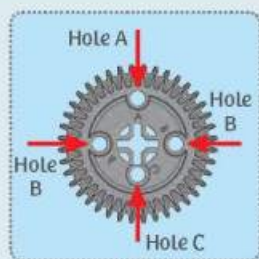
5

6

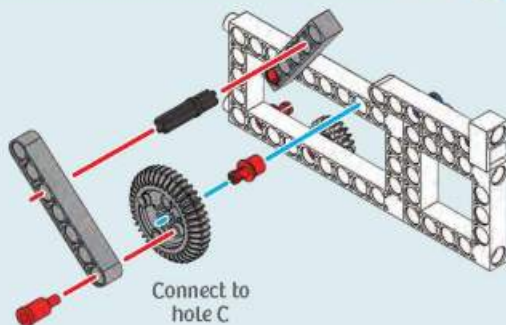
7

8

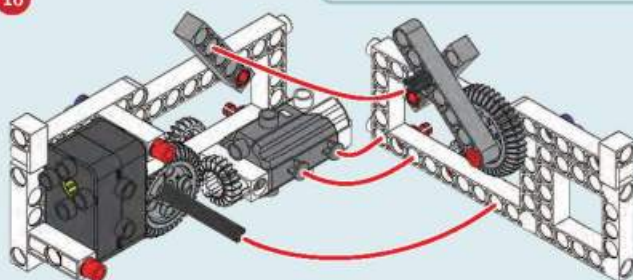
Pull the plug through the square frame.



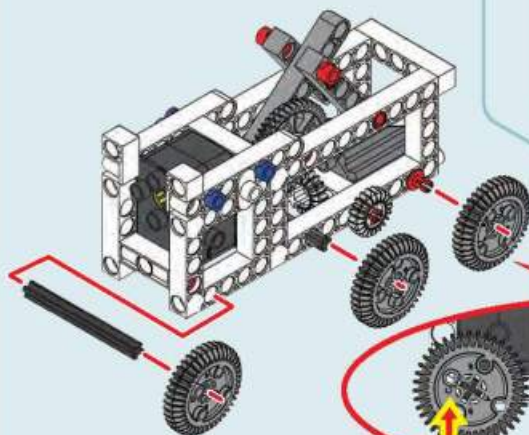
9



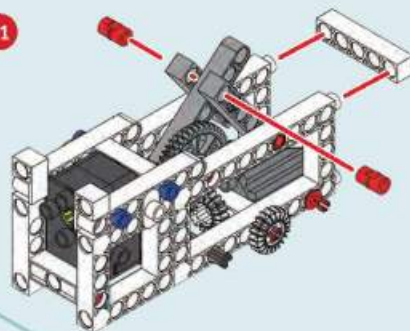
10



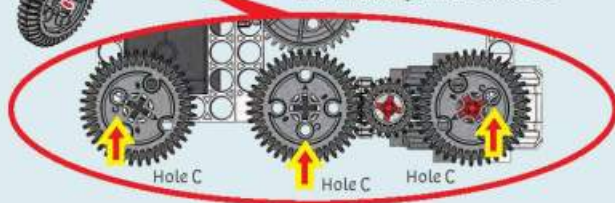
12



11



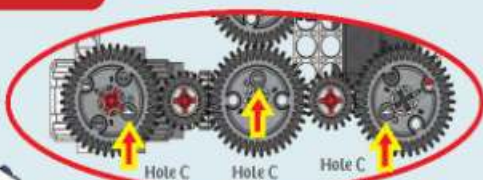
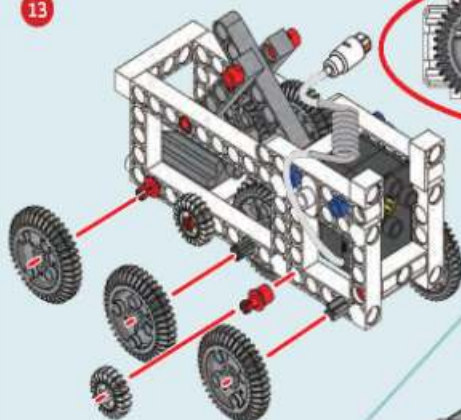
Align the gears exactly as shown.
The arrows point to holes C.





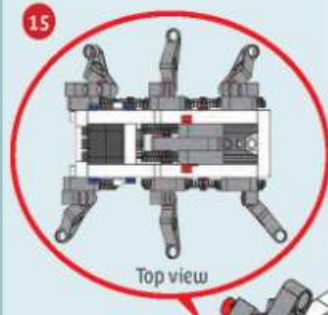
BEETLE

13



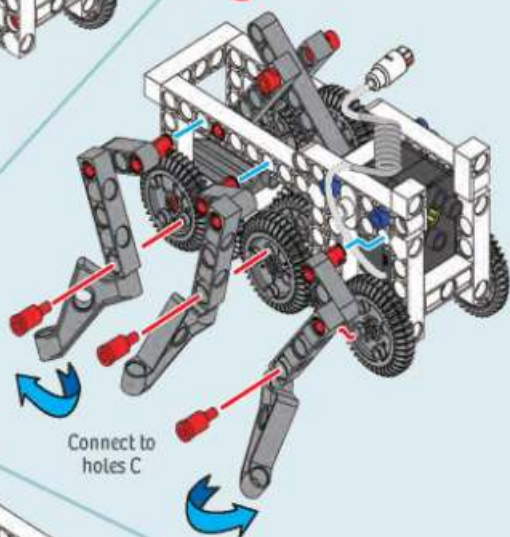
Align the gears exactly as shown.
The arrows point to holes C.

15

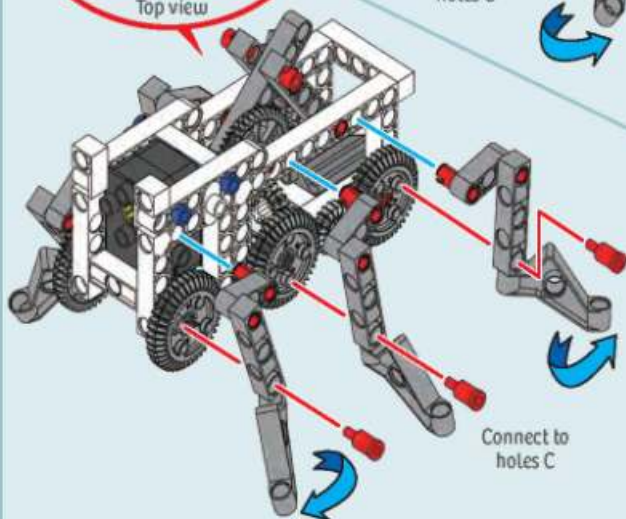


Top view

14



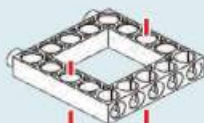
Connect to
holes C



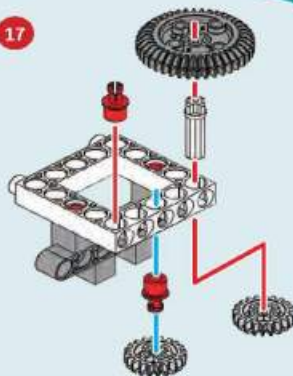
Connect to
holes C



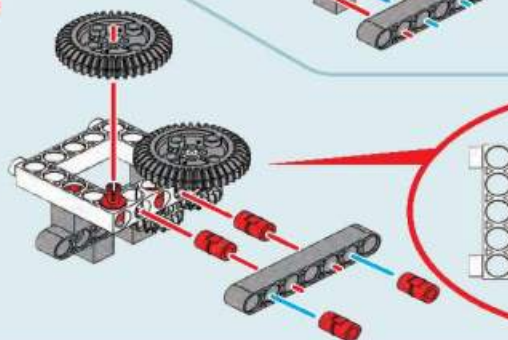
16



17

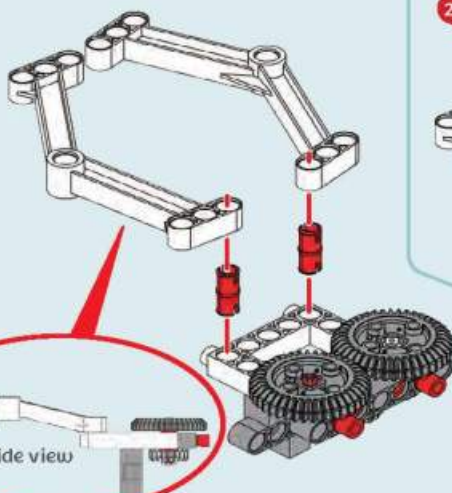


18



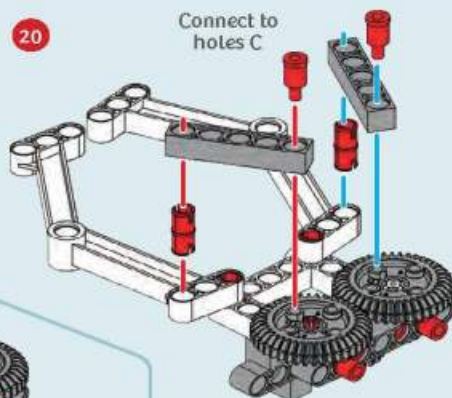
Top view

19



Side view

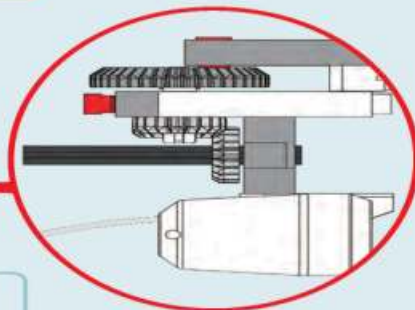
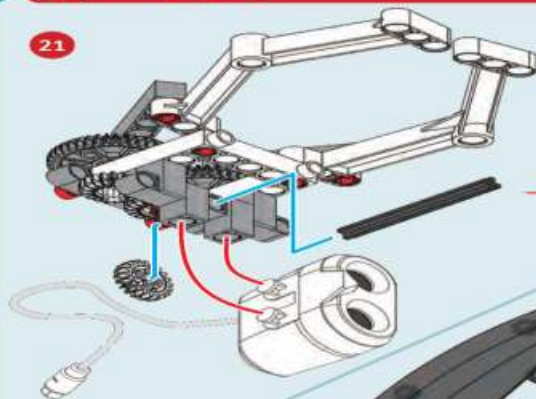
20

Connect to
holes C

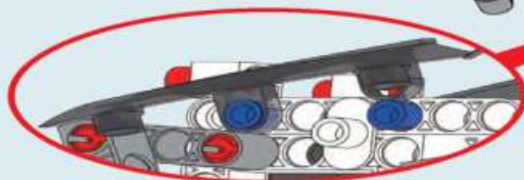
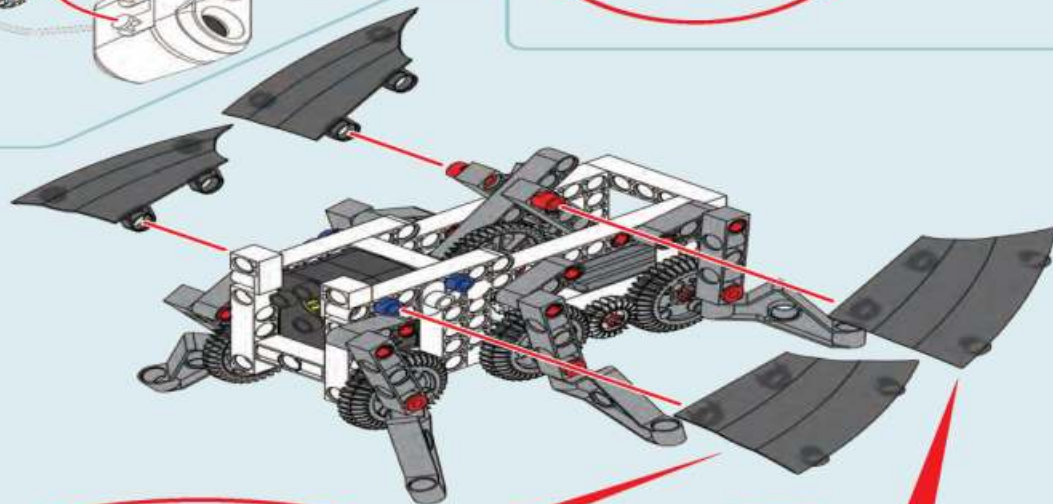


