13

building the SENTIN3L

In this chapter, you'll build the SENTIN3L, a badass security robot. It walks on three legs and has two wicked blaster cannons (see Figure 13-1). As you build, you'll learn how to create mechanisms that transform rotation into alternating motion. These mechanisms are particularly useful when designing walking robots. You'll also learn how to assemble structures diagonally within the constraints of LEGO geometry and how to assemble curved structures like the SENTIN3L's elegant back shield.

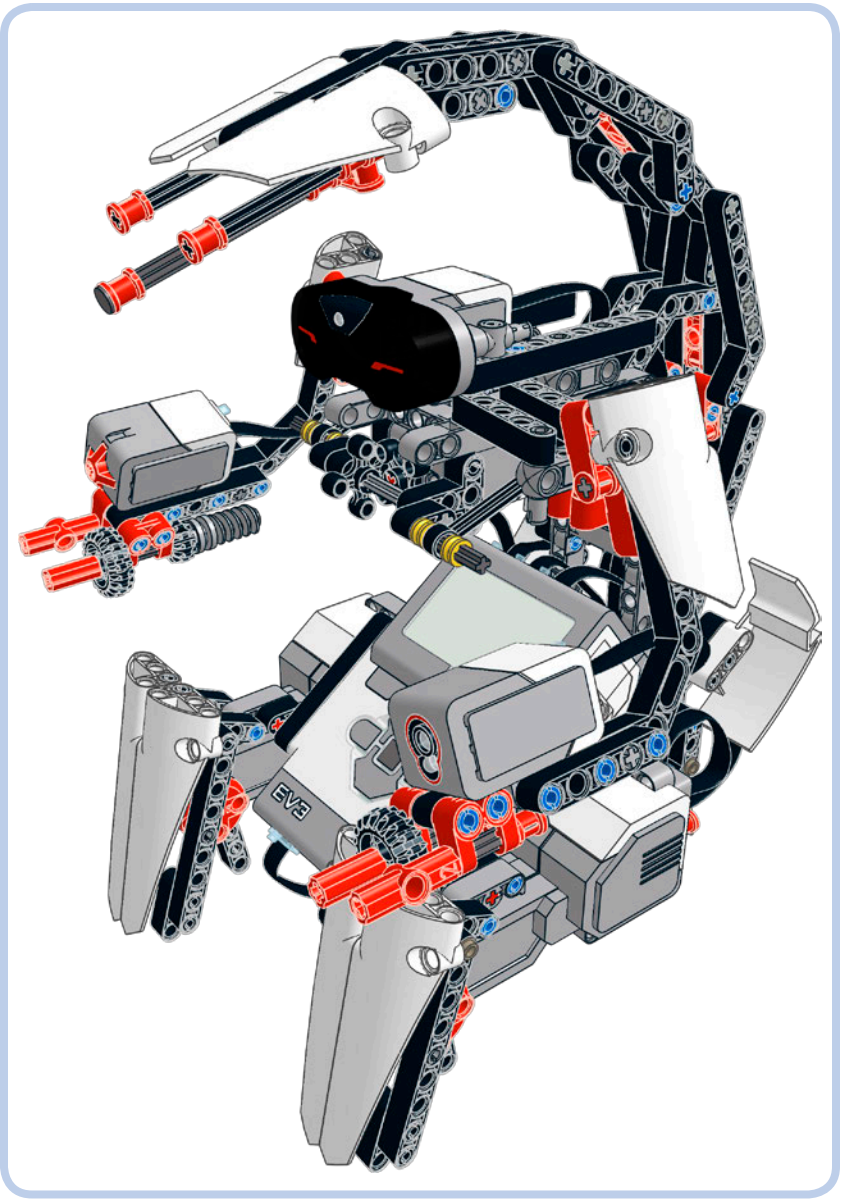
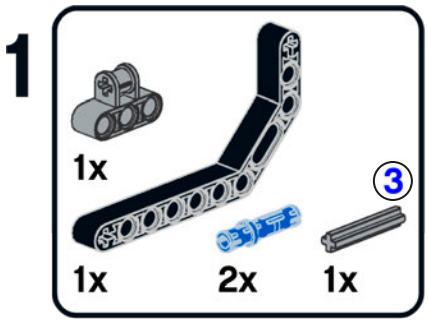
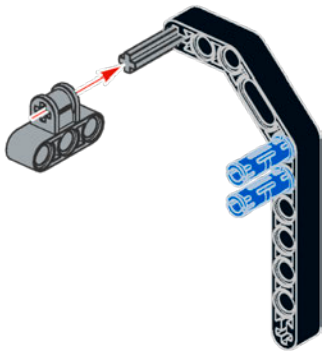
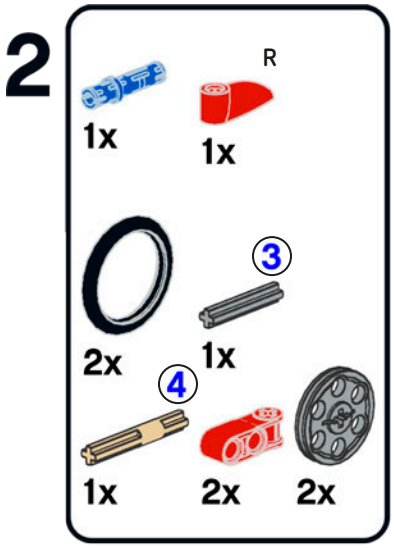


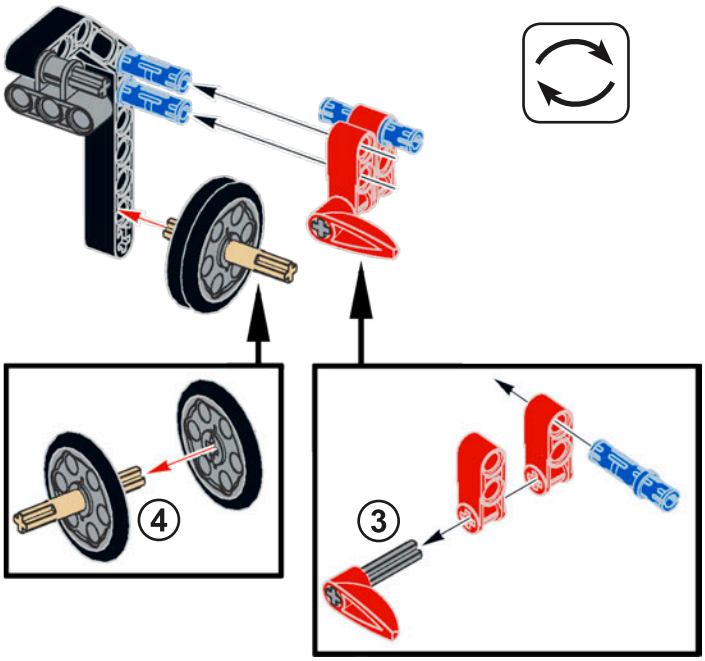
Figure 13-1: The SENTIN3L

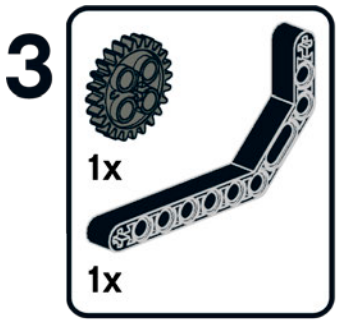
main assembly

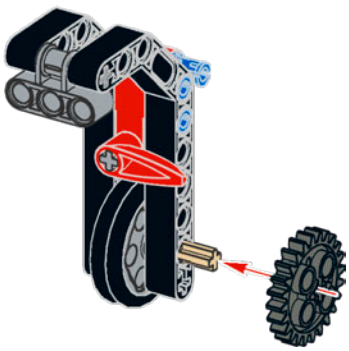


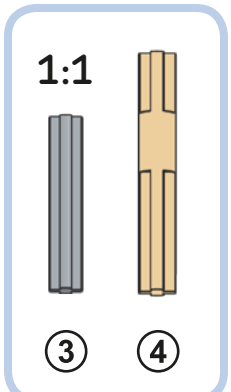


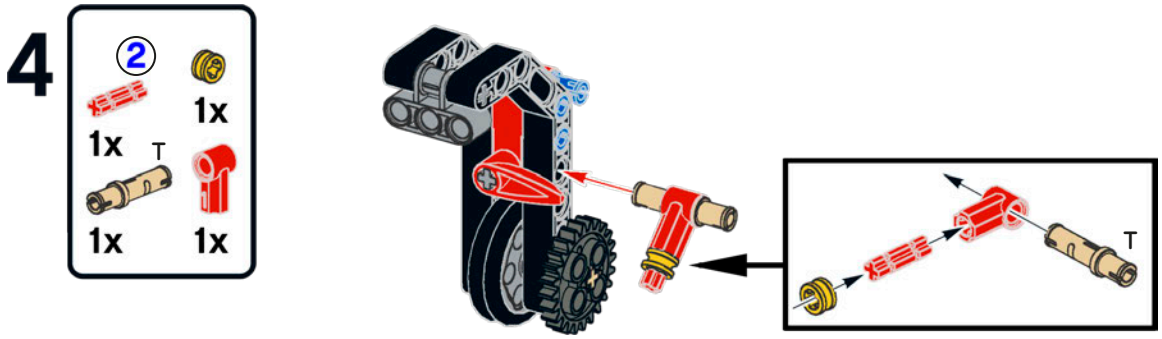








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2
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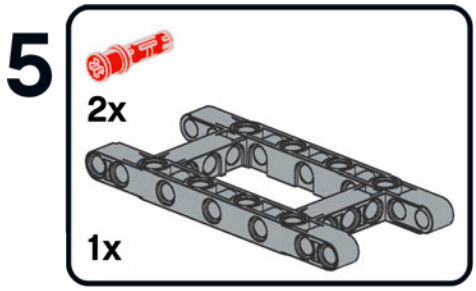
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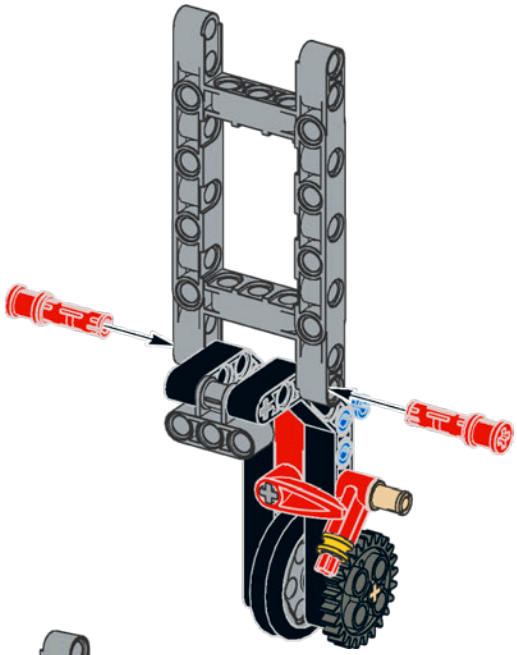
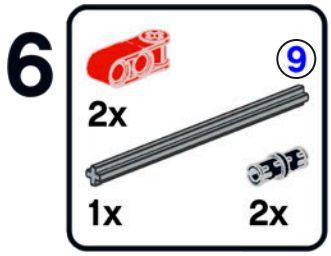
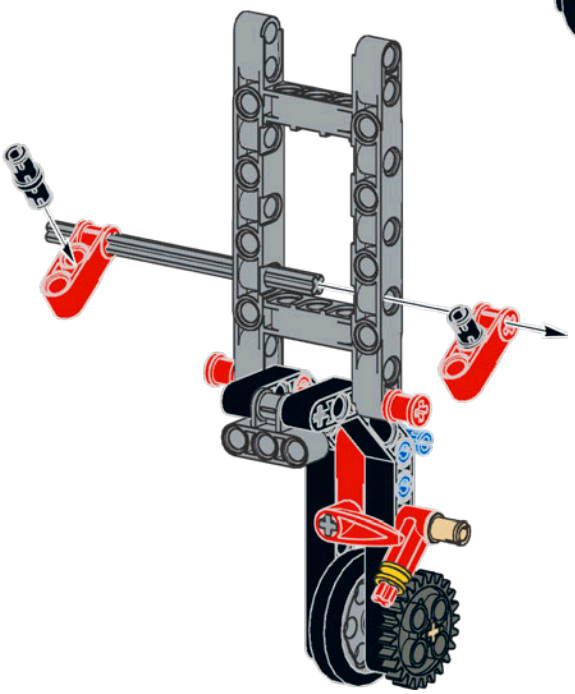
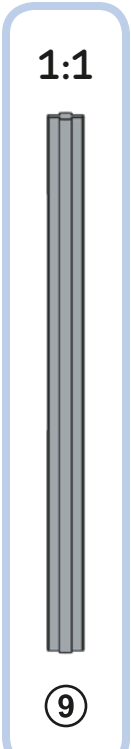
2x
1x




6
9
2x
1x
2x

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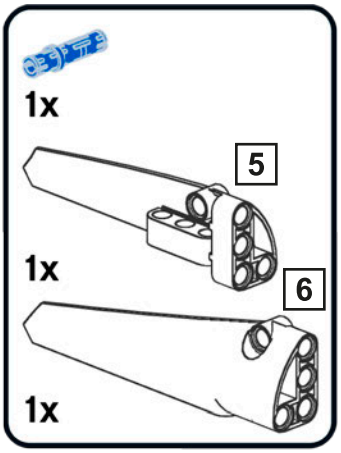

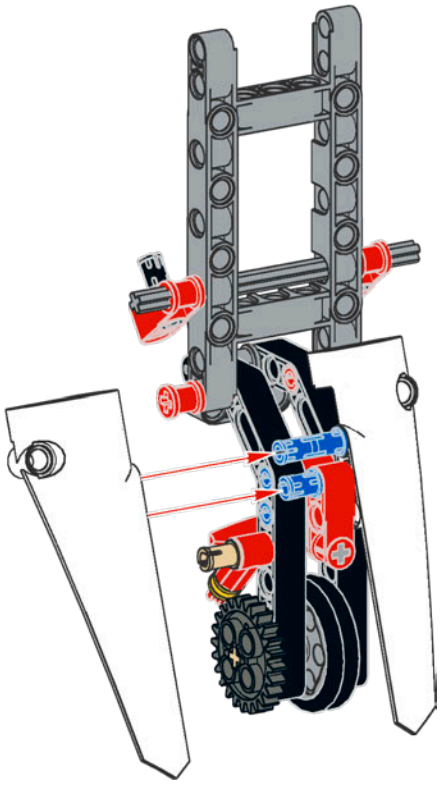

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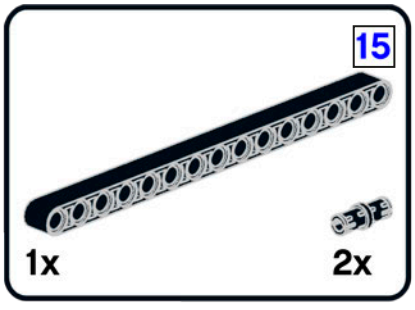

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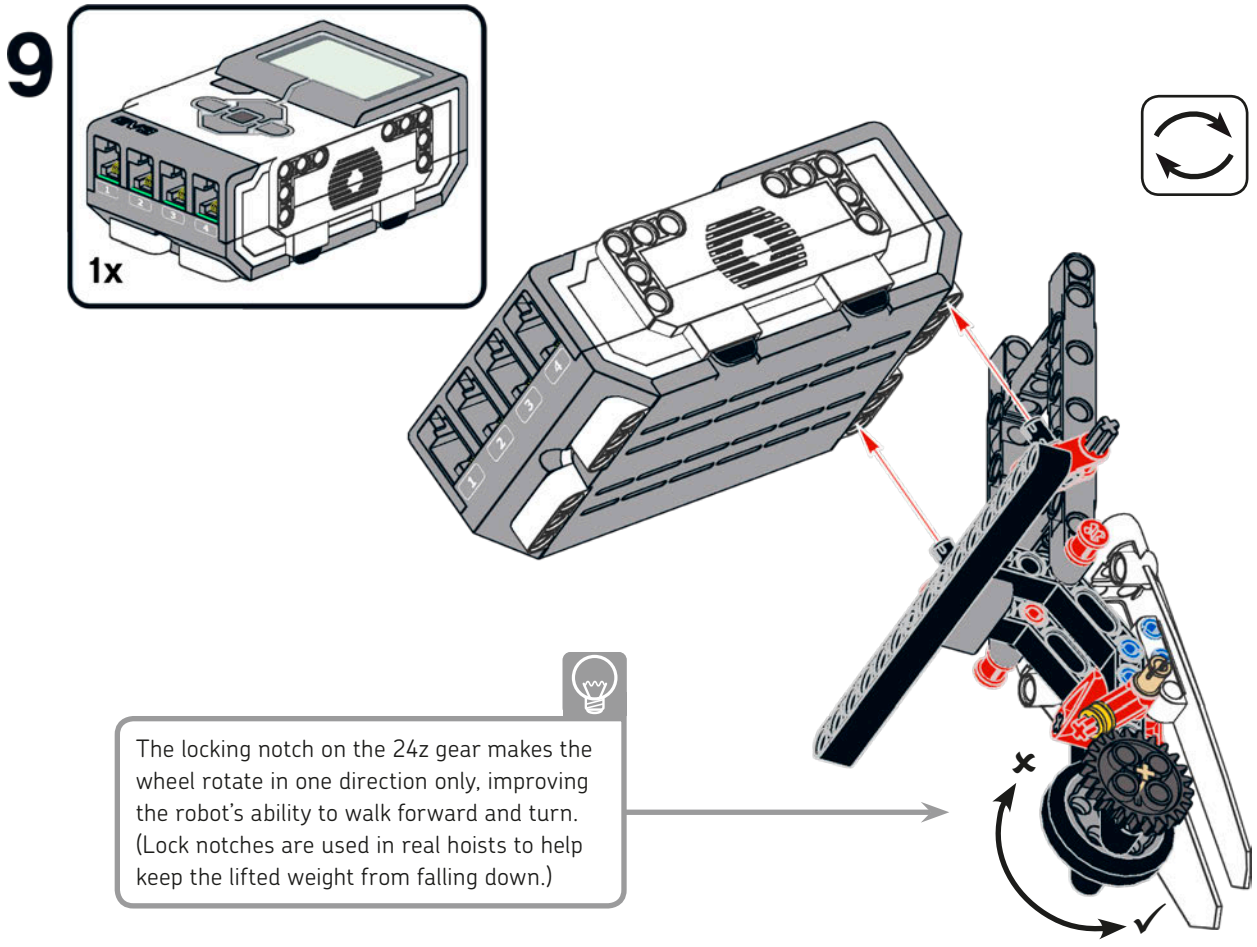
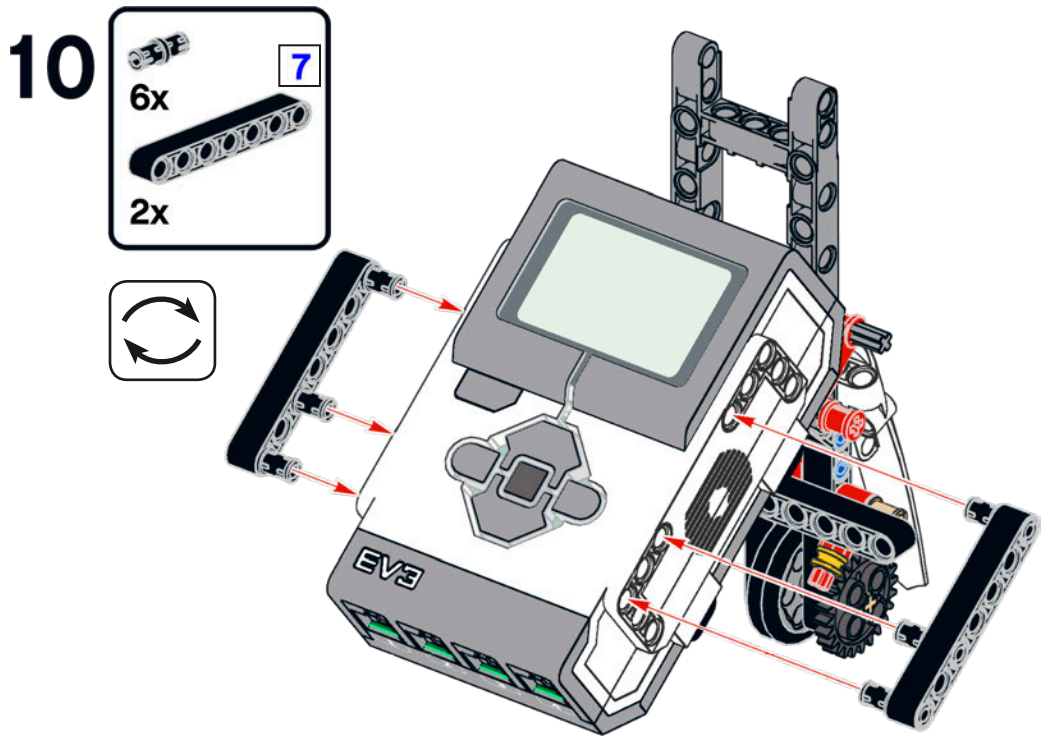

9
1x
The locking notch on the 24z gear makes the wheel rotate in one direction only, improving the robot's ability to walk forward and turn. (Lock notches are used in real hoists to help keep the lifted weight from falling down.)