BEETLE

21

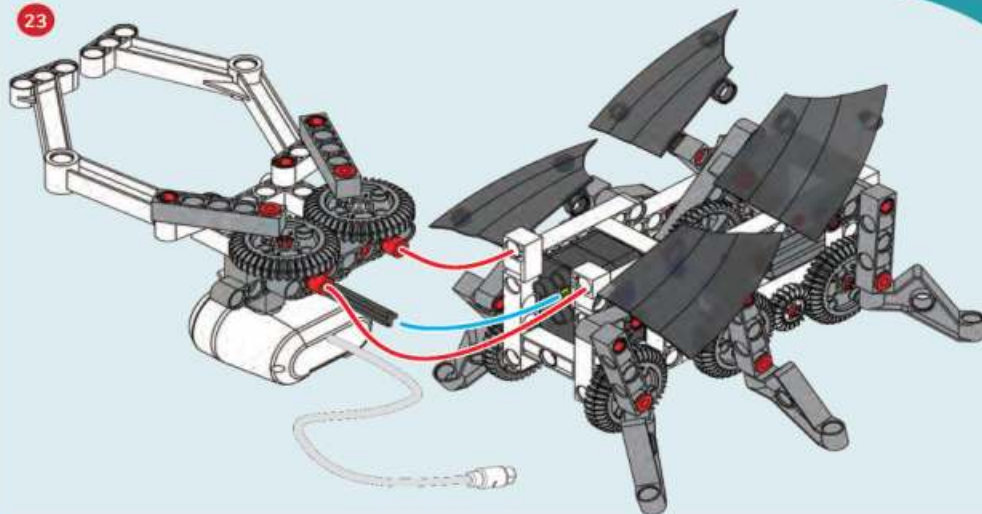


22

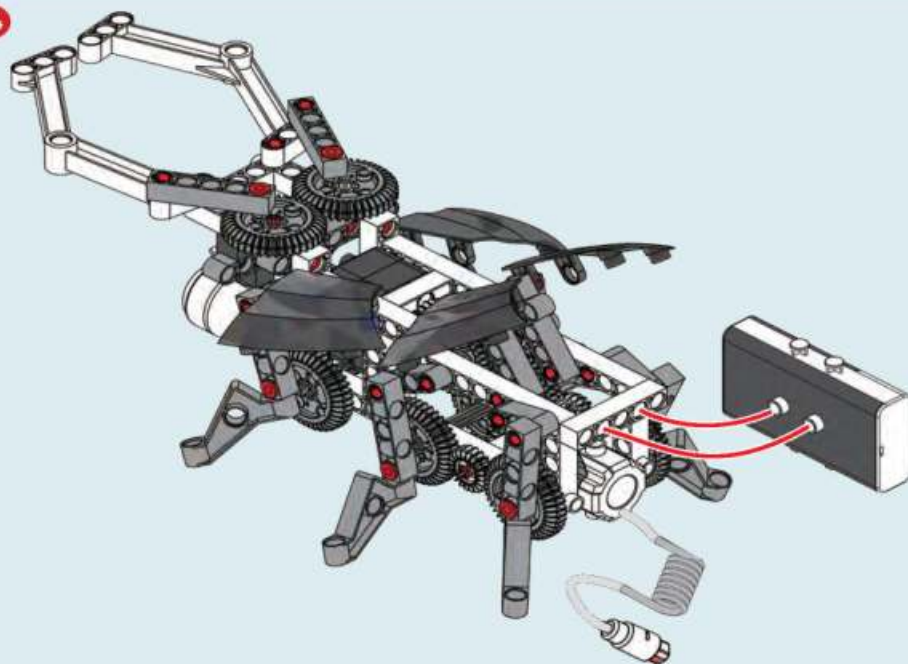




23

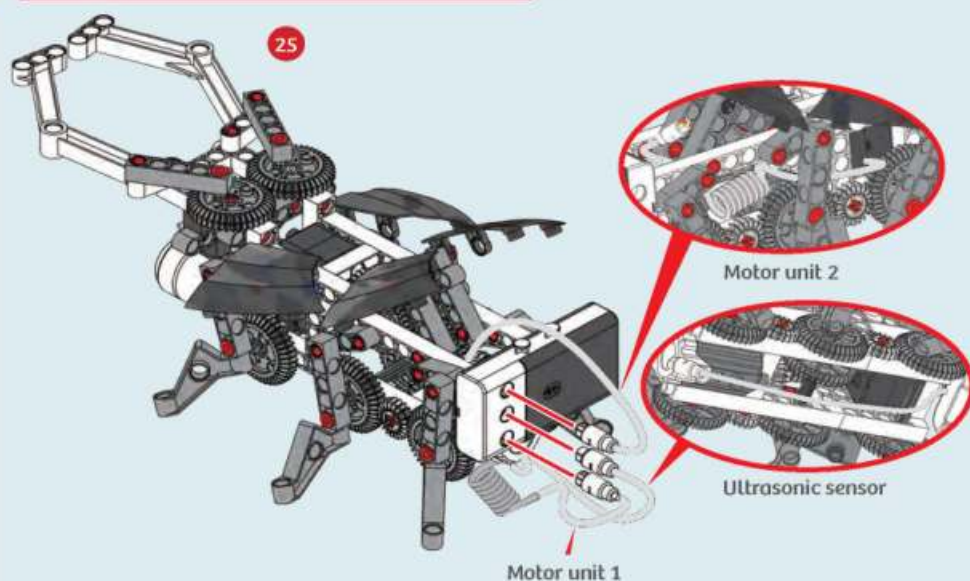


24



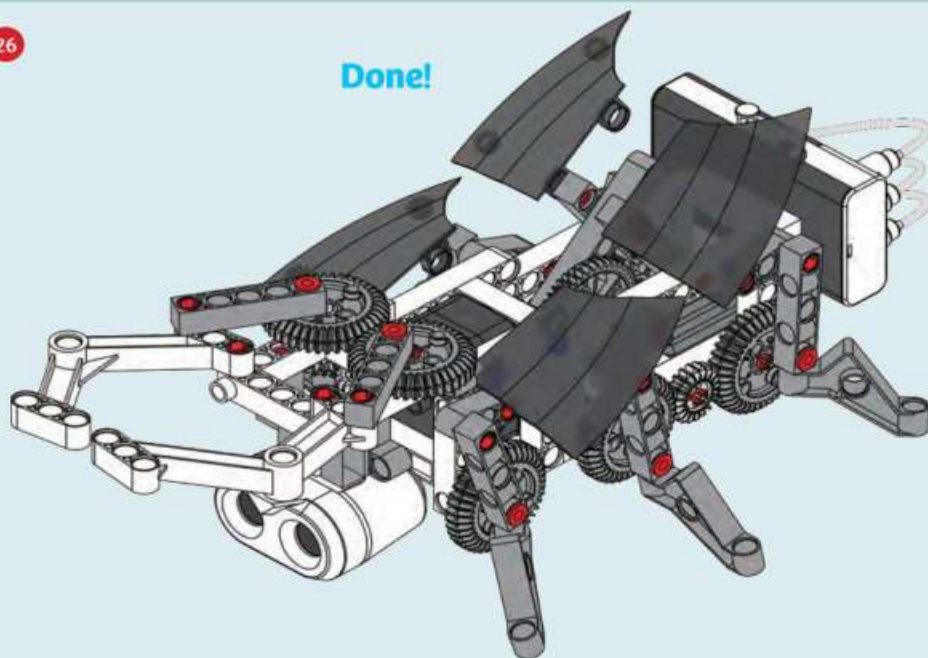


BEETLE



26

Done!



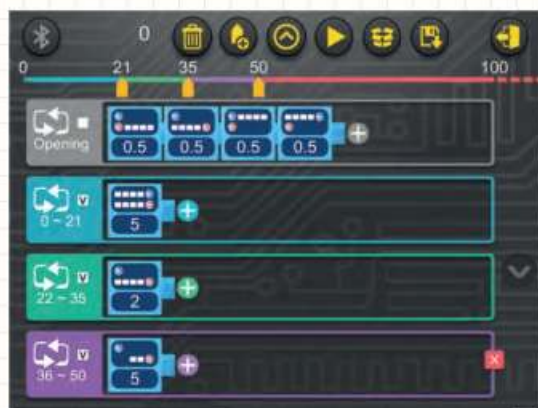
PROGRAMMING



SAMPLE PROGRAM FOR THE BEETLE ROBOT

Use this program to make your beetle robot walk forward until it detects an obstacle with the ultrasound sensor. When the obstacle is detected, the robot will move its front pincers and flap its wings to scare off any potential predators. If the obstacle keeps approaching, the beetle will start to back away.

This program is preloaded in the app under Program 4. Test it out and write down how the robot behaves for each program segment below.



DEMO PROGRAM:

Program 4

OPENING SEGMENT:

SEGMENT 0-21:

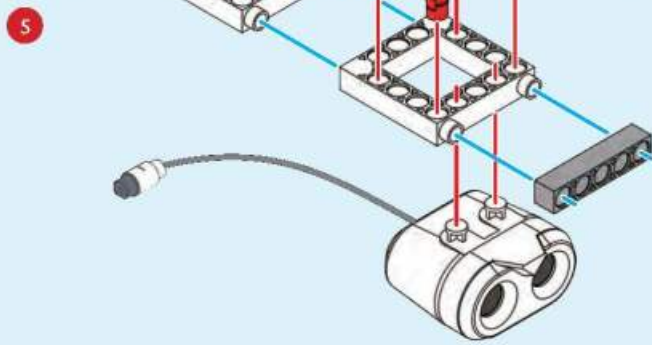
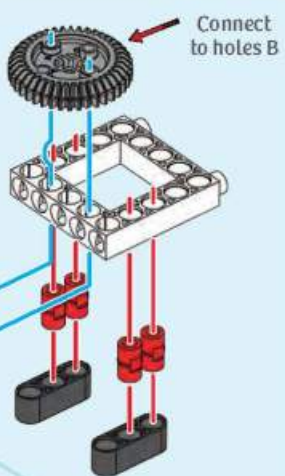
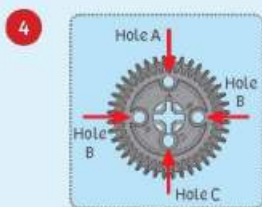
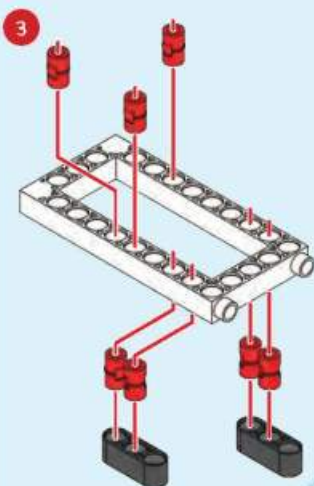
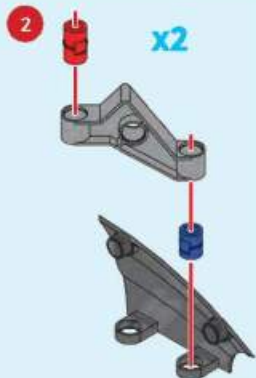
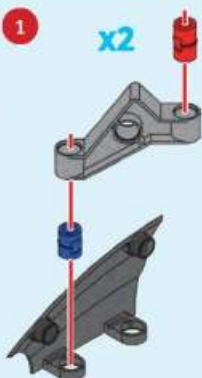
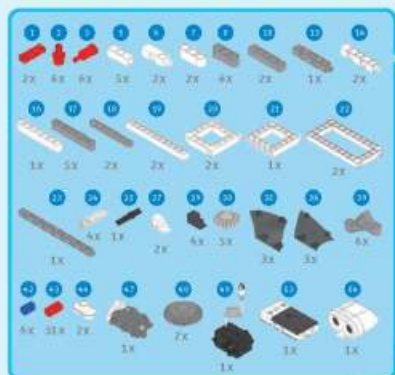
SEGMENT 22-35:

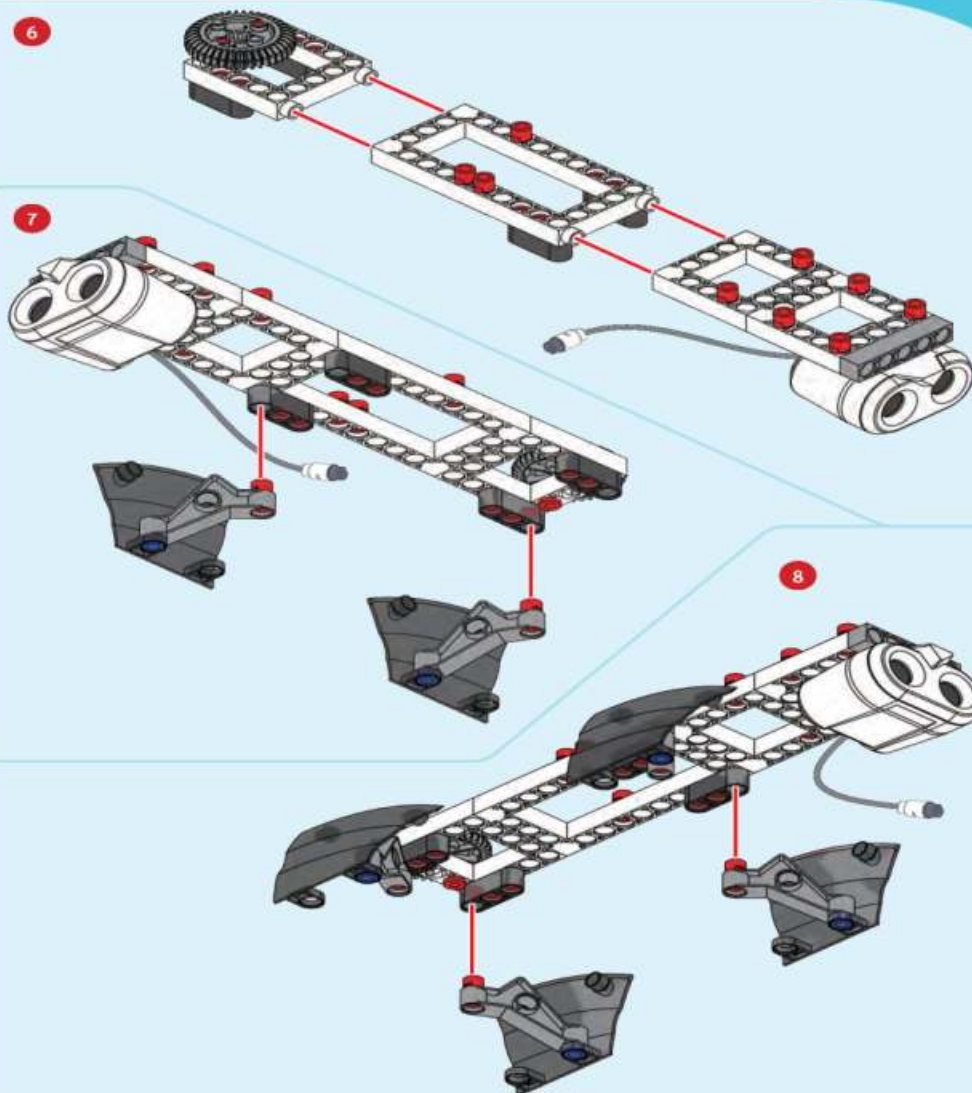
SEGMENT 36-50:

SEGMENT >51:



CROCODILE

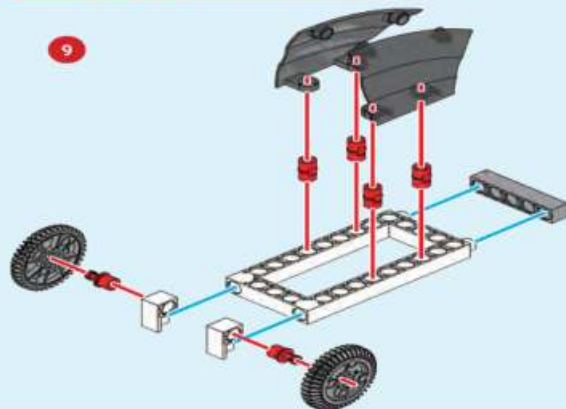




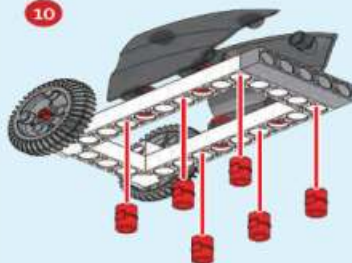


CROCODILE

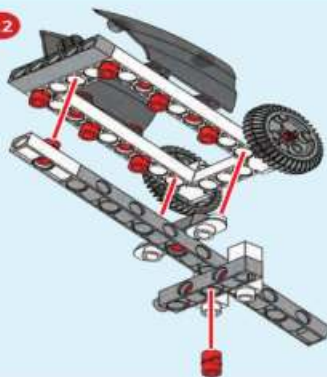
9



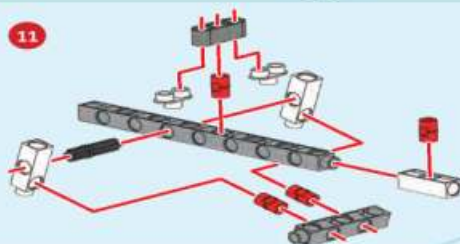
10



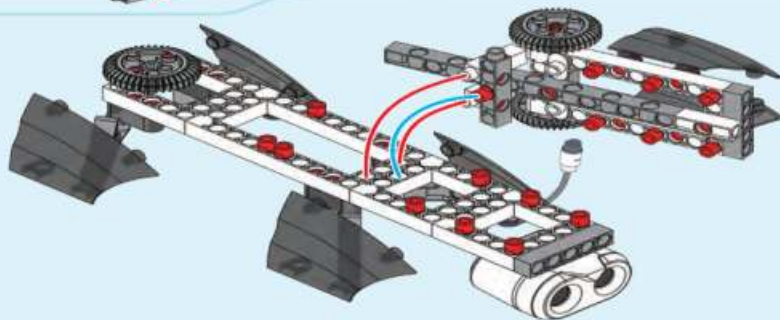
12



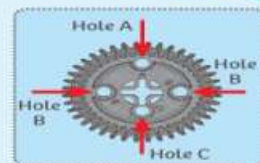
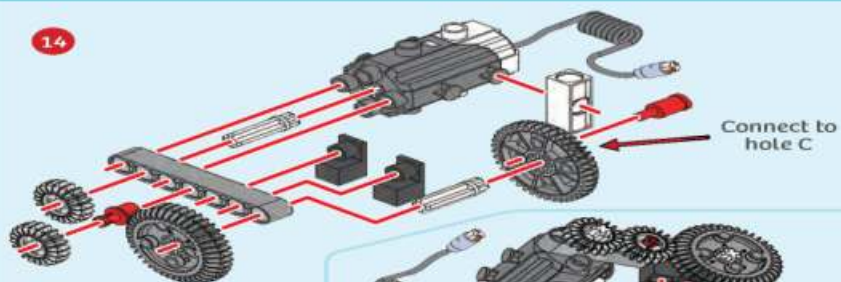
11



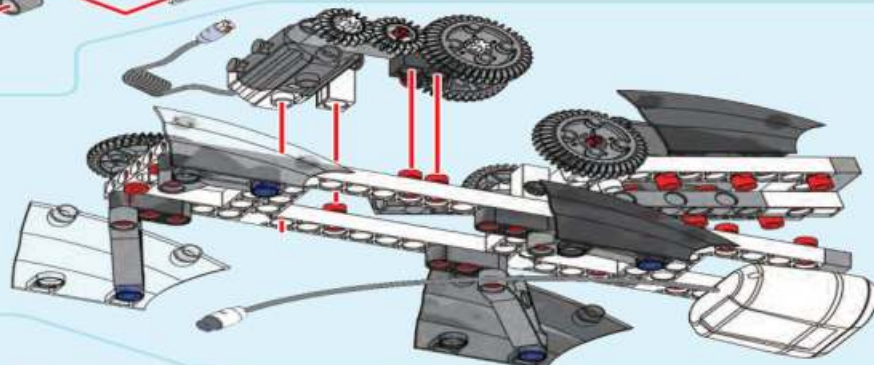
13



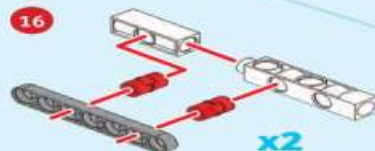
14



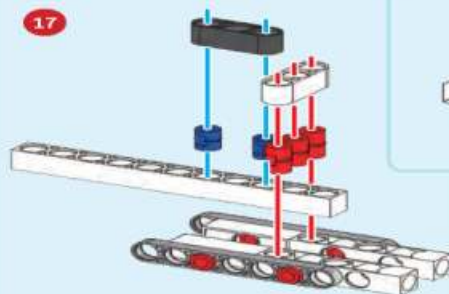
15



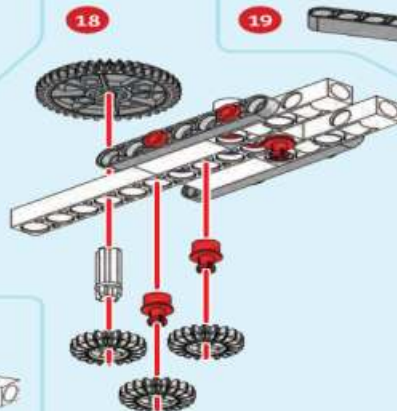
16



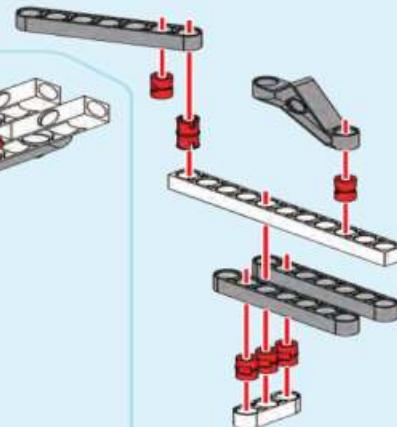
17



18



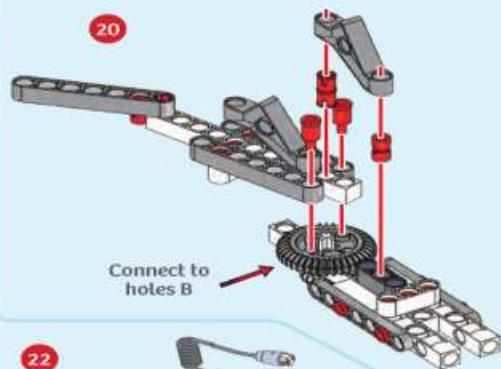
19



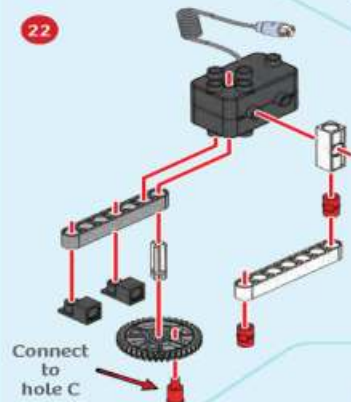


CROCODILE

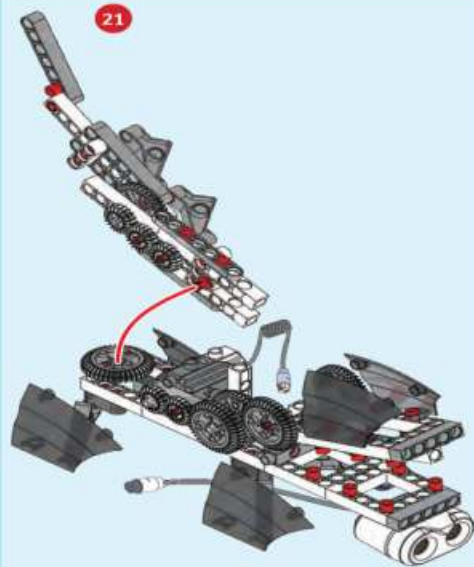
20



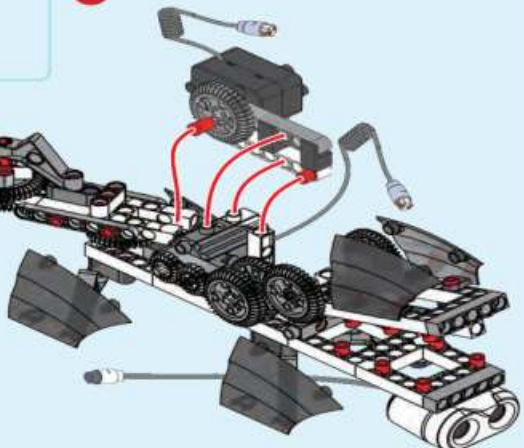
22



21

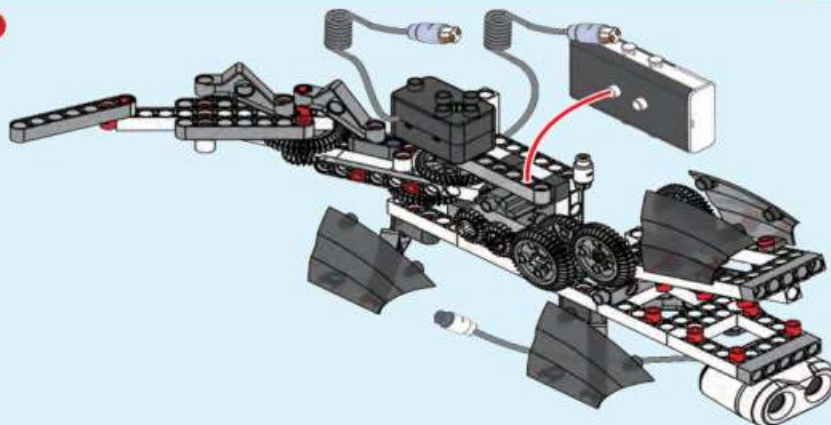


23

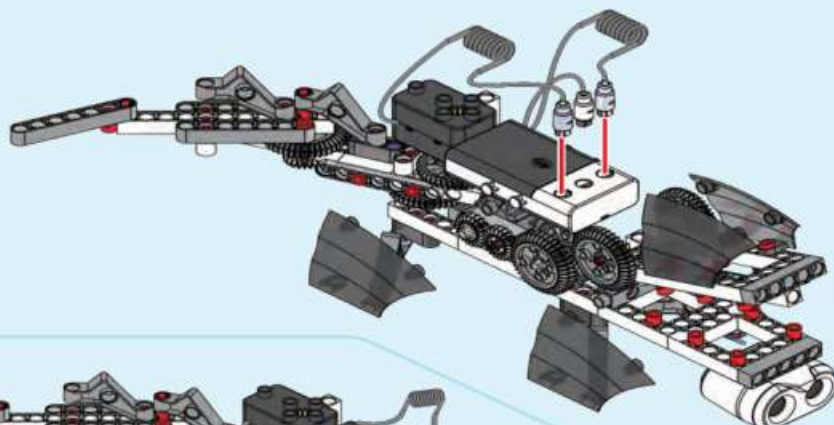




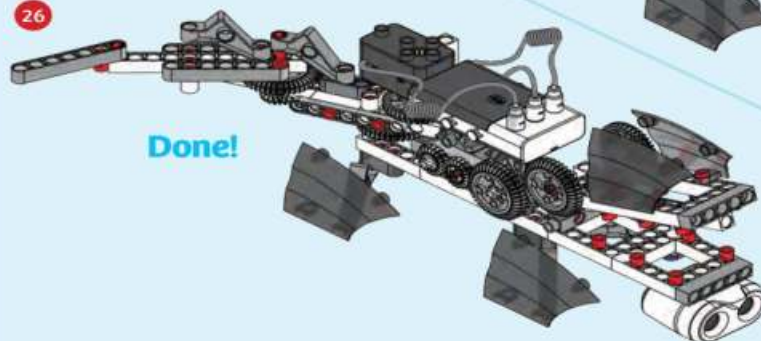
24



25



26



Done!



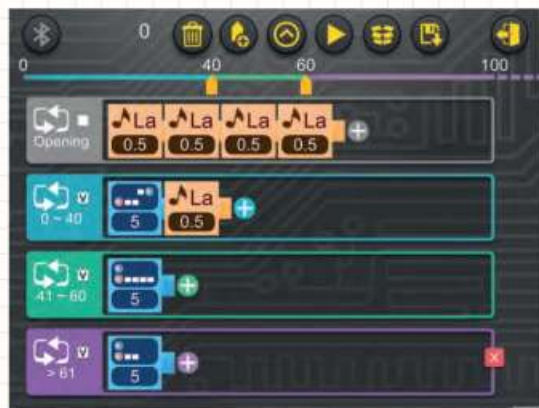
PROGRAMMING



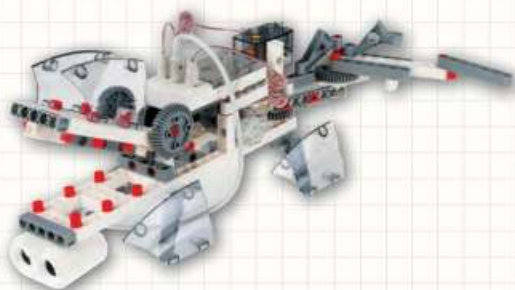
SAMPLE PROGRAM FOR THE CROCODILE ROBOT

Enter this program to make your crocodile robot wiggle its tail. When it senses something coming closer to it, it opens its mouth to scare off potential enemies.

This program is preloaded in the app under Program 2. Test it out and write down how the robot behaves for each program segment below.