10
7
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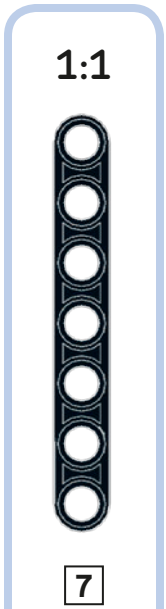
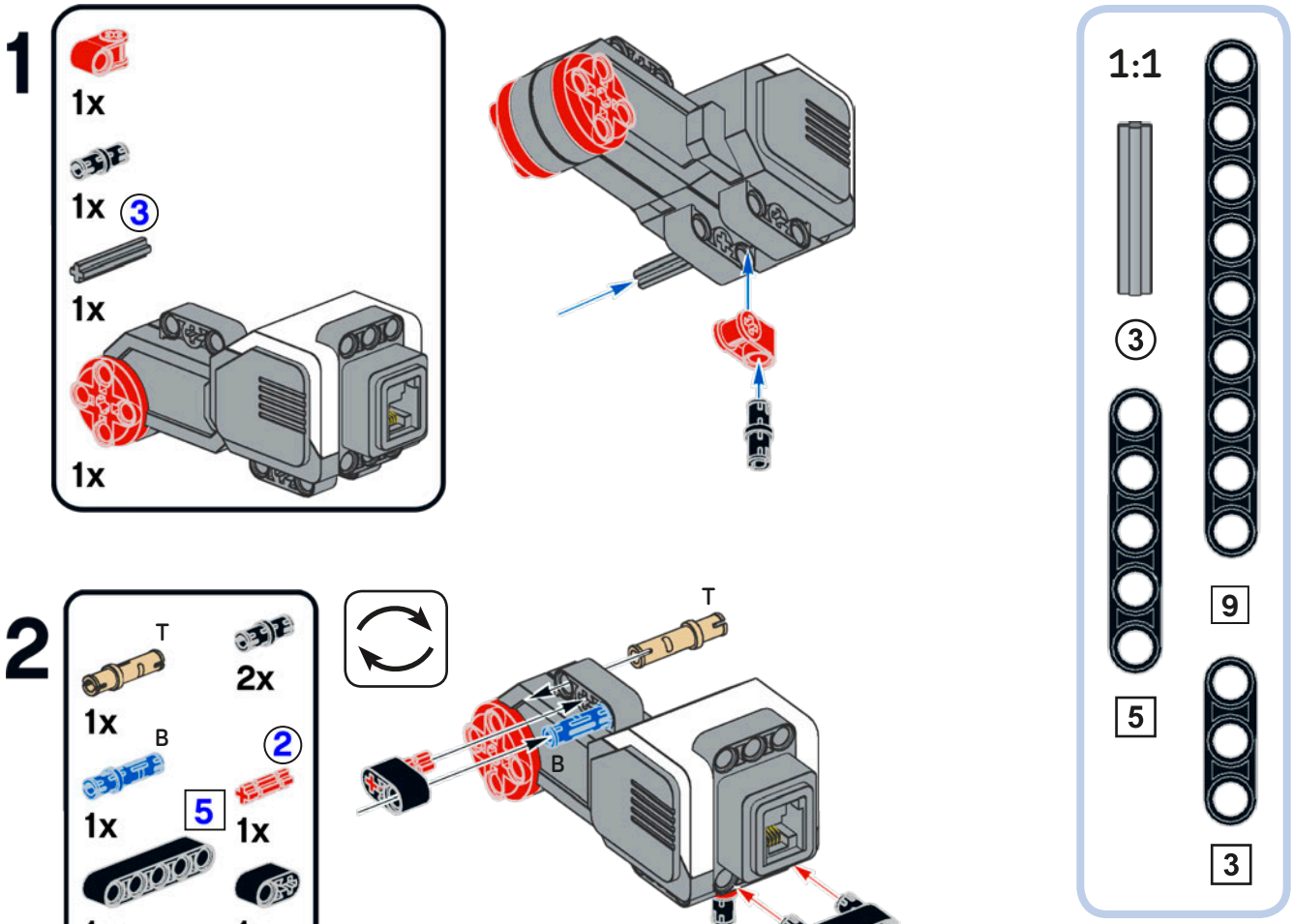
EV3


1:1
7

right leg assembly



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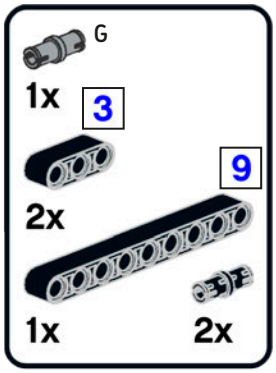
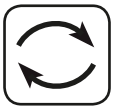
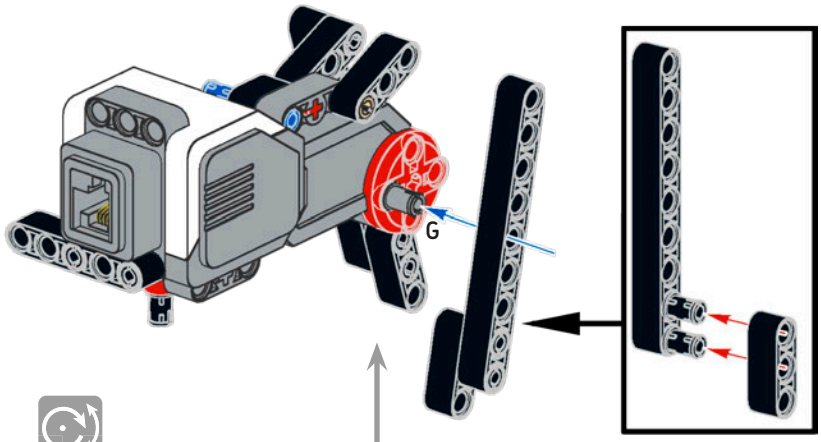
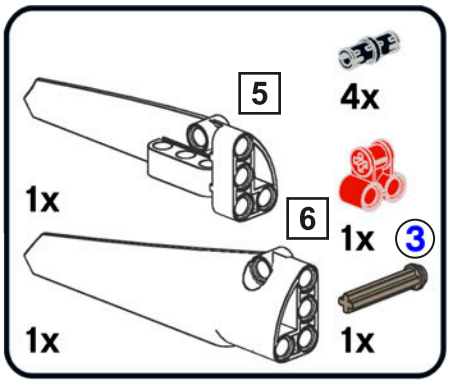


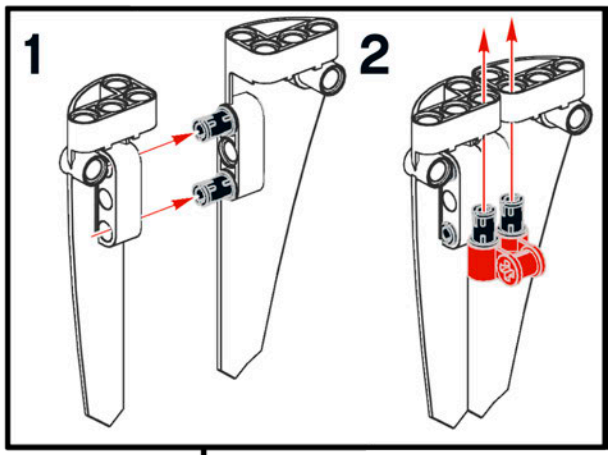


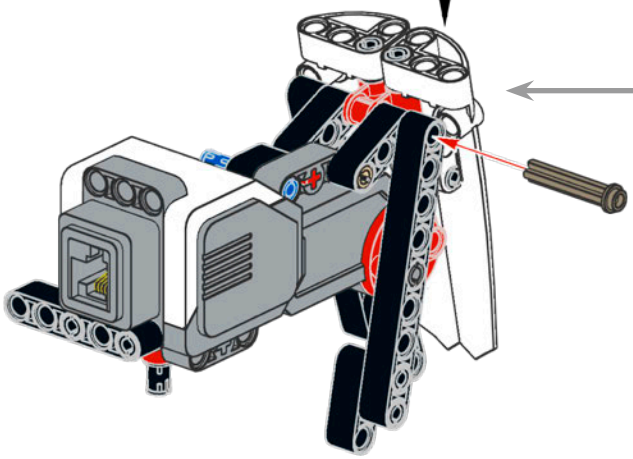


If you attach the leg to an off-center pin on the Large Servo Motor shaft, you'll create a *cam*, which transforms the continuous rotation of the shaft into a reciprocating motion of the leg. The cam allows the robot to walk.

5

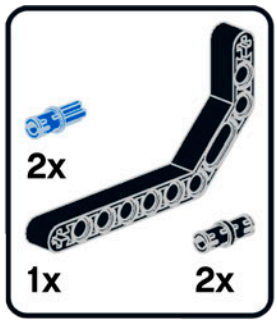


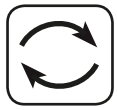


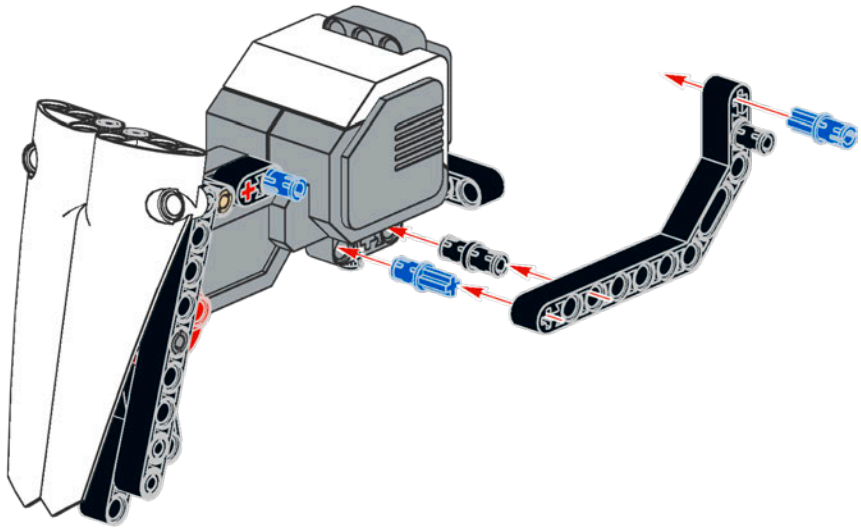


These white panels make a mock leg that covers the actual walking legs.

6







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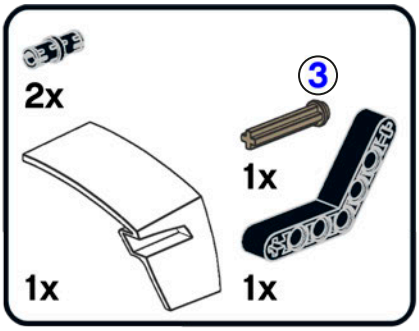
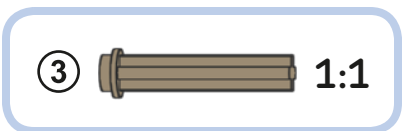
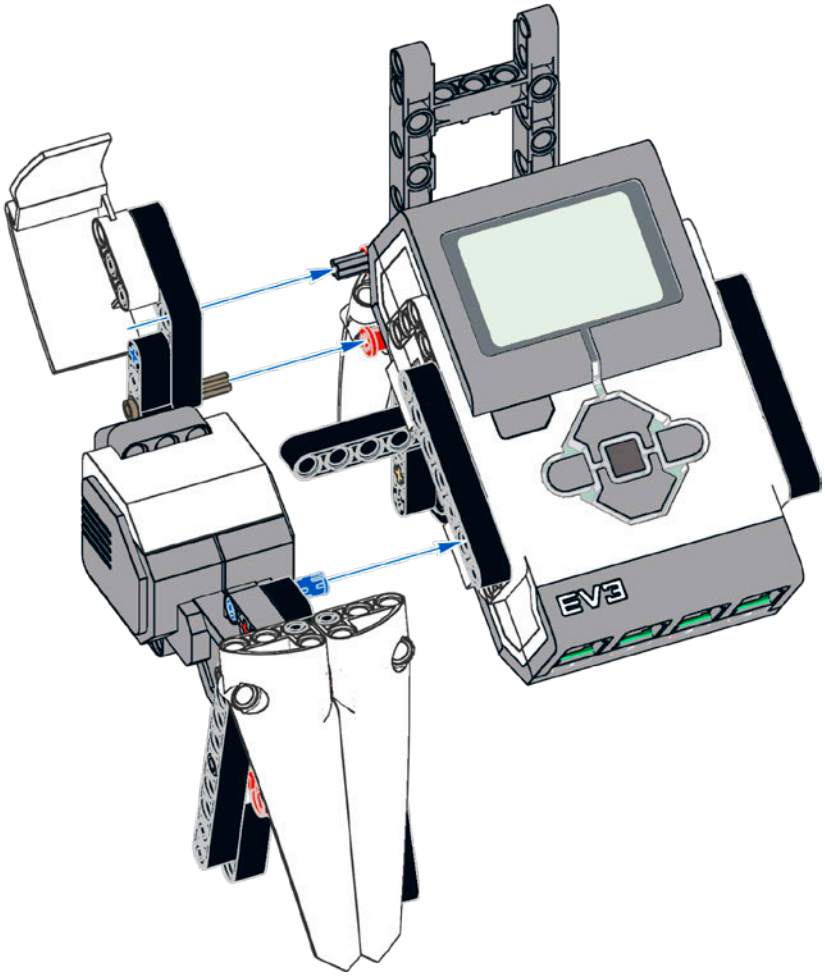


The right leg is actually composed of two legs. This solution, together with the rear wheel, greatly simplifies the robot's programming, but that means the SENTIN3L is not a proper tripod robot!