PROGRAMMING NOTES



DEMO PROGRAM:

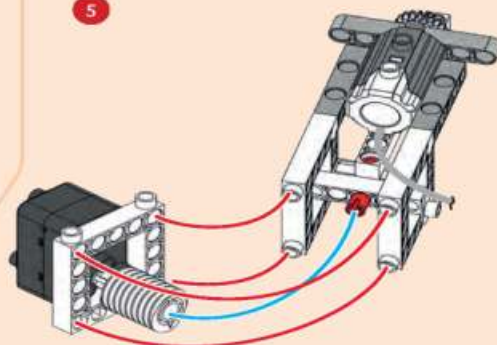
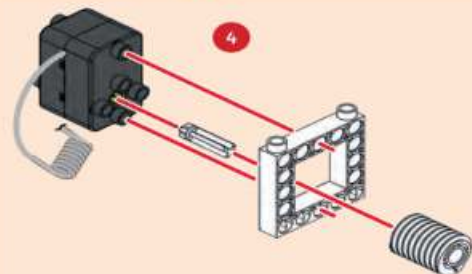
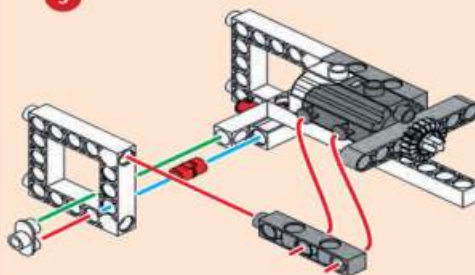
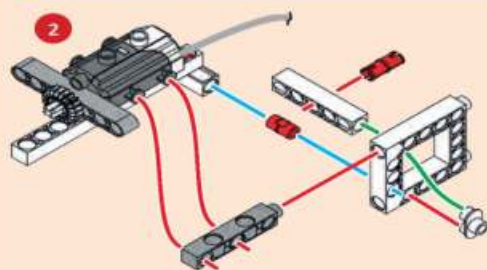
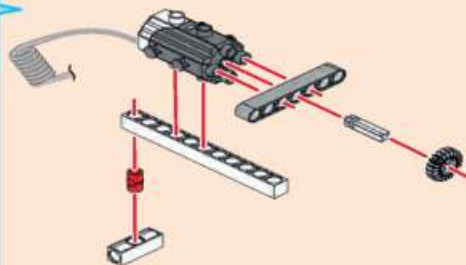
Program 2

OPENING SEGMENT:

SEGMENT 0-40:

SEGMENT 41-60:

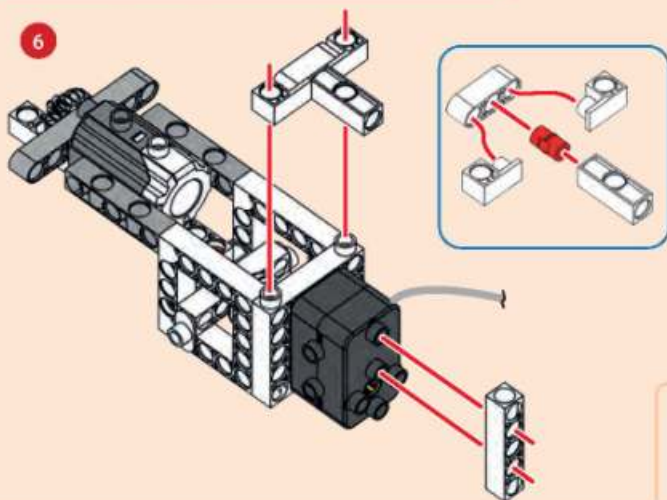
SEGMENT >61:



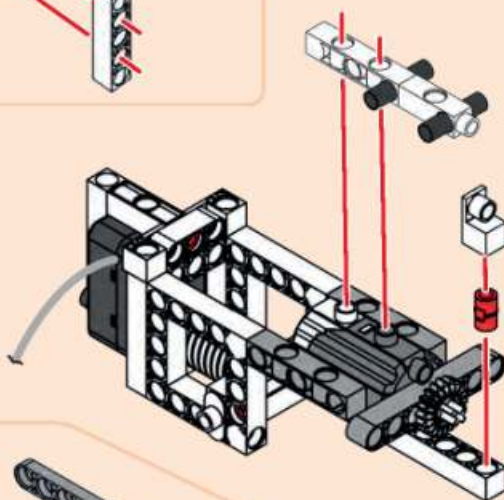
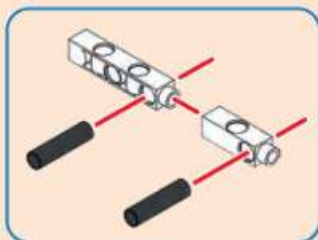


TILTROTOR AIRCRAFT

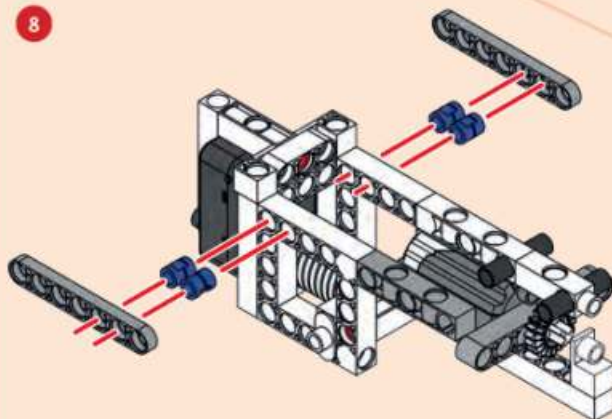
6

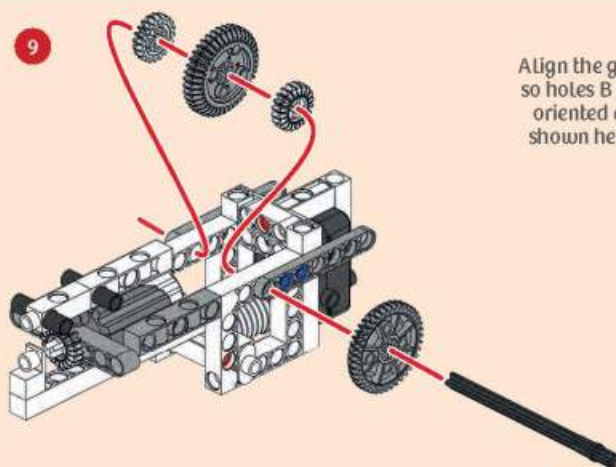


7

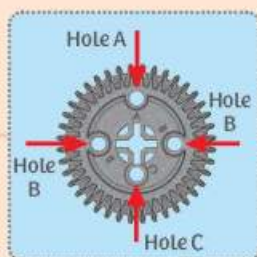
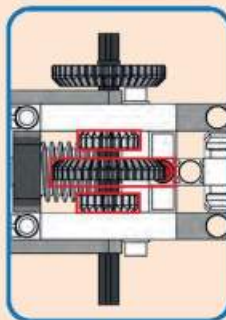
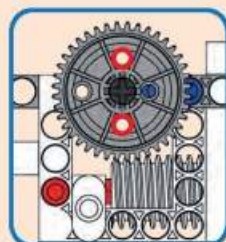


8

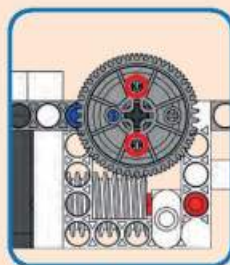




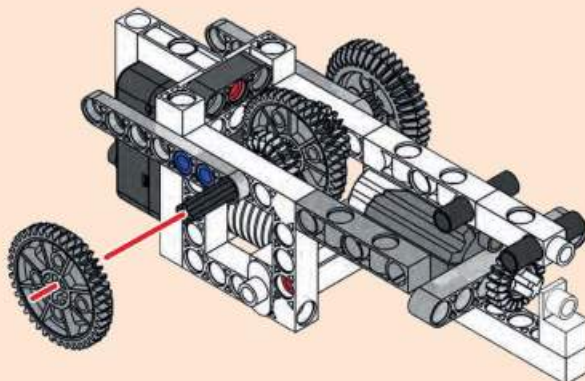
Align the gear so holes B are oriented as shown here.



10



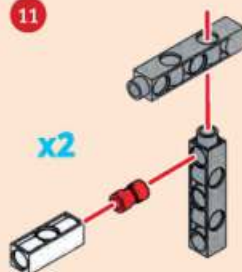
Align the gear so holes B are oriented as shown here.



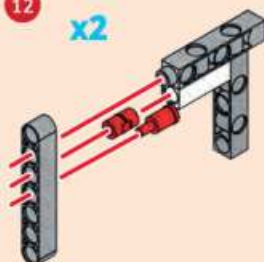


TILTROTOR AIRCRAFT

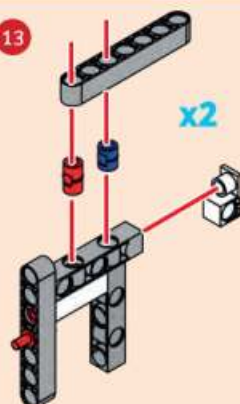
11



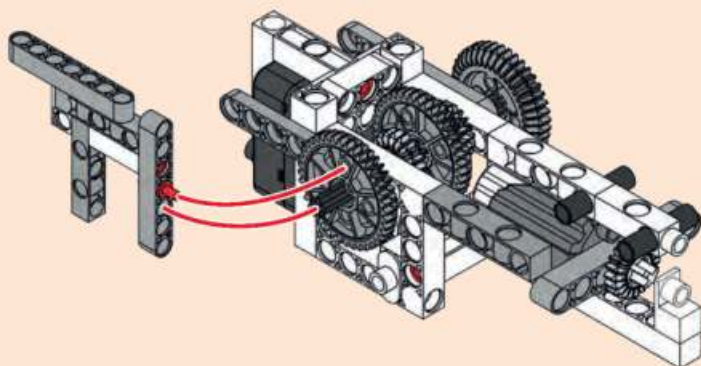
12



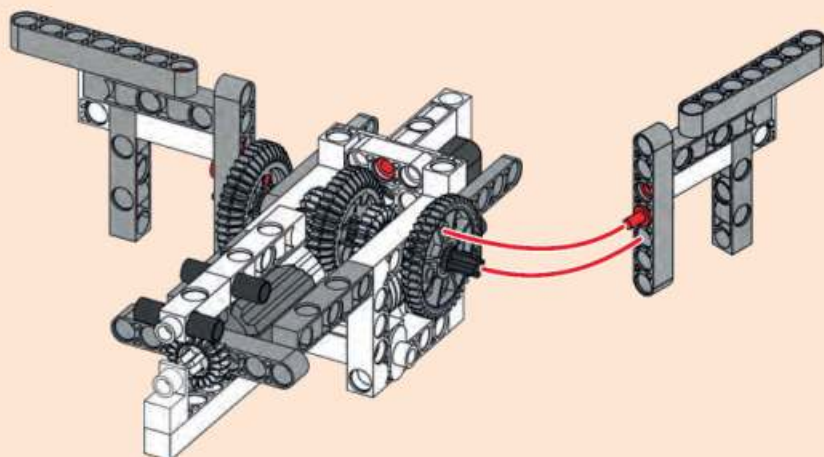
13



14

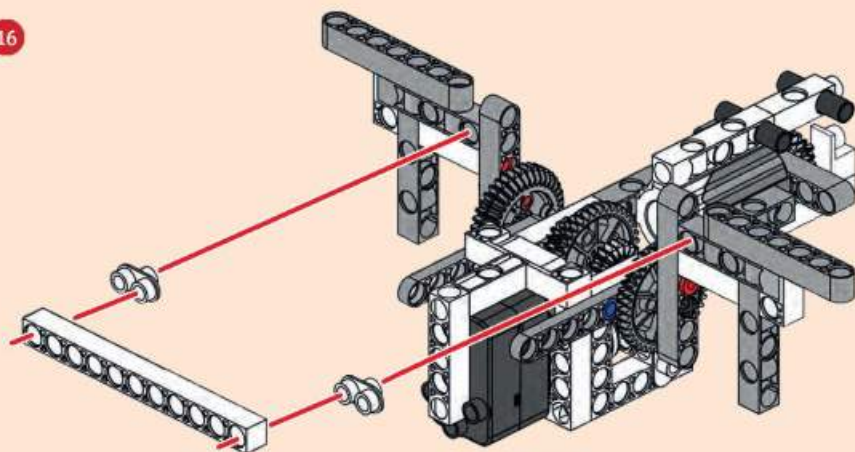


15

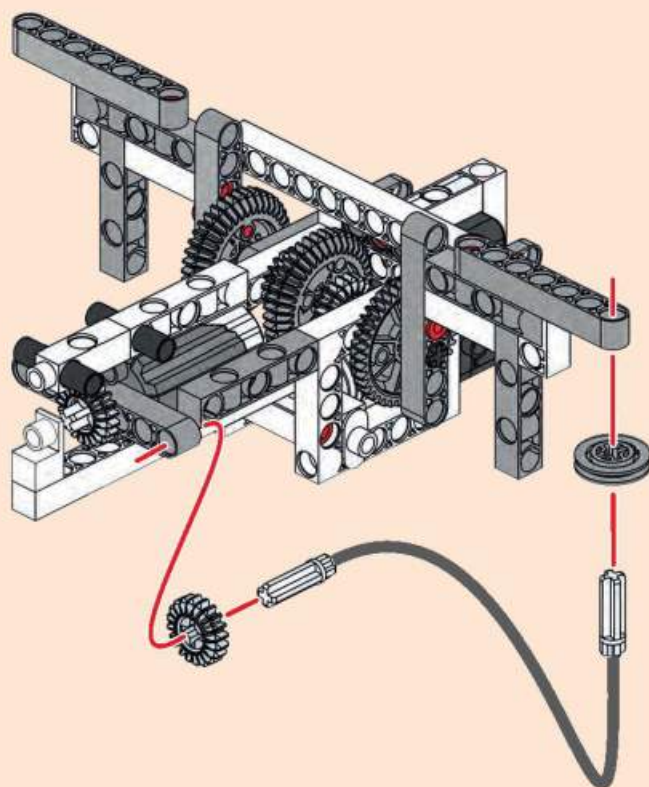




16



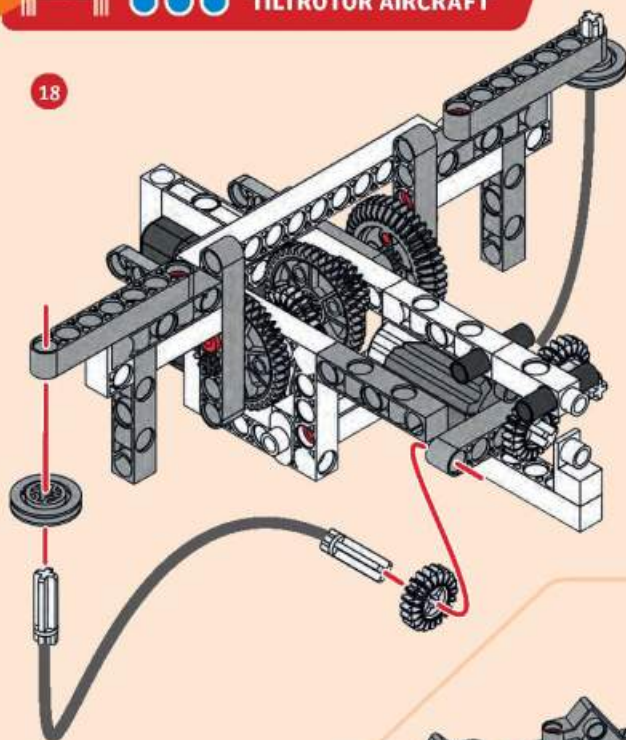
17



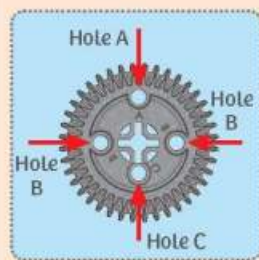
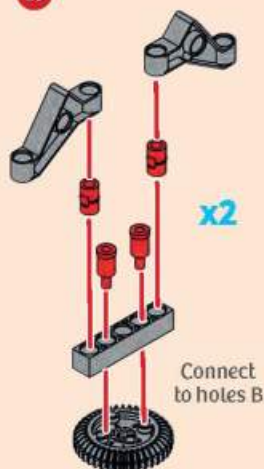


TILTROTOR AIRCRAFT

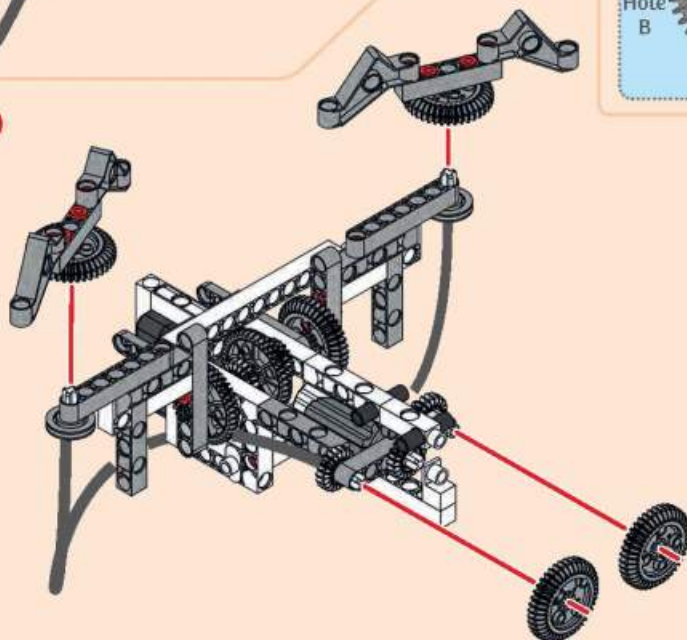
18



19

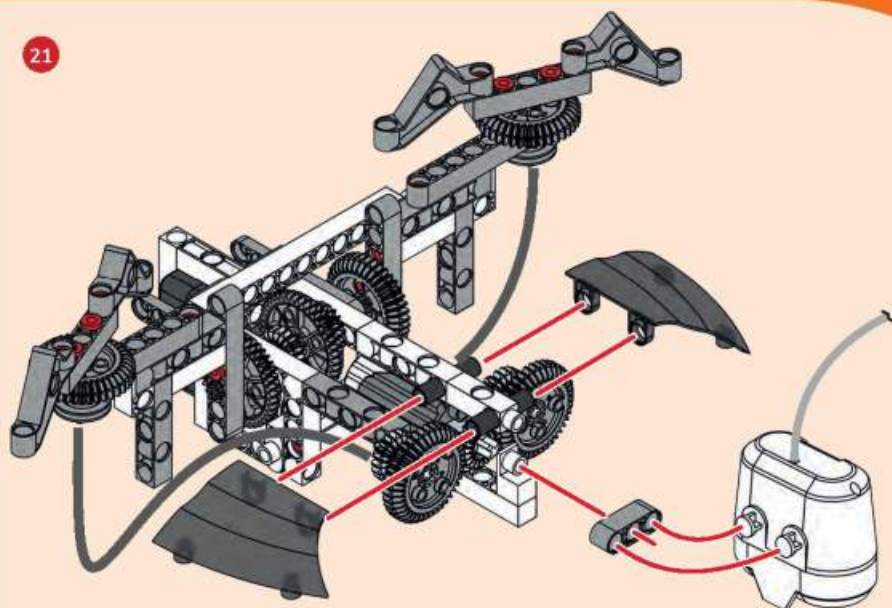


20

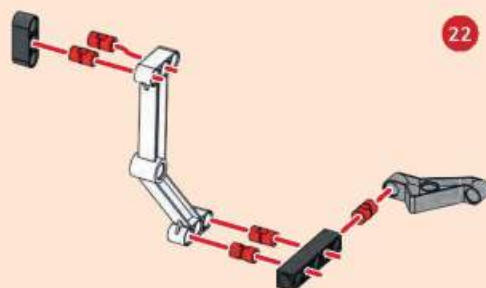




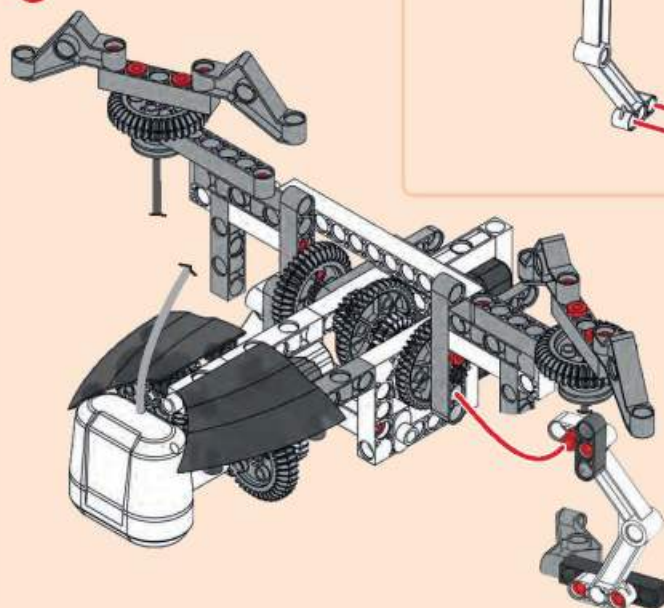
21



22



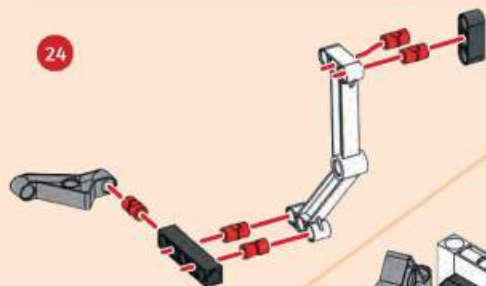
23



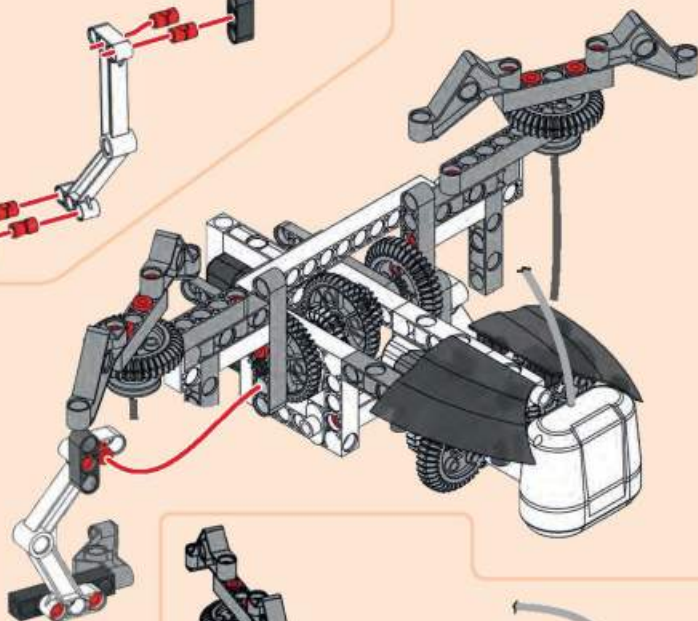


TILTROTOR AIRCRAFT

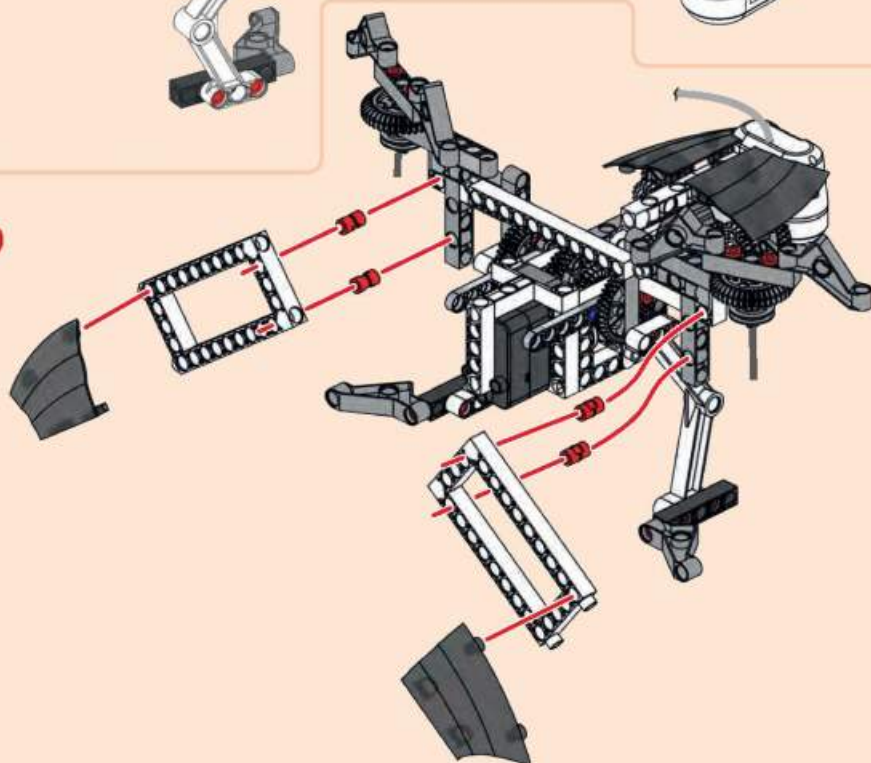
24



25

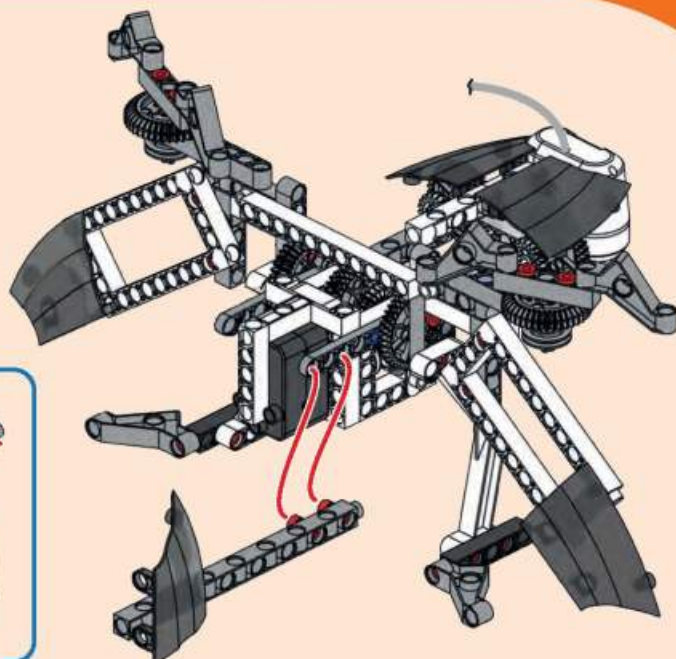
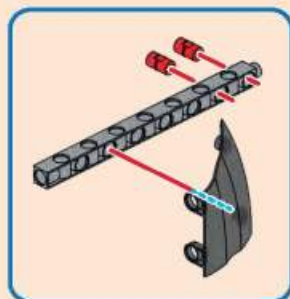


26

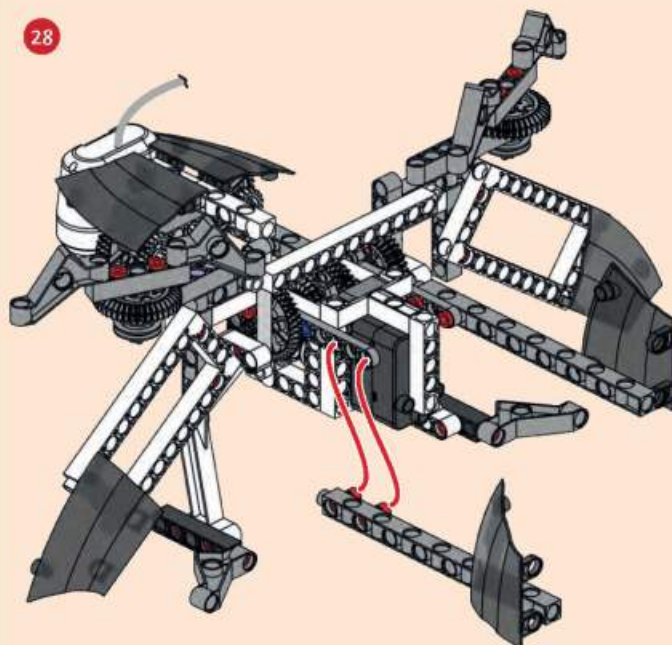
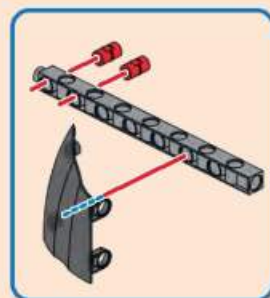




27



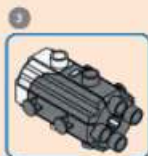
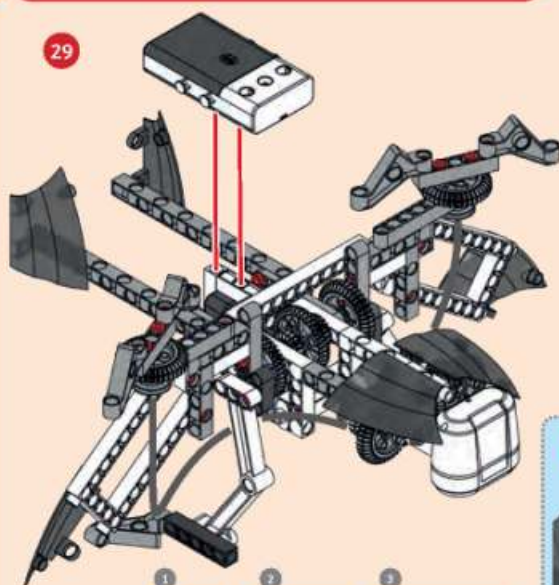
28



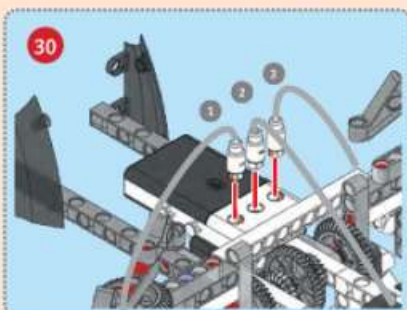


TILTROTOR AIRCRAFT

29

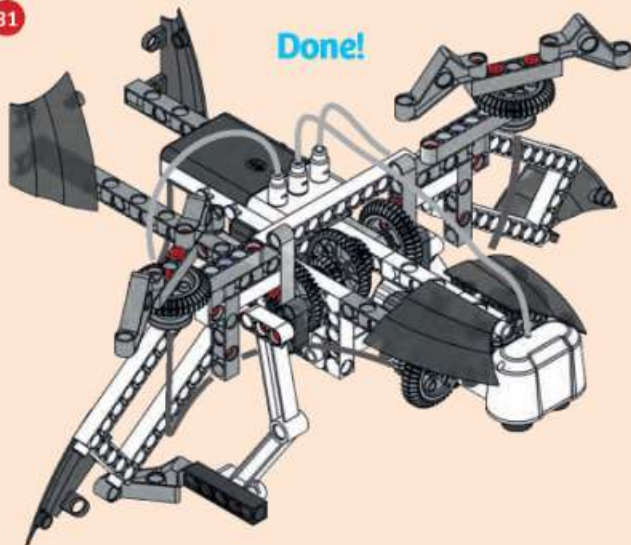


30



31

Done!