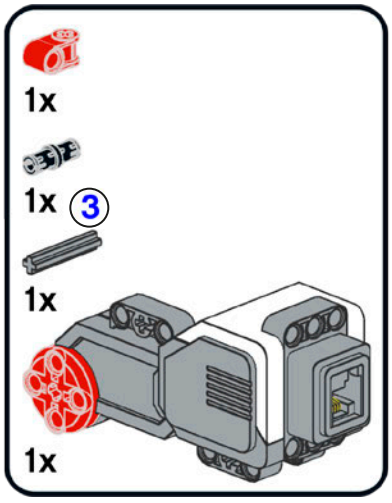
main assembly

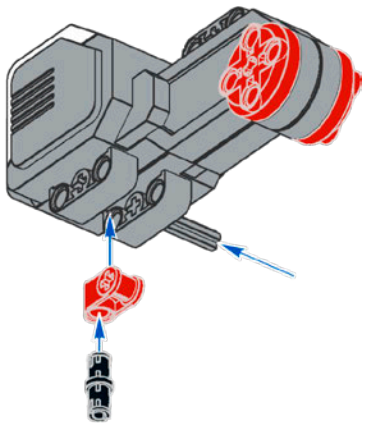
11



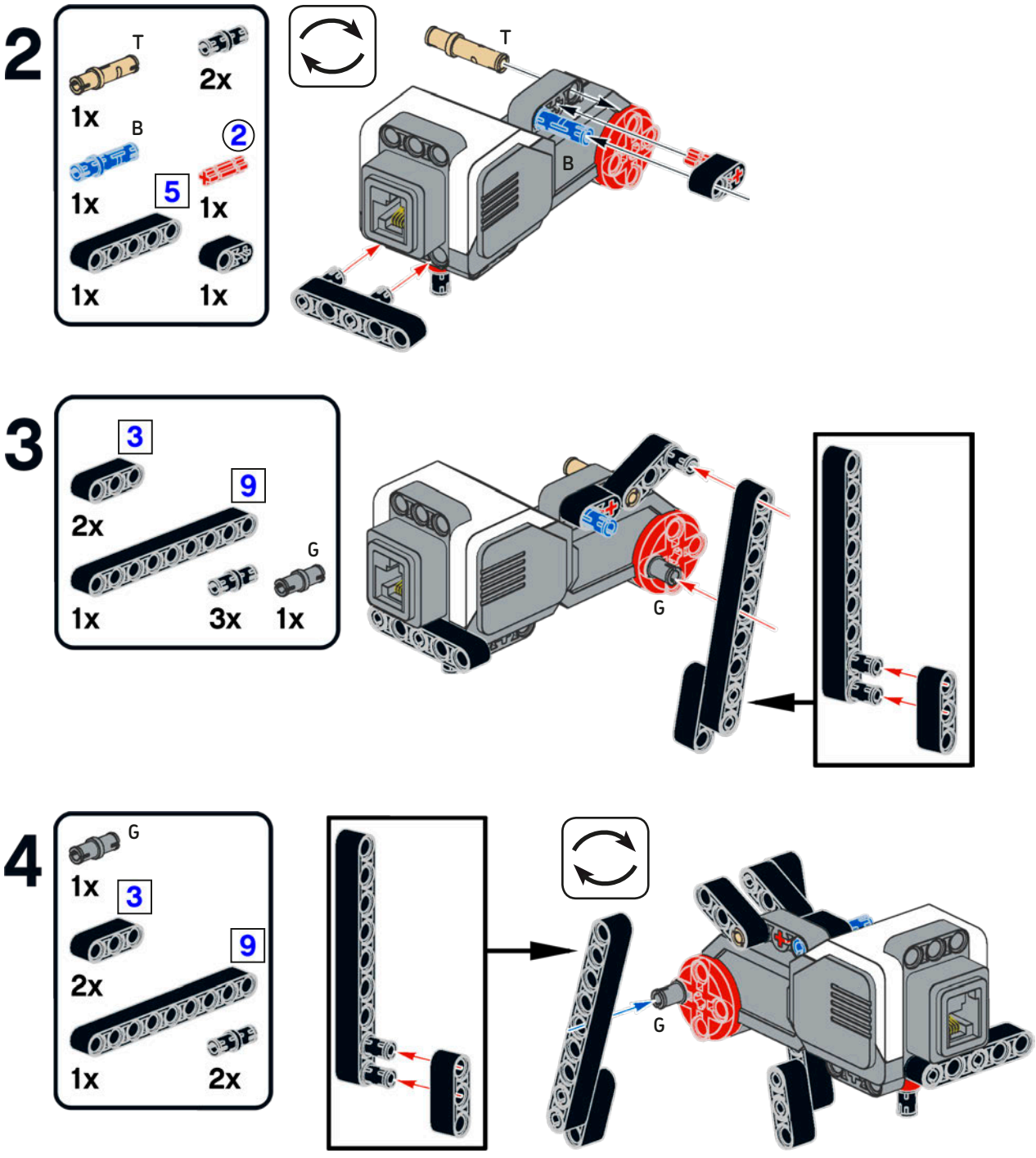
left leg assembly

1





3 1:1


2
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3
2x
9
1x
2x
G
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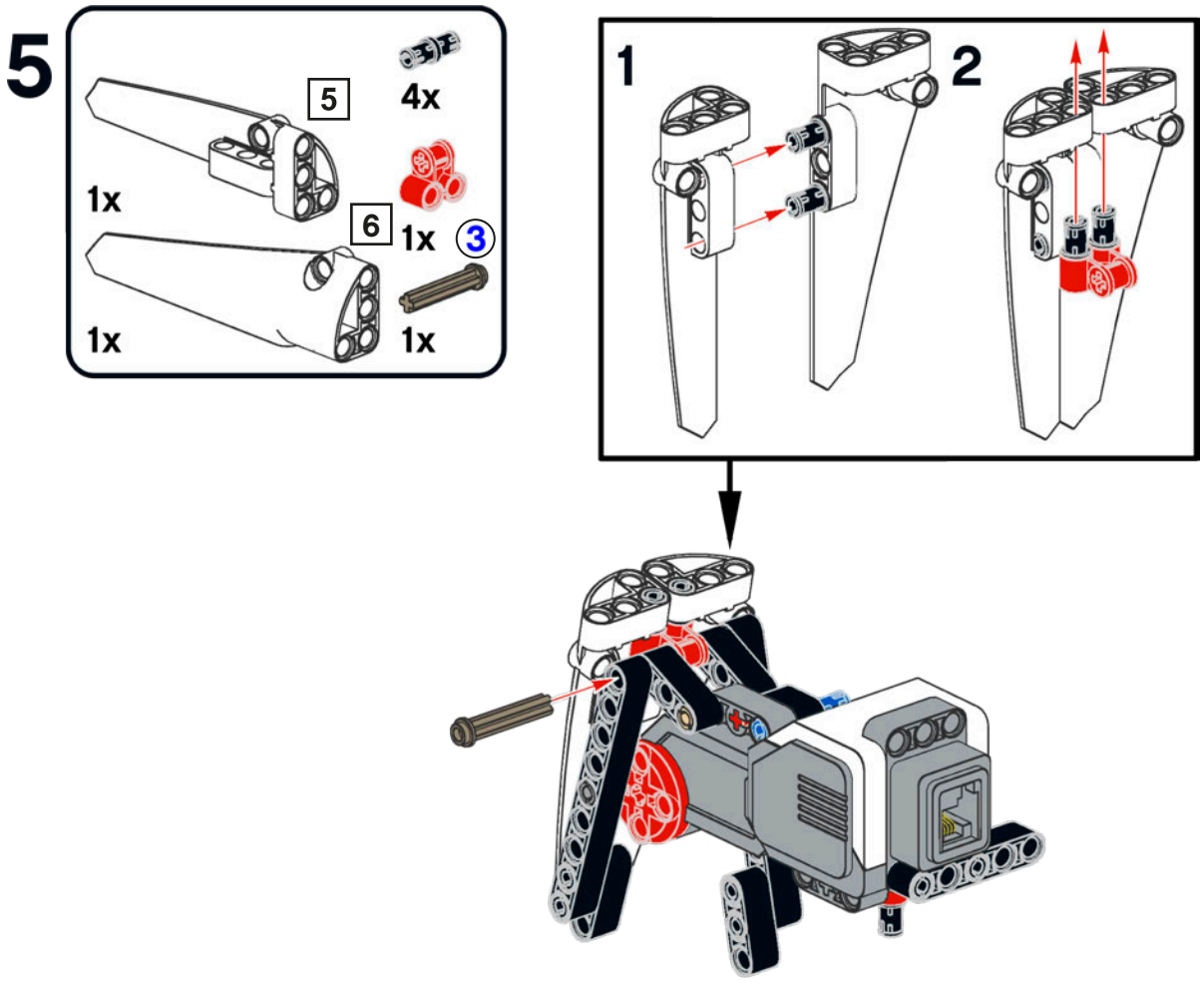
3
9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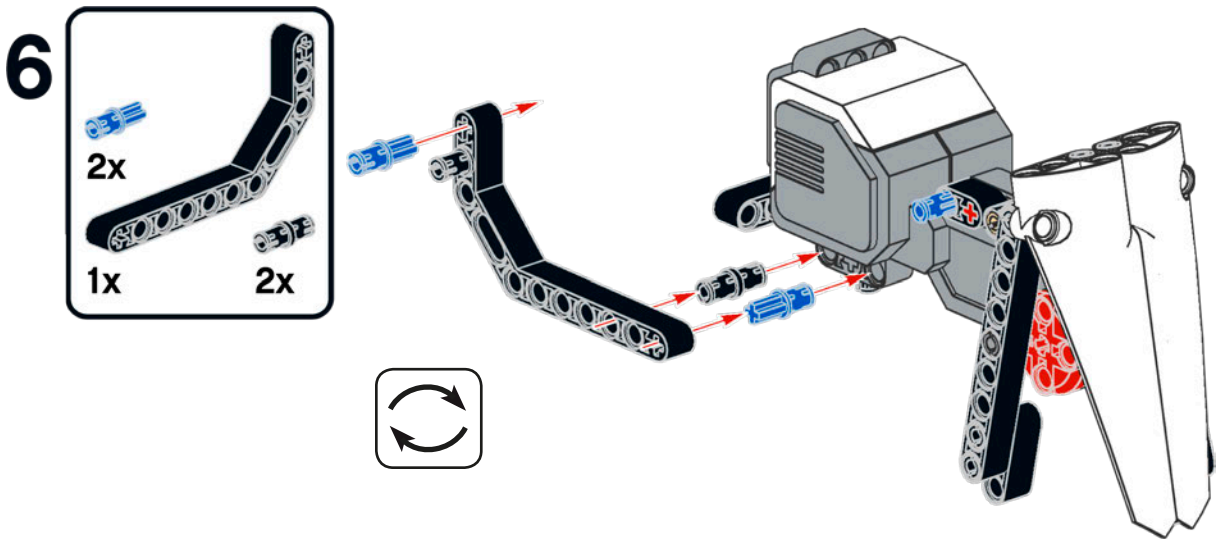
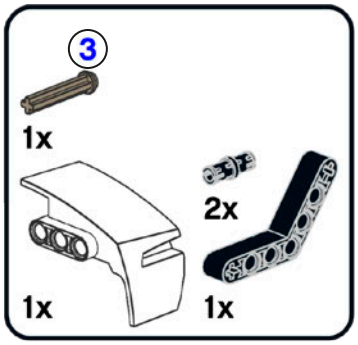
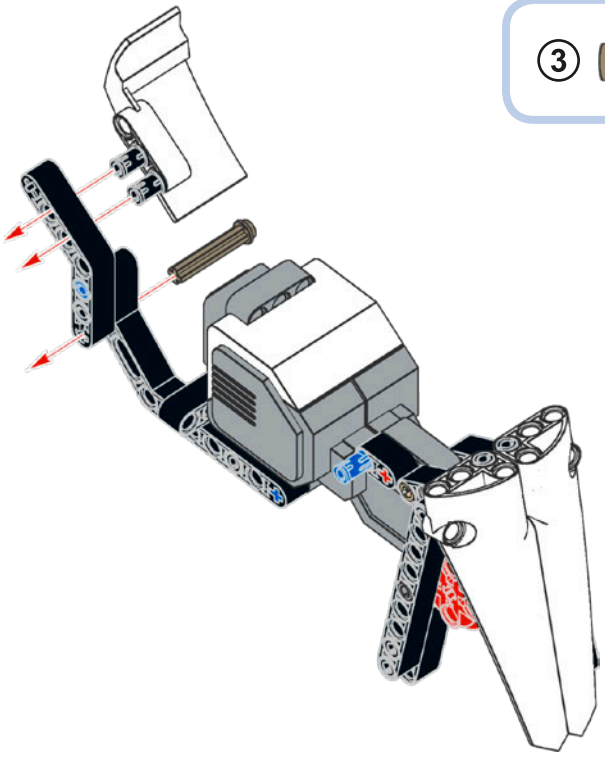
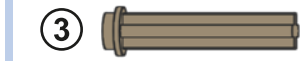

6
2x
1x
2x

7

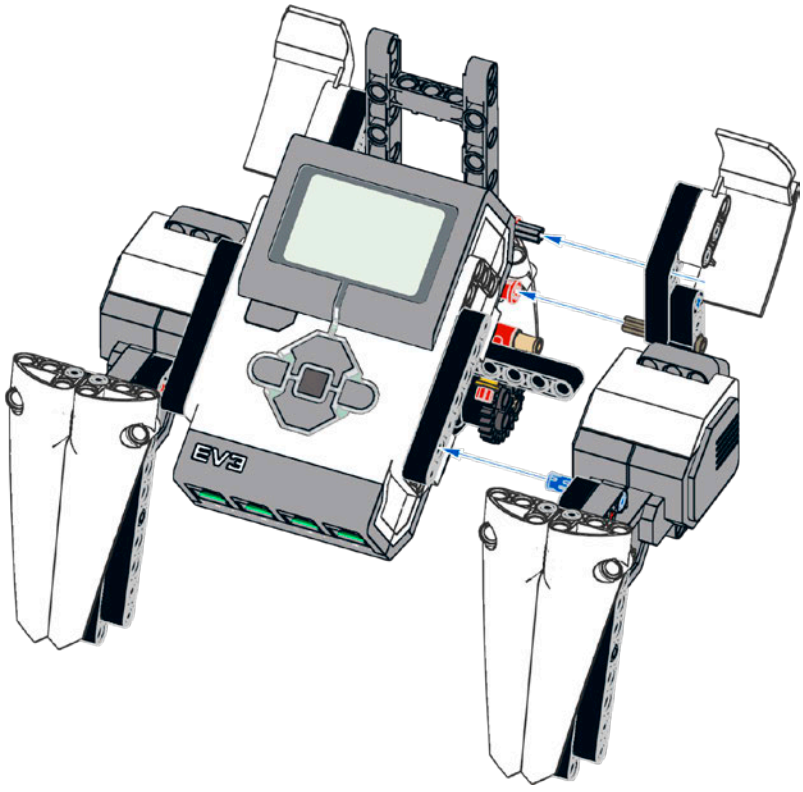




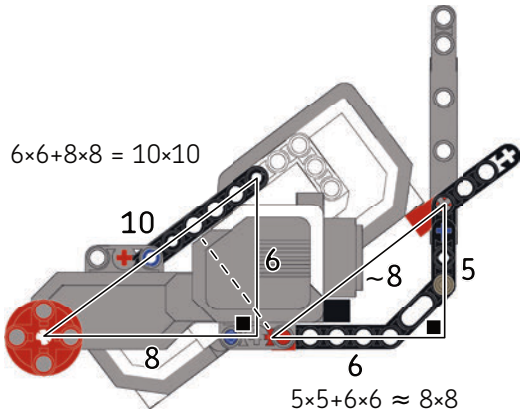


main assembly

12



The Pythagorean Theorem states that the area of the square of the hypotenuse (the side opposite the right angle, indicated with a black square) is equal to the sum of the squares of the two legs (the two sides that meet at a right angle). The bigger triangle (whose sides are 6M, 8M, and 10M, as shown in the figure) shows this relation. Even though the hypotenuse of the smaller triangle is not a whole number (it's slightly shorter than 8M), the assembly still works, and the parts are flexible enough that we don't have to force them too much to make things fit.



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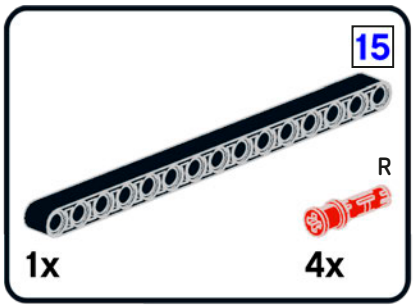
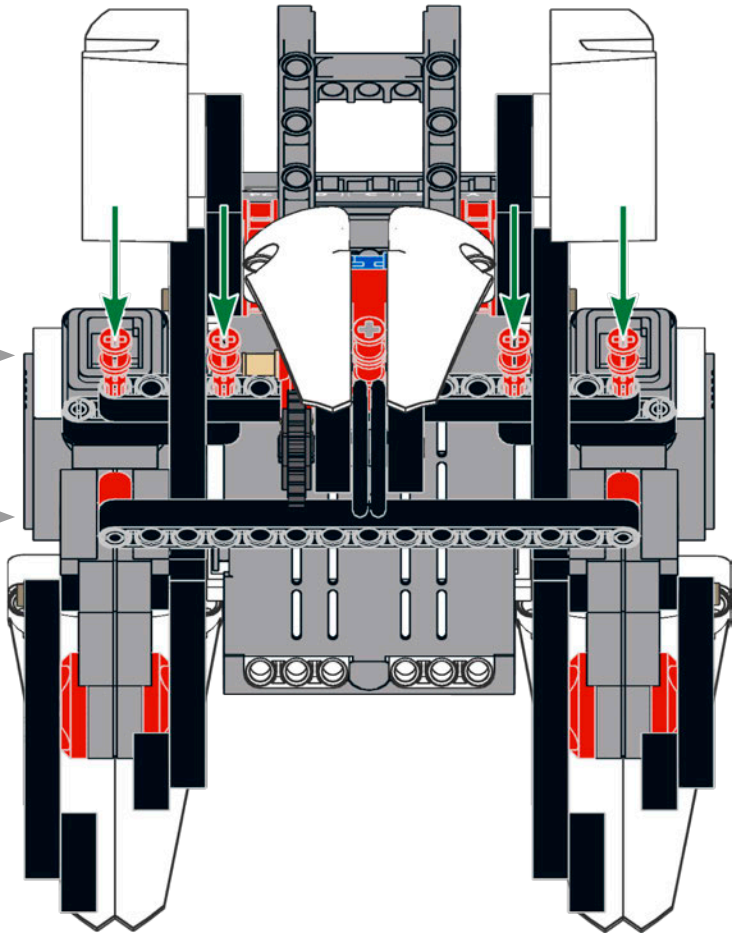


Add the 15M beam to brace the leg assemblies. Then insert four 3M red pins with stop bushes to lock the rear leg assembly.



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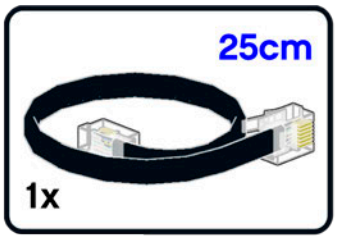
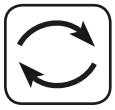
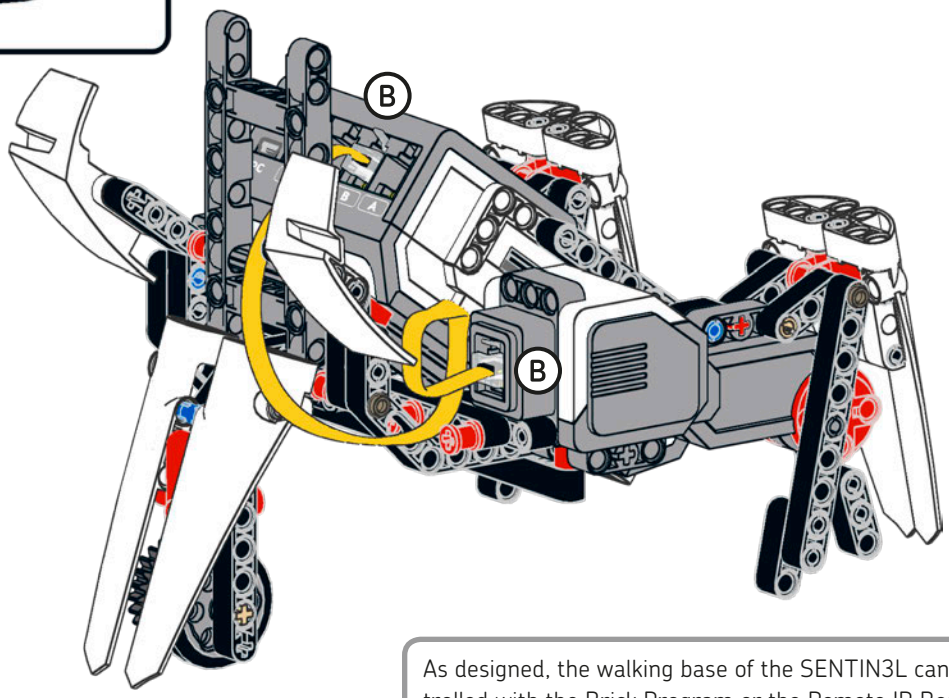
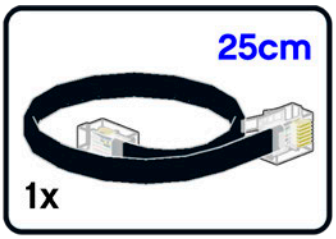


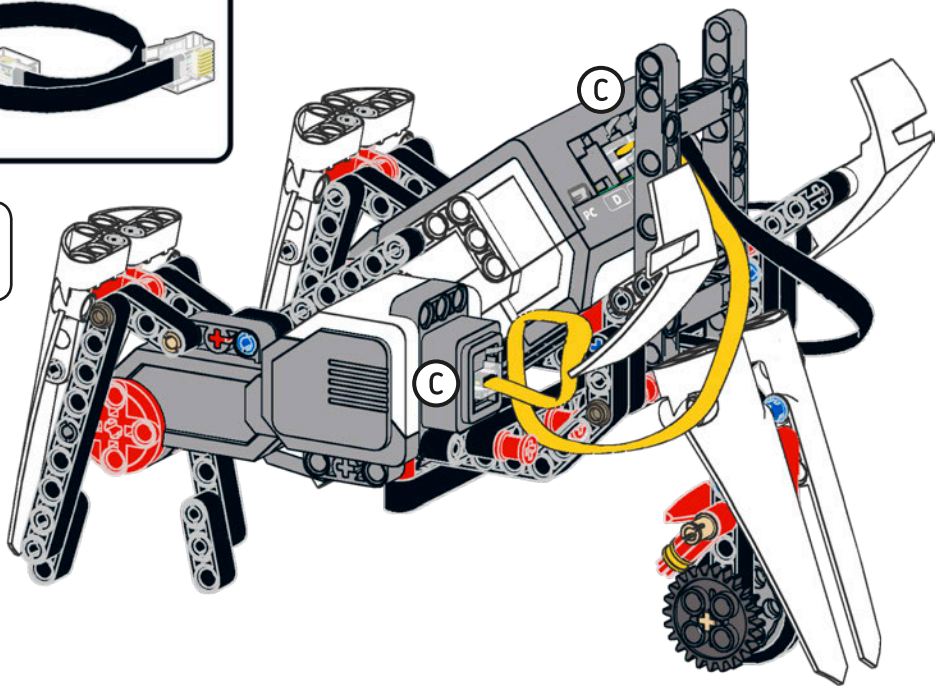


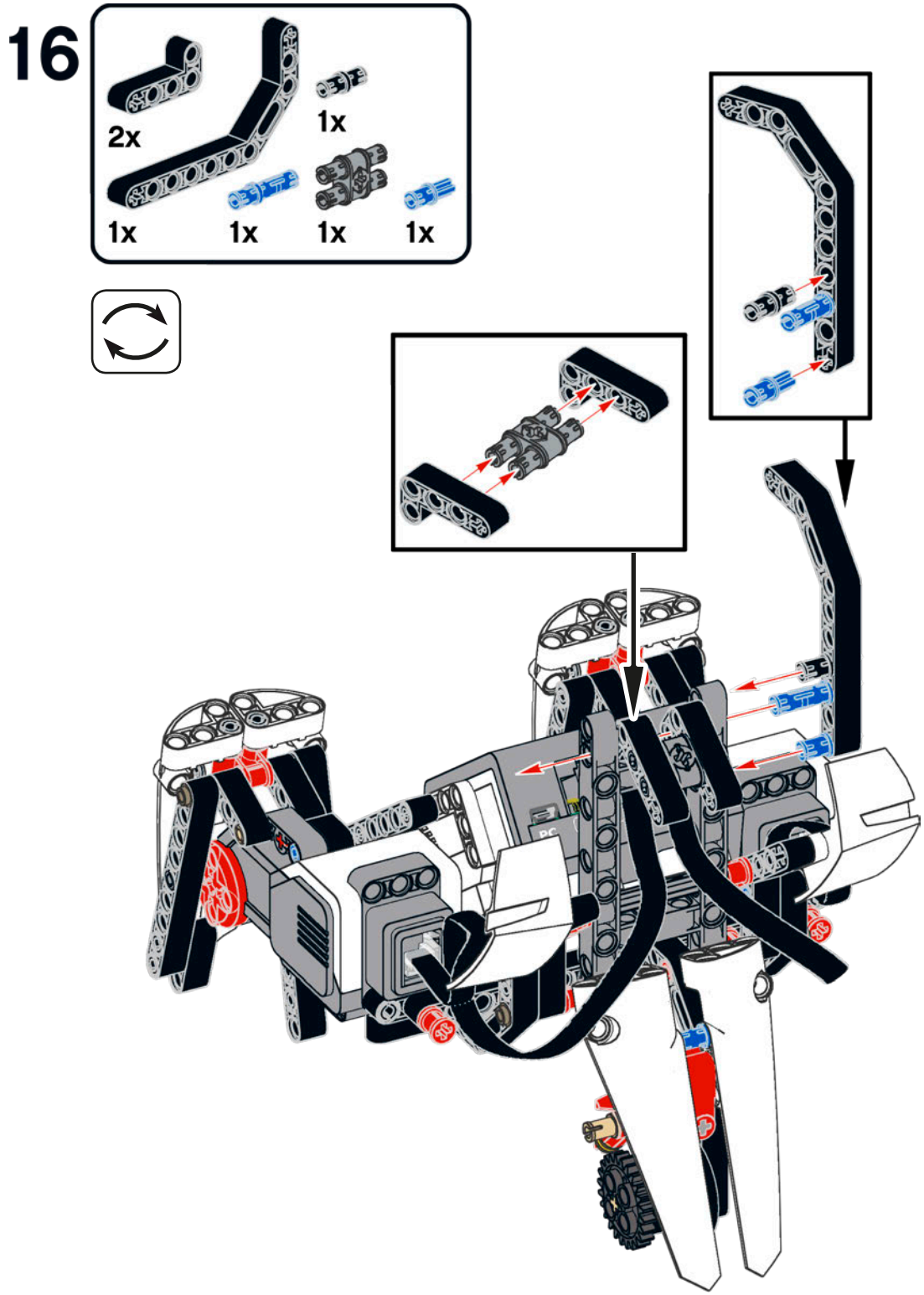


As designed, the walking base of the SENTIN3L can be controlled with the Brick Program or the Remote IR Beacon, as can R0V3R and any other differential drive mobile robot. Just drive motors B and C to make it walk forward or turn.