PROGRAMMING



SAMPLE PROGRAM FOR THE TILTROTOR AIRCRAFT

A tiltrotor aircraft has rotors that swivel to change from an orientation that pulls the aircraft upward, like a helicopter's rotor, to an orientation that pulls the aircraft forward, like a propeller on an airplane. This model mimics that behavior:

First, motor 1 makes the rotor blades start turning. Then, you lift the model up off the table with your hand. Once the model is several centimeters from the table surface, the ultrasonic sensor detects the absence of the ground. The program tells motor 2 to rotate the wings into horizontal flying mode. Now you can pretend the model is flying around. When it's time to land, if the aircraft approaches the tabletop again, the sensor will tell motor 2 to swivel back into landing mode, and the landing gear extends. Now you can safely land the aircraft.

This program is preloaded in the app under Program 6. Test it out and write down how the robot behaves for each program segment below.



DEMO PROGRAM:

Program 6

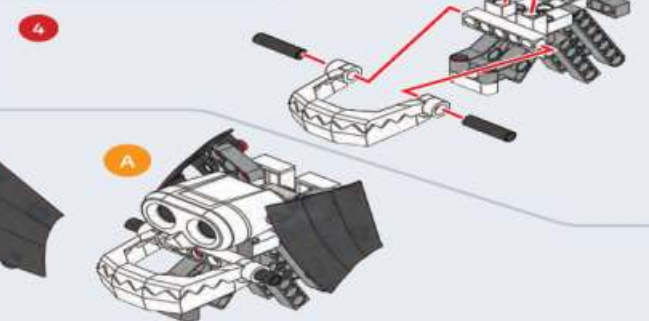
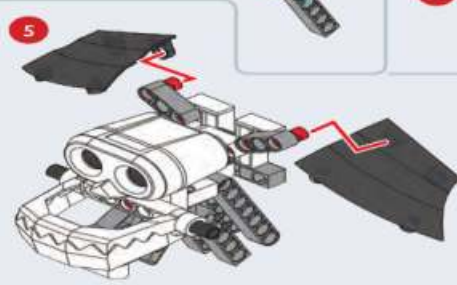
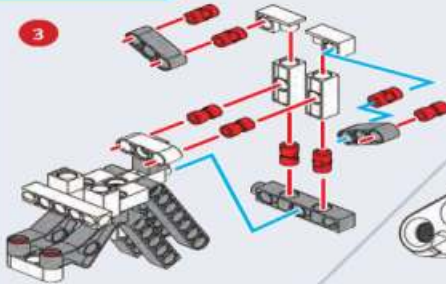
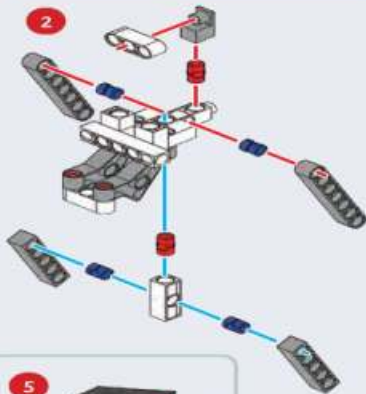
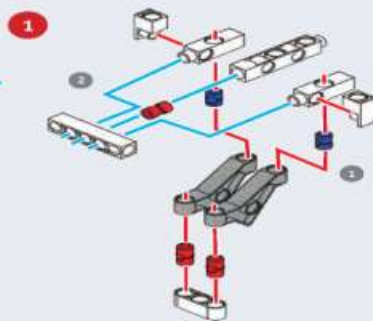
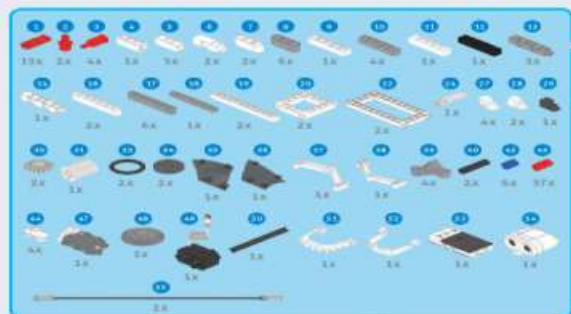
OPENING SEGMENT:

SEGMENT 0-10:

SEGMENT 11-30:

SEGMENT 31-75:

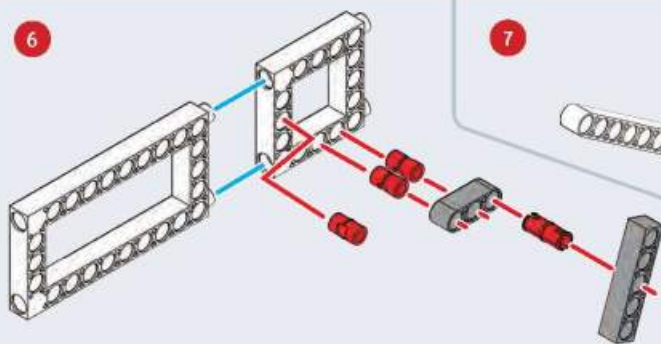
SEGMENT >76:



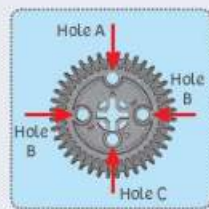
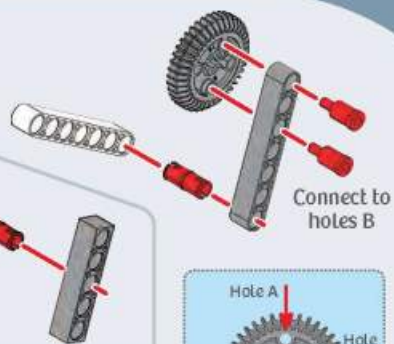


Robo Dog

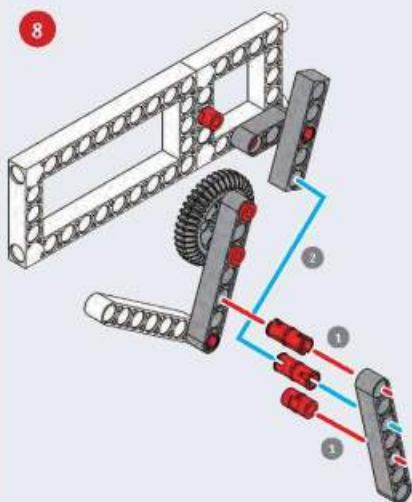
6



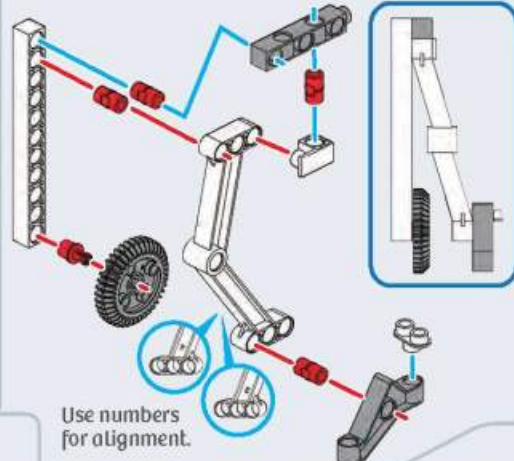
7



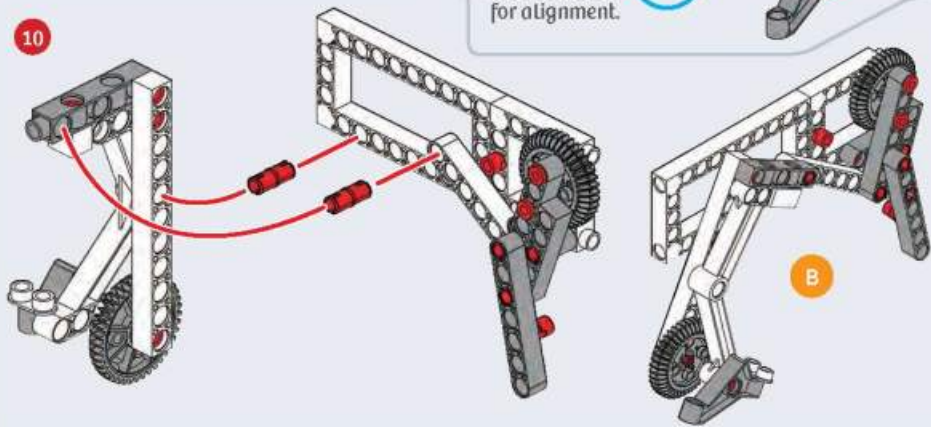
8



9

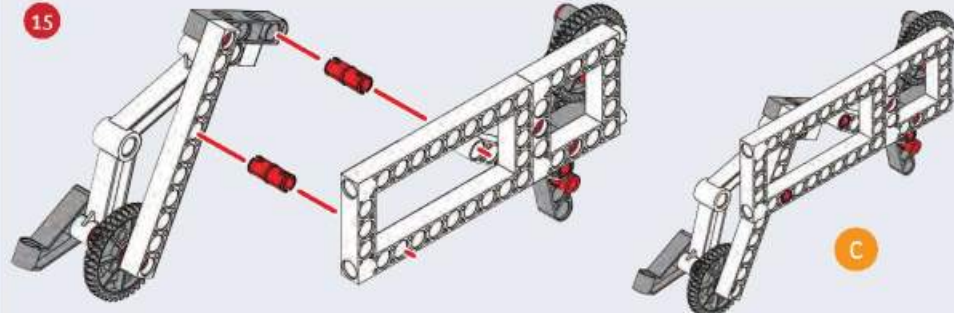
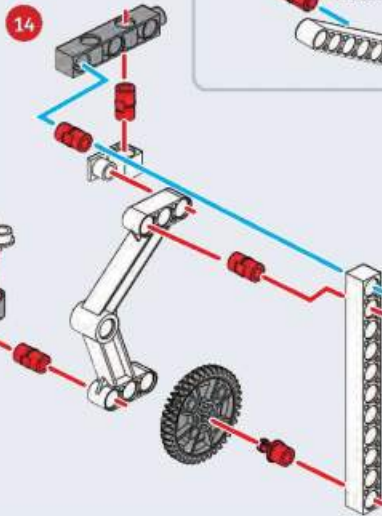
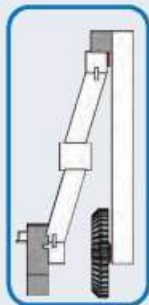
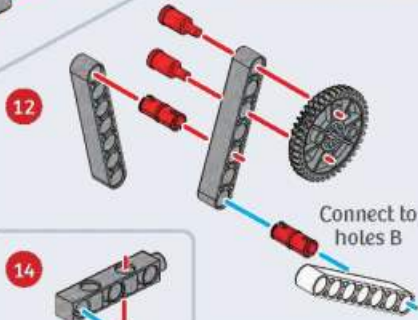
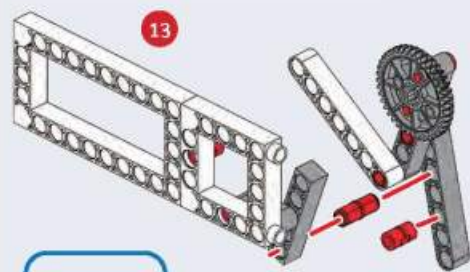
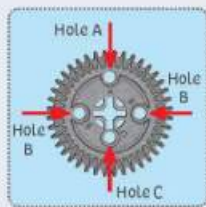
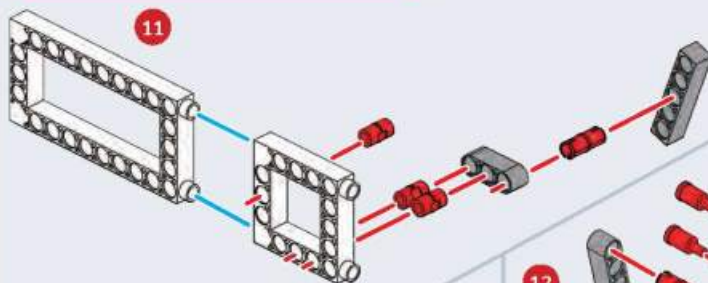


10

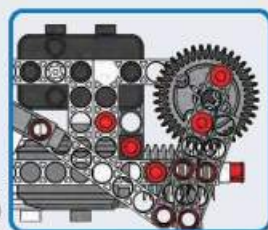
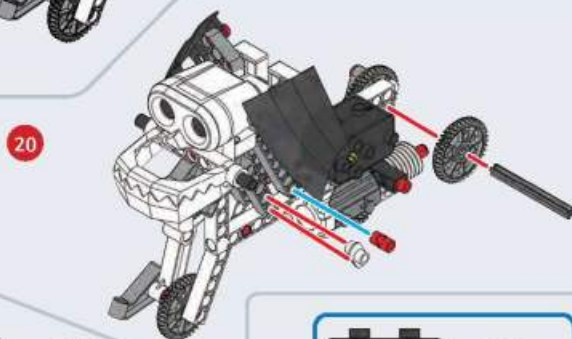
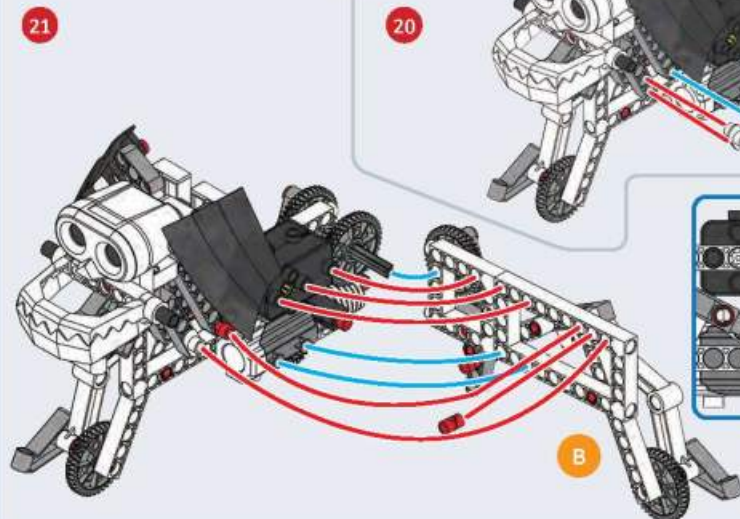
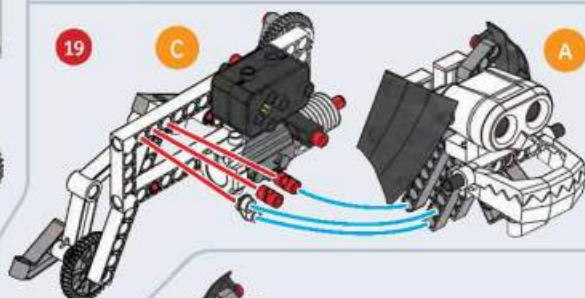
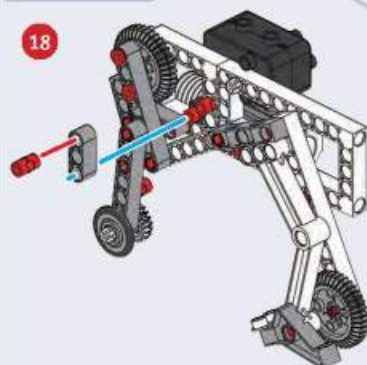
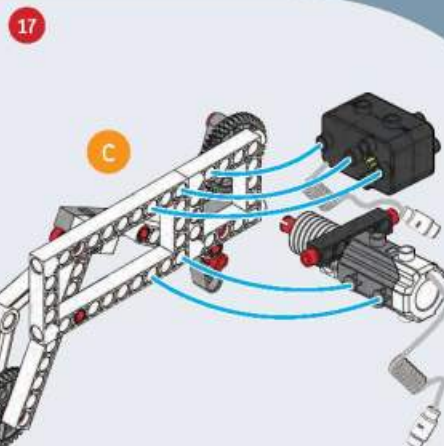
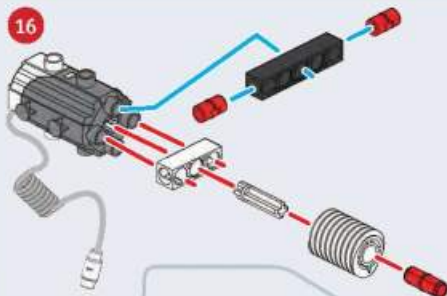




ROBO DOG



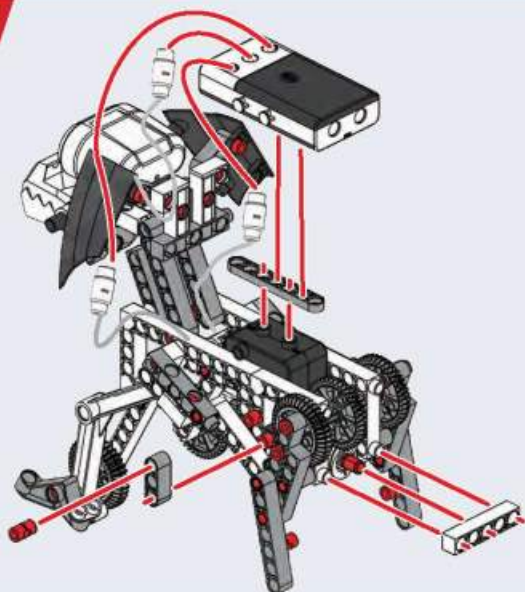
C



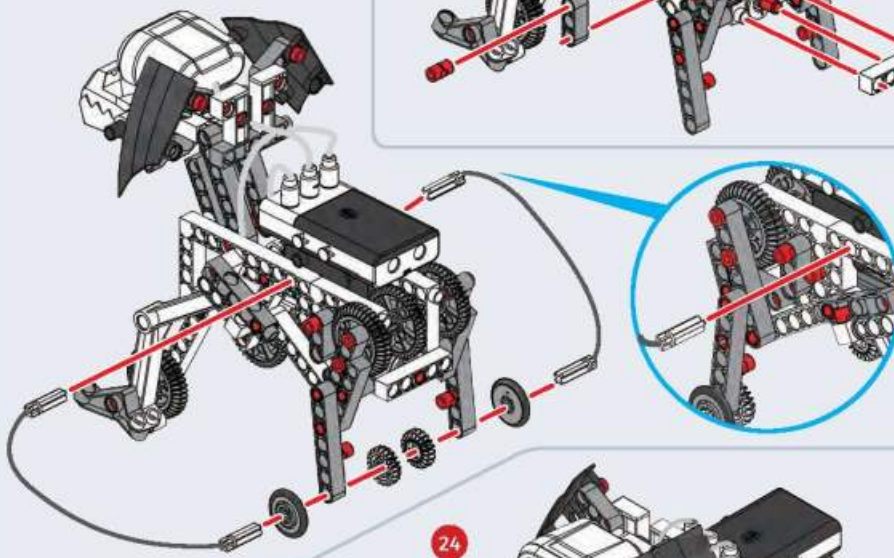


ROBO DOG

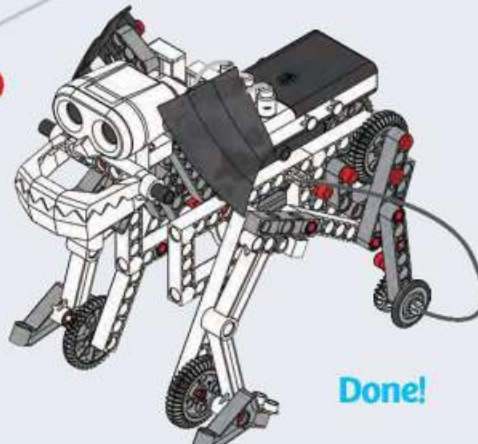
22



23



24



Done!

PROGRAMMING



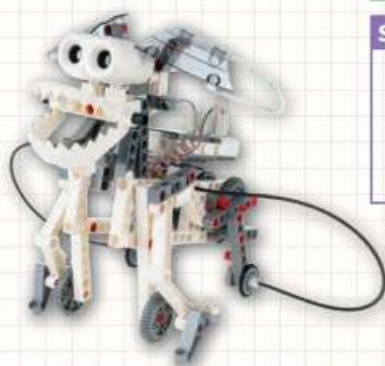
SAMPLE PROGRAM FOR THE ROBO DOG

Enter this program to make your robo dog walk forward and sit down.

This program is preloaded in the app under Program 3. Test it out and write down how the robot behaves for each program segment below.



PROGRAMMING NOTES



DEMO PROGRAM:

Program 3

OPENING SEGMENT:

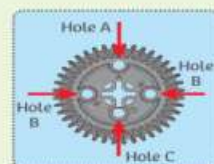
SEGMENT 0-25:

SEGMENT 26-40:

SEGMENT >41:

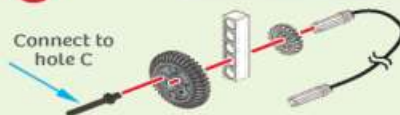


ROBOTOSAURUS

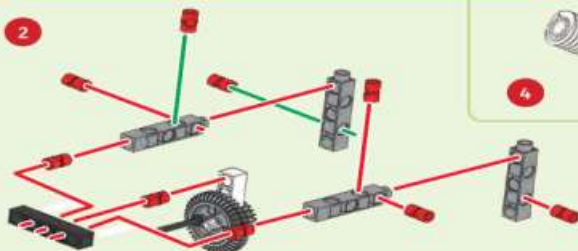


1

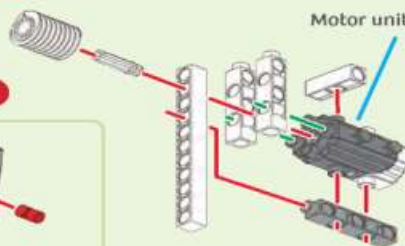
Connect to



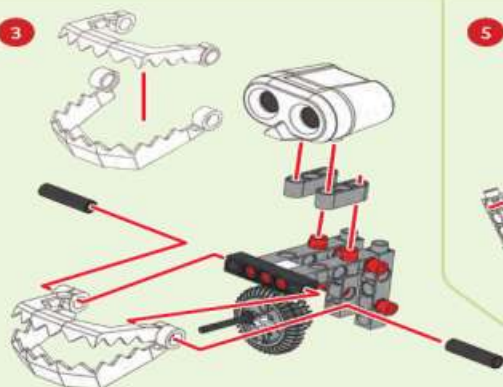
2



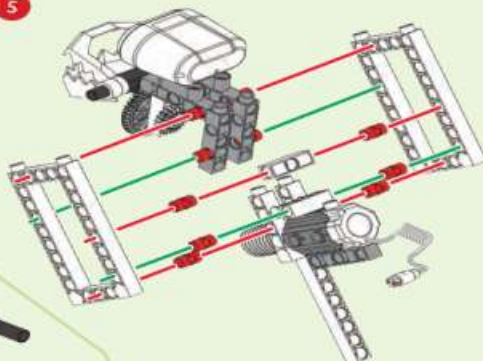
Motor unit 1

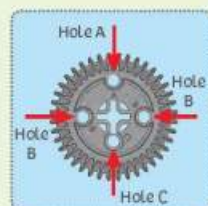
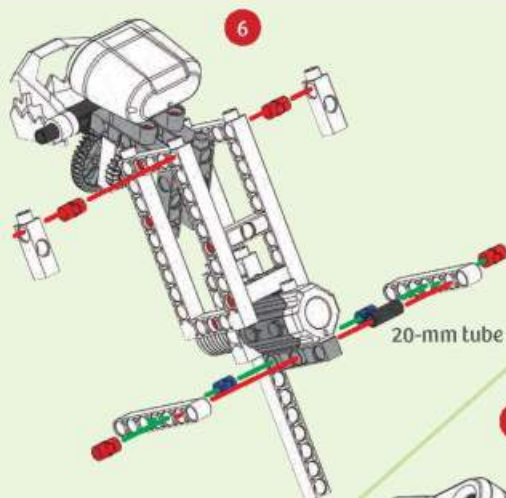


3



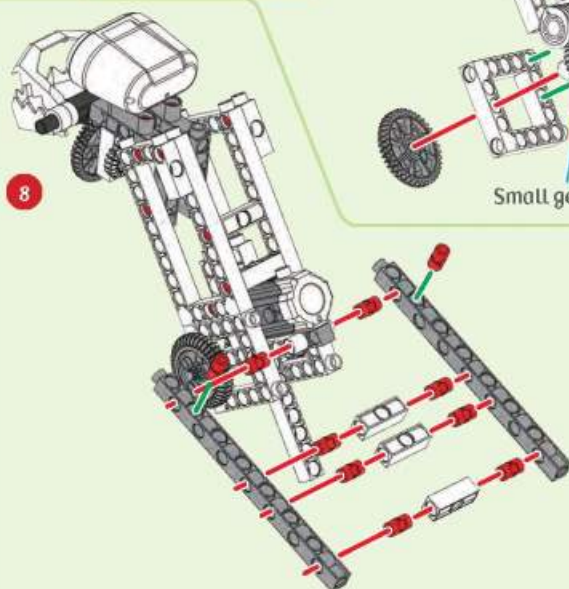
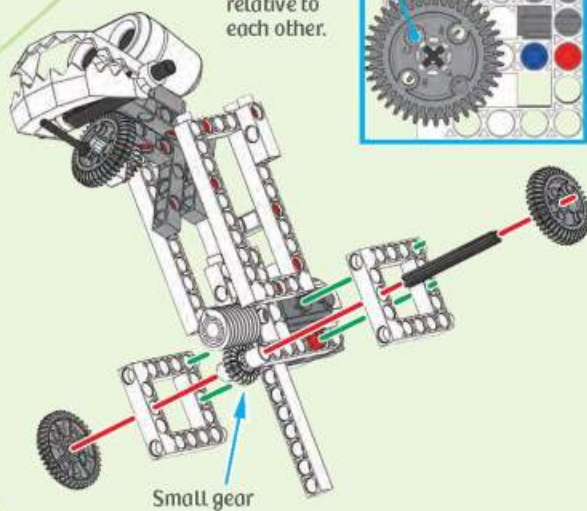
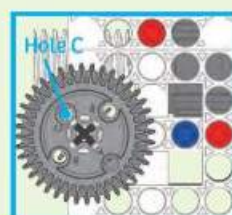
5