15

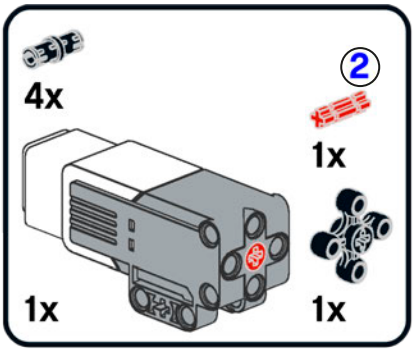


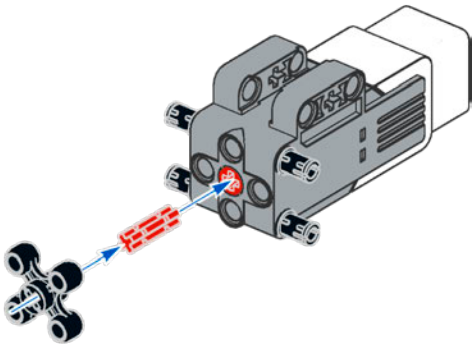



16
2x
1x
1x
1x
1x
1x

chest assembly

1





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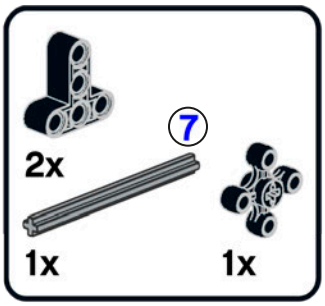

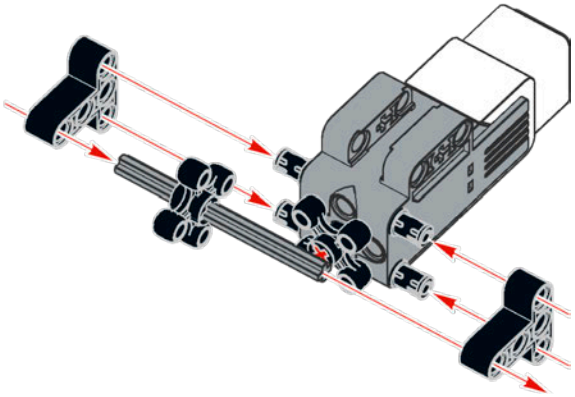

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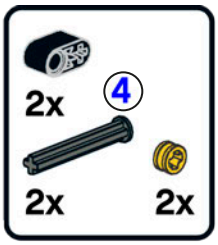
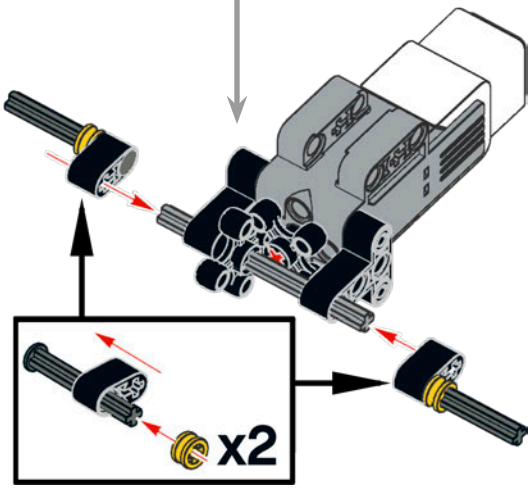
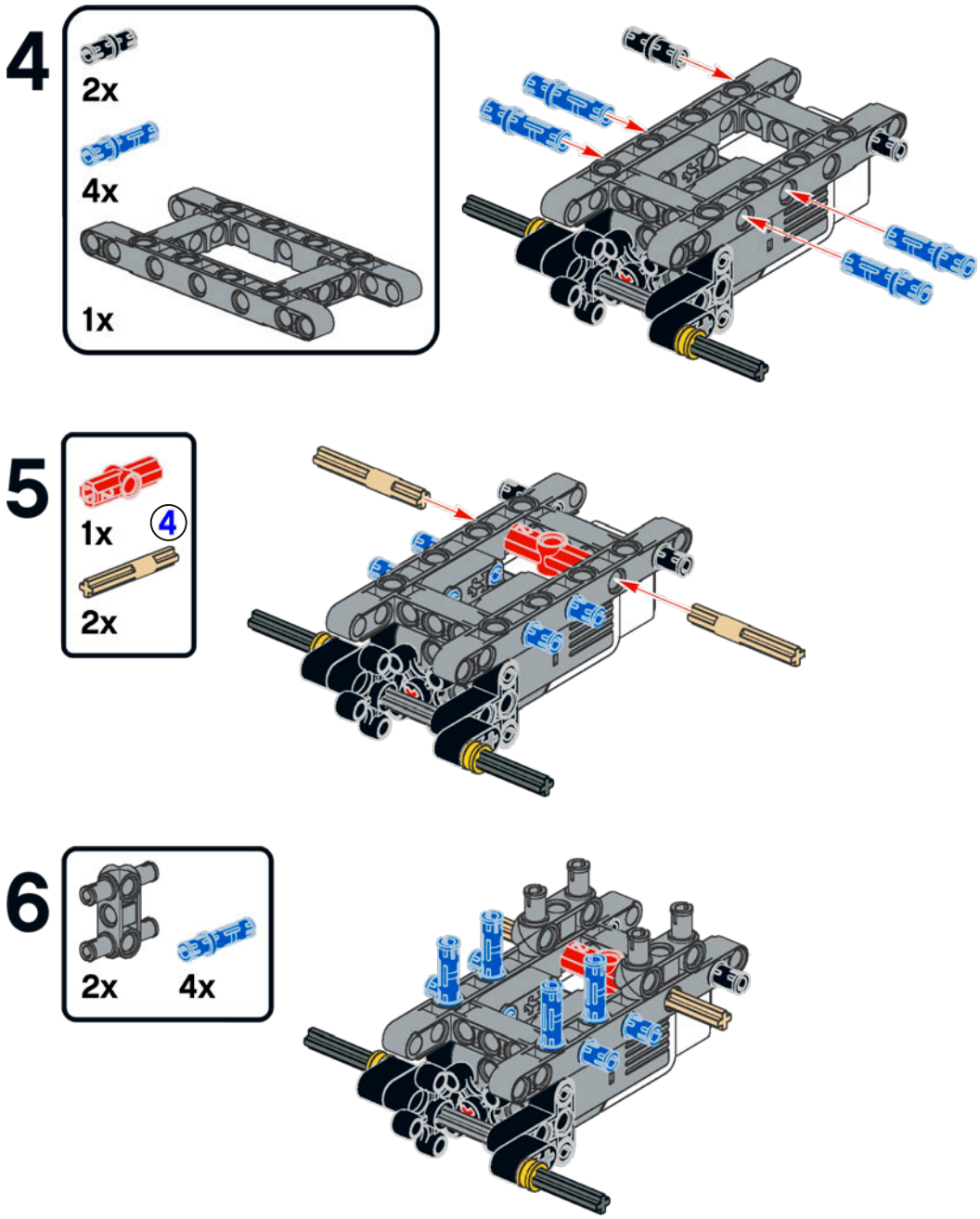
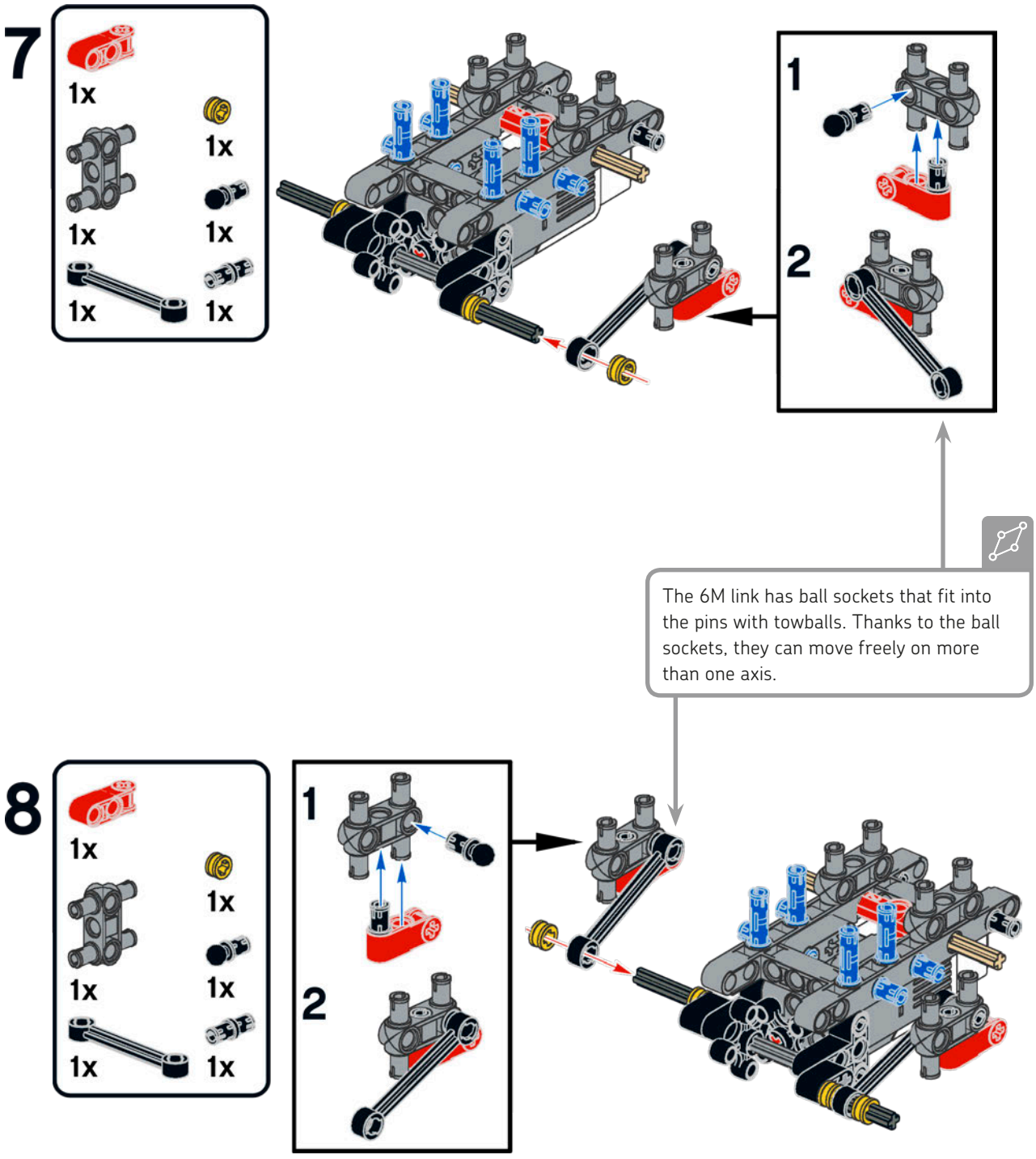


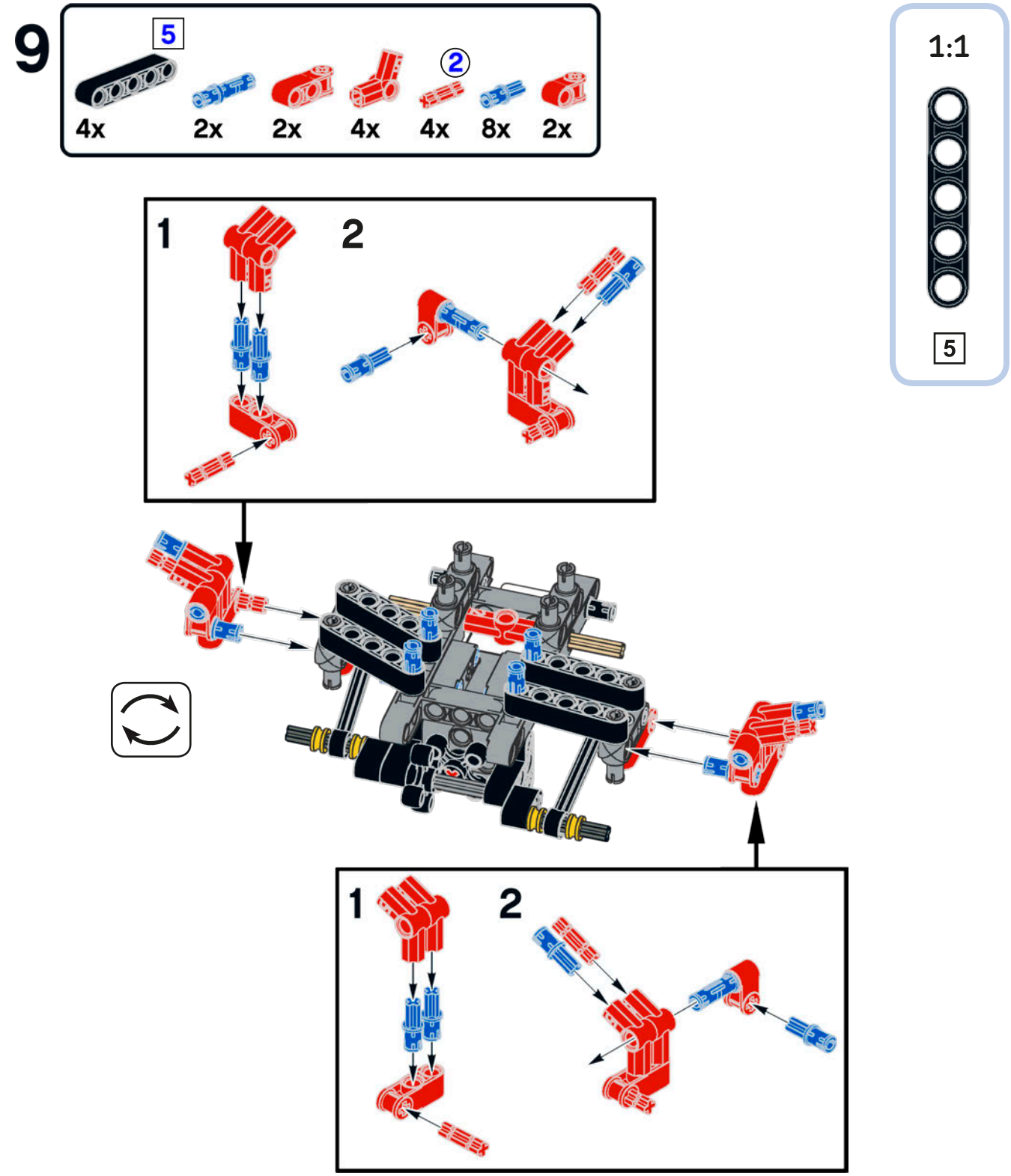
You can easily reuse this assembly in your creations. If you choose to use knob wheels, the driving axle will come out from the side rather than the front of the motor.



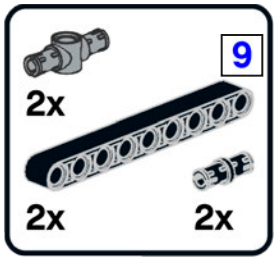
Don't insert the 2M beams all the way onto the 7M axle; leave some space between them and the T beams. Otherwise, the flat heads of the 4M axles with stop might catch on the holes of the T beams when the pieces rotate.

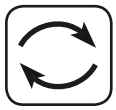

4
2x
4x
1x
5
1x
4
2x
6
2x
4x
7
4
4
1:1

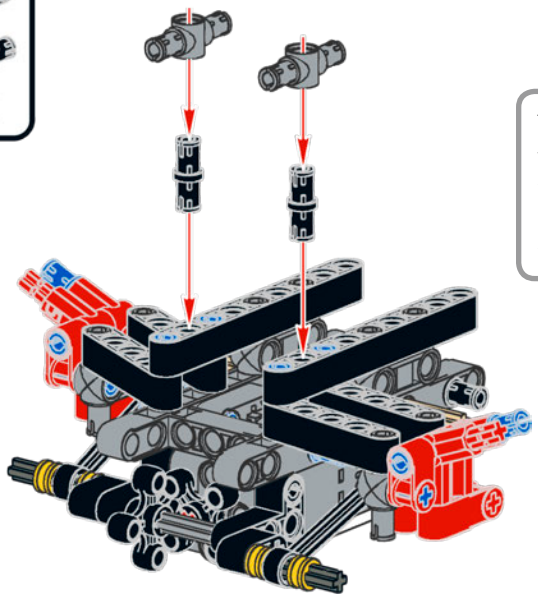

7
1x
1x
1x
1x
1x
1x
1
2
The 6M link has ball sockets that fit into the pins with towballs. Thanks to the ball sockets, they can move freely on more than one axis.
8
1x
1x
1x
1x
1x
1x
1
2


9
5
4x
2x
2x
4x
2
4x
8x
2x
1:1
5
1
2
1
2

10

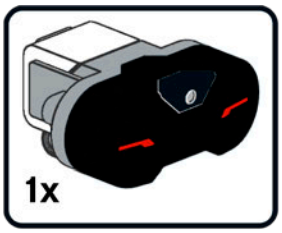


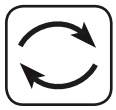


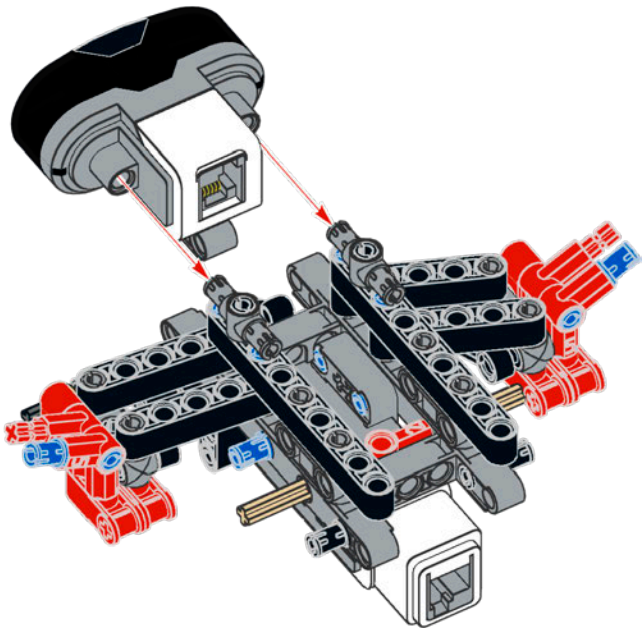


The 2M beams are cams that transform the rotation of the motor shaft into a reciprocating motion of the robot's shoulders (back and forth), which simulates the recoil of cannons.

11





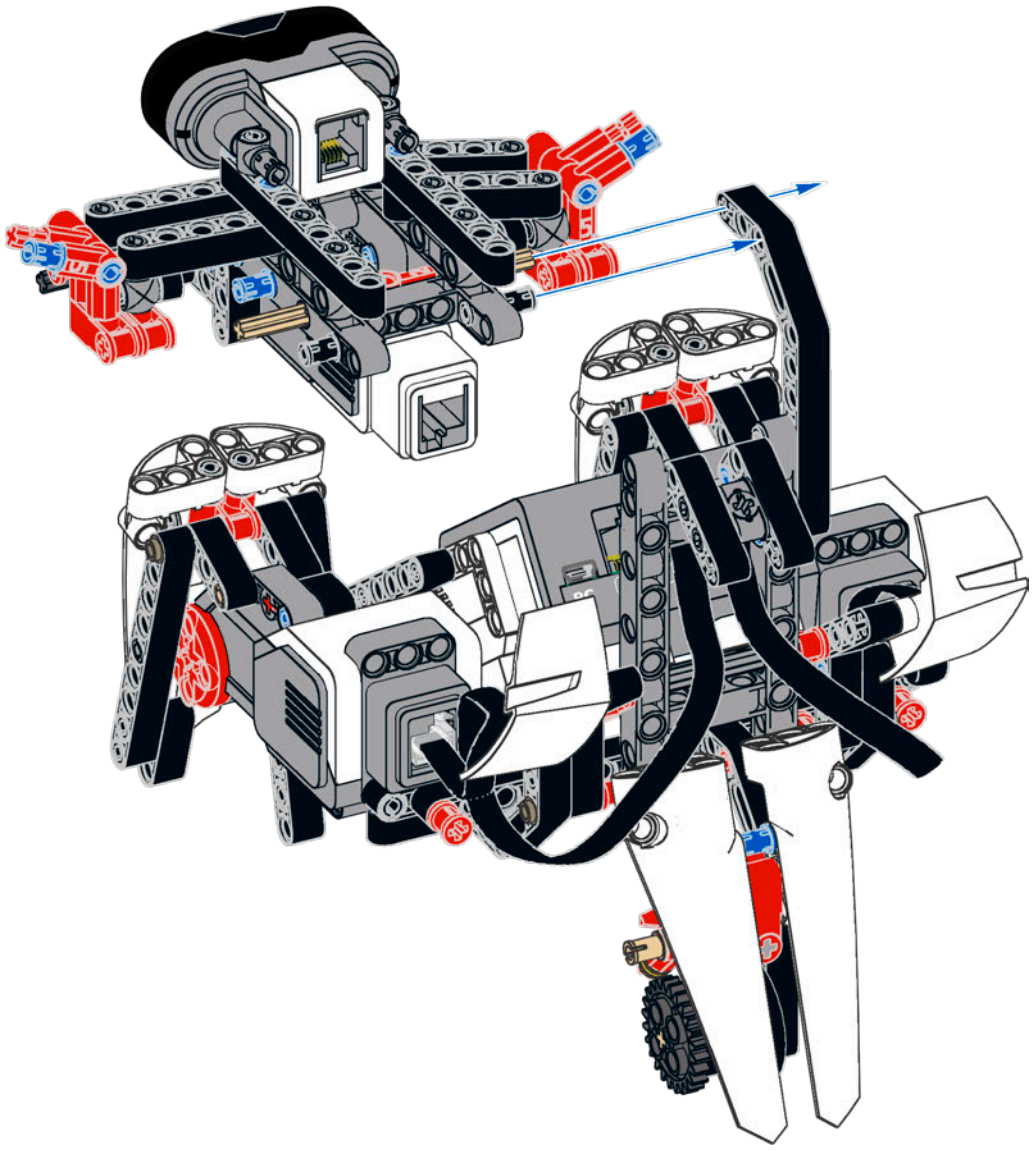


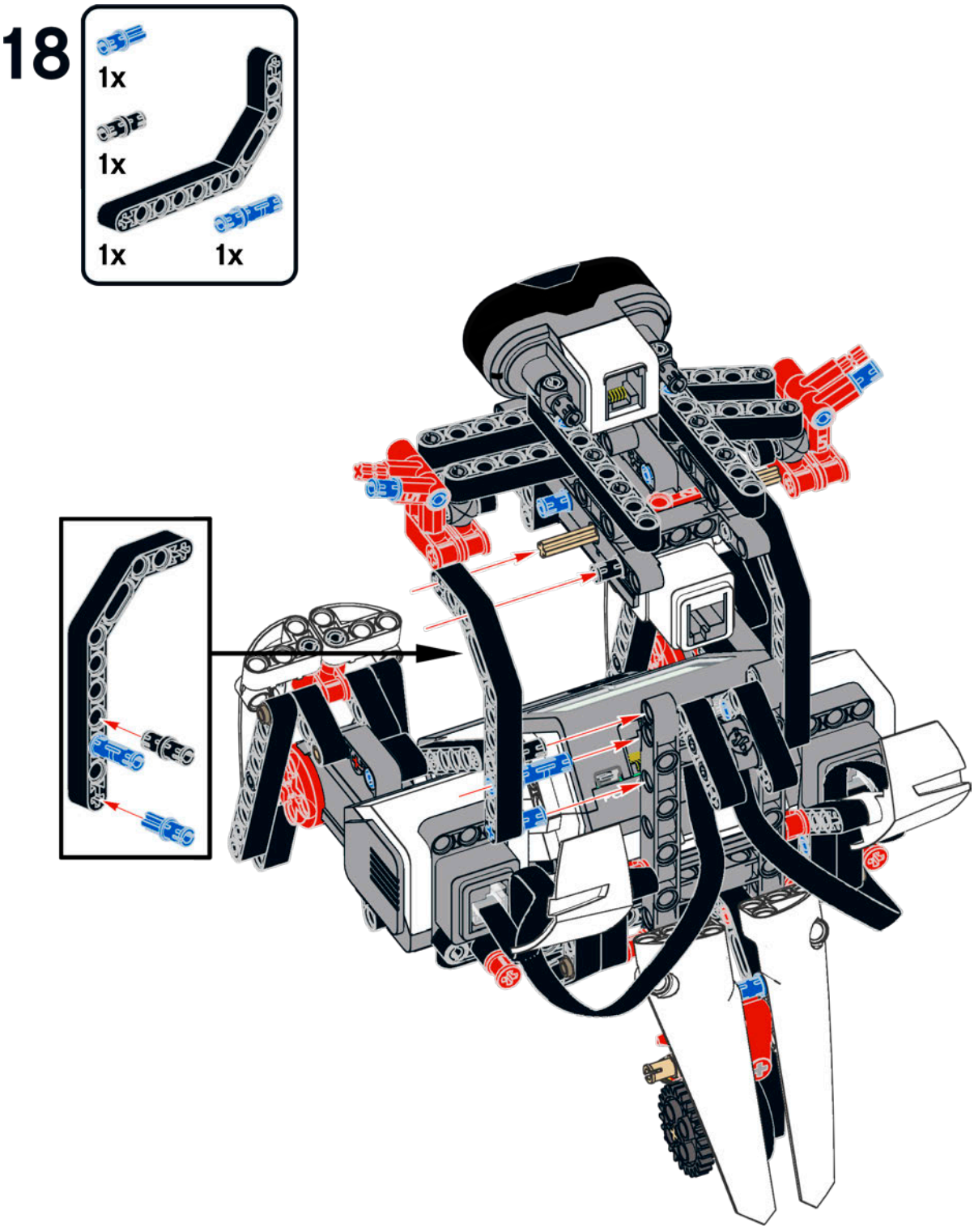
1:1

9

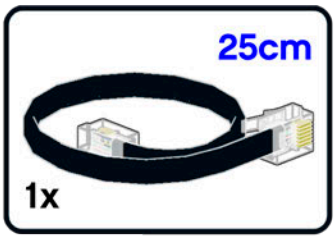
main assembly

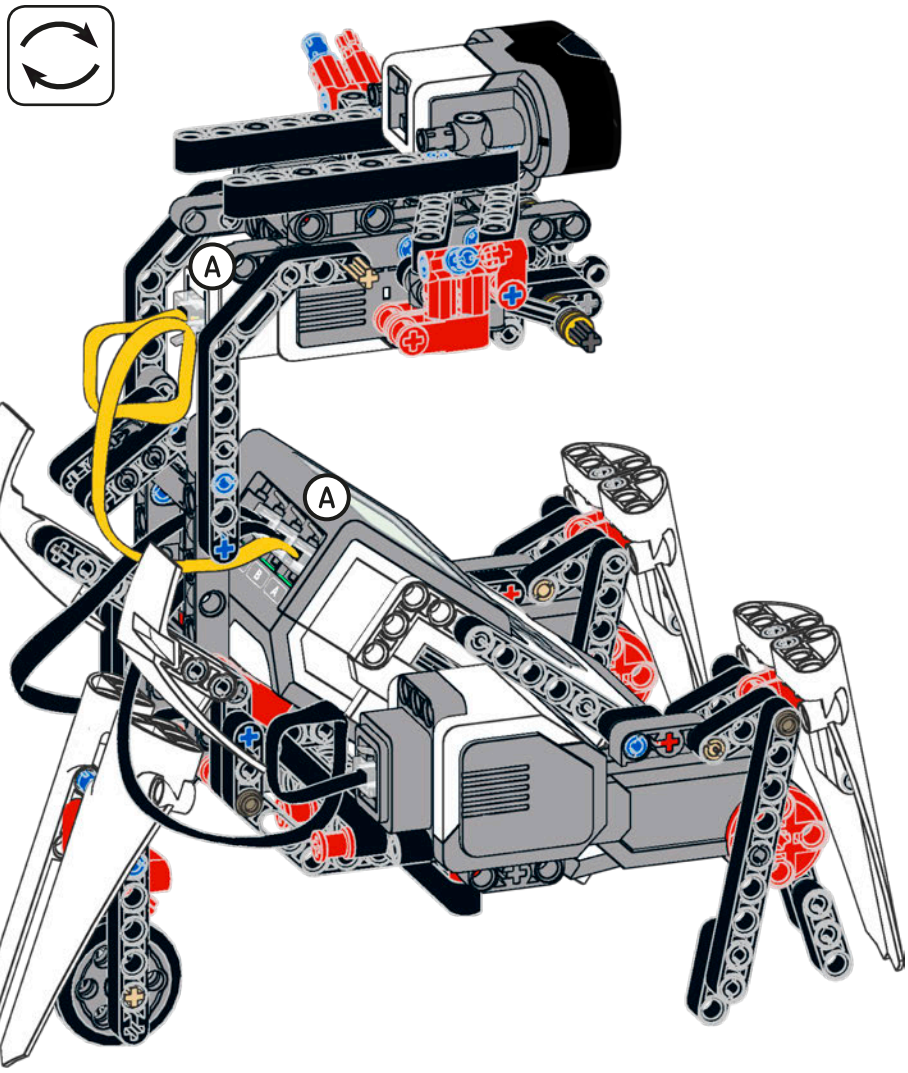
17




18
1x
1x
1x
1x

19





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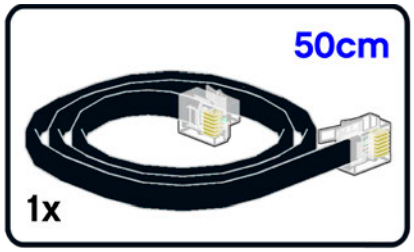

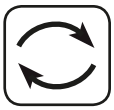

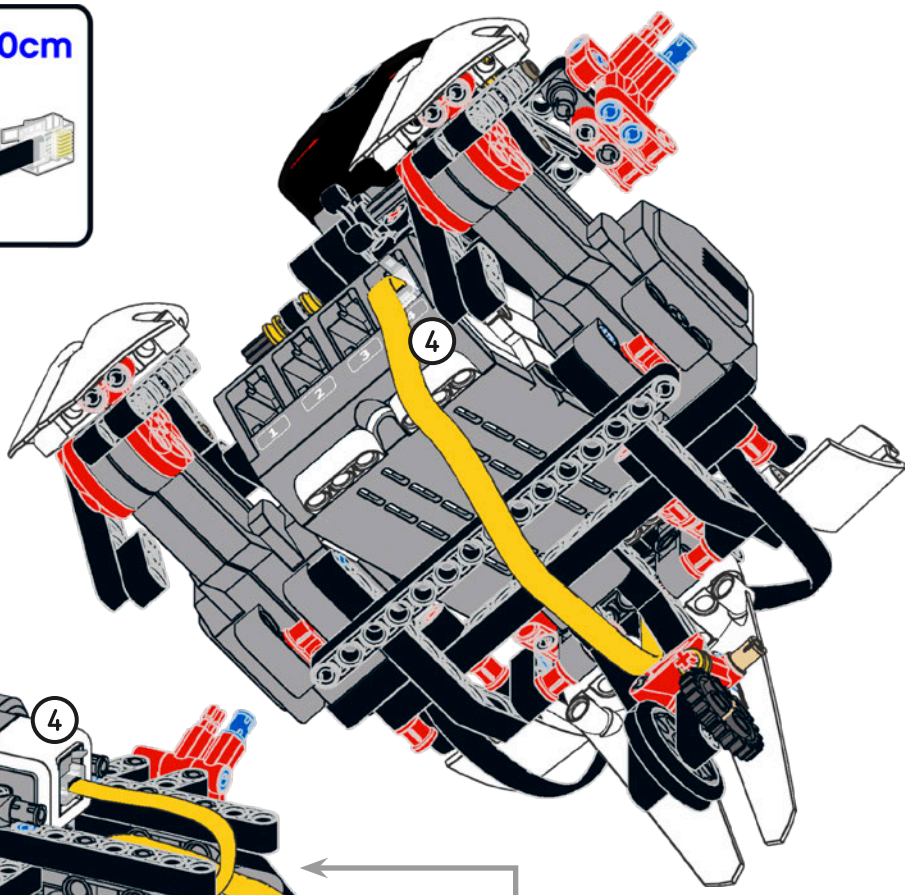

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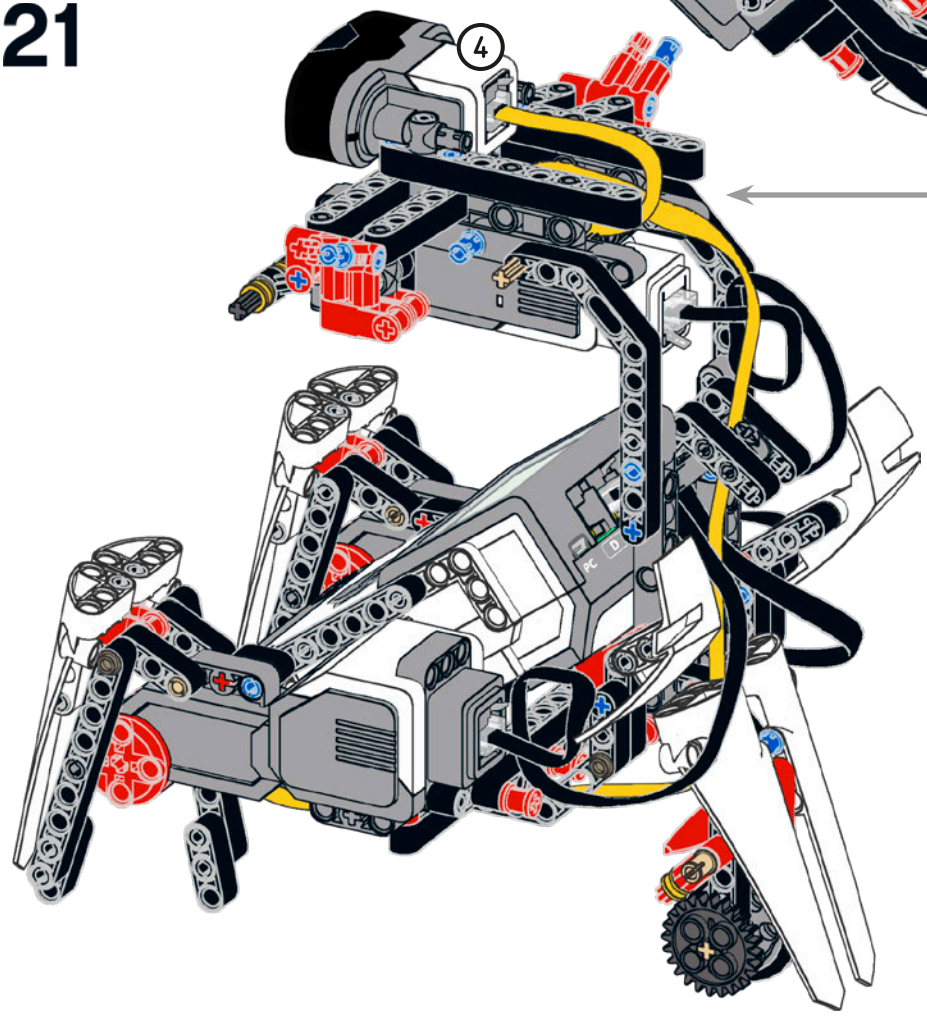
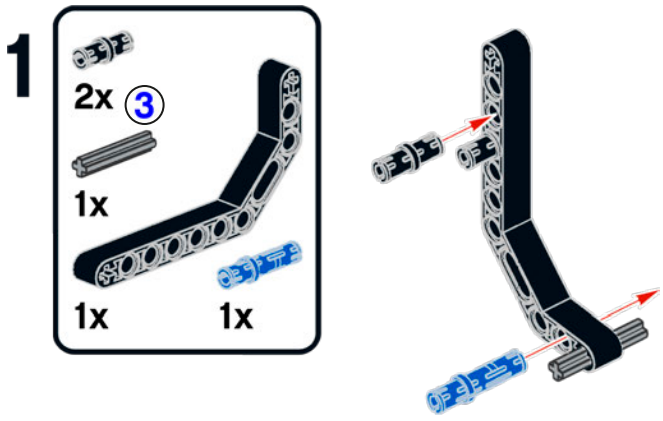
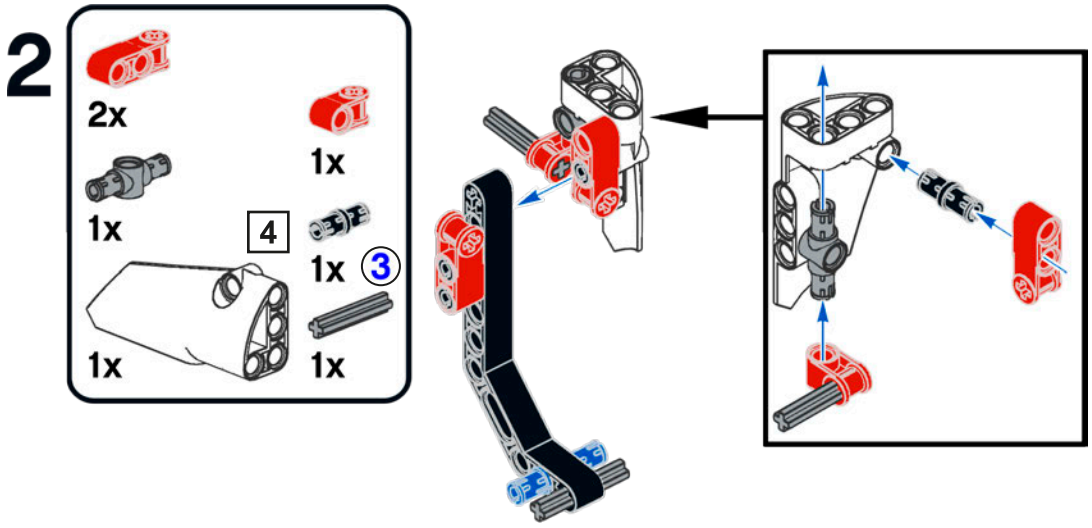
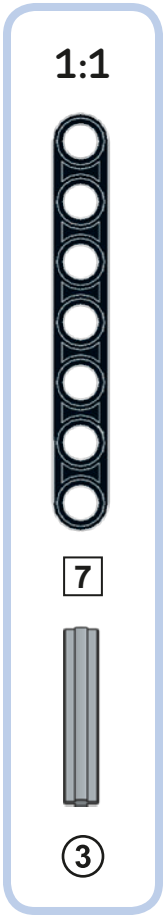
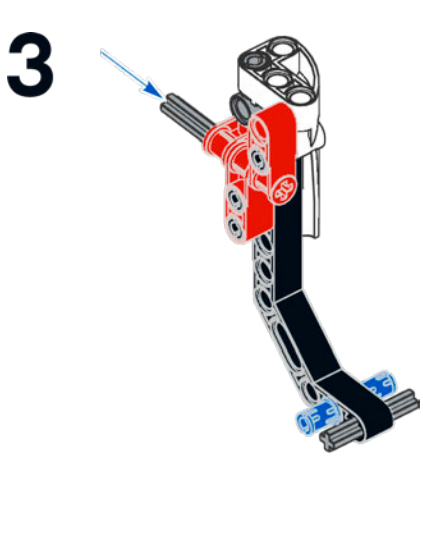