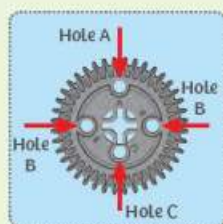
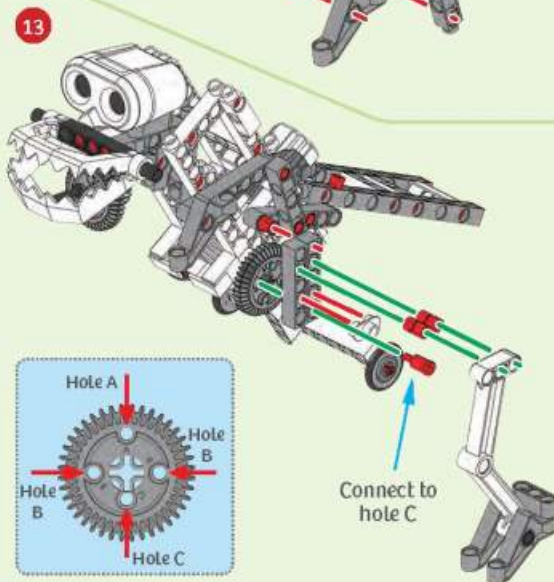
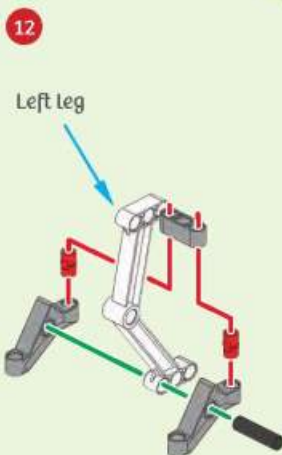
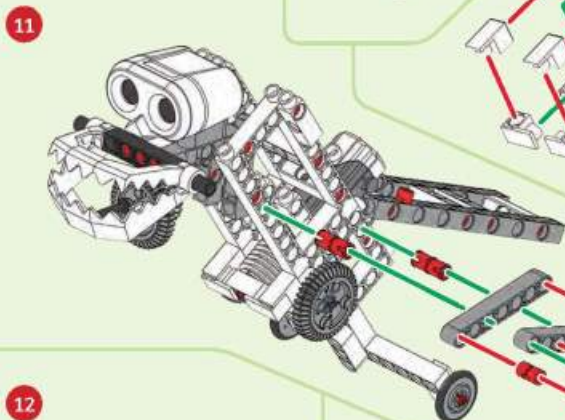
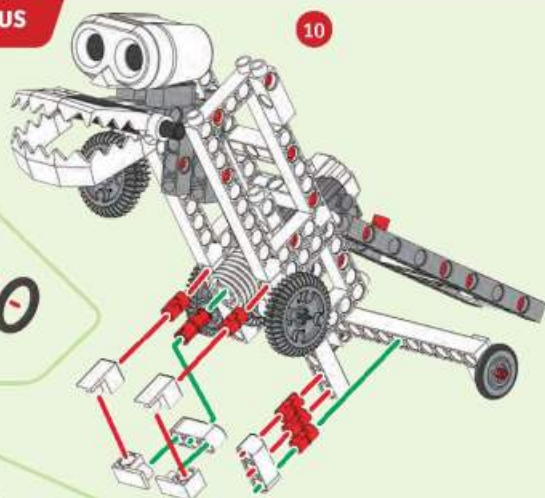
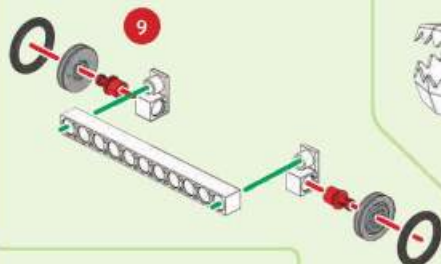
Note: The two gears are rotated 180 degrees relative to each other.

7



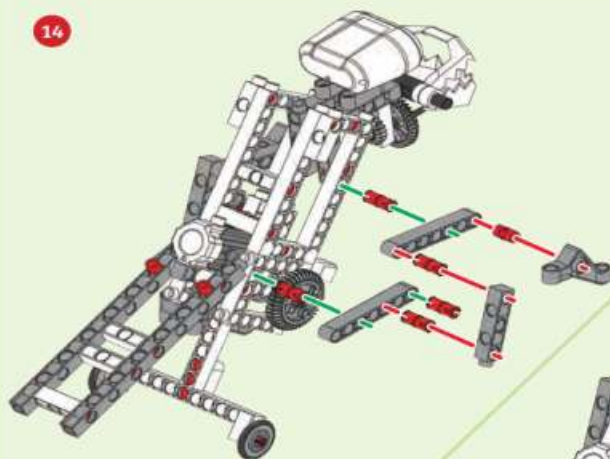


ROBOTOSAURUS

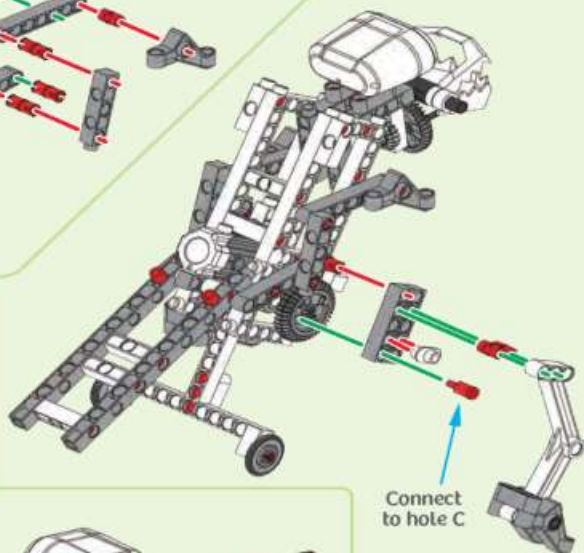




14

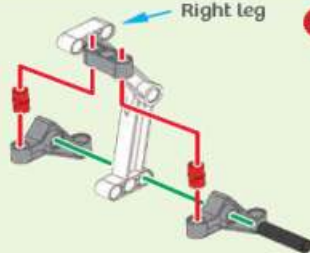


16

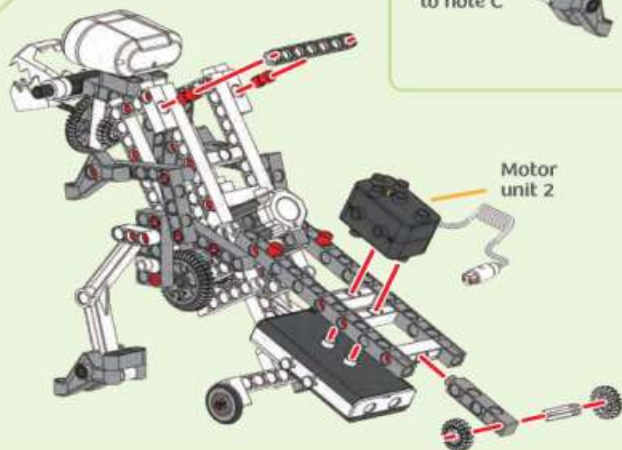


Right leg

15



17

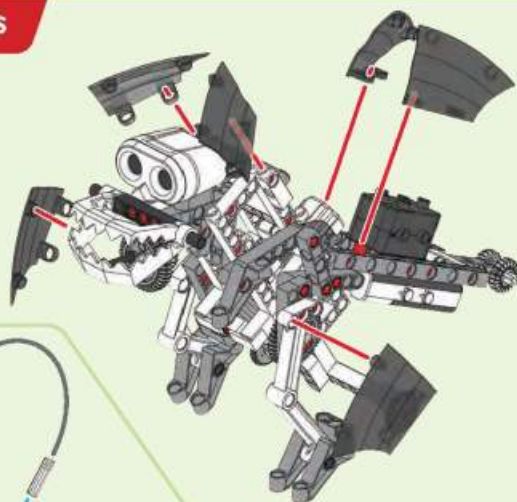


Motor unit 2

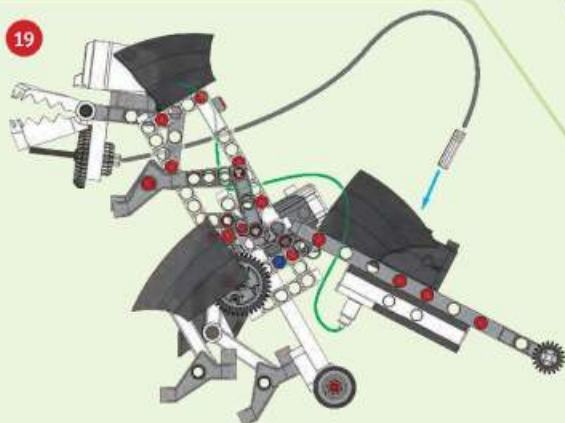


ROBOTOSAURUS

18



19

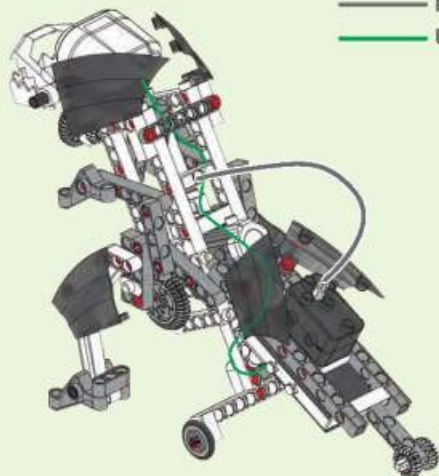


— Flexible shaft
— Ultrasonic sensor cable

Ultrasonic sensor

Motor unit 1

Motor unit 2



20

Done!



PROGRAMMING



SAMPLE PROGRAM FOR THE ROBOTOSAURUS

Enter this program to make your robotosaurus walk forward. By this point, can you read the program well enough to interpret what the robot dino will do before you run the program for the first time?

This program is preloaded in the app under Program 5. Test it out and write down how the robot behaves for each program segment below.



DEMO PROGRAM:

Program 5

OPENING SEGMENT:

SEGMENT 0-10:

SEGMENT 11-30:

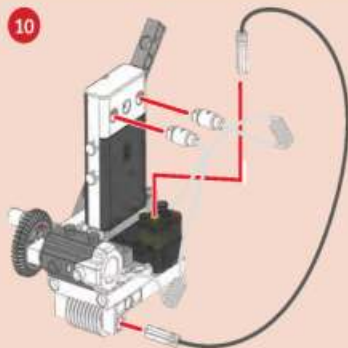
SEGMENT >31:

PROGRAMMING NOTES

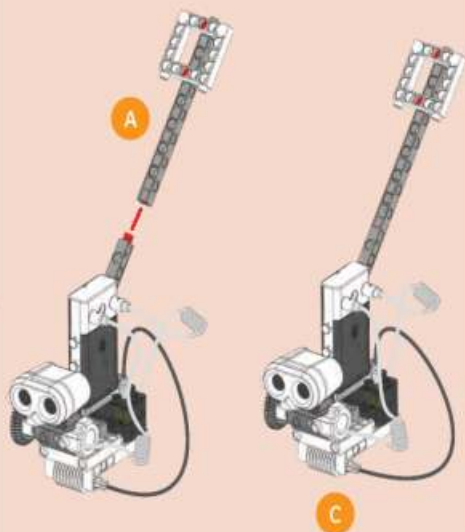




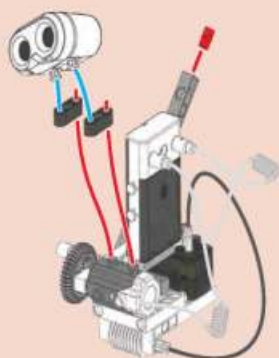
10



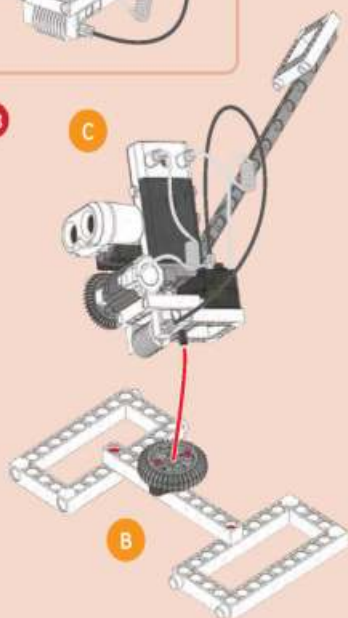
12



11

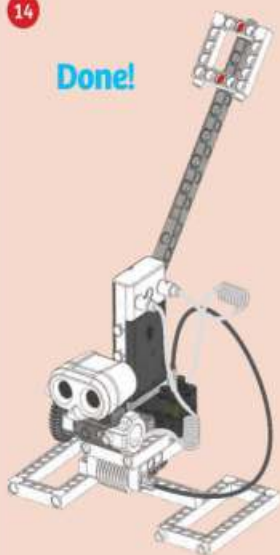


13



14

Done!



Warning. Do not aim at eyes or face.
Never launch heavy, sharp-pointed,
or sharp-edged objects.



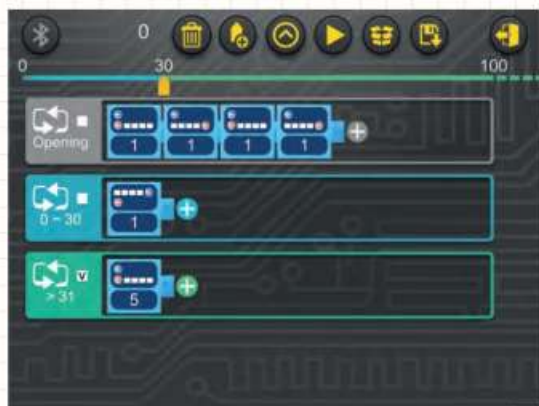
PROGRAMMING



SAMPLE PROGRAM FOR THE AUTOMATIC CATAPULT

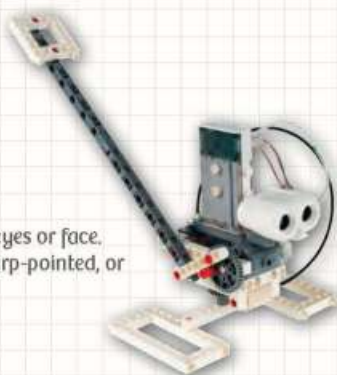
This program tells the catapult to scan for objects with its sensor. When the sensor detects an object, the catapult will fire. You will need to supply your own small, lightweight ball (like a ping pong ball) or a ball of crumpled up paper. Can you try to sneak past the catapult without it seeing you and firing off its defense mechanism?

This program is preloaded in the app under Program 1. Test it out and write down how the robot behaves for each program segment below.



PROGRAMMING NOTES

Warning. Do not aim at eyes or face. Never launch heavy, sharp-pointed, or sharp-edged objects.



DEMO PROGRAM:

Program 1

OPENING SEGMENT:

SEGMENT 0-30:

SEGMENT >31:

WHAT ELSE CAN YOU BUILD?

Now that you have built the eight robotic machines in this kit, can you design your own robots and write your own programs to control them? Use your imagination to think up a cool robot that uses the ultrasonic sensor to respond to its environment.