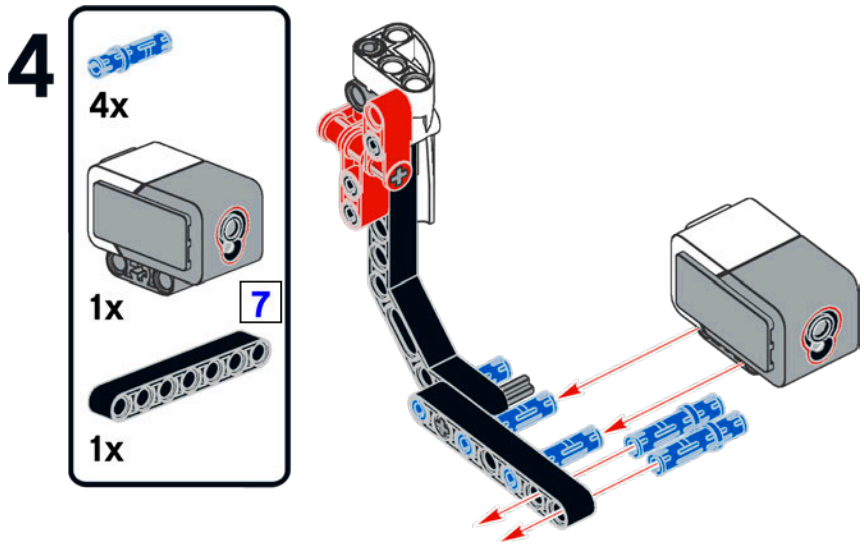
left arm assembly

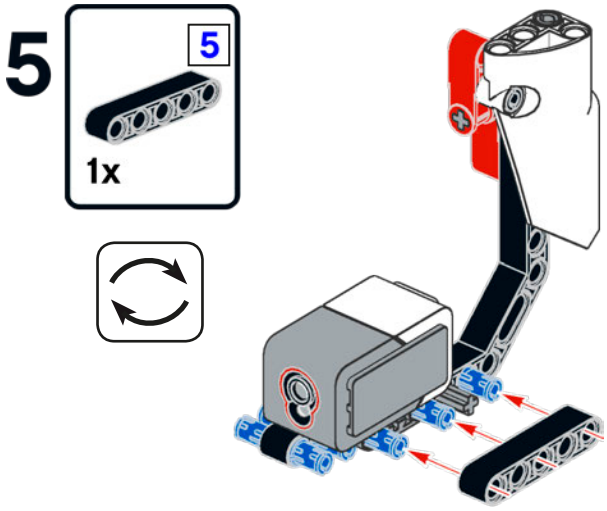




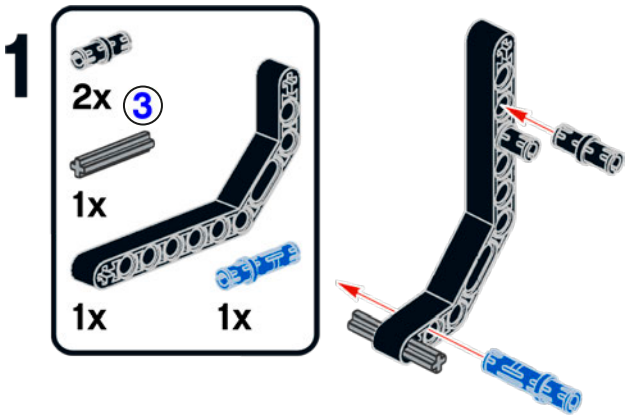


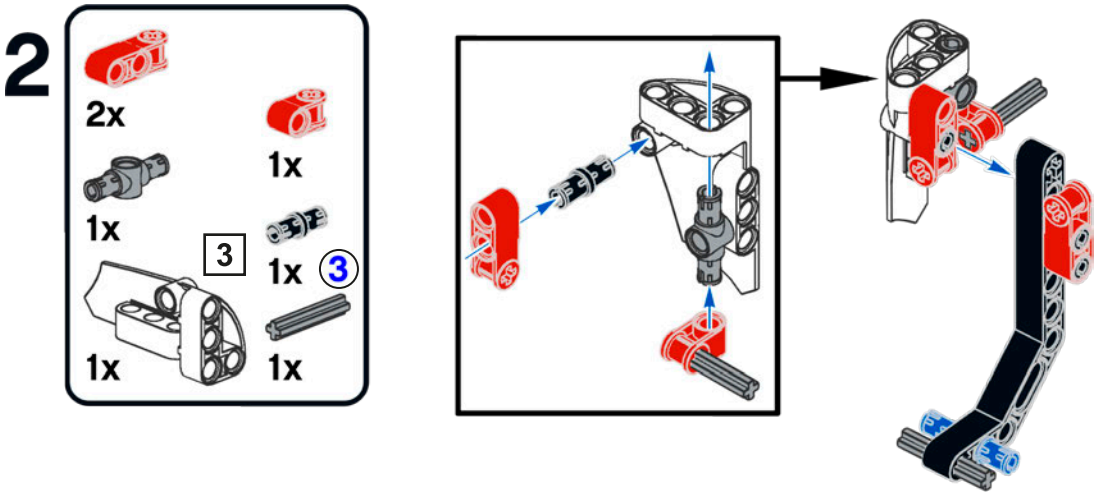


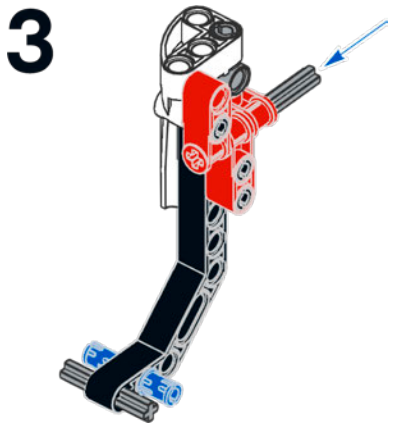


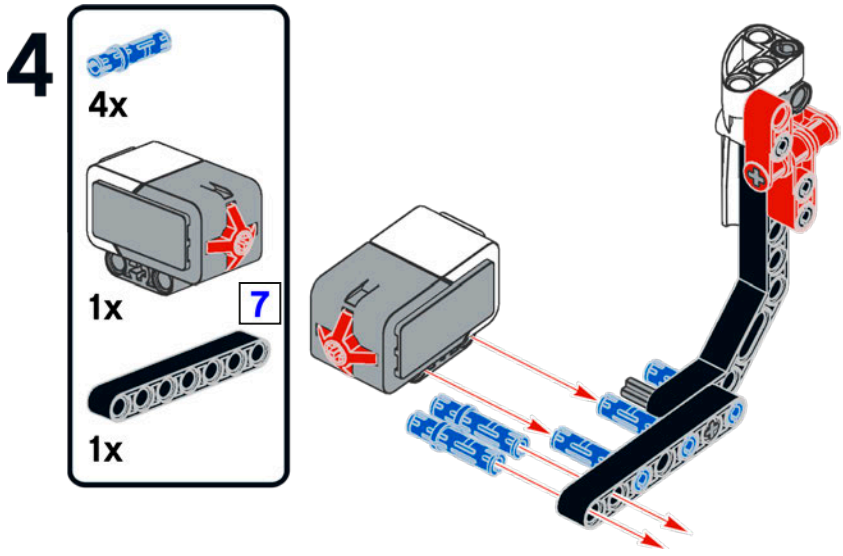


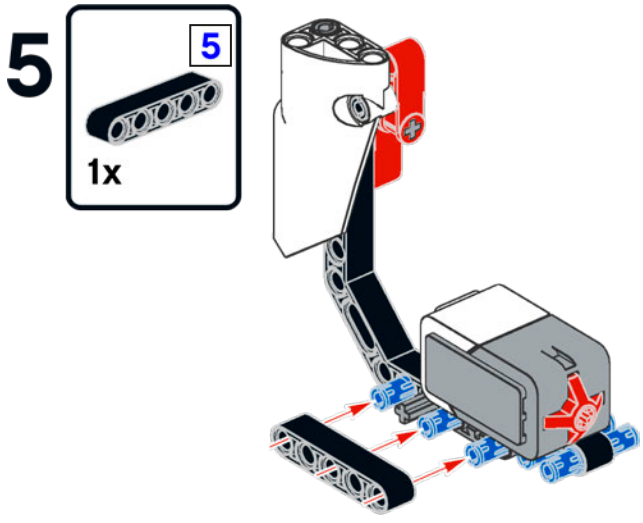
right arm assembly







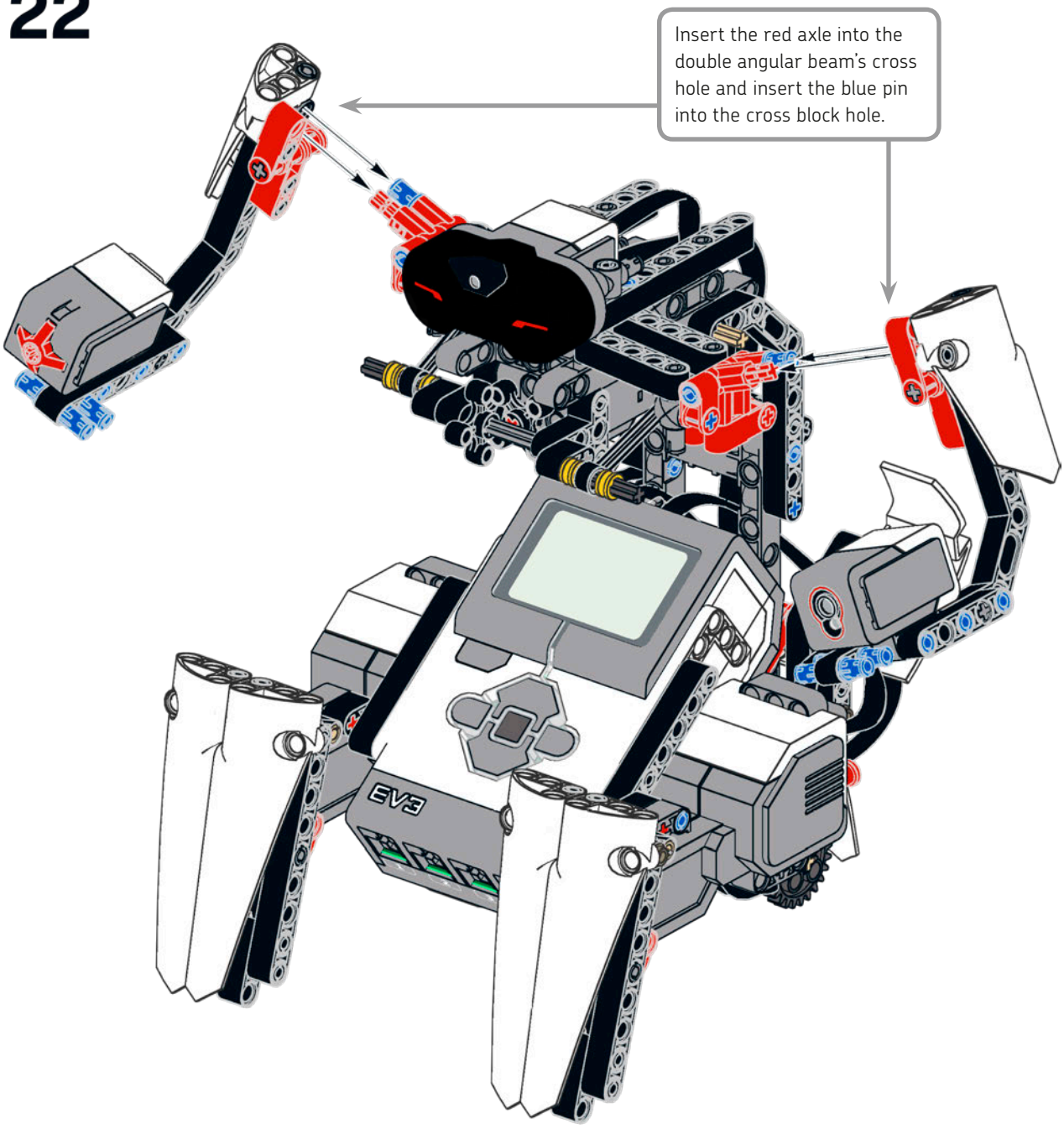




1:1

main assembly

22



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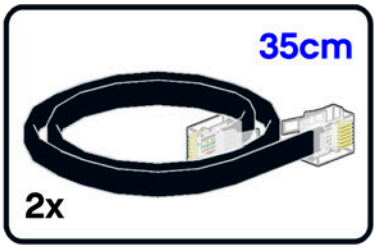
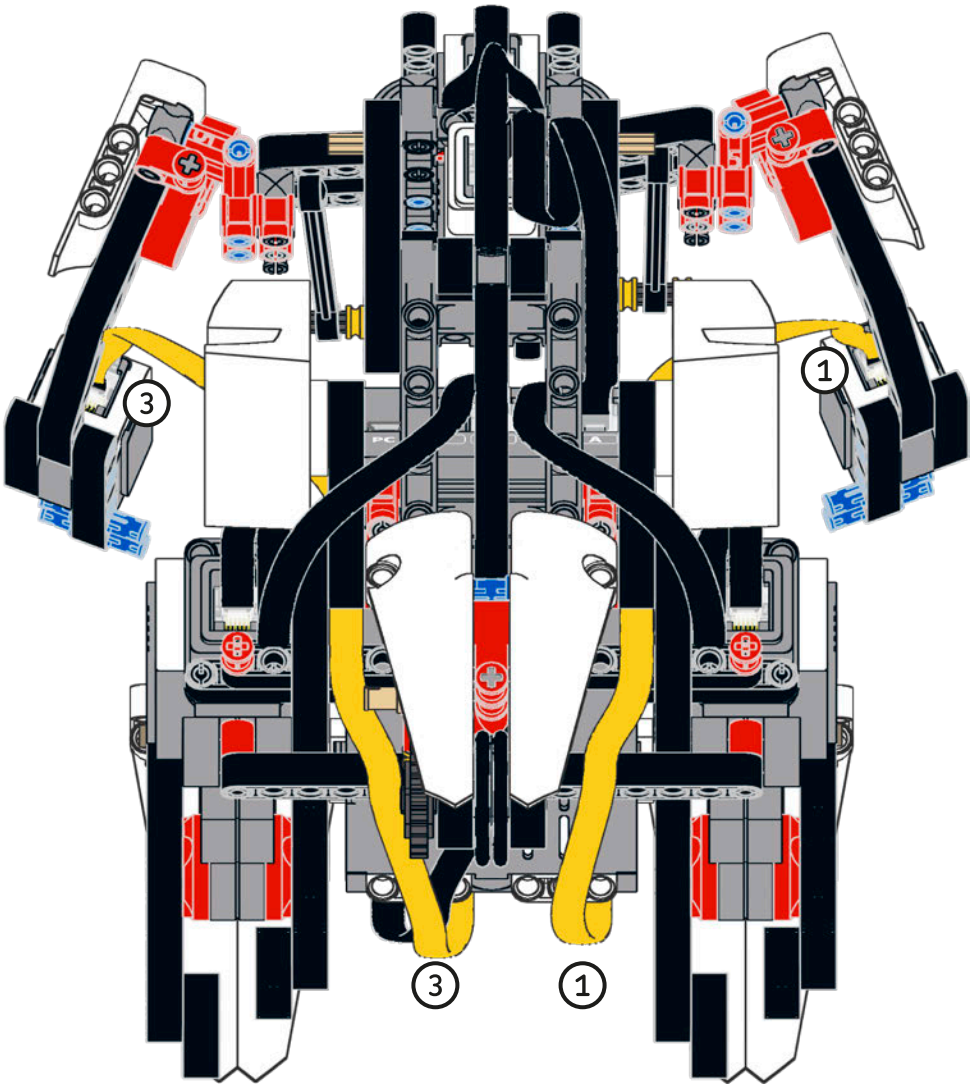
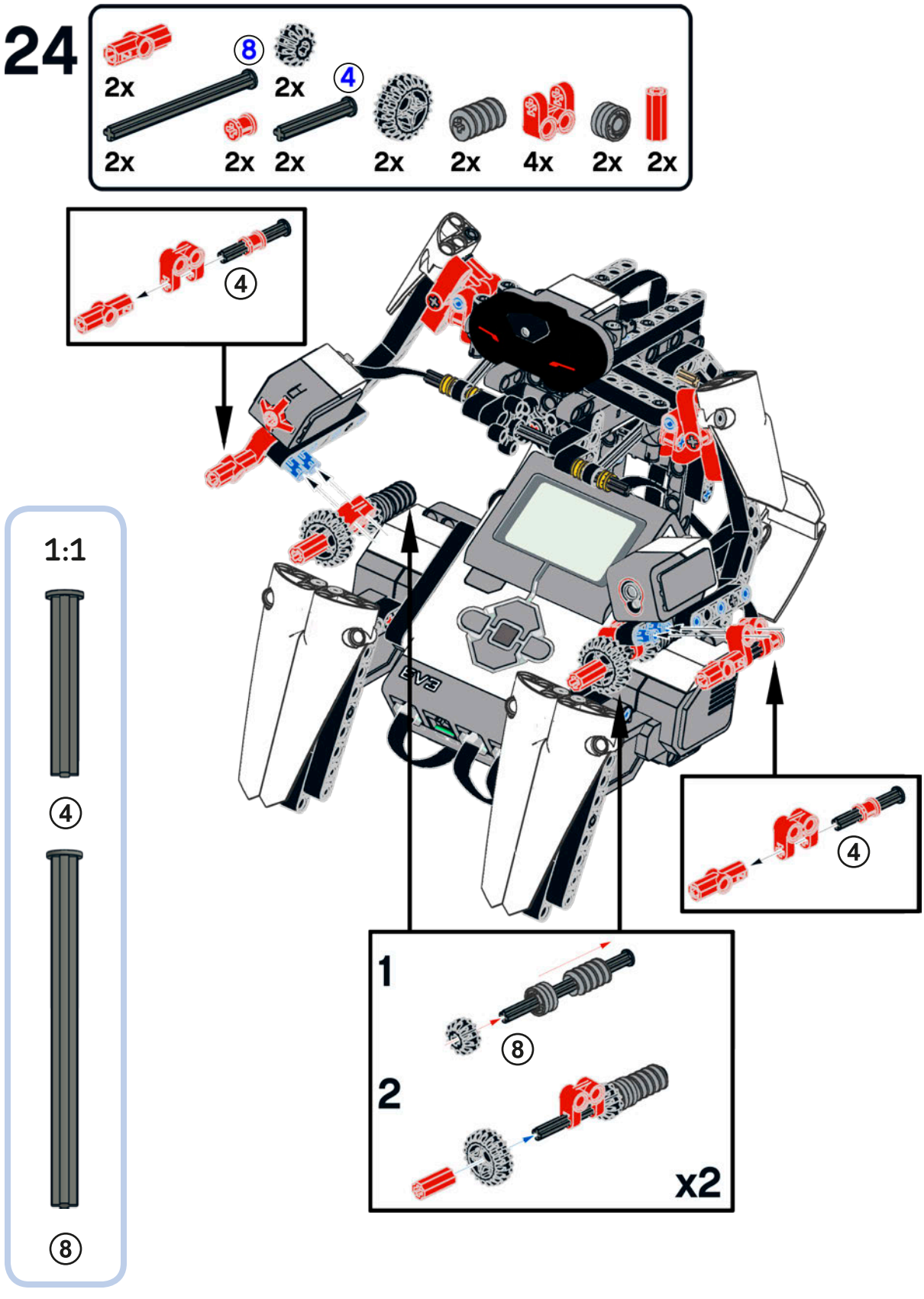
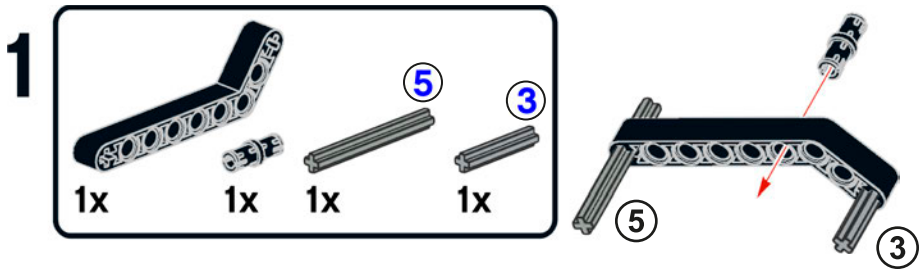
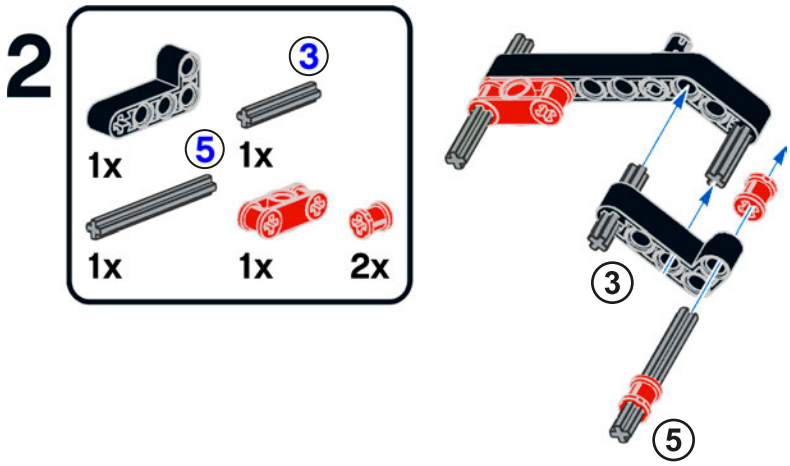


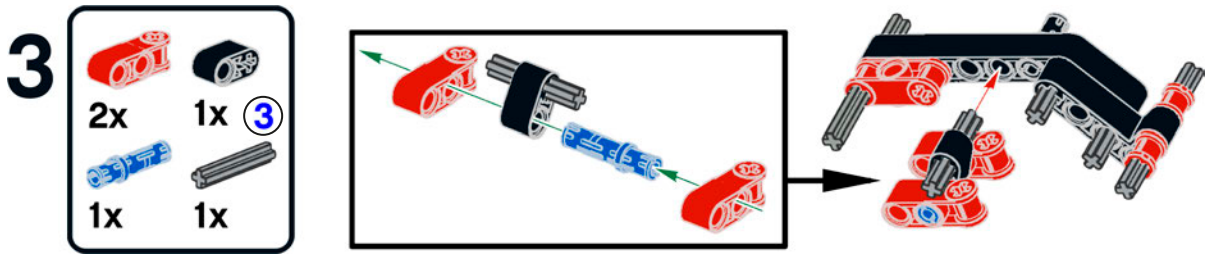


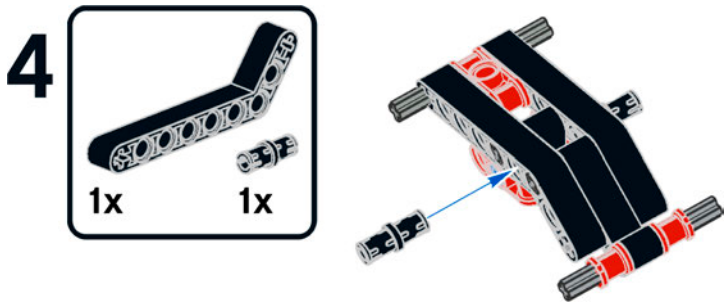

24
2x
8
2x
4
2x
2x
2x
2x
2x
4x
2x
2x
4
1:1
4
8
4
1
8
2
x2

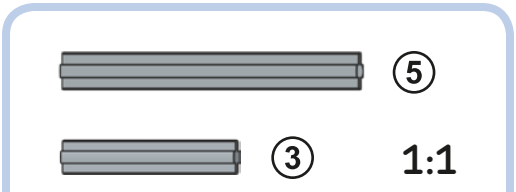
back shield assembly











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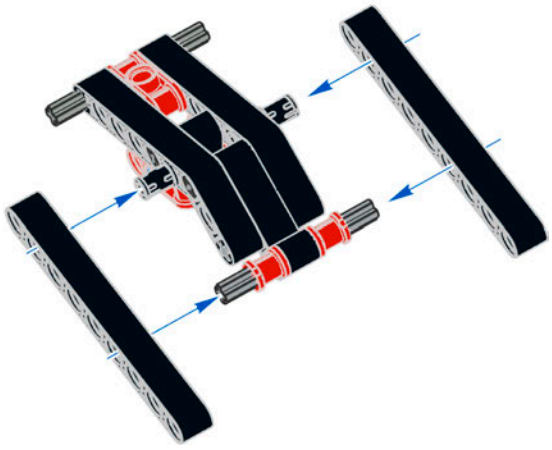
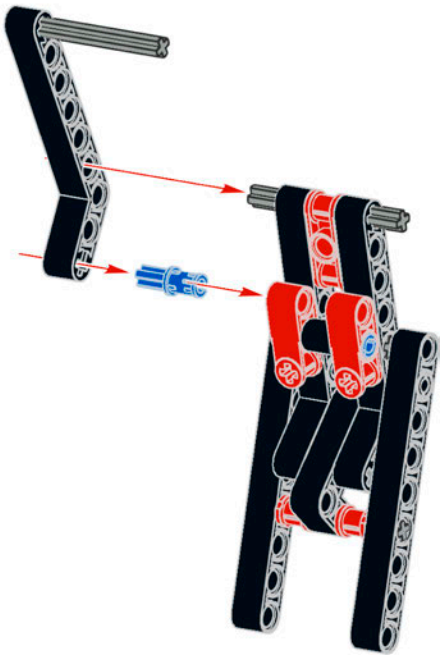
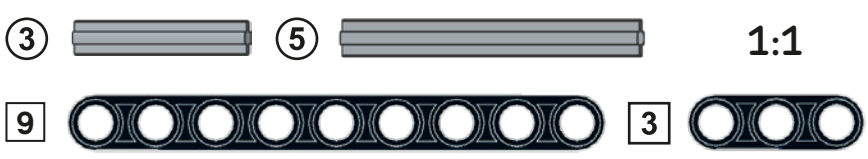
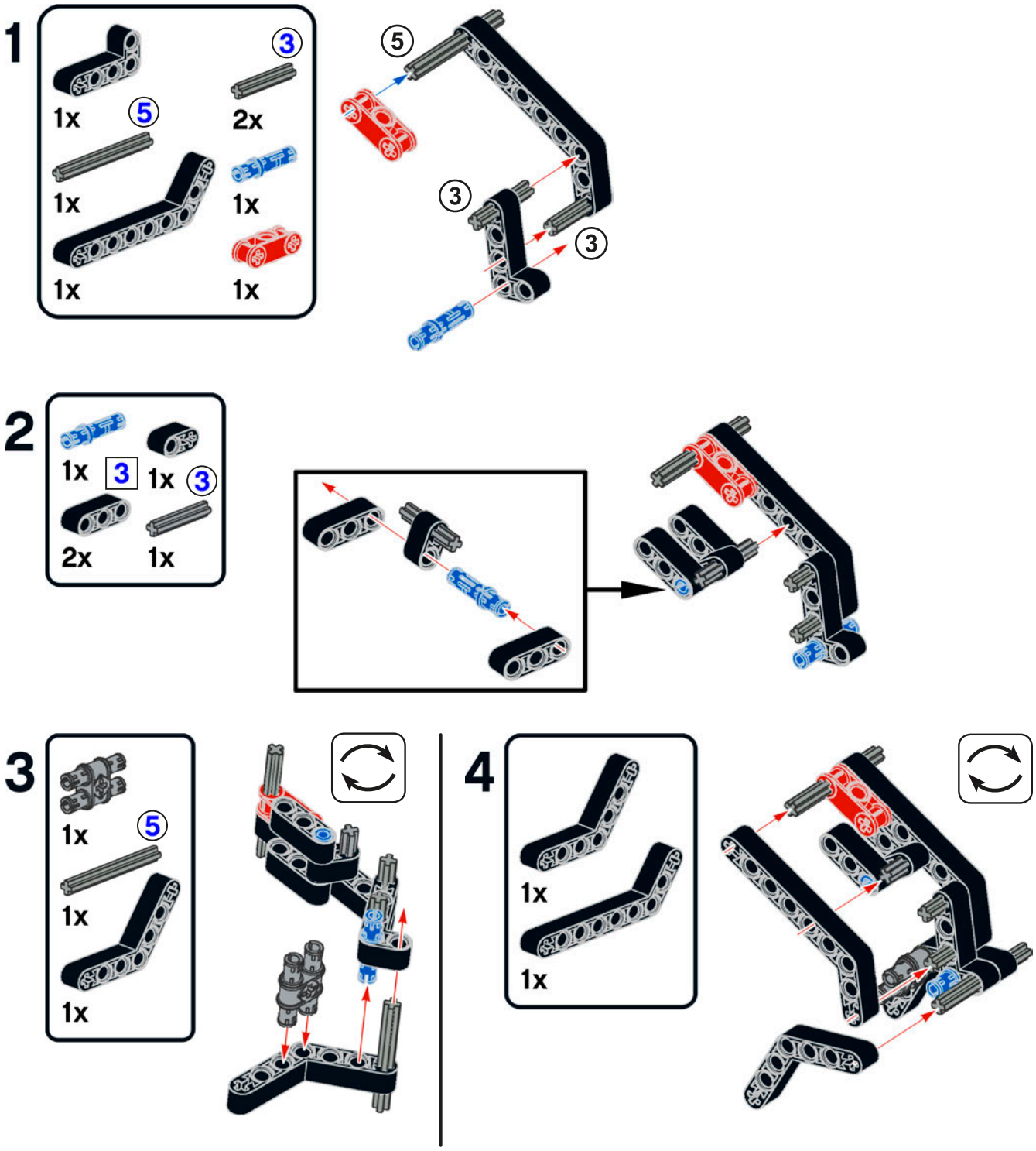


6





back shield middle subassembly



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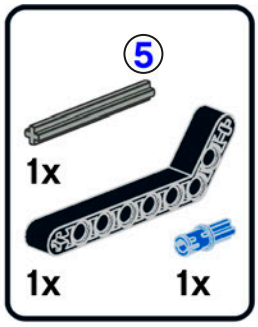
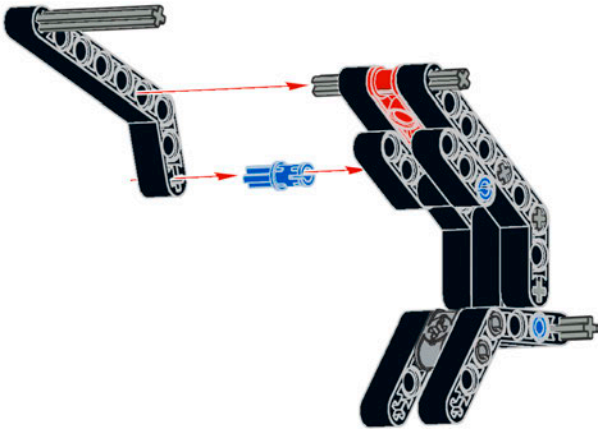
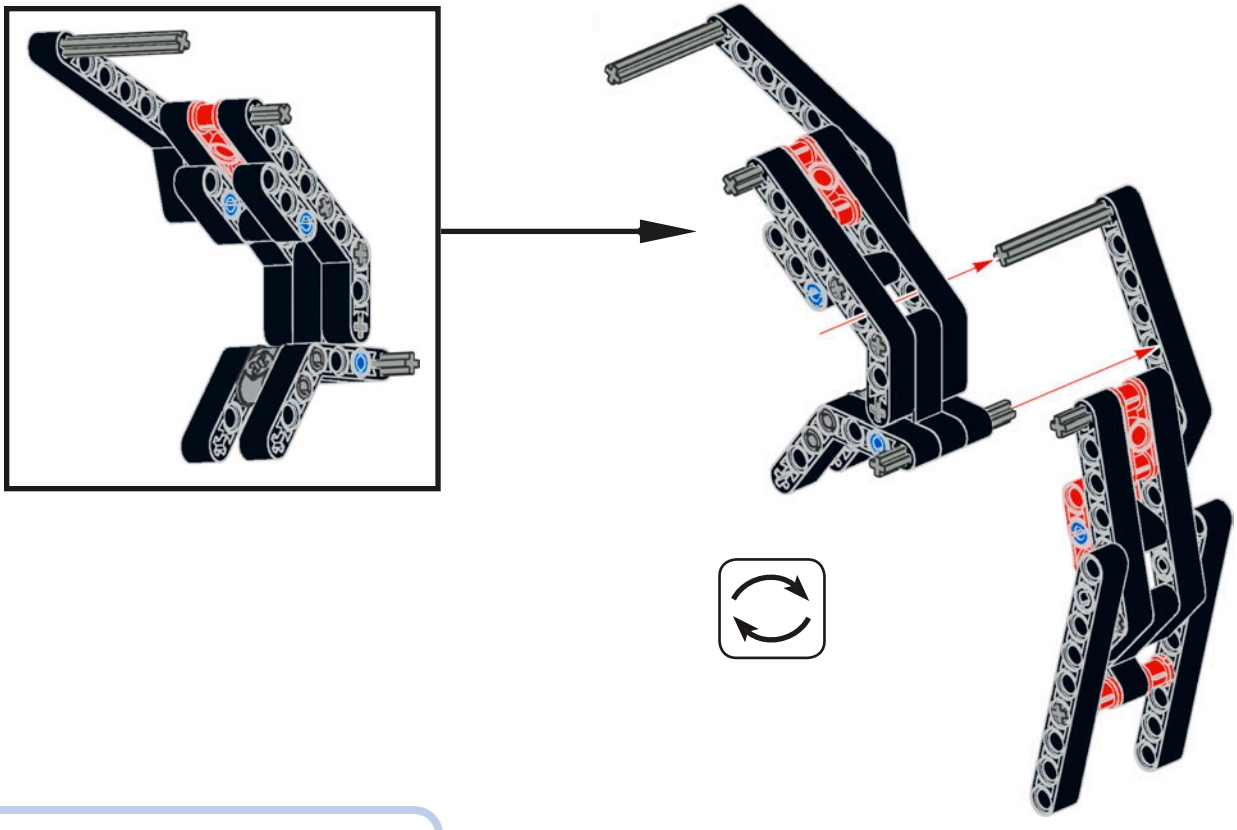
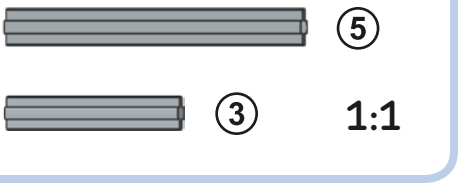


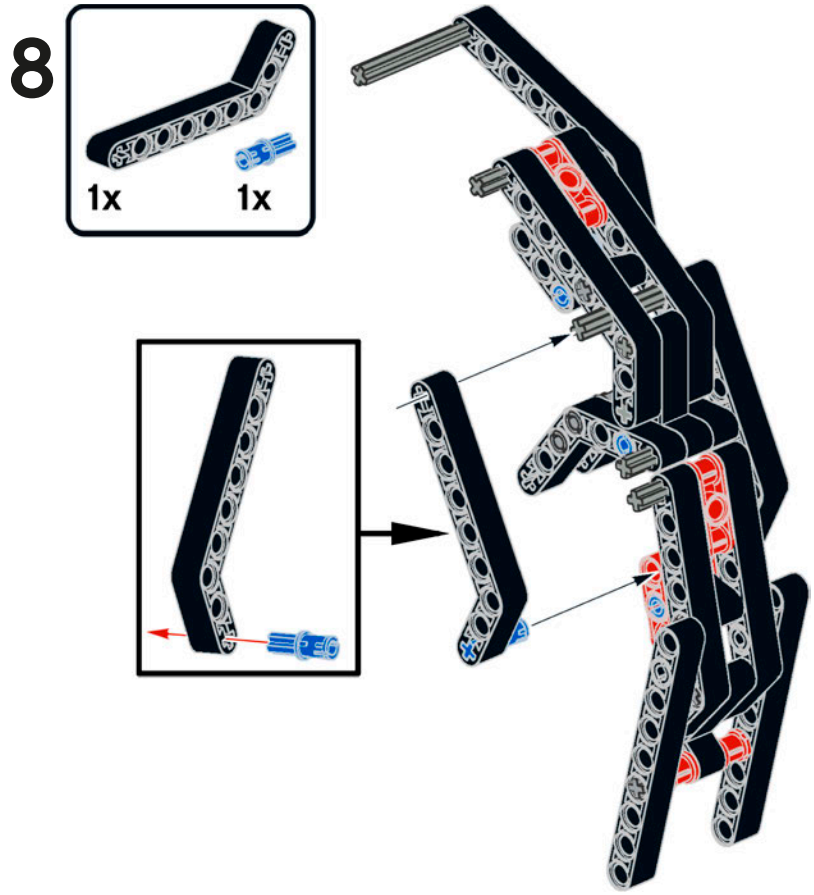


continuing the back shield assembly

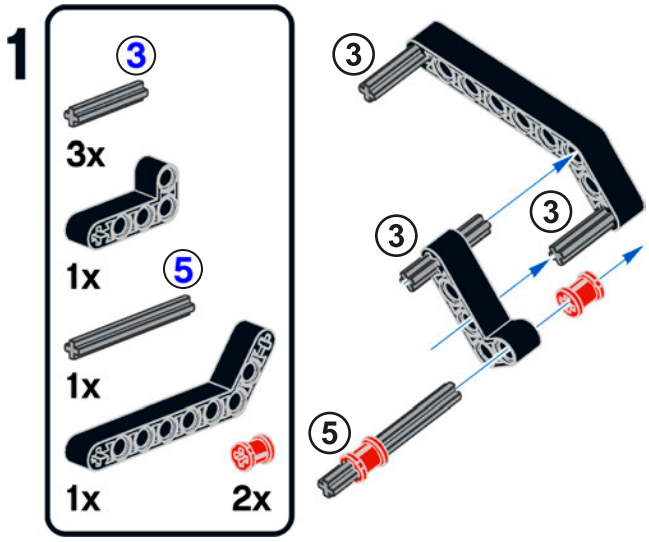
7

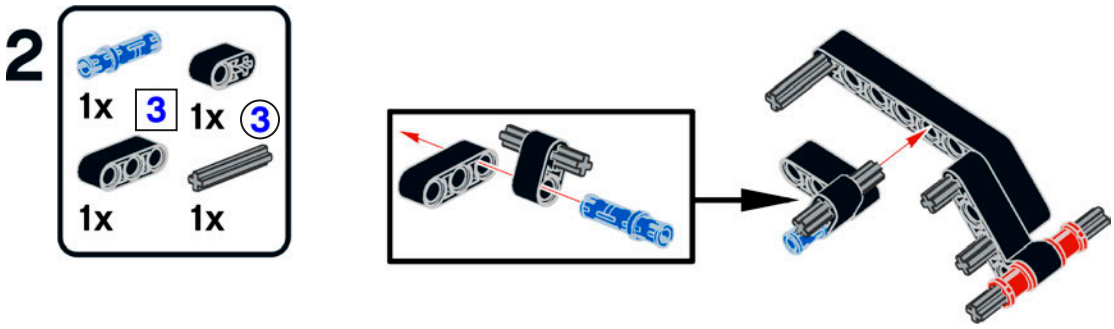


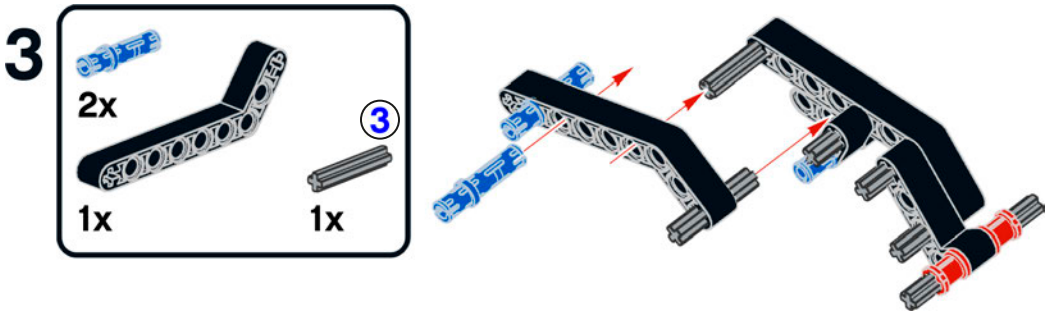


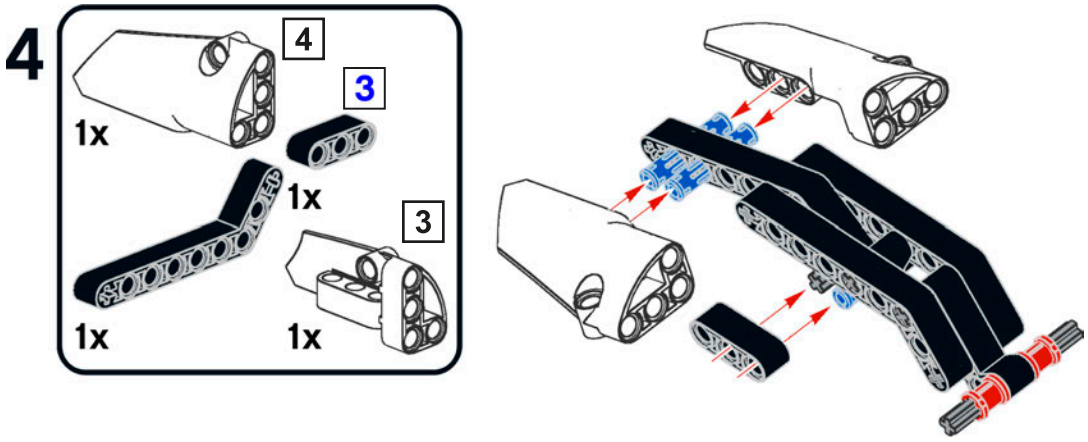


head subassembly



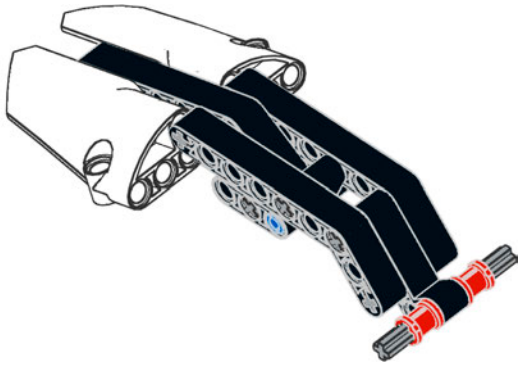

2
1x
3
1x
3
1x
1x


3
2x
3
1x
1x


4
4
3
1x
1x
3
1x
1x

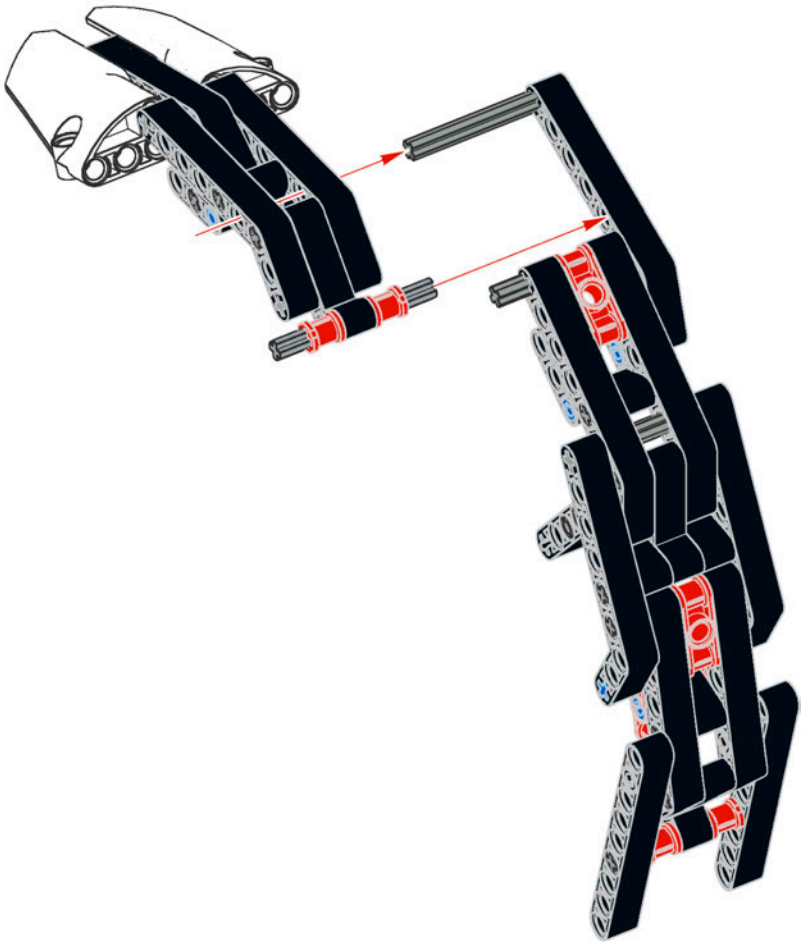

3
3
1:1

5



completing the back shield assembly

9



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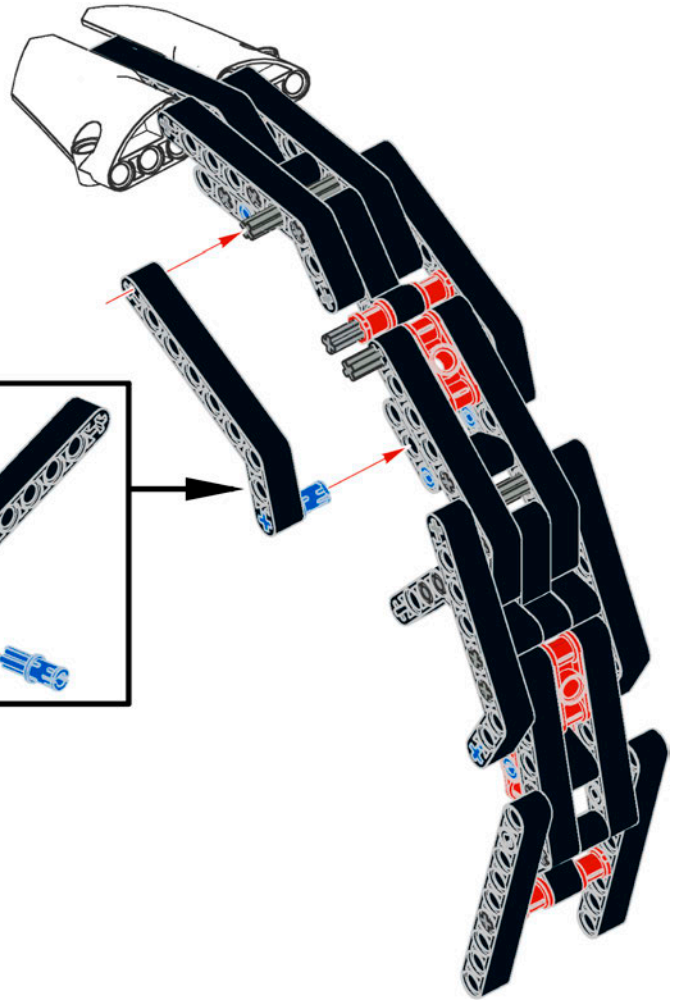
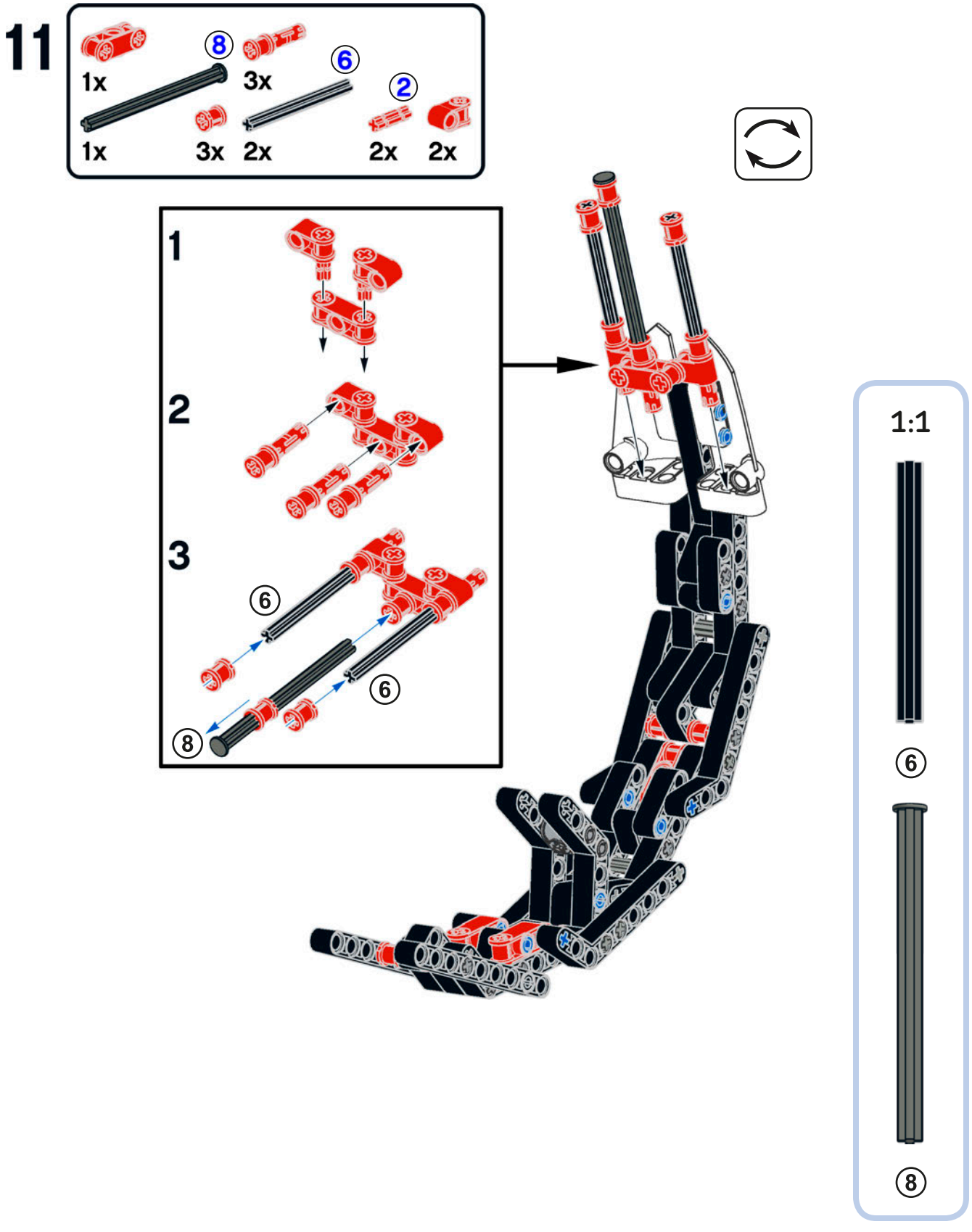
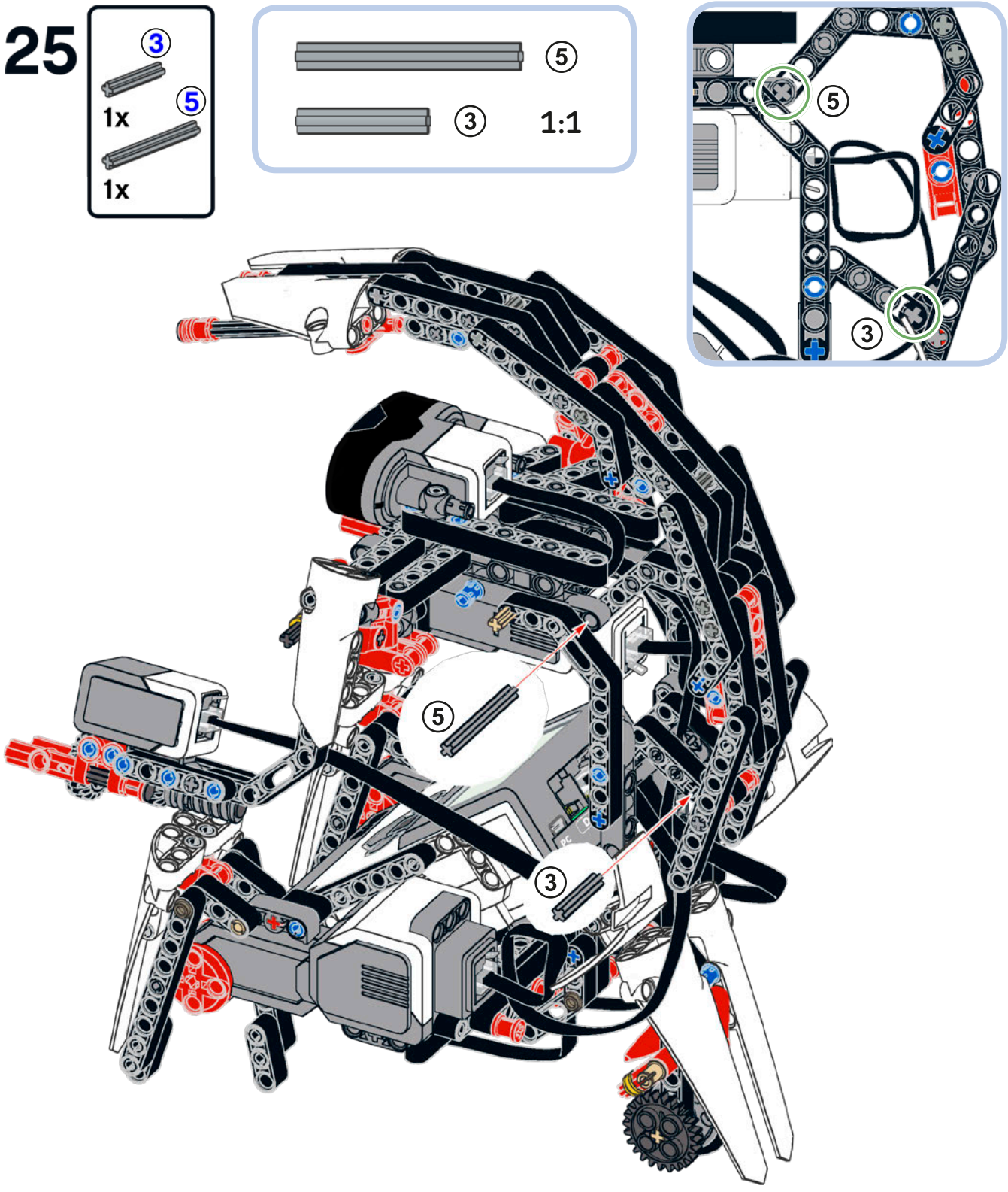


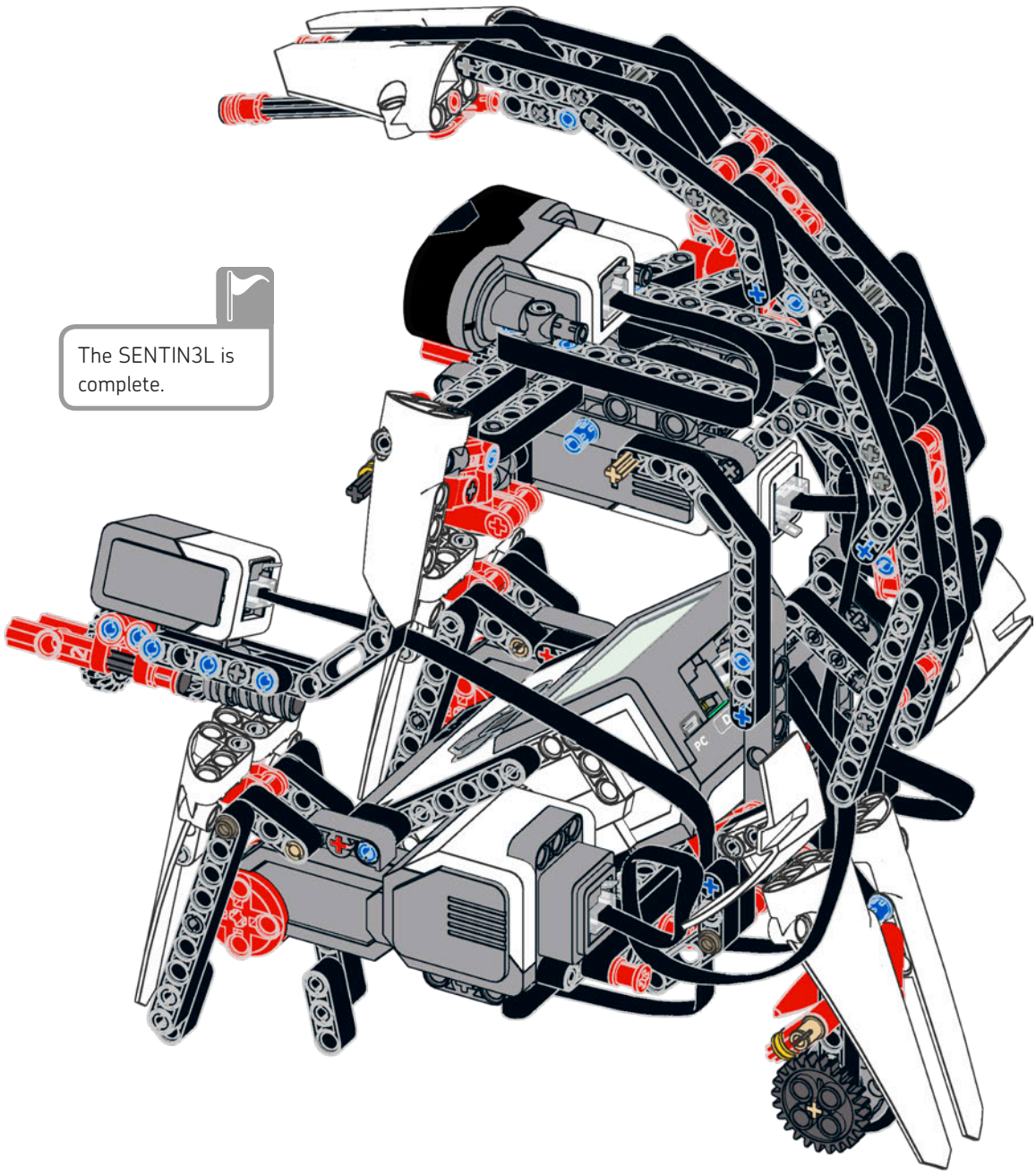
The curve of the shield is created by combining a series of these modules. Notice how I've combined different angular beams to make small angles.


11
8
6
2
1x
3x
1x
3x
2x
2x
2x
1
2
3
6
6
8
1:1
6
8

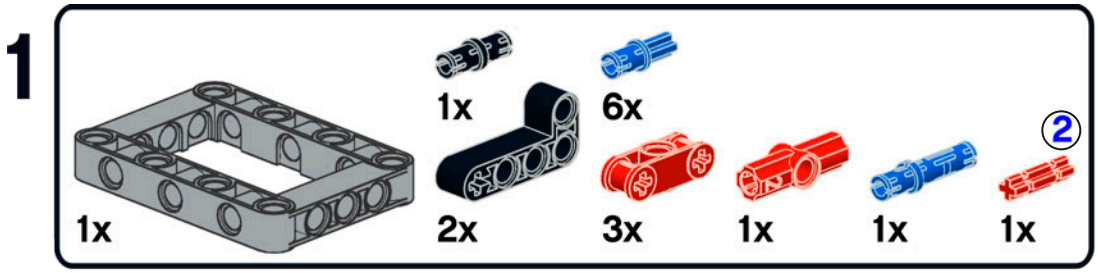
main assembly

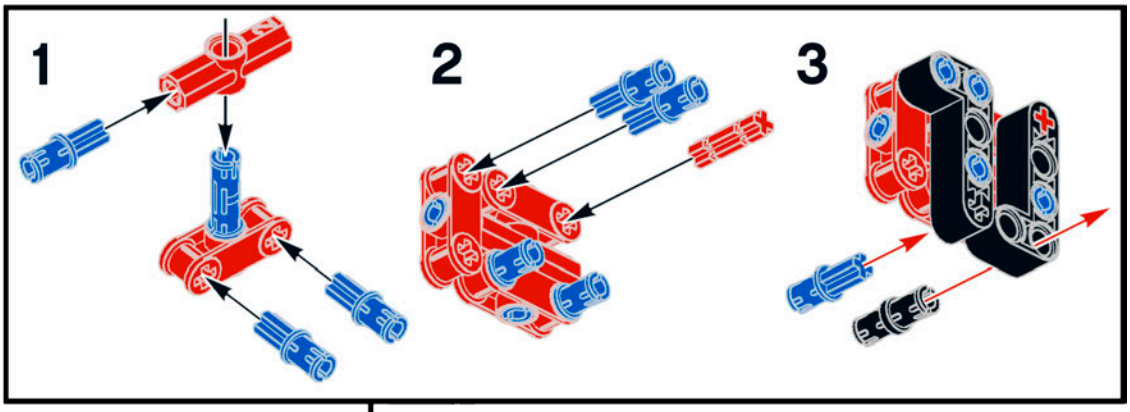


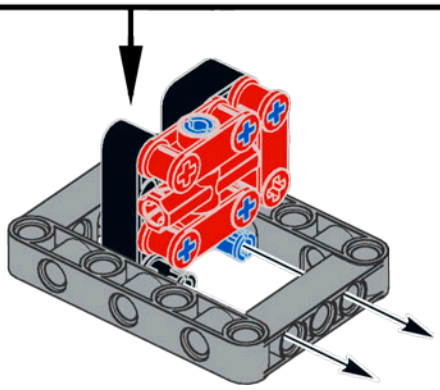
26



building the COLOR CUB3

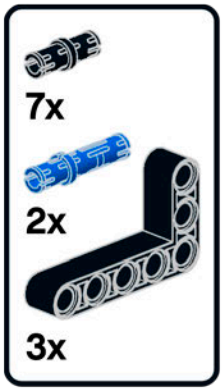


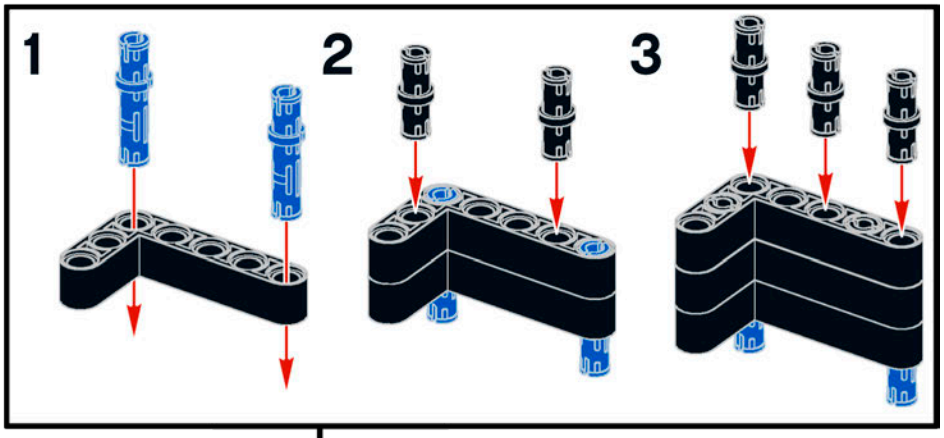


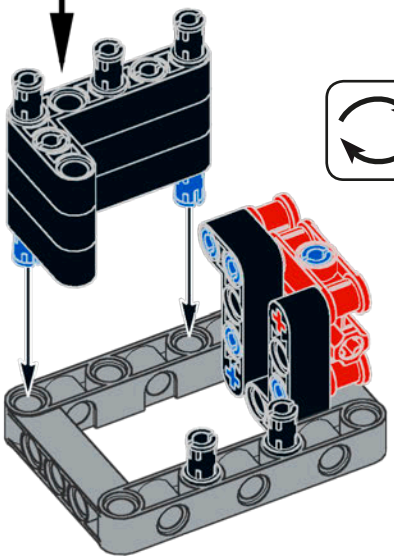


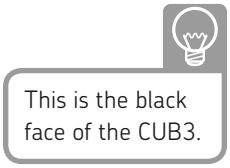
You will use the COLOR CUB3 to program sequences of actions by showing the colored sides to the SENTIN3L. This is the red face of the CUB3.

2



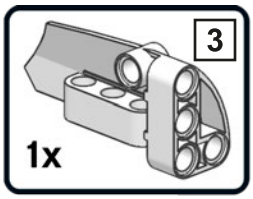


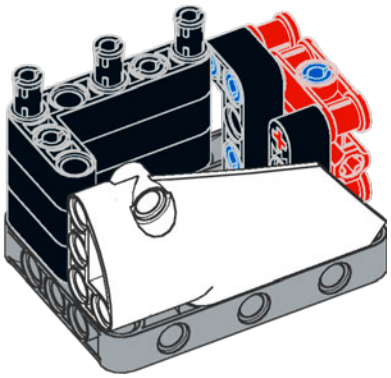


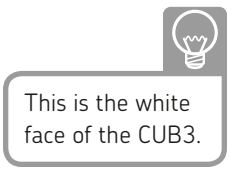


This is the black face of the CUB3.

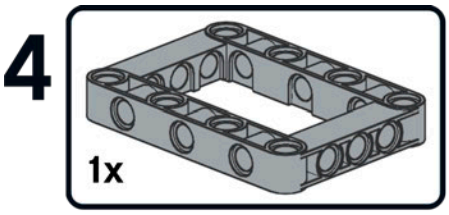
3

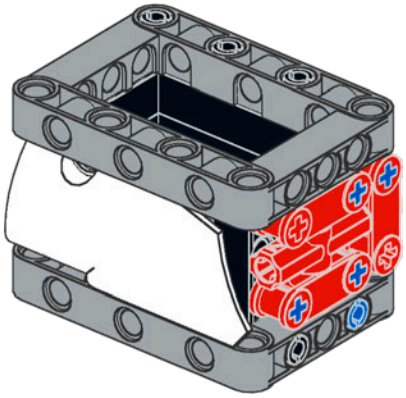






This is the white face of the CUB3.





The COLOR CUB3 is complete.

conclusion

In this chapter, you built the SENTIN3L, a security robot that walks on three legs and is equipped with twin blaster cannons. (Well, actually it has four legs and a back wheel, but it *looks* like it's walking on three legs.) Since the motor's continuous rotation is transformed into walking motion, there's no need for special sequences in the program (as with WATCHGOOZ3), so you can easily program and remotely control the SENTIN3L as you would a wheeled robot.

In the next chapter, you'll learn how to make programs that allow you to record, save, and replay simple sequences of actions